Anaesthesia Essays on Its History

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Anaesthesia

Essays on Its History

Edited by
Joseph Rupreht, Marius Jan van Lieburg,
John Alfred Lee, Wilhelm Erdmann

Foreword by Thomas E. Keys

With 76 Figures and 28 Tables

Springer

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1st print 1985
2nd print 1998

ISBN-13:978-3-540-13255-4 e-ISBN-13:978-3-642-69636-7
DOI: 10.1007/978-3-642-69636-7

2119/3140-543210

Foreword to the second print

Following the success of the First International Symposium on the History of Modern Anaesthesia (1st ISHA), Rotterdam, May 1982, an international editorial board prepared majority of papers for print. Additional editing was performed by the Springer-Verlag staff. In 1985, two thousand volumes of the book *Anaesthesia - Essays on Its History* - were printed. Within two years the book was out of print and has become a much sought collector's item. The book became a popular source of scientific references.

The 1st ISHA was followed, at five-year intervals by memorable meetings in London, Atlanta and Hamburg. Interest in these meetings has increased so much that the 2001-Santiago de Compostela ISHA will be the first at a four-year interval. Each ISHA meeting was followed by printed proceedings. In parallel to the ISHA meetings historians of anaesthesia organized and present their papers at regular society meetings.

The ever-increasing wave of interest in the history of anaesthesia left many potential buyers of the "Essays-1985" empty-handed. The Department of Anaesthesia at the Erasmus University of Rotterdam responded to the demand for this book, the first of its kind, by sponsoring the second print. We are very appreciative to the Springer-Verlag Publishers for the expedient production of the second print.

Rotterdam, January 1998

Joseph Rupreht
Wilhelm Erdmann

Foreword to the first print

The zealousness displayed by the participants of the First International Symposium on the History of Modern Anaesthesia was most revealing. Over 120 papers were read and there were about 200 participants. Prof. Wilhelm Erdmann, Head and Chairman of the Department of Anaesthesiology at the Medical Faculty of the Erasmus University of Rotterdam, and the enthusiastic and hard-working Secretary of the Symposium, Dr. Jože Rupreht (Ljubljana-trained, in the Viennese medical tradition), merit the credit for the enduring success of this undertaking. As a Liberal Arts major, I especially enjoyed meeting many of the pioneers because of their emphasis on humanism.

Among the illustrious participants was Sir Robert Macintosh, who inspired Dr. Barbara Duncum to write an outstanding book on the history of anaesthesia. It is also of interest to note that Sir Robert was knighted for his accomplishments on anaesthesia – as was Sir Geoffrey Organe, later. Sir Robert established the Chair of Anaesthesia in Oxford, the first fully endowed chair of anaesthetics in the world. The accomplishments of women in anaesthesia must also be acknowledged. I am thinking especially of Prof. D.M.E. Vermeulen-Cranch of the University of Amsterdam, who gave her farewelloration, entitled "Process of Emancipation", in September 1983. She was the first professor of anaesthesiology in continental Europe, where the spirit of Erasmus of Rotterdam – a great humanist of the Renaissance – still prevails. Influenced by the same spirit, another participant in the Symposium, Prof. Selma Calmes, of the Department of Anaesthesiology at the University of California, Los Angeles, is working on a book showing the accomplishments of women anaesthesiologists, which should be most enlightening. After all, as mentioned in my book *The History of Surgical Anesthesia*, [1, p. 3] ... the first anesthesiologist probably was a woman, for the head of the primitive family was the Great Mother ... she was priestess and sorceress, and consequently was the founder of the healing art. When a primitive sick man could not relieve his pain he called on the priestess ...

Although one could go into much more detail about the many illustrious participants and their accomplishments, this is hardly necessary, as a reading of these excellent papers will attest. There are some omissions, of course, and it is regretted that the great achievements of Dr. John Snow, the first medically qualified anaes-

1 This small volume was frequently reprinted, and even the latest reprint edition (Robert Krieger, 1978) is again out of print. It is time for the newer generation to take over this exciting field. And many new books are in the making, such as those authored by Rod Calverly and William Beattie.

thesiologist, were not included. Perhaps the next symposium will have a paper on his many contributions. Even though his dates are not quite modern (1813–1858), his accomplishments were, especially his book *On Chloroform and Other Anaesthetics* (1858), the first comprehensive textbook on anaesthesia [2].

There has been a real renaissance of interest in the history of anaesthesia. Among those responsible for this rebirth, besides Dr. Rupreht and Dr. Erdmann, are Dr. Selma Calmes and Dr. Rod Calverley, now on the Board of the new American society, the Anesthesia History Association. It held its inaugural meeting in Atlanta, Georgia, during the annual meeting of the American Society of Anesthesiologists, on 9 October 1983. The meeting was well attended, and the evening was profitable and delightful.

Mention should also be made of the accomplishments of the nurse anaesthetists [3]. They are many in number, and generally they work under the direction of a physician-anaesthesiologist.

Although modern anaesthesia was America's first great medical discovery, it soon traversed the globe and found worldwide acceptance.

The British, for example, have made many coeval and historic contributions. Besides Dr. Duncum one thinks of Prof. T. Cecil Gray, who pioneered the British use of curare [4], and Dr. J. Alfred Lee, who was a pioneer in the use of spinal anaesthesia and is currently working on the fifth edition of a textbook on spinal analgesia [7]. Dr. Lee's latest (9th) edition of *A Synopsis of Anaesthesia* (1982), which he edited with his colleagues R.S. Atkinson and G.B. Rushman, is provocative in outlining the many duties of the modern anaesthesiologists [5]. It would appear that to practice adequately the anaesthesiologist needs a background in history, physiology, cardiology, biochemistry, physics and other learned disciplines relating to all branches of medicine. Space does not permit me to give details of the accomplishments of many other nationals, but a reading of the papers in this volume should be of benefit. These papers, besides outlining the important accomplishments of the pioneers – many of whom addressed the Symposium – attest to the past, present and future of this all-embracing interdisciplinary specialty.

Sir William Osler (1849–1919), whose collection of books and documents on anaesthesia are now housed in the Osler Library at McGill University, Montreal, will always be vividly remembered for his profound statements, his eponyms, his idealism and his interest in books and people. His philosophy is well defined in his last and finest lecture "The Old Humanities and the New Science" [6], delivered in 1919 when Sir William served as President of the Classical Association, an organization of British scholars which was established in 1904 with this object: "To promote the development and maintain the well-being of classical studies and among other things to encourage investigation and call attention to new discoveries." Harvey Cushing mentioned in the Introduction:

> In preparation for his lecture he arranged an exhibit illustrating the important part Oxford had once played in science and natural philosophy in days antedating the Royal Society ... He exhibited from his own collection ... those volumes which constituted ... the outstanding classics in Science and Medicine .... He regarded these books as instruments for the advancement of knowledge ...

Osler concluded the paper with a statement: "To have lived right through an epoch, matched only by two in the story of the race, to have shared in its long struggle, to have witnessed its final victory ... to have done this is a wonderful privilege."

In many ways Osler's endeavours are a parallel of the Rotterdam Symposium, which brought together scholars from the world of anaesthesiology. Osler would have rejoiced in this rebirth of the humanities and their influence on the current practice of anaesthesiology. Moreover, at the Rotterdam Symposium the idea was brought forward by many that a monument entitled "The Conquest of Pain by Anaesthesia" should be constructed to give singular testimony to the great achievement of the human race in our era. We all may hope that this project will soon be realized and will also serve as a permanent reminder of the first international meeting on anaesthesia history. However, these historical essays on anaesthesia may themselves have an impact on the future of anaesthesiology. Let us enjoy the fruits of past accomplishments in this now learned profession and look ahead to 1987 when we shall again assemble.

Thomas E. Keys

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Preface

We have not attempted to make each contribution a strictly uniform presentation. Each paper is written in an individual style which reflects the author's feelings and ideas, and we have decided to make only the most necessary minor editorial alterations. The contents and messages of this volume, its philosophy and love of medicine will thus not be an editorial treatise on significant events of the past in anaesthesiology. In their own words, expressing their own thoughts, the writers describe some of the significant events of the past, or the period they themselves have lived through, and some of the lessons which are to be learnt from a study of the history of anaesthesia.

The consideration of bringing important historical data to the modern reader has played a secondary role in moulding the many contributions into a book. Primarily, we wished to convey the outstanding achievements of the past: the concern to ease suffering and the modesty of some of the notable workers who have influenced, taught and guided us. However, there remains much to be clarified about the developments in anaesthesia and especially about the process in which the profession of anaesthesiologists came into being. Much information is given on the question how; the question why the process has developed as recorded by the contributors to this section is left to the future historians, who will pay attention to the fascinating story of anaesthesiology.

The recent Meeting of the First International Symposium on the History of Modern Anaesthesia, held in Rotterdam in the spring of 1982, was a memorable success and well served its major purpose. While it was being organized the nestors of anaesthesia gave support and encouragement in trying to put on record the significant events and the feelings of those who happened to be behind the scenes when the changes were taking place, and we think that this goal has, in a large degree, been achieved. The Symposium also became a milestone in the development of the specialty. By looking back one can better understand the present situation and decide what should be done for the specialty in the future.

The Symposium was a forerunner of the vigorous interest which exists in the history of anaesthesia. It has become a catalysing event, and as a result several organizations have been formed, worldwide, for the study and teaching of this aspect of our specialty. This interest shows that the younger generation of anaesthetists is proving worthy of the constributions of their predecessors. It may now be firmly hoped that through the study of things past will emerge fresh initiative in research, and that the humanistic and historical message passed down to us will serve as standards and judgements of Things Future in Anaesthesiology.

The Rotterdam Symposium also acted as a meeting place for many colleagues, teachers, friends and pupils. Ideas were freely exchanged; there were music, intellectual discussion and a most enjoyable social programme, with arrangements for seeing some of the many delightful local beauty spots. Thanks to the uncommon intellectual vigour and emotional involvement of the participants, the Symposium was given the highest possible compliment by being called "the happiest meeting ever".

The Editors wish to acknowledge their gratitude to the publishers, Springer-Verlag, for the assistance given during the preparation of the present volume.

Rotterdam, May 1985

Joseph Rupreht
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1 Introductory Essay

1.1 Anaesthesiology: Its Origins and Its Mission

J. Rupreht and Th. E. Keys

Sir William Osler's poetical rhetoric is powerful. In his address to the Royal Society of Medicine on 15 May, 1918, he stressed his view that it is not the very first discoverer who is worthy of a credit for discovery but the one who brought it into practice so that the knowledge could be understood, learned, taught and applied by others [1]. This view has been generally adopted, especially since in the field of discovery it is usually impossible to say who really was the first [2].

We have achieved the state of knowledge that enables us now with certainty to answer many questions concerning the roots of anaesthesia. It is also well known that more and possibly different details will be dug from the past with assiduous study. The necessity of early and planned collecting of data which some day may be of outmost historical importance has been recognized. The by-now famous project "Living History" at the Wood-Library Museum of the American Society of Anesthesiologists at Chicago can serve as an example. Most scholars have also acknowledged that interpretation of historical facts can be of great importance for the picture we have about things past. It is being realized that many a discovery occurred simultaneously and independently at different places or even in different periods.

A difficult problem to resolve, however, is the question why anaesthesia, as we know it now, developed in the last 150 years – not earlier and not later. The drugs and pain had been pre-existent. We know that ancient writers knew how to alleviate pain [2] but that this knowledge was forgotten for many long dark centuries. An empirical answer to this formidable problem was given by Prof. W.W. Mushin from Cardiff to one of the present authors in a video-interview for the Audiovisual Centre of the Erasmus University Rotterdam [3], which now is a part of the "Living History" project of the Wood-Library Museum at Chicago. According to Professor Mushin, the answer lies in the fact that the general cultural atmosphere of the civilized countries had to be ready for the acceptance of relief of pain and only then could anaesthesia be developed. His analysis on the philosophical backgrounds of the early days of anaesthesia leaves, however, ample room for further pondering about this problem. It is included elsewhere in this volume (see Chap. 6. 11).

The history of modern anaesthesia must be re-written, taking into account the fact that all details of developments will never be known, and that it is the change in the ethical attitude to the alleviation of pain which played a major role and not the discoveries as such. The term "modern anaesthesia" is somehow vague (R. R. Macintosh, unpublished letter). Indeed, what appeared to be "Modern Trends in Anaesthesia" [4] in 1958 is by now a rewarding source of historical data. The idea of

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including in the name of the symposium on the history of anaesthesia the adjective "modern" had two backgrounds. First, what we have now may appropriately be called "modern". Second, and most important, many of the pioneers who established our specialty as we perceive it now are still among us. They, when gathered, could tell us about past developments in the then modern anaesthesia. By carefully listening to their reminiscences, we would be able to capture some of the zest of their time and the understand personal inclinations and motives that guided their creative work in a new medical field.

There are generally valid ethical and moral principles which change little with the passage of time. Of these, care and concern for the patient's wellbeing is on of the pillars of medicine – indeed of cultured civilization itself. By studying the inclinations and actions of the pioneers in anaesthesiology it must then be possible to trace the development of the humanistic attitudes in medicine as we know them now. Insight into the roots of our moral background – the concern for the patient – will in turn guarantee a correct approach to further development of our specialty along the lines of humanistic visionaries.

Insights into the problems of human wellbeing are also dependent on technical progress. It is important, however, never to lose sight of the fact that it is the idea and the attitude of concern for the sick which is the real medicine, irrespective of specialized subdivisions, and not the timely findings in the realm of auxiliary technical or methodical means. Success in modern anaesthesiology can easily lead to oversimplifications, and one must always interpret and apply the knowledge with due modesty. Recently, in the study of pain, misleading suppositions have been guiding the research away from the ethical lines that it should follow. Science was guided more by the question of what pain is, than by that of how to handle pain. Benedetti rightly stressed that a simple electrical event like an evoked cerebral potential (ECP) cannot serve as a measure of pain in man [5]. Indeed, an anaesthetist knows that there is more to pain than that which can be measured. A patient's pain distress is only grossly related to the pain stimulus. Pain remains an individual and largely incommunicable state of distressed existence.

Attitudes to Pain

In analysing the attitudes towards the suffering caused by pain and its alleviation we must also think of the deep-rooted feeling of the primordial sin for which one must pay in suffering. What else could this be than the subconscious feeling that in being "aware" of our own existence we are aware and afraid of its risks – the greatest of them being death. This feeling was aptly used and misused by many philosophical and religious-thinking models. Humanists in the Renaissance started to doubt the conviction of the Dark Ages that suffering and pain may have an elevated moral value [6]. In liberating man to think freely they also exposed him to awareness of pain, the ultimate of which is the extinction of life itself – death [7]. However, they also enabled the human race to make a conscious search for treatment of corporeal or spiritual suffering. They pointed towards the era in which the primordial sin should no longer be outweighed by extinction; in other words, when the unique freedom of "being human and aware" will not be cursed by the wretched fear of foreboding extinction.

The humanist Desiderius Erasmus of Rotterdam was one of the most outspoken protagonists of the changes in thinking that took place towards the end of the Renaissance [8]. After a stormy career he became the greatest scholar of his time. Like the youth of today, Erasmus lived during a period of intense political, intellectual and religious change. Against this background, Erasmus was able to develop and sustain a profound philosophy of tolerance and pacifism. There has always been a struggle between humanism and scholasticism. Scholasticism during the fifteenth century and earlier was preoccupied with philology. Texts were rarely scrutinized for authenticity. The *Canon of Avicenna* had been used as the basic textbook in the schools of medicine of all the universities of Europe since about 1200. The translations of this and other medical authorities were inaccurate, and medicine suffered as a consequence. The humanists revived the spirit of criticism and attempted to get at the true meanings of the authors. Humanists' objections to the medieval pedagogy were many. It was the humanists who brought about the change of education from reading by rote, say, the works of Galen to teaching outside of the classroom through informal lectures in such subjects as botany and astronomy. Thus in medicine there was a return to the thinking of Hippocrates, who lectured under the famous plane tree at Cos. It was a revolt against the past and the logicotheological systems of the Middle Ages. Knowledge of the classics, perfect command of Latin, appreciation of the wisdom of the ancients, poetry, literature, rhetoric, history and law were some of the weapons which humanism used against the "scholasticism" of the time. This was to be one of the major trends of this period. Erasmus was the most influential of the humanists, although there were others such as Rabelais, Jan Hus and Tomasso Parentucelli, who became Pope Nicolas V and the founder of the Vatican Library. Several centuries had to pass, however, before the changes in thinking also changed the attitudes in medicine. In the catholic regions, the illustrious doctor Johannes Antonius Scopoli deliberately broke with the old habit of copying unproved "facts" from old books [9]. He widely advocated the exploration of things "without any hypothesis and fallacious aid of books with one's own eyes as if nobody had yet written about them" [10]. Fortunately, this great physician received moral recognition by the ingenious Linnaeus [11] and has since been remembered by anaesthetists by the name of an alkaloid derived from the plant called after him: scopolamine [12]. The experimental approach in medicine was not easily adopted. One only has to remember the anecdotal troubles that Paracelsus had to overcome. But why did Paracelsus the revolutionary never tackle the problem of pain? In a vast part of the then civilized world medicine was not yet ripe for practising the humanistic ideals. The philosophical attitudes of the Dark Ages were hard to erradicate. Even Baudelaire, at the second half of the nineteenth century, while discussing the loss of free will under hashish as a moral problem, questioned the benefit of anaesthesia: *"Malgré les admirables services qu'ont rendus l'éther et le chloroforme, il me semble qu'au point de vue de la philosophie spiritualiste la même flétrissure morale s'applique à toutes les inventions modernes qui tendent a diminuer la liberté humaine et l'indispensable douleur."* [In spite of the admirable services of ether and chloroform, in my view and seen trough the eyes of spiritual philosophy, the same moral problem exists with all modern inventions which tend to diminish human liberty and indispensable suffering. (Translation by authors.)] Following this recapitulation of the attitudes to pain that held strong in France in Beaudelaire's time, he then sarcastically tells a story of a knightly

French general who died during an operation "in spite of chloroform" [13]. Anecdotally, although devilish in the doubt he casts on the essential principle of taking away consciousness during an operation, he described precisely the various pharmacological effects of several drugs. Such a mixture of attitudes, knowledge and emotion weighed heavy on the Continent and formed a major obstacle in the struggle for the conquest of pain. Attitudes often were based on forbearance of pain, thus holding back the development of experimental or empirical knowledge about pain alleviation.

The situation was very different in the Anglo-Saxon countries. In Great Britain Queen Victoria broke with the traditional view of giving birth in pain. She trusted her wellbeing to a pragmatically established anaesthetist with empirically perfected techniques, in spite of the moral upheaval which this caused among the church authorities. August Bier's story is similar: He punctured the liquor space and introduced local anaesthetic. At the cost of two heavy headaches (his and his assistant's) he established a great venue for the relief of surgical pain.

However, it was not in Great Britain that Sir Humphrey Davy's epochal observations on the destrucion of surgical pain [14], were brought into the service of suffering man. Forty-seven years after the publication of Davy's research work, a new brave American put it into practice. It was in America that the French Revolution caused changes greater even than in France. The search for new methods and their application was basically essential for the survival of the young continent. So it is the American melting pot, the whole continent with its vast human and natural resources and its in-built territory, which may proudly bear the banner of promotion of anaesthesia. In less than a hundred years, America became the leader in the field of anaesthesia. Attitudes slowly changed in most other countries, and the new specialty was introduced into medicine. It must be mentioned, however, that for unknown reasons some civilized nations have still not fully introduced the benefits of anaesthesia, such as painrelief in labour. Many medical schools have not realized that a special curriculum in anaesthesia has to be given to undergraduate students. Numerically, anaesthesiologists are becoming nearly the biggest medical specialty, but the introduction of lecturing on the subject is decreasing.

In anaesthesiology, great achievements have taken place in less than a century, and the rate of development of the last 40 years has scarcely before been recorded in medicine. In 1935, when Sir Robert Macintosh was visiting Professor Bauer's department at Heidelberg, students laughed "long and loud" at hearing that there were doctors in England who administered only anaesthetics (R.R. Macintosh, unpublished letters), and until the end of World War II there was not one single specialist anaesthetist in the whole of continental Europe. Even in 1950, as the great German doctor H. Killian reports (unpublished letter), a committee of German surgeons concluded that "there is no urgent need for training of physicians in anaesthesia". Nowadays, there are thousands in the German Federal Republic alone.

While surveying the great work that has been done in anaesthesia and still having among us many pionieers of the specialty who can put achievements into the correct time perspective, one cannot but feel confident about the future of the specialty. Anaesthesia has clearly helped medicine in its search for a "humanistic look" [15]. The intellectual and moral visions of the great Renaissance humanists are being translated into the everyday life of a doctor.

It is becoming clear that the mission of anaesthesia is not purely technical, but humanistic. It is therefore very fortunate that the first international meeting on the history and destination ot this specialty was held at Rotterdam, the city coupled with the name of the greatest of humanists, Desiderius Erasmus. It was in the universal spirit of Erasmus and his humanist contemporaries that the gathering was celebrated. This Symposium testified that in order to improve anaesthesia there must be a balance achieved between education, practice and research. With these conditions fulfilled, anaesthesia will be able to realize its humanistic mission.

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2 Pioneers in Anaesthesia

2.1 Foreword

W. Erdmann

W. Erdmann

Any new speciality attracts pioneers at only one time during its development. Anaesthesia has only recently been acknowledged, throughout the world, as a recognised speciality in its own right. In its short history, little more than 100 years, its pioneers have leveled the jungle of ignorance to build a road on which our generation can proceed. However, when considering recent developments in medicine, we can reasonably conclude that modern surgery was able to progress only in light of the advancements in anaesthesia, with the related achievements of more advanced and safer anaesthetic methods. This development took place in the second half of the last century following the outstanding progress in the field of anaesthesia. Morton and Snow (who by the way was the first full-time anaesthetist) are only a few among a large group of physicians contributing to this advancement at that time.

Meanwhile, new methods have evolved, and higher standards in anaesthesia techniques and advances in pharmacology have been achieved. Great minds that have contributed to the achievements of modern anaesthesia have to be discussed on the merits of their contribution. The persons vanish but their work remains.

Artifical Anaesthesia and Anaesthetics is the title of a full-sized textbook of anaesthesia which was published in 1881 by Henry U. Lyman in the Woods Library of standard medical authors (William Wood & Company, New York, 1881). The first chapter of this textbook is entitled "History of Anaesthesia" and contains a full description of the developments with special emphasis on the 17th, 18th and 19th centuries. Pioneers of modern anaesthesia in this period, most of them still living when the book was written, were represented through description of their methods. The relative importance of their individual contributions to the progess of anaesthesia was evaluated and credited by their peers of that time. These great men included Perrin, Snow, Simpson, Sanson, Aristie, Turnbull, Kappeler and Rottenstein. However, others not recognized at that time have since won acclaim. For example, Charles Waterton (1782–1865), Francis Sibson (1814–1876) and Joseph T. Clover (1825–1882), were not given an honourable mention because, at that time, their contributions were considered to be negligible.

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A typical case is that of Charles Waterton. Waterton demonstrated as early as 1814, in animal experiments (donkeys), the muscle relaxing properties of Curare which, as he discovered, led to death if this was not prevented by prolonged artificial ventilation performed with balloons. Curare was not introduced into clinical practice until 1942, creating a gap between discovery and clinical application of nearly 150 years. Curarisation is a relatively young development in medical practice and, even today, no anaesthetist would consider functioning without the availability of muscle relaxants. Thus Waterton, 150 years after his discovery, has been re-evaluated and is currently included amongst other established pioneers of modern anaesthesia.

Similarly, little has been written in medical history literature about the lives of Francis Gibson and Joseph T. Clover, both of whom have made important contributions. Ralph M. Waters is recognised as having had a great influence on modern anaesthesia. He was an outstanding teacher, as well as a scientist, and not only created a specialised anaesthesia school, but also made an impact throughout Europe after the first generation of Swedish anaesthetists had passed through his school: Torsten Gordh, Olle Friberg, Eric Nilsson and Carl-Gustav Dhunér. Guedel, Apgar and Lundy are without doubt true nestors in modern anaesthesia. Their personalities and contributions are all of a recent nature as they are either still living or have only recently died. Ritsema van Eck was an initiator and active promoter of the World Federation of Anaesthesiologists. Ritsema van Eck was Professor and Chairman in the small but historical University of Groningen. His Asian-Dutch background made him the "right person at the right time" to achieve this combination of world-wide mutual collaboration. It is interesting to note that news concerning anaesthesia as a speciality came to Australia in early 1847 and the new methods were already being applied two months later, in June 1847. Since those times, Australia has developed her own sophisticated methods and anaesthesia has remained there, to this day, a highly appreciated speciality.

The following section "Pioneers of Anaesthesia" begins by presenting the great and leading figures in modern anaesthesia over the last 60 years. Sir Ivan Magill, who is still living, has had an influence on all generations of anaesthesiologists of this century. The section ends with another great person from these times, Henning Ruben, who speaks for himself and describes from his own experience how he became involved in the development of anaesthesia and resuscitation equipment.

Many of the pioneers described in this book are still amongst us. Some are still actively nurturing their creations. With their help we shall be able to look back on the early years of this century when the "speciality" of anaesthesia was no more than wishful thinking, a dream without reality in most parts of the world. *"Das Abenteuer der Narkose"* (Killian) – "The Adventure of Anaesthesia" – is thus presented to us. Just as a nation proud of its history boldly faces the future, so a progressive speciality needs a sound knowledge and appreciation of its proud past.

2.2 Sir Ivan Magill's Contribution to Anaesthesia

J.B. Bowes and J.S.M. Zorab

Magill's name is attached to a variety of anaesthetic apparatus such as tracheal tubes and anaesthetic circuits so that his name is one of the few household names in a specialty which is not noted for publicity. Such a widespread use of Ivan Magill's name implies a life of pioneering achievement at a time when a new specialty was undergoing profound change. For the earlier details of Ivan Magill's life we are indebted to the account of his life by Stanley Rowbotham [1], who was Magill's closest colleague for many of those early formative years. Ivan Magill was born at Larne, Co. Antrim on 23 July 1888. He was educated at Larne Grammar School. Larne is principally known as the Irish port on the shortest sea crossing of the Irish Sea. He travelled a few miles to the south of Larne for his university education in Belfast. At this time he was a rugby forward, was keen on tennis and represented his university as a heavyweight boxer [2]. Although in later years Magill did not return to his native land for anything except the briefest of visits, this land of his birth and childhood provided him with two legacies, namely the nickname of "Paddy", which has always been the affectionate term bestowed by the rest of the United Kingdom upon an Irishman, and his unmistakeable Irish accent.

In 1913, after qualification in Belfast, he made the very short trip to Liverpool to take up junior posts. Liverpool is not only geographically close to Belfast but also has a large Irish population, which must have made the city seem very homely to the young doctor. His career was interrupted by the start of World War I. In Rowbotham's view Magill had been showing a decided predilection for surgery, and but for the war it is unlikely that his inclinations would have been towards anaesthesia [1]. During these war years Ivan Magill saw very active service in France; he served in the rank of Captain and during much of his service he acted as Medical Officer in charge of troops. Peter Randall pointed out that it was at this time that Magill developed a taste for Burma Cheroots which were described as being remarkably black and ferocious and soon became his trademark [2].

When the war was over Magill spent a brief spell at the Barnet Hospital [1], and early in 1919 he was posted to the Queen's Hospital for Facial and Jaw Injuries ad Sidcup, to the south of London. In Magill's words this posting was "more by chance than by choice", but it was to prove crucial to Magill in particular and to anaesthesia in general [3].

His former colleague Stanley Rowbotham describes the situation at Sidcup, where no previous anaesthetic experience would have been adequate to cope easily with the problems which the newly developing art of plastic surgery presented at that time.

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Most of the anaesthetists at Sidcup were non-resident civilians, whilst the newly posted officers were resident and so were plunged into the task of administering some of the most difficult and hazardous anaesthetics that one could meet. When Magill joined the Hospital at Sidcup the usual anaesthetic for plastic and jaw operations was rectal oil ether. As Rowbotham pointed out, this was far from being a satisfactory method [1]: The patient who was too light of anaesthesia at the start often became very deep during the operation; after return to the ward the recovery was prolonged, sometimes as long as 24 h. The maintenance of the airway was difficult, and the efforts to keep the airway patent with oral airways and Silk's nasal tubes often severely hampered the surgeon. Intratracheal insufflation was at first performed with the apparatus designed by Kelly: An electric motor was used to drive air through ether which was later heated by passing through a coil in a warm water bath [4, p. 181]. The anaesthetic agents were then delivered to the patient via a 22 gauge (5 mm inside diameter) catheter, which was inserted into the trachea as far as the carina. This apparatus was later modified by Shipway, who was very certain of the advantages of warming the ether which was used for anaesthesia [4, p. 183]. The insufflation pressure in the catheter was maintained at between 10 and 30 mm Hg, sufficient to inflate the lungs and to maintain efficient oxygenation of the blood. However, if the intrathoracic pressure was too large, then cyanosis of the lung ensued; this was treated by disconnecting the tube from the pressure bottle for 2 s [4, p. 179]. The uncertain depth of anaesthesia, the possibility of the patient's condition deteriorating as a result of Valsalva manoeuvre from the intrathoracic pressure, the various fire hazards in the presence of ether and lastly the mixture of blood and ether vapour which was blown out through the mouth must have sorely tried both surgical and anaesthetic patience. In order to prevent some of the excess of vapours and the foaming blood blowing into the surgeon's face a second catheter was passed. With the second tube free expiration could occur and the pharynx could be packed with gauze to protect the surgeon from the ether-laden expiration or from a spray of blood [5].

That Magill accepted the situation which existed at that time is shown by his first paper, which describes the now famous forceps which were initially designed for the passage of the insufflating catheter. Magill's initial acceptance of these methods is also shown in the classic paper written with Rowbotham in which the details of this insufflation technique are described [6]. However, Magill was soon to show his practical engineering bent by various modifications to the ether insufflation apparatus. Two sources of pressure were introduced: a hand bellows to force the ether through the drip feed and a foot pump to force air into the system, where it is heated in a double chamber by either hot water or an electric light bulb [7]. As with previous apparatus Magill's vaporizer contained a pressure manometer, thermometer and some form of safety valve. The main change in the apparatus which he described 2 years later was to accomodate the use of nitrous oxide [8]. Nitrous oxide and oxygen were measured by the depression of a water level in a glass tube for the nitrous oxide and by a bubble flow meter for oxygen so that it was possible to estimate the percentage of oxygen in the inspired mixture; the example cited was 10% oxygen in the inspired mixture. Although there was an ether vaporization chamber in this 1923 apparatus it was much less sophisticated than that of the 1921 apparatus so that it is not surprising that the later modification contains the "fusion into one composite unit of an endotracheal ether insufflation apparatus and a nitrous oxide and oxygen apparatus". A further refinement was made to the ether vaporization in that it now took place in a dome-shaped chamber which was placed high in the apparatus so that it was visible from all angles. There was also the facility to mix chloroform with the inspired gas [9].

So far there has been no real justification for the fact that Magill is a household name, known even outside anaesthetic circles. Up to this point he had been a first-class clinical anaesthetist coping with very difficult cases and modifying the rather crude apparatus which had not yet been standardized. It is typical that the next step of anaesthetic evolution which was fostered by Magill was occasioned by the surgical necessity of the anaesthetist having to avoid the sterile field of the operation site. There was also the consideration for a particular patient, a 27-year-old female, who had had previous unfortunate experiences with both ether and chloroform and so had requested that only nitrous oxide should be used. Few anaesthetits of such eminence would have shown the willingness to be as adaptable as Magill, who set out to use nitrous oxide. He cut off a piece of rubber tube which was much wider in calibre than the previously used intracheal catheters and so enabled a to-and-fro ventilation to take place. Although the paper which he had written with Rowbotham had foreshadowed this technique of "to-and-fro" ventilation, the fact that there had not been a sudden change to this technique shows that the older technique of a double catheter through the cords with the pack in the nasopharynx was proving moderately satisfactory. Magill outlines the advantages and disadvantages of this to-and-fro type of ventilation with a wide-bored endotracheal tube. The disadvantages he cites are the necessity for complicated apparatus and the certain amount of delay before the operation can begin: "Both these factors chiefly arise in private practice". There is a small confusion of nomenclature in that Magill used the term "intratracheal" to describe intubation with a narrow-bored catheter in the trachea and "endotracheal" when the tube was of wide bore and the flow was "to-and-fro". Nowadays, International Standards would prefer use of the term "tracheal" intubation.

Magill became very adept at "blind" nasotracheal intubation. Part of this skill was due to practical technique and the correct positioning of the head in slight extension (later to be known as "sniffing the morning air"), but doubtless intubation was also helped by his considerable strength [3]. At his 90th birthday celebration in 1978, which was held at the Royal Society of Medicine, Magill derived considerable amusement from the young anaesthetics who were crowding around him palpating his still considerable biceps muscles. Such muscles were undoubtedly useful later in fly fishing, for which he had a fascination and in which he became an expert; there are many decorations from this sport in his London flat. Magill has a puckish sense of humour, and there is the story of him presenting himself to a friend, disguised in gown and mask, as a distinguished but infuriatingly stupid foreign visitor. Another aspect of this was shown when visitors would come to watch the master. Magill would delight in waiting for the correct depth of anaesthesia and then ask the visitor to fetch something from his kit and then, quick as a wink, flip the tube in while the visitor's back was turned [2].

When Magill intubated by the oral route he developed his now widely known laryngoscope, which he called a speculum [10]. The maintenance of anaesthesia was frequently at that time by some form of draw-over inhaler, but Magill preferred nitrous oxide and oxygen, with a minimum amount of ether. He used a small continuous flow apparatus which was provided with a half-gallon bag of thin texture close to the machine and a delicate spring expiratory valve close to the patient. The tracheal tube was connected to the rest of the apparatus by means of a metal elbow, known as "Magill's connector". Allegedly the position of the reservoir bag and expiratory valve was determined by the wish to remove the irritation of the expanding and contracting reservoir bag from the proximity of the surgeon. In any case the arrangement as described by Magill has been shown during spontaneous ventilation to be as efficient as the more recent circuits [11]. As well as the care for the adult patients facing plastic operations, Magill was probably the first to adopt the endotracheal technique for cleft palate and hare lip operations in infants [1]. Magill admits to approaching the problem of intubating the neonatal larynx with considerable trepidation as there was the risk of traumatic oedema in the larynx [5].

In 1923 Ivan Magill was appointed to the Brompton Hospital. The Brompton Hospital was the foremost chest hospital in England at the time – a position which it has retained up to the present day. Although Magill retained his interest in plastic anaesthesia, this appointment meant that he started to develop an interest in thoracic anaesthesia, and the type of patient in those days was very different from those of today. In Magill's words, "Operation is usually decided upon when medical measures alone have failed to arrest the disease. Hence many of these patients are more or less chronic invalids ... [12]. Magill had two major interests in thoracic anaesthesia. The first interest was in the problems associated with wet lung and the spread of secretions to the healthy part of the lung. The second interest was in the variety of techniques used to secure anaesthesia or analgesia. In this instance it is apparent just how receptive Ivan Magill was to new ideas. His treatment of wet lung was by use of a pair of endobronchial tubes with a bronchoscope for their introduction. In Magill's description the tube for the left bronchus has the spiral wire entirely covered with rubber and that intended for the right bronchus has the spiral wire beyond the cuff left bare so that although the tube may be located within the right bronchus the right upper lobe is not obstructed when the cuff is blown up [5]. The other way of controlling secretions was by the use of a blocker, which consisted of a suction catheter mounted with an inflatable cuff, passed independently of the anaesthetic tube in the trachea. The variety of techniques which Magill used for thoracic surgery are surprising. However, one of the interesting aspects is that, in spite of pioneering tracheal intubation and the various methods of separating the lungs, for the majority of cases Magill appears to have used face piece administration with nitrous oxide and oxygen [13]. Other techniques included chloroform, cyclopropane, spinal and paravertebral block for thoracotoplasties. The latter techniques were combined with the use of Nembutal as a basal hypnotic. In view of the future disasters when thiopentone was used as the sole agent, it is interesting that Magill recommends that the employment of a barbiturate as the sole anaesthetic is inadvisable [14].

As well as the ability of Ivan Magill to accept change and in cases to foresee events, one is struck by the basic humility of the man who recognized that techniques which were highly skilled and were realized only after much practice would soon be superseded. For example, the use of short-term relaxants would mean that any junior anaesthetist could intubate and that blind nasal intubation would only be used as a rare technique. Similarly, the work on the various types of bronchial blockers would be obsolete in the presence of the double-lumen tubes such as the Carlens tube.

Ivan Magill was very keen on promoting the status of anaesthesia. Personal status did not interest him, although during such a distinguished career, as well as being knighted, he has received many honours from all over the world. He felt that anaesthesia would only advance if it became less dependent on surgical domination. Some of the views can be obtained from his eulogy of Ralph Waters, whom he obviously looked upon as a kindred spirit [15]. Perhaps it is difficult for the younger anaesthetists to realize how successful Magill and his colleagues have been in this quest for an improved status for the anaesthetists. In the Proceedings of the Royal Society of Medicine which have been mentioned there are several instances of surgeons entering the discussion, or rather pontificating on such subjects as the desirability of intubation, the pros and cons of various agents and fluid balance. All these topics anaesthetists would now consider their sphere of interest. Magill realized that the way forward could only be by an anaesthetic examination. Although Magill is now very much associated in the minds of the younger anaesthetists with the Royal Society of Medicine, he realized that such a meeting place could not be the platform for launching an examination for anaesthesia. This meant the formation of the Association of Anaesthetists, which held its first examination in 1935. Even so, Magill remains very much for us as a friendly presence in the Royal Society of Medicine. His flat is just a few yards from the place where most of his papers were read, and he still frequently attends the monthly RSM meetings.

Acknowledgements. Thanks are due to Miss Lynne Breeze for secretarial assistance.

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2.3 J. T. Clover: A Giant of Victorian Anaesthesia

R. K. Calverley

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Joseph Thomas Clover (1825–1882) was the leading anaesthetist of Victorian England for more than two decades following the death of John Snow in 1858. His reputation as a clinician, inventor and author is remembered in the United Kingdom through the Clover lectures of the Royal College of Surgeons of England. Anaesthetists of other countries, however, have little knowledge of his remarkable career beyond identifying a celebrated photographic study of Clover anaesthetizing a seated man while palpating his patient's pulse. His life is important to us, however, for his history carries anaesthetic practice from its beginnings in 1846 until 1882, when his achievements were the latest advance exactly a century before our meeting.

If Joseph Clover had written a textbook, he would be better remembered, but a complete account of his activities is not available. Duncum's excellent study, *The Development of Inhalational Anaesthesia* [1], features his professional achievements. Some Clover lectures [2–4] provide welcome biographical material, but other information can be found only in personal papers. Although a portion of these is in the possession of Addenbrooke's Hospital, Cambridge, a larger collection is prized by the University of British Columbia, Vancouver, Canada, and is the source of this presentation. K. Bryn Thomas surveyed the Canadian material in 1972 [5].

Student days

Joseph Clover was born at Aylesham, Norfolk, on 28 February 1825. He entered medicine at the age of 16 as an apprentice to a Norwich surgeon, Charles M. Gibson, and served as a surgical dresser until 1844. During that period he developed a respiratory infection, possibly tuberculosis, which forced an interruption of his work and left him with "a delicate constitution not expected to lead to a long life". After partial recovery he was able to continue medical studies at University College Hospital in London, from where he graduated with distinction in 1846.

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His school notes show the interests and limitations of medicine at that period. Anatomy, materia medica and descriptions of diseases dominated his academic studies. Clover drew the larynx and listed the vessels and nerves of the neck and limbs in great detail, but the trunk and abdomen were reviewed with much less attention, thus reflecting the limited surgical horizon before anaesthesia.

His personal papers contained brief notes describing 140 operative procedures in the preanaesthetic period 1841–1846. Amputations and lithotomies predominated. Mastectomies were reported regularly. Abdominal surgery was rare, save for the repairs of incarcerated hernias, but two attempts at colostomy were described. Not every patient was acutely ill or in pain before surgery, as Liston repaired a cleft lip in a 4-year-old child without anaesthesia and divided extraocular muscles in attempts to correct strabismus. Despite the surgeon's renowned speed, a uterine fibrectomy lasted over 2½ h.

At every operation the surgeon's assistants subdued the struggling patient, but Clover makes no reference to pain, the horrible accompaniment of every procedure. A surgical text by Clover's instructor, Robert Liston, entitled *Elements of Surgery* [6] also all but ignores the patient's suffering. Unfortunately, Clover's notes are interrupted a few weeks before William Squires anaesthetized Frederick Churchill with ether on 21 December 1846. It is not known with certainty if Clover or his fellow student, Joseph Lister, witnessed this historic event. Ten days later on 1 January 1847, Closer saw Squires attempt two anaesthetics in which Clover noted that "the experiment completely failed" [5, p. 437].

The Young Physician

Joseph Clover became a house surgeon and, after gaining a fellowship from the Royal College of Surgeons in 1850, a resident medical officer of University College Hospital, London. He was an occasional anaesthetist in the course of his surgical duties. A note from 1852 inquired, "What is the (commercial) source of chloroform?" John Snow reports that "the plan of administering chloroform with the head and shoulders of the patient covered with a towel, was introduced by Clover, ... and it is right to state that it lead to no accident in his hand" [7, p. 186]. Despite Snow's complimentary reference, Clover's notes of that time contained only passing references to anaesthesia.

He entered private practice in 1853 at 3 Cavendish Place, London, and remained at that address for the rest of his professional life. His practice consisted initially of general medicine, anaesthesia and a preoccupation with urology, particularly the technique of lithotrity – the crushing and evacuation of bladder stones. He created a workroom where he fabricated anaesthetic and urological inventions.

His creativity fostered a close association with Henry Thompson, the leading urologist of the day. Clover developed lithotrity blades to crush stones, an aspirating syringe to retrieve the fragments and "Clover's crutch", a popular leg restraint for use during lithotomy. As late as 1880, he continued to sketch new appliances for his urologist friends. While Thompson was able to crush the bladder calculus of King Leopold of the Belgians without anaesthesia in 1862, a personal note from Thompson suggests that he regarded Clover as a urological colleague as well as the anaesthetist he would have chosen had anaesthesia been required.

A Busy Anaesthetist

The motivation for Clover's transition to anaesthetist was not recorded. Perhaps anaesthesia offered him a less arduous life than general practice or he may have been influenced by an increased demand for his services after the unexpected death of John Snow in 1858. Clover gained appointments at University College Hospital, Westminister Hospital and the London Dental Hospital and began a career that brought so many demands that he reported providing a total of over 20000 anaesthetics. Very few of these cases are mentioned in his notes. It is probable that the pace of his practice denied him much free time, as suggested by this undated note reading: "My Dear Sir, I have to give chloroform at the Great Western Hotel at 1.20 and at Finsbury Pavement at 3 p.m. I am afraid if the latter operation should be a long one, I can't be with you until a quarter past four o'clock." In those days before telephones, a surgeon might send a personal note in a copperplate hand with a request such as "I have promised to see a case at 10 exactly on Thursday, but it will not take more than ten minutes. Sincerely yours, James Paget." A century later similarly optimistic surgical promises are transmitted, but without graceful calligraphy.

Clover's clinical career was very successful. He received notes expressing appreciation of his services from many socially prominent figures, including the Princess of Wales (later Queen Alexandra), Sir Robert Peel, Sir Erasmus Wilson and Florence Nightingale. The preserved portion of the nurse's letter reads: "... with my admiration and gratitude for skill and kind inventiveness which makes pain so painless without injury to the health" [5, p. 441]

Clover anaesthetized the deposed monarch Napoleon III at his residence, Camden Hall, Chislehurst, Kent. Sir Henry Thompson's notes described the care of this terminally uraemic patient [8]. On 26 December 1871 he wrote, "... Mr. Clover the most experienced chloroformist of the day. The Emperor took the anaesthetic well ..."; On 2 January, "... he took the chloroform as easily as before ... he recovered consciousness gradually and watched by Mr. Clover until intelligence had fully returned, made the usual expression of surprise that the operation had been performed ..."; and on 6 January, "10 a.m. ... just before preparing to take the chloroform the Emperor had a severe shiver, and it was necessary to wait ... at noon Mr. Clover placed him easily under its influence as before." Clover dispatched a telegram to his wife on 9 January which read, "His Majesty passed a tranquil night and an operation was to be performed at noon, but he expired suddenly at 10.45 a.m." No record of Clover's emotional response has been found. He would have realized that had this death occurred during surgery, both anaesthesia and anaesthetist might carry a major responsibility.

Anaesthetic Apparatus

Clover's realization that chloroform was safer when administered in known concentrations led to the successful introduction of the chloroform bag inhaler, which he constructed of waterproof silk cloth, a rubber-lined face mask and hand-carved inspiratory and expiratory valves of ivory supported by springs [1, pp. 242–244]. The face mask contained a flap to permit the addition of room air to dilute the anaesthetic.

A bellows forced 1000 cubic inches (16.3 87 litres) of air across an evaporating vessel into the bag. John Snow had considered this approach a decade before, but had not "introduced the plan into general use, as the balloon would sometimes have been in the way of the surgeon [7, p. 80]. Clover was more successful, but the device was never popular. In 1868, he reported no deaths among 1802 applications, but later was to review a personal fatality in searching detail, including a description of attempts at resuscitation. He attributed the death to his undetected error in calculating the volume of air diluting the chloroform.

In 1864 the Royal Medical and Chirurgical Society established a committee to investigate fatalities into chloroform. Joseph Clover was an expert assistant to that group and conducted numerous animal experiments for their use. Even though they considered that his apparatus was the best available and concluded that chloroform mixtures were safe, Clover himself counselled that the pulse must be continuously observed during anaesthesia and the anaesthetic discontinued temporarily should irregularities or diminished pulse volumes be noted: "If the finger be taken from the pulse to do something else, I would give a little air ..."

During March 1868, Clover observed a dental surgeon, T. W. Evans, administering nitrous oxide. He was attracted by the effectiveness and safety of the agent and improved its delivery by using his Clover bag. He realized that a supplemental reservoir bag near the mouthpiece would provide a more constant concentration of the anaesthetic, and so he introduced a rebreathing bag to the circuit [1, p. 286]

Clover employed a nosepiece to provide continuous nitrous oxide anaesthesia during dental surgery, but found that the anaesthetic concentration might be inadequate unless chloroform were added [9]. Beginning in 1874, he introduced a series of inhalers to be employed in a nitrous oxide ether sequence. Through his success, ether came back to prominent use. He dedicated many free hours in his workshop creating his "Combined Gas/Ether Sequence". This commercially successful apparatus was manufactured by Mayer and Meltzer in 1876 [10]. The author described the advantages as (1) greater economy, (2) rapidity of response and (3) regulated control of anaesthetic concentration. It was purchased for use in many hospitals.

In 1877 Clover introduced a more successful apparatus, the "portable regulating ether inhaler" [11]. This compact and robust instrument allowed a skilled anaesthetist to give ether rapidly and safely in office and hospital practice and it retained a place in the United Kingdom until World War II [12]. In later decades many modifications were made, including those of Wilson-Smith, Hewitt, Probyn-Williams, Rowling and Ombredanné [13]. There is every possibility that had Clover lived longer he would have continued to modify this device, for a desire for improvement was always at the heart of his efforts.

Retrospective assessment of his equipment by Professor Nunn has proved that Clover's patients experienced both hypercapnia and hypoxia [14]. Rebreathing accelerated induction but was dismissed as a hazard, since Clover noted that "all animals rebreathe partially". The deleterious effects of continued rebreathing were modified because Clover lifted the mask regularly. In his time supplemental oxygen was not employed in Britain. While his notes reflect his broad interests in reading current medical literature, he made no comment of Edmund Andrew's use of a 20% oxygen-nitrous oxide mixture in 1868. Even this Chicago surgeon was inconvenienced by the bulk of his oxygen-nitrous oxide apparatus. Andrews remarked that "in city practice among the higher classes, however, this is not an obstacle, as the bag can always be taken in a carriage without attracting observation [15]. Commercial oxygen cylinders became widely available in Britain after Clover's death. While Clover's apparatus has no current application, we remember that it was the best of its day and that he advanced anaesthetic practice through his skillful management of these devices.

Last Days

He maintained an interest in newer anaesthetic agents, including ethidine dichloride, which he used more than 1200 times before 1880, and ethylbromide, which he found very unpleasant. He was very interested in resuscitation and recommended that "when air is prevented entering the chest in spite of respiratory efforts, I should raise the chin as far as possible from the sternum. I have found this as effective as drawing out the tongue and much more speedily effected. If respiration has stopped I would use gentle artificial respiration taking care that the air passes through the larynx." He tested the effectiveness of artificial ventilation by a variety of manual methods in cadaver studies and recommended Sylvester's technique over all others then available.

After a year of poor health, he died of uremia on 27 September 1882 and was buried in the Brompton Cemetery, a short distance from the grave of Britain's other great Victorian anaesthetist, John Snow [16]. Correspondence from Clover's friends and colleagues to his widow and published tributes reflect the great esteem in which he was held [17, 18]. They tell of his gentle manner, his absolute unselfishness and active sympathy with the joys and sorrows of others. He relieved the sufferings of thousands of patients by his dedication to improved anaesthetic practice. His legacy is an important part of our heritage.

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2.4 Charles Waterton (1782–1865): Curare and a Canadian National Park

J. R. Maltby

J.R. Maltby

Charles Waterton was born on 3 June 1782 at Walton Hall, near Wakefield in the north of England. He was known as the Squire of Walton Hall and became one of England's best-known nineteenth-century naturalists and taxidermists. At the age of 14 he was sent to the newly founded Stonyhurst College in Lancashire, which was run by Jesuit priests, with whom he kept up correspondence and visits throughout his long life. In 1804, at the age of 22, he left England to manage family estates in Demerara, in what is now Guyana. Then in 1812 he gave up the estates and set off on the first of his four *Wanderings in South America,* which are described in a book of that title, first published in 1825 and most recently republished in 1975 [1]. The remainder of his life was devoted to natural history, taxidermy and the establishment of the world's first bird sanctuary at Walton Hall. He died in May 1865 and is buried in the grounds of Walton Hall, which has recently been restored and is now a most attractive country club.

Blowpipe and Blowpipe Arrows

It was on the first of his four wanderings that he saw the effects of curare, observed its manufacture and performed various experiments with it. He described in some detail the blowpipe through which the Indians would blow arrows to distance of 300 ft (100 m) to kill birds and small animals. It was 10–11 ft (3–3.5 m) in length and completely smooth inside. He also brought home to England blowpipe arrows, a quiver, and arrowheads, and these are on display in Wakefield Museum. The arrowtips are coated with a grey substance, and samples from a block of this substance have recently been confirmed by the Departments of Anaesthesia and Pharmacy at Leeds University to contain *d*-tubocurarine.

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Challenge from President of the Royal Society

What stimulated Waterton's interest in curare is not absolutely clear. There was knowledge of the poison from the reparts of earlier explorers, including Von Humboldt, La Condamaine and Bancroft, and there were suggestions in Waterton's time that it might be of use in the treatment of hydrophobia and tetanus. The stimulus for Waterton's exploration seems to be revealed in a letter which he wrote to the Mayor of Nottingham in 1839 referring to a meeting many years earlier, probably about 1800, with Sir Joseph Banks, President of the Royal Society. Waterton wrote:

> After dinner the conversation turned on foreign parts and I told him of the Indian poison; and how the hunters were wont to use it in the chase.
>
> 'My young friend', said Sir Joseph, 'I believe, that you believe what you have just recounted; but let me tell you, I have been a great traveller; and all the investigation which I have been able to make concerning the nature of this poison, tends to convince me that it is not sufficiently strong to kill the larger animals such as men and cattle ... When you yourself shall have witnessed its deadly effects on man or cattle we will no longer doubt its deadly virulence.'

Waterton's Route in Guyana

Waterton accepted this challenge and set off in 1812 from Stabroek, now Georgetown, the capital of Guyana, on a 3-month journey by canoe with six savages. They proceeded up the Demerara River for about 400 miles (640 km), portaged across to the Essiquibo, followed one of its tributaries and portaged again into a tributary of the Rio Branco, finishing at the inland frontier post of Portuguese Guiana, Fort San Joachim. About half way up the River Demerara, Waterton came upon the first sample of curare at an Indian habitation.

> A small quantity of the wourali poison was procured, it was in a little gourd. The Indian who made it, said that he had killed a number of wild hogs with it, and two tapirs. Appearances seemed to confirm what he said; for on one side it had been nearly taken out to the bottom, at different times, which probably would not have been the case, had the first or second trial failed.

Experiments with Curare

Waterton then tested the sample by wounding a middle-sized dog in the thigh with a poisoned blowpipe arrow. Within 3–4 min the dog began to stagger and lay down. He barked once and his voice was low and weak. His heart continued to beat for several minutes after the rest of the body was motionless and in 15 min he was dead.

The challenge given to Waterton by Sir Joseph Banks was to prove that curare was effective on large animals. Waterton described an experiment on a large, well-fed ox weighing 900–1000 lb (400–450 kg). He used three wild hog arrows, one into each thigh and the third into the extremity of the nostril. He stated that the curare appeared to take effect in 4 min; the ox set himself firmly on his legs and did not move until the 14th minute. He tried to walk, staggered and fell. He breathed hard and emitted foam from his mouth, then he gradually became weaker and in a minute or two more his head and forelegs stopped moving. His heart continued beating faintly for several more minutes but in 25 min from the time of being wounded he was quite dead. Waterton contrasted this experiment with one on a full-grown fowl into whose thigh he ran a poisoned blowpipe arrow. The fowl showed symptoms during the second minute and by the end of 5 min it was dead.

Waterton then drew the conclusion which to us might be quite obvious, but which had eluded the President of the Royal Society, that with curare there was a dose–weight relationship:

> Make an estimate of the difference in size between the fowl and the ox and then weigh a sufficient quantity of poison for a blow pipe arrow, with which the fowl was killed, and weigh also enough poison for three wild hog arrows, which destroyed the ox, and it will appear that the fowl received much more poison in proportion than the ox. Hence the cause why the fowl died in five minutes and the ox in five and twenty.

Manufacture of Curare

It seems likely that Waterton actually observed the preparation of curare. The Macusi Indians went out into the forest to collect the vines, a root of very bitter taste and two bulbous plants which contained a green and glutinous juice. Having scraped the curare vines and bitter root into thin shavings they stewed these in an earthen pot to make a coffee-like liquid. Into this they squeezed the juice from the bulbous plants. Lastly they added ants, strong pepper and the pounded fangs of the labarri snake (of whose necessity Waterton was dubious). The mixture then allowed to simmer on the stove, with more of the juice of curare being added. When it became a thick syrup, a form of quality control was carried out. A few arrows were poisoned with it to test its strength and, if satisfactory, the product was stored dry in a little pot or calabash. Even today the curare we use in the operating room is still obtained from vines in South America. The initial preparation, to the stage described by Waterton, is carried out by Indians near the head waters of the Amazon. From there it is sent to the drug houses for purification and standardization.

Life-saving Artificial Respiration

Waterton wished to know if there was an antidote for this paralysing poison. The Indians told him of pouring sugar cane juice or rum down the throat of an animal or holding a wounded animal submerged up to its mouth in water. He tried these remedies several times and they always failed. He then made the comment: "It is supposed by some, that wind, introduced into the lungs by means of a small pair of bellows, would revive the poisoned patient, provided the operation be continued for a sufficient length of time." Back in England in 1814 he tested this hypothesis on a donkey, along with Sir Benjamin Brodie, the surgeon, and Mr. Sewell of the London Veterinary College.

> The she-ass received the poison in the shoulder and died apparently in 10 minutes. An incision was then made into its windpipe and through it the lungs were regularly inflated with a pair of bellows. Suspended animation returned. The ass held up her head, and looked around, but the ventilating being discontinued she sunk once more in apparent death. The artificial breathing was immediately

recommenced, and continued without intermission for two hours more. This saved the ass from final dissolution; she rose up, and walked about; she seemed neither in agitation or pain. The wound through which the poison entered was healed without difficulty. She looked lean and sickly for about a year but began to mend the spring after; and by mid-summer became fat and frisky [2].

However, more than a century passed before curare was used clinically in anaesthesia and in the treatment of tetanus.

Waterton Lakes National Park, Canada

Waterton Lakes in Southern Alberta were named in Charles Waterton's honour in 1858 by Thomas Blakiston, naturlist and magnetic observer with the Palliser expedition, exploring for passes through the Canadian Rockies.

A $ 1.50 Canadian stamp depicting Waterton Lakes National Park was issued by Canada Post on 18 June 1982 and a "silver" souvenir dollar bearing Waterton's head was available as legal tender in the Park and surrounding towns during the summer of 1982. The year 1982 marks three interesting anniversaries related to Waterton and curare: the 200th anniversary of the birth of Charles Waterton, the 50th anniversary of the dedication of the Waterton-Glacier International Peace Park in Western Canada and the United States and the 40th anniversary of the introduction of curare into clinical anaesthesia by Griffith and Johnson in Montreal.

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2.5 Francis Sibson (1814–1876): Pioneer and Prophet in Anaesthesia

J. R. Maltby

J.R. Maltby

Francis Sibson was born in 1814 near Maryport, in Cumberland, England. When he was 5 years old his family moved to Edinburgh, where, at the age of 14, he became a surgical apprentice and received his diploma from the Royal College of Surgeons of Edinburgh at the age of 17½ years. From 1835 to 1848 he was Resident Surgeon and Apothecary to the Nottingham General Hospital, and it is in the last 2 years of this appointment, immediately following the discovery of ether and chloroform anaesthesia, that we are particularly interested.

After a gap of 17 years from graduating in Edinburgh Sibson decided to move to London, where he obtained his batchelor's degree with Honours in Medicine and a week later proceeded to the masters degree, receiving the gold medal for his commentary. The following year he was elected Fellow of the Royal Society. From 1851 until his death in 1876 he was one of the physicians at St. Mary's Hospital in London.

During his 13 years in Nottingham Sibson published many papers on the anatomy, physiology and pathology of the heart and lungs. In 1844, several decades before the use of local anaesthetics for supraclavicular brachial plexus blocks, Sibson described the strengthened supraclavicular portion of the pleura which may be punctured during that procedure and which became known as Sibson's fascia.

The pleura which covers the portion of lung above the clavicle is strengthened and brought under muscular control by a fascia, the aponeurosis of a small muscle, the pleural scalenus, rising from the transverse process of the last cervical vertebra and inserted by a dome-like fascia into the whole of the upper edge of the first rib [1].

Pupillary Signs in Anaesthesia

Although John Snow classified the stages of etherization in 1847, he paid little attention to pupillary signs: "In the earlier cases I used to raise the eyelid to look at the pupil. I was not able to learn much from it, as generally it is not much altered from its natural state and remains more or less sensible to light in all stages of etherization." The following year, 1848, Sibson wrote:

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Under the increasing influence of etherization and chloroform pupils first contract and then oscillate between contraction and dilatation and finally dilate. So long as the pupil is contracted a dreamy state often exists and the patient, when operated upon, frequently manifests an unremembered consciousness; he is in fact in a state of sopor. When the pupils dilate, and the iris is immovable, consciousness is extinguished – the patient is in the state of coma [2].

Artificial Respiration

Snow and Sibson both made the observation that, in deep anaesthesia, cessation of respiration generally occurs while heart action is still present. Whereas Snow stated that (in animals) if the breathing had not actually ceased when the vapour was discontinued they always recovered, Sibson went further and stated that:

If natural respiration ceases, there is nothing for it but to establish immediately artificial respiration. Ammonia, cold water, bleeding, will be resorted to in vain. We ought, then, whenever we administer chloroform, to be ready, in case of need, to perform artificial respiration [2].

Sibson even designed a chloroform inhaler which could be used for artificial respiration. The lower orifice had a one-way valve for inspiration while the upper one contained an expiratory valve. The tube to which this valve was attached could be drawn out so as to expose an aperture through which artificial respiration could be performed, the technique for which Sibson described thus:

Invert the mask firmly on the face, press back the larynx against the oesophagus and spine – inspire deeply, and distend the chest by blowing through the upper tube. Renew the artificial respirations in rhythmical succession, about 16 in each minute [2].

Although Sibson does not elaborate on his reasons for pressing back the larynx – whether to prevent air from passing down the oesophagus or gastric contents from passing up into the pharynx – this mention of cricoid pressure precedes Sellick's description of its use to prevent gastric regurgitation by more than a century.

Chloroform Deaths

Sibson was considered an expert on the early chloroform deaths in which the patient suddenly became blanched and the heart stopped, either at the same time or even before respirations ceased.

More than 100 years later, in 1965, a joint subcommittee on dental anaesthesia was appointed in the United Kingdom, whose terms of reference were:

To consider the use of general anaesthetics in general dental practice and to advise:
1. How far the administration of general anaesthetics for conservative treatment can be justified, and
2. How far the administration of general anaesthetics for any purpose without the attendance of a second practitioner can be justified [3].

The report made virtually the same comments as Sibson had done in 1848 when he wrote about sudden chloroform deaths:

In three out of the four fatal cases, chloroform was administered by the operator: this should never be. Chloroformization is the exhibition of a subtle poison, and ought to be watched by its administrator with undivided attention through the whole of its operation ... In dental surgery (except in extreme cases) and in trivial operations, the use of chloroform is not justifiable [3].

He then added a footnote:

Since this was written, a fifth case of death from chloroform (in India) has been reported in the Gazette. Like the four other cases the operation was trivial; like three of them, chloroform was administered by the operator himself, and in the sitting posture. During the operation scarcely a drop of blood escaped. The patient was probably already dead!

Facial Neuralgia

During 1847 Sibson wrote on the treatment of facial neuralgia by the inhalation of ether. He treated his first patient for this condition on the 30 January 1847, less than 6 weeks after the first operation in Great Britain under ether. This 21-year-old female had an aching, stinging, jumping pain on the left side of her face; she felt as if a sharp instrument were run into her cheek. Violent paroxysms usually came on after each meal and lasted about 2 hours. After having tried various remedies for 4 weeks she tried ether inhalation. The pain disappeared in about 2 min without loss of consciousness. In about 10 min the pain returned to a slight degree and was again removed by inhalation. Of five patients so treated two became completely free of pain after each had received a second treatment a few days after the first; one continued to have the paroxysms, though with longer intervals of freedom; while in the other two any improvement was very short lived and the treatment was eventually abandoned. Sibson also tried chloroform and effected a cure in two out of seven patients. It was 70 years later that trichloroethylene inhalations were found to be a useful treatment for trigeminal neuralgia, when they were thought to be a completely new treatment. It is interesting that in 1931 the results with trichloroethylene in 177 patients were 25% cured and 51% partially relieved, very similar to Sibson's results with ether and chloroform more than 80 years earlier.

Sibson's Association with Charles Waterton

Sibson, like Sir Benjamin Brodie a generation earlier, was associated with Charles Waterton, the squire of Walton Hall and famous naturalist, in experiments using curare. In 1839 they gave curare to a donkey, and Sibson spent several hours squeezing the bellows through a tracheostomy for artificial respiration. This animal died 3 days later, but a second one, which needed artificial respiration for only 1 h, survived.

Treatment of Tetanus

It was the opinion of Sibson and other leading medical men of his time that curare might be of use in the treatment of hydrophobia and tetanus. There were reports in 1859 that curare had been successfully used in the treatment of both animal and human tetanus; however, Sibson had reservations about its use in severe cases:

... in order to overcome tetanus, it was necessary to give an adequate dose and he feared that an adequate dose would be such as absolutely to call for artificial respiration ... He feared that the symptoms of tetanus would be found too severe to be overcome without loss of life [4].

Nearly 100 years passed before this treatment for tetanus, the Total Paralysis Regime, was used in Copenhagen with experience gained from long-term artificial ventilation of patients during the great poliomyelitis outbreak in 1952.

Other Interests

Apart from his extremely busy medical life, Sibson's main interests were his regular early-morning walks in the London parks and his Alpine mountaineering holidays. He was always interested in nature. Whereas in London he might study trees and birds, on his Alpine holidays he took great interest in the structure and movement of glaciers. It was on his way back from a holiday abroad that on 7 September 1876 he collapsed and died in Geneva. His body was brought back to England and buried in the graveyard of Acton Parish Church in London.

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2.6 The Continuing Influence of Ralph M. Waters on Education in Anesthesiology

L. E. Morris

L.E. Morris

Recently qualified anesthetists have insufficient knowledge of history to recognize either the extent of remarkable change which has occurred over the past several decades or the magnitude of indebtedness owed to those through whose efforts our present professional position has been secured. The current generation is able to practice modern anesthesiology in all its aspects in relative comfort because of the background of effort, the scientific advances, struggles, and successes of prior years. Every decade has had its special problems, triumphs, and frustrations; its leaders who rose to the occasion of new challenges; its builders who laid the foundation for development in succeeding generations. Of all the notables and luminaries associated with the rapid development of modern anesthesiology in the first half of the 20th century the most outstanding was Ralph M. Waters, who joined the medical faculty at the University of Wisconsin in 1927. In less than a decade his ideas and the contributions from his department made Madison, Wisconsin the focal point of interest in the world of anesthesia.

More than to any other single person we are all most indebted to Ralph Waters for the impetus and direction which emanated from his vision and which continues to affect us individually and collectively. It is my purpose here to try to provide some insight into the extent of our indebtedness.

Consider first the background of environmental circumstances against which Waters had developed his interest and experience of 15 years in clinical anesthesia before coming to the University of Wisconsin. In the United States for the first 75 years after the initial demonstrations of the anesthetic effects of ether, nitrous oxide, and chloroform, the administration and management of an anesthetic was deemed to be an exercise for junior assistants, hardly worth notice and certainly not special study by serious-minded physicians. With few exceptions medical students observed anesthetics given only by technicians, did not recognize the opportunity for dynamic study of physiology and pharmacology, and were not challenged. Surgical procedures of the time were neither lengthy nor complicated, largely curtailed by the limitations of casual management of the anesthetic and its consequent morbidity. Specialists were self acclaimed and self taught. Individual techniques were often guarded as commer-

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cial secrets. No formal postgraduate hospital training had been offered in anesthesia, and only occasionally were short "how to do it" courses available to interested physicians. In the British medical world too, despite the fact that their anesthetics were routinely given by physicians, the scientific correlations and the truly academic approach were to wait for another generation.

Waters came then to Wisconsin in 1927 to fill a need for exposing medical students to the discipline of anesthesia within their medical curriculum and to establish an academic program for giving graduate physicians a full understanding of the basic scientific considerations appropriate to the management of safe clinical anesthesia. Waters became the first Professor of Anesthesia. He sought and established enduring cooperative relationships with the basic scientists among faculty colleagues in physiology and pharmacology. His residents, in the course of their training, were assigned to research time in the departments of physiology and pharmacology. The first anesthesia residents at Wisconsin were appointed in 1928. There followed a steady flow of eager students into a previously neglected area. Although most came from the United States, there were others from Canada, Sweden, Mexico, Argentina, Brazil, Peru, India, and China. Each in his own way went forth to share the infusion of knowledge and enthusiasm received at Wisconsin. In the subsequent 20 years there were a total of 60 physicians who spent a major part of a year, or 2, or 3, or more years in the Wisconsin environment. Many were mature individuals with prior experience in basic science, private general practice, or other clinical disciplines. All acknowledged a major influence upon their professional lives. Two-thirds of Waters' residents have devoted at least a part of their professional lives to teaching anesthesia, and more than one-half of these have at one time or another served as chairman of a teaching department or as organizer and director of the teaching program in a medical school.

A review of the professional genealogy of anesthesiology reveals the startling fact that hundreds of academicians throughout the world and more than 80 departmental chairmen in medical schools in the United States alone have been of the Waters' lineage. Those of his students fortunate enough to establish working liaison with sympathetic basic scientists were able to organize teams that were productive in gathering new knowledge and successful in stimulating individuals who became subsequent leaders in teaching centers. Others among Waters' students who were less forceful or perhaps in a less fortunate academic climate had to content themselves with satisfying regional needs by providing physicians well trained in the sophisticated management and care of patients during clinical anesthesia.

The Waters' influence worked in many ways. Numerous visitors came to see and learn about the organization of a department for the teaching of physicians in the specialty of anesthesia and then returned home to emulate the model. Foreign visitors included, among others, Michael Nosworthy, Robert R. Macintosh, Olive Jones, and Gar Pask from the United Kingdom, as well as the Australian pioneers, Gilbert Troop, Gilbert Brown, Geoffrey Kaye, Stuart Marshall, and Harry Daly.

Some visitors indeed saw only techniques, but others caught the enthusiasm of our teacher and set up centers that equaled or outshone the model. Other individuals came for short visits and often stayed beyond their original intent. The most notable short-term visitor was E. A. Rovenstine, who came for 3 weeks and stayed as both student and staff member for 5 years before going to New York University to establish the prestigious anesthesia center at Bellevue Hospital. Waters helped to insure the success of this project by sharing his own staff and students for various periods of assignment at the new center. All in all, no less than six physicians from the Wisconsin program participated in the early phases of the establishment of the new department in New York City. Ivan Taylor, Perry Volpitto, and Burt Herschenson were each at Bellevue for up to a year, while Hathaway and Duncan Alexander went for shorter periods. Virginia Apgar and Austin Lamont each came later. It is interesting that as new teaching programs were established, in some instances professional descendants were sent home for a visit with "grandpa" as "exchange residents" at Madison (e.g. Etsten from Alexander's program at Albany and Harmel from Lamont's program at Johns Hopkins).

Some Wisconsin medical students exposed to the Waters' charm and quiet dynamics found themselves drawn inexorably back into the specialty after viewing the sharp contrasts of less sophisticated management of anesthesia as they had observed elsewhere during internship and further postgraduate studies. An example of this is Harold Bishop, a Wisconsin graduate in 1933. After an internship, he continued as a resident in anesthesia at the Philadelphia General Hospital, which was then temporarily staffed in anesthesia by Waters' residents Neff and Stiles. In later years Harold Bishop became a professor and chairman at the New York Medical College, and numbered among his students is Hamilton Davis, who subsequently became department chairman at the University of California, Davis, California.

In later generations, trainees have often extended their education beyond the clinical anesthesia residency to prepare themselves for leadership positions. For instance, Evan Frederickson and Joseph White, residents in Stuart Cullen's program, were among the half-dozen who earned a masters degree while exploring various aspects of research with me in the pharmacology laboratories at the University of Iowa. Frederickson and White also went to Seattle on the staff of the University of Washington before their own appointments as Professor and Chairman in departments at the University of Kansas and the University of Oklahoma. Similarly there have been those who have "topped up" their education by following clinical residency experience elsewhere with a fellowship or staff appointment at one of the subsequent dominant centers in Pennsylvania, New York, or California.

There is a further fact which is evidence of the continuing influence of Waters and his students. All of the first four United States NIH grants for training in anesthesia research were awarded to institutions where anesthesia was headed by first- and second-generation Waters' students. These were Morris in Seattle, Dripps in Philadelphia, Papper in New York, and Cullen in San Francisco.

Many contributions to the progress of anesthesiology were associated with the name of Waters and the University of Wisconsin, including:

1. Development and refinement of the closed system for carbon dioxide absorption
2. The consequent introduction of the gaseous anesthetic cyclopropane to be clinically used in the closed system
3. Cuffed endotracheal tubes
4. Controlled respiration
5. Endobronchial anesthesia
6. Various important modifications of anesthesia equipment

However, in historical perspective, Dr. Waters will be remembered most of all as a medical educator. As he came to Wisconsin it was his avowed purpose "to teach doctors to go out and teach other doctors" a professional approach to anesthesia, and in this intention he has been proved eminently successful. Dr. Waters was a vigorous but modest man, imbued with integrity, common sense and an ability to project his enthusiasm, thereby stimulating his associates to think and contribute. Through his students and subsequently through the teaching by those students of their students a major influence has been exerted.

Waters and his students plowed new ground. They brought a concern for consideration of fundamentals which improved their care of individual patients during anesthesia and lowered morbidity. Open review and discussion of clinical problems was initiated. We now call these morbidity and mortality conferences. They sought and found the foundations of our specialty in the basic sciences from which and in partnership with which we continue to progress.

Waters' residents ("the droplets") demonstrated a remarkable cohesiveness in devotion and loyalty to their teacher, returning annually as Aqualumni for an Easter scientific meeting and for reinfusion of the Wisconsin spirit. Ralph Waters set the stage and trained the directors and producers; they in turn selected the players, whose talents and contributions have been widely recognized by the current generation.

2.7 The Influence of Ralph M. Waters on the Development of Anaesthesiology in Sweden*

T. Gordh

During the 1930s the Swedish surgeons who travelled abroad to the United Kingdom and the United States came home very impressed by the anaesthetic techniques developed in those countries, where anaesthesiology was already a recognized specialty in medicine. Visiting surgeons from those countries were of the opinion that Swedish surgery was good, but anaesthesia bad. The surgeons gave spinal and regional anaesthesia, and the general anaesthesia was handled by the youngest assistants, nurses or even attendants. The situation was roughly similar all over Europe.

The chief surgeon at the University Clinic of Serafimer Hospital in Stockholm, Prof. Gustav Söderlund, saw the advantage of anaesthesia as a medical specialty. At that time (1938) I was the youngest of his surgical residents and, as such, was delegated to handle anaesthesia for his operations without knowing much about it. Professor Söderlund wanted to improve the situation, and I was asked if I was interested in devoting myself to this new specialty. To protect my surgical ambitions I promised to "think it over".

In the summer of that year the famous British anaesthesiologist Michael Nosworthy came to Stockholm and I made an appointment to talk with him. On the way to Nosworthy's hotel I crashed my 10-year-old Packard Roadster with bad mechanical brakes into a truck. This day ended both the car and my surgical ambitions, for after the interview with Nosworthy, in which the whole story of the rapidly developing specialty of anaesthesiology was presented, I realized the tardiness of the country and the necessity of its advancement to be in the forefront in anaesthesiology, as it was in other aspects of medical specialties.

Nosworthy, whom I consider my godfather in anaesthesiology, was a friend of Ralph M. Waters and very promptly arranged for me to become a member of Professor Waters' department at Madison, Wisconsin, where I arrived in October 1938 (Fig. 1). It was typical that Dr. Waters himself met me at the railway station and arranged accommodation within the hospital; I became a junior resident with U.S. $ 25 a month plus free food, lodging and laundry. I started from scratch and, from my earlier experience, I soon found that I had arrived at the real Mecca of modern anaesthesiology. It was hard work, but my enthusiasm and interest in the new specialty became all consuming.

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* Ralph Waters Award Lecture, Chicago, 7 May 1982

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Fig. 1. Ralph M. Waters

I realized the importance of the basic principles for safe anaesthesia adopted at Waters' clinic which were unknown in Sweden. Ralph Waters formulated the design for a modern anaesthesia department, with emphasis on patient care, teaching and research. He was the first to establish anaesthesiology on a scientific basis to create a medical art and specialty from what earlier had been mainly a practical, clinical and technical art. Typical of the man was his statement at the inauguration in 1933 of the independent department of anaesthesiology at Madison, the first in the United States:

> It is the aim of the Department of Anaesthesia at Wisconsin to serve as an interpreter of the pharmacologic, biochemical and physiological information as well as to apply such knowledge to safe pain relief for patients to the aid and improvement of modern surgical technique, to better education of medical students and graduates and perhaps to the development of a little better anaesthetic procedure.

Waters had a vision of anaesthesia different from those who had preceded him. He saw the necessity of applying the principles of laboratory research to the practical solution of clinical problems. He established the first residency training programme in the United States, which combined instruction in the basic sciences in relation to anaesthesia with instruction in clinical practice. I was lucky to belong to the first generation of professional anaesthesiologists trained by Waters. His pupils were called "droplets", and the group "Aqualumni" was formed in 1937. As was stated in the constitution, "The sentiments of loyalty to, and affection for our chief, Dr. Waters, have prompted the organization of this group." Aqualumni worked like a travel club and met every Easter in Madison with scientific sessions and social programme. An Aqualumni Newsletter was distributed twice a year, with letters from the chief and the members containing social and scientific news. I even received these Newsletters during the war, and they were very valuable to me, isolated as we were.

Here are some examples of Watersiana. Dr. Waters: "I don't pour knowledge in your brain with a funnel. I draw it out of you. The word education comes from the Latin word *educatus,* which means draw up." Dr. Waters kept the standard of English language high, and at the staff meetings there was always a censor appointed to criticize the language. If someone said, "the surgeon went into the abdomen", Dr. Waters rang his bell. If a surgeon asked an assistant to pull up his uterus, Dr. Waters said, "It is not your uterus. Say 'Pull up the uterus'". Dr. Waters was once asked if he had a well-unified department. He answered, "I have 12 departments, myself and 11 residents with their own minds." I remember Dr. Waters had a heavy book on physiology, which he did not like very much. He said that the best use of the book was to demonstrate the Hering–Breuer reflex in the laboratory by placing it on the dog's chest or abdomen.

Dr. Waters was a generous and wise man with common sense. He was also ahead of his time. In 1933 he wrote in the *Journal of the American Dental Association* about procaine toxicity [1]:

> When the reaction is severe: to restore and maintain oxygen in the cells of the body is of the utmost necessity. Artificial respiration immediately with or without oxygen, is the one life-saving procedure. Time is the important element. If to inflate the lungs with pure oxygen, means stepping across the office to reach an oxygen cylinder, omit the oxygen and blow your own expired air directly into the patient's nose or mouth. Do this regularly and persistently, in the meantime lowering the head of the patient. Be sure that the patient's chest is actually inflated each time you blow. If the patient is in a convulsion, it may be difficult to inflate the chest. Do not go for added supplies or aid. Intravenous barbituric acid would doubtless stop the convulsion, provided the injection could be made by a helper. Direct mouth to mouth, or mouth to nose artificial respiration is always instantly available. Attention to this fact will save most if not all patients in the case of procaine poisoning.

This was the year 1933!

After my stay in Madison, where general anaesthesia dominated, Dr. Waters advised me and helped me with introductions to visit other anaesthesia centres in the United States. I went to Ralph Knight in Minneapolis and to the Mayo Clinic, where I saw John Lundy and his staff, with R. C. Adams, E. B. Tuohy and T. H. Seldon, doing sacral and epidural anaesthesia. There I met a surgeon, Leonard Stalker, who had arranged a round trip looking for a place to settle down and he asked me to come along. We went by railway through the country: Kansas City, Oklahoma City, Dallas, Houston, Austin, Phoenix, San Diego, Los Angeles and San Francisco. There were great opportunities at that time. In Dallas, for instance, there was only one anaesthetist, an older obstetrician, who had switched over to anaesthesia. In Los Angeles I met Arthur Guedel and Charley McCuskey. My surgical friend eventually settled down in Rochester, New York. I also visited leading departments on the east coast, made many friends and learned a lot, especially about spinal anaesthesia. I recall the names: Paul Wood, Lewis Wright, Philip Woodbridge, Henry Ruth, Ralph Tovel, Urban Eversole, Leo Hand and of course Emery Rovenstine and Virginia Apgar. They all gave me valuable information and advice.

In March 1940 I left for Sweden on the M. S. Drottningholm, which had a special permit to sail during the war. I received these telegrams as a token of great friendship and encouragement in my new task when I left New York: "Best wishes for a pleasant trip from your friends at Bellevue. Come again. Department of anaesthesia." "Waters' droplets send fond au revoir. Good sailing. Best fortune to you and Swedish anaesthesia. Vice presidents." We had a club of four members of the department where we were all vice presidents. Harvey Slocum, who owned a car, was VP in transportation, Digby Leigh in entertainment and Barney Sircar in housekeeping, as he had a room at the University Club. I was VP in cuisine and provided Swedish food and aquavit. So we had some fun too, besides the hard work.

Om 8 April 1940, the day before the German invasion of Norway and Denmark, I arrived, 32 years old, back in Sweden to assume the first position of a professional anaesthesiologist in the nation–actually on the European continent–created at the newly established University Clinic of Karolinska Hospital in Stockholm. In the luggage I brought a Foregger anaesthesia machine, layringoscope, Waters' soda-lime canister and airways, endotracheal tubes and a bottle of the cream of American anaesthesiology, vintage 1940. I followed Dr. Waters' advice when introducing a new specialty: first, the patient's needs with emphasis on safety and freedom from pain; second, the teaching; third, the research. Today we are able to start with all of these features, thanks to our pioneers. I found that the most pressing need was to raise the general standard of anaesthesia throughout the country by teaching doctors, students and nurses the fundamentals I had learned from Dr. Waters. This era was filled by propaganda in articles, by lectures and travelling. My first publication had the characteristic title: "The free airway". I showed the importance of modern anaesthesia by results, e.g. diminished surgical mortality. The most dramatic and important changes towards lower surgical mortality were technically simple and inexpensive, such as premedication with morphine-scopolamine; anaesthesia records; recognition of anaesthesia signs and stages; free airway by Waters' airway, nasal tube or intubation; fluid balance; oxygen and lowering the head end in resuscitation, together with careful personal supervision – see, hear or feel every breath. The monitors were your eyes, hands and brain. These were the basic ingredients of safe anaesthesia for all, adopted from Waters' clinic. To these have gradually been added new agents, new methods and more complicated and expensive techniques – the last, in my opinion, with only marginal benefit in mortality of general surgery. I thought my time spent in Madison was so valuable that I sent my first assistants to that Mecca after basic training. After the war, in 1945, it was Olle Friberg. He became a clever clinical anaesthesiologist at Sabbatsbergs Hospital in Stockholm, where the Swedish pioneer in thoracic surgery, Clarence Crauford, did the first human pneumonectomy in the world and later the first operation for treatment of coarctation of aorta. Eric Nilsson later became Professor of Anaesthesiology at the University of Lund and wrote his thesis in 1951 on the treatment of barbituric acid poisoning, the Scandinavian method, which became a classic [2]. He also introduced neuroleptanaesthesia in Sweden. Carl Gustav Dhunér became Chief of the Department of Anaesthesia at the University of Gothenburg and was a good clinical worker, with regional anaesthesia as his special interest. His thesis came rather late, in 1972, entitled "Mepivacaine and vasoconstrictors in regional anaesthesia" [3].

My own thesis about circulatory and respiratory changes during ether and intravenous anaesthesia was published in 1945 and dedicated to Dr. Waters and to the other men who had made me interested in anaesthesia [4]. A detail in this study might be of interest for this report. It concerns the provocation of the Hering–Breuer reflex in deep ether and deep intravenous anaesthesia in man by inflation of the lungs. The reflex cannot be provoked in ether anaesthesia, which I found to act as a functional central vagotomy, while in intravenous anaesthesia an accentuated Hering–Breuer reflex was observed as a vagal apnoea. In the experimental animal the vagal apnoea is abolished after bilateral vagotomy, and the situation equals that in ether anaesthesia. If Hering and Breuer in 1868 had used ether or chloroform anaesthesia in their dogs instead of morphine, their classic reflex would possibly not have been discovered. In 1955, Olaf Norlander completed his thesis on total hemoglobin, blood volume and circulatory changes in surgical patients [5].

Dr. Tatum, Professor in Pharmacology at the University of Wisconsin, and Dr. Waters stated that the barbiturates appear functionally to decerebrate the animal without seriously impairing the vital medullary centres. This view I experimentally verified in my thesis. I showed a comparison between deep intravenous anaesthesia in the rabbit and pontile decerebration in the intact animal. In both experiments exactly the same effect on respiratory activity was obtained by the following procedures. Head-up tilt of 30° caused immediate vagal apnoea by expansion of the lungs through the traction of the viscera on the diaphragm. In this position spontaneous respiration was restored by compression of the abdomen or the chest (remember Waters' experiment with the book) or 30° head-down tilt. All these procedures decreased the lung expansion with less mechanical stimulation of the vagal receptors in the alveoli. This effect of barbiturates as a functional decerebration in the midbrain compared with the anatomical one might explain their fitness for use against convulsions caused by toxic cortical reactions to local anaesthetics – a treatment I first learned from Dr. Waters. These academic theses and many other research projects by the Swedish pioneers may have been initiated during their work in Waters' clinic and are in fact a scientific follow-up of his clinical experiences and observations. He gave us ideas, and anaesthesiology was still a virgin field for scientific research.

We corresponded regularly, and during the first years of establishing the specialty I appreciated both his criticism and encouragement. This is an excerpt from a letter written in 1948:

> Your worries about shortage of capable men in Sweden is similar to ours in this country. We are still way behind and it just can't be helped at once in either country. Time and hard work is the only remedy. I believe the mistake we made here was in failing to pay enough attention to the medical students before they graduate. If well founded before they leave Medical School, many of them can be most useful as part time anesthetists wherever they are. However, let me assure you all four that the increase in numbers occurs much more rapidly as time goes on and more teachers begin to function. With the four of you functioning you will be surprised how soon you will catch up in a country as small as Sweden. Not so many years ago 75 was good attendance at a meeting of anesthetists here. This fall it was over 900 and next year it will be over a thousand, I don't doubt.

He was right, and the fast development of chief positions in anaesthesiology was a sign of the need for the specialty at Swedish hospitals. The rapid growth of anaesthesiology was also stimulated by the Board of National Health and Welfare through its gradually accepted policy that all hospitals which admit acute cases should include at least the four departments of surgery, internal medicine, radiology and anaesthesiology. The growth of the specialty was given further stimulus by the activities of anaesthesiologists in resuscitation and intensive care units.

In 1947 Dr. Waters became the first honorary member in the Swedish Society of Anaesthesiologists, and in the same year he received the Order of Wasa from King

Gustav V of Sweden as an appreciation of his contribution to the development of anaesthesiology in Sweden. Both he and the University appreciated the distinction.

Dr. Waters visited Sweden once, in 1950, when he was a teacher at the World Health Organization anaesthesia course in Copenhagen. He died on 19 December 1979, at the age of 96, at his home in Orlando, Florida. I had visited him there several times, including the occasion of his 90th birthday. The last picture I know of was taken in 1978, when Alon Winnie and I paid him a visit. There are three generations of anaesthesiologists. In his obituary I wrote: "Ralph Waters was one of the great pioneers in anaesthesiology and a highly appreciated teacher and scholar. I hope that his spirit, with its wisdom and common sense will remain in and continue to guide Swedish anaesthesiology."

Dr. Waters trained about 60 residents, who went on to become chairmen of their own university departments of anaesthesia and to preach and practice the Waters' gospel of professionalism in academic anaesthesiology. They were from many countries, and he always set out the United Nations flag when they visited him. I am sure every one will agree with me: Ralph Waters' influence on the sound development of modern anaesthesiology was unique, profound and worldwide.

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2.8 John S. Lundy: Father of Intravenous Anesthesia

G. Corssen

G. Corssen

At noon on 23 October 1957, Dr. John Lundy was driving east on 6th Street Southwest in Rochester, Minnesota. At Broadway he attempted to turn left onto Broadway when his ancient and dilapidated automobile was demolished – almost obliterated – by the car of a Stewartville man proceeding south on Broadway. Dr. Lundy picked himself up off the pavement with an assortment of well-chosen remarks, walked to a filling station across from the scene, sat down on a bench in front of the place, and proceeded energetically to outline specific details as to where he was to be taken, what was to be done for him, who was to see him, and who was to be notified.

When a police officer called Dr. Seldon to tell him about the accident and to inquire about Dr. Lundy's condition, Dr. Seldon became alarmed and called St. Mary's Hospital at once. He talked to an elderly sister in charge of the floor on which Dr. Lundy's room was situated. She broke out into tearful lamentations and exclamations of dismay. "Oh", she said sadly, "if you can find him for us, would you please call us at once? He got up, put on his clothes and simply vanished." Dr. Seldon located Dr. Lundy at his residence. He had complete amnesia for the incident. He said he could recall nothing except that he had been driving his decrepit automobile, had awakened in St. Mary's Hospital, did not know why he was there, concluded that there was no reason for him to be there, and so he had gone home, for he was a busy man.

Life for this productive man began in North Dakota in 1894. He graduated in medicine from Rush Medical College in Chicago. Dr. Lundy became head of the Department of Anesthesiology of the Mayo Clinic in Rochester, Minnesota in 1924. Before his retirement from the Mayo Clinic in 1959, he was a pioneer in graduate training of young physicians in the field of anesthesiology and was a founder of the American Board of Anesthesiology in 1937, serving as its president until 1942. Dr. Lundy's contributions to medicine and anesthesiology are manifold. He contributed more than 600 papers to the anesthesiology literature and was the author of the monograph *Clinical Anesthesia* [1], which was the first authoritative volume in the field.

It is little known, even among anesthesiologists, that John Lundy introduced the concept of "balanced anesthesia". In an article which appeared in 1926 in the *Min-*

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nesota Medical Journal he focused on the need for utmost safety in anesthesia practice and argued successfully in favor of simultaneously administering various anesthetic agents, each at its optimal capacity, thereby avoiding overdose with one single anesthetic agent [2]. He compared balanced anesthesia with a balanced food diet in which one avoids too much of one type of food, thereby reducing the possibility of indigestion and other intestinal problems. Lundy's concept of balanced anesthesia has since been accepted throughout the world as one of the safest and most effective approaches to pain relief during surgery.

Most physicians are also unaware that John Lundy established the first blood bank in the United States in 1935 and that in 1942 he opened the first postanesthesia recovery room at St. Mary's Hospital in Rochester, Minnesota. What is common knowledge, however, at least among anesthesiologists everywhere, is that Dr. Lundy introduced sodium pentothal into clinical anesthesia. Following the synthesis of thiopental by Tabern and Volviler, Dr. Lundy directed the first clinical trials with this ultra-short-acting barbiturate in 1934 at the Mayo Clinic and published in 1936 preliminary human pharmacologic studies and early clinical experience with the agent [3]. Earlier clinical investigation with the use of sodium amytal and subsequently with pentobarbital had satisfied Dr. Lundy with regard to their usefulness as anesthesia induction agents. However, it was the prolonged duration of action of these agents which proved to be a drawback and did not appear to warrant continuous use as surgical anesthetics.

Dr. Lundy published his clinical experience with intravenously administered pentothal in 2,207 patients in the December, 1936 volume of the *American Journal of Surgery* [4]. He proposed for the average adult a dosage of 15 ml of 5% solution of pentothal, a total of 750 mg, and recommended the injection of this dose over a period of 15 min. Being fully aware of the respiratory depressant action of pentothal, he described a simple device for the detection of respiratory impairment or apnœa induced by too rapid injection of pentothal. He fastened a fluffy piece of cotton to the upper lip of the patient, using a narrow piece of adhesive tape and injected pentothal intravenously, slowly enough so that the motion of the cotton did not stop. This ingenious tool, referred to as Lundy's butterfly, is still widely used by nurse anesthetists throughout the United States.

After his retirement from the Mayo Clinic, Dr. Lundy moved to Chicago and joined Northwestern University School of Medicine as Associate Professor of Surgery and Anesthesiology. In 1964 he returned to Seattle, Washington to continue practice as a consultant anesthesiologist. It was during these years that he established a highly sophisticated and complete library on intravenous anesthesia, which was housed in the basement of the apartment building in which he occupied a spacious and comfortable flat. When he was not administering anesthetics in the Seattle area, Dr. Lundy enjoyed being in the library and assisting visitors to find their way through the many documents reflecting the history of intravenous anesthesia.

Anesthesiologists are many things, but one thing they are not is dull. Dr. Lundy proved this to me personally when early in the spring of 1970 I arrived in Seattle for the first time. I had just completed writing the first chapters of a book on intravenous anesthesia and it was my hope to gather more information about some of the historical aspects of intravenous anesthesia and, in particular, to learn about the role which John Lundy had played in connection with the introduction of sodium thiopental into clinical anesthesia 30 years before Dr. Lundy personally answered the bell and, after I had briefly explained who I was and what I intended to do, he invited me to join him for breakfast, which he swiftly prepared while asking me questions regarding my plans to write the monograph on intravenous anesthesia. Naturally, he referred to the classic book on intravenous anesthesia written by Chas Adams [5] while he was an associate of Dr. Lundy in the Department of Anesthesiology at the Mayo Clinic. Dr. Lundy almost casually mentioned that his associate had devoted the best part of a lifetime to completing the book and had died shortly after it had appeared in the libraries all over the world. With a peculiar sense of humor he expressed his hope that I would live at least a few more years after finishing my book in order to respond to critics more and foes who might question its value and significance.

What followed this informal and most friendly first encounter with John Lundy was truly a unique experience for me. He asked me how much time I had set aside for studying in the library and when I told him that I intended to stay for several days he seemed pleased. He offered to be with me all day or at least as long as I could stand him. He then gave me a complete tour through the various sections of the library and I could not help but be fascinated by his brilliant and keen sense, and the genuine enthusiasm with which this giant of modern anesthesia talked about the history of accomplishments in intravenous anesthesia.

On subsequent visits during the ensuing years and on two occasions when he was visiting professor to the University of Alabama School of Medicine, Birmingham I continued to be fascinated by Dr. Lundy's sharp mind and, above all, his never-ending desire to instill into everybody listening to him some of his vast knowledge in medicine and, in particular, anesthesiology. What struck me most was his "matter-of-fact" attitude. It became clear to me that he preferred showing by example rather than involving himself in lengthy, complicated, and potentially confusing discussions.

Dr. George Hallenbeck, Chief of Gastroenterological Surgery at the Mayo Clinic, with whom I had the pleasure of being associated for a number of years in Birmingham, Alabama, tells the story of when he, together with a young pediatric fellow in surgery, were trying to place a needle in the vein of an infant who needed intravenous feeding. After a number of attempts, Dr. Hallenbeck decided to call Dr. Lundy. He came, found the vein and placed the needle in an instant, walked out, and strode down the corridor toward the operating rooms. The pediatric fellow was irritated by this virtuoso performance and resolved to unhorse Dr. Lundy's serene composure. He ran to the door and shouted down the corridor, "Dr. Lundy, the solution is not running into the vein." Dr. Lundy continued his measured pace down the corridor but half-turned his face and over his shoulder said, "Open the clamp and it will."

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2.9 Development of the Apgar Score

S. Harrison Calmes

One contribution of American anesthesia is important for other specialties also. The Apgar Score, for evaluation of the transition of the newborn baby to extrauterine life, is used by both obstetrics and pediatrics as well as anesthesiology. I investigated the development of the Apgar score as part of a larger project on Virginia Apgar's life. For this study, I recorded oral history interviews with nine of her colleagues and reviewed archival material at Mount Holyoke College, South Hadley, Massachusetts.

The Apgar Score was the result of the interaction of several factors: Apgar's situation as a woman in the male medical world, the development of new technology, and the arrival of important personnel at Columbia. Probably the most important factor was that Virginia Apgar was a woman. She had wanted to be a surgeon after graduation from Columbia University's College of Physicians and Surgeons in 1933. She won a surgical internship at Columbia, and she performed brilliantly. However Dr. Alan Whipple, Chairman of the Surgery Department, discouraged her from becoming a surgeon and argued that she should enter anesthesia instead. The four other women surgeons that Whipple had trained had not been able to become financially successful, because of patients' attitudes towards woman surgeons and because of inability to get further training. Whipple also felt strongly that anesthesia needed more physician involvement. Most anesthesia in America at that time was given by nurse anesthetists who were excellent technicians. Whipple felt, however, that technical skill was not enough and that surgery could not progress unless anesthesia was improved [1]. Apgar was nearly US $ 4000 in debt from her medical school expenses [2] and it was the middle of America's Great Depression. She accepted Whipple's advice and entered anesthesia.

Her anesthesia training was first with the nurse anesthetists at Columbia. This was for 1 year [1]. Then she spent 6 months with Ralph Waters at Madison, Wisconsin and another 6 months at Bellevue Hospital, New York with Ernest Rovenstine [3]. She returned to Columbia in 1938 as Director of the Division of Anesthesia under the Department of Surgery [4]. She proceeded to develop a strong Division, although it was an uphill battle. She began medical student teaching, began residency training, phased out the nurse anesthetists, introduced all the new agents and techniques as they became available, and expanded the Division's activities outside the operating rooms (see Table 1).

These achievements were in spite of enormous problems. There was great difficulty in recruitment. Anesthesia was thought to be a nurse's job, and it was difficult to attract bright physicians, especially males. There was an overwhelming work load,

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Table 1. Characteristics of anesthesia practice at Columbia, 1938–1946[a]

	1938	1939	1940	1941	1942	1943	1944	1945	1946
Agents used most often (in order of frequency)	NA	Ether N_2O Avertin	NA	NA	Ether TP N_2O	Ether TP N_2O	Ether TP N_2O	NA	NA
Endotracheal tubes placed	NA	232			531	616	822		
Spinals	NA	166			731	547	387		
Comments	Punch cards begin		Cyclo explosion	Conductive rubber available	Conductive floors installed	Curare first used		Nerve block clinic	Take over care of patients with respiratory depression
	Ether explosion		Cyclo abandoned	First use of TP in obstetrics	All conductive rubber now nonconductive	Cyclo used twice		More cyclo used Ether fire	More use of TP as induction agent

NA, not available; TP, thiopental (pentothal); Cyclo, cyclopropane; N_2O, nitrous oxide

[a] Data is taken from Apgar's Annual Reports of the Division of Anesthesia. Not available for every year.

especially during World War II. Some of the surgeons, who were used to ordering the nurse anesthetists around, would not accept physician-anesthesiologists. She had difficulty getting inadequate compensation and even being able to charge fees!

In 1948, the move for a separate Department of Anesthesia, not just a Division under the Department of Surgery, was begun. Some said that because she was a woman she would not be considered for the departmental chairmanship [5] (R. Patterson 1980, personal communication). Others said she disliked administration and was glad to be freed from it [1, 6]. Many of the administrative difficulties which led her to dislike administration were due to the fact that she was female. No matter what the exact cause, Emmanuel Papper, one of the few research trained anesthesiologists, was brought in to be Chairman of a separate Department of Anesthesia in 1949.

Apgar moved then into obstetric anesthesia. Freed from the time-consuming hassle of administration, this was where she made her greatest contributions. At that time, this was quite a neglected area, and she developed a teaching program. Residents were now required to rotate on obstetric anesthesia for 2 months. Two of these residents, Sol Shnider and Frank Moya, went on to become the leaders in obstetric anesthesia research and training. She expanded the agents and techniques available. However, general anesthesia was still given by mask. The risk of aspiration in pregnant patients was still not fully recognized [7, 8].

Probably her greatest achievement was the development of the Apgar Score. The idea for this came in 1949. Each day, the Columbia anesthesiologists ate breakfast together in the hospital cafeteria. One day, a medical student said something about the need to evaluate the newborn. Apgar said, "That's easy! You'd do it this way." She picked up the nearest piece of paper, which was the sign that said, "Please bus your own trays", and wrote down the five points of the Apgar Score. She then dashed off to obstetrics to try it out (R. Patterson 1980, personal communication). It was first presented at a meeting in 1952 and was published in 1953 [9]. There was some resistance initially, but the Score was accepted and is now used throughout the world.

The importance of the Score was that the newborn baby could now be observed in a standard way which looked at more than one sign. She at first planned the Score to be done 1 min after birth so that it would be a guide to the need for resuscitation. She had to emphasize that physicians should not wait the entire 1 min to complete the Score before resuscitating an obviously depressed baby [10]. Others started measuring the Score at longer intervals after birth to evaluate how the baby responded to resuscitation, if that was necessary. Eventually, the 1-min and 5-min Apgar Scores became standard. Acceptance of the 5-min Score came when it was found to be a predictor of mortality in the neonatal period and also of future neurologic development [11].

Using the Score as a method of standard evaluation, she then went on to relate it to the baby's acid-base status and to maternal anesthetics. She was aided in this by the arrival of important personnel and the development of new technology. L. Stanley James, a pediatrician from New Zealand, had met Apgar soon after his arrival in the United States, because of his interest in infant resuscitation. After finishing a pediatric residency at Bellevue Hospital, New York, he went to work for her as a research assistant in 1955. He had a background in cardiology and had technical knowledge. These became his contributions to the projects [12]. The other important person was Duncan Holaday, who had trained in anesthesia and who then did research at Johns Hopkins. Apgar recruited him, and he arrived at Columbia in 1950. For their projects, he developed a nitrogen washout technique for measuring cyclopropane, used the Nadelson microgasometer to measure arterial blood gases in the presence of anesthetics, and, finally, developed better pH measurements [13]. The availability of the Astrup pH electrode in 1960 made pH measurement much easier, and the group bought one of the first available [14].

With this personnel and the new technology, Apgar was able to demonstrate important basic concepts. Hypoxic, acidotic babies were found to have low Apgar Scores. Also, acidosis and hypoxia were *not* normal conditions at birth, as was previously thought. These conditions should be treated [14]. They investigated the effects of maternal anesthetics on the baby. They found cyclopropane to be more depressant than other agents, and consequently its use in obstetrics decreased markedly [12, 15]. Finally, the Collaborative Project, a 12-institution study involving 17221 babies, established that the Apgar Score, especially the 5-min Score, was a predictor of neonatal survival and of future neurologic development. This was published in 1964 [12, 17].

Apgar, a woman, couldn't be a surgeon so she entered anesthesiology, which needed physicians. She couldn't be a departmental chairman, so she entered obstetric anesthesia, where once again there were great needs. This move freed her from administration, and she made her greatest contributions in this area. A chance remark to her led to the birth of the Apgar Score in 1949 and its publication in 1953. The arrival of Duncan Holaday and L. Stanley James at Columbia, and the development of new technology for measuring blood gases, pH, and anesthetic blood levels, were other contributing factors to the development of the Apgar Score. These all interacted to give us today a most useful tool, a tool that serves as a common language between the three specialties that care for newborns – obstetrics, pediatrics, and anesthesiology.

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2.10 Arthur E. Guedel (1883–1956)

R. K. Calverley

R.K. Calverley

A few dedicated men forged a remarkable revolution in anesthetic practice in North America during the first half of the twentieth century. Arthur Guedel was a leader of this distinguished group. His early career carried him from practice in Indiana to service in World War I as the "motorcycle anesthetist." After years of dedicated service as a teacher and investigator, he became the first American to be awarded the Henry Hill Hickman Medal of the Royal Society of Medicine in 1941. Following his death his friends developed the Guedel Memorial Anesthesia Center in San Francisco, whose extensive collections of correspondence and personal papers provide an intimate view of his career.

Early Years

Arthur Guedel was born in Indiana on 13 June 1883. A persistent ability to overcome adversity can be illustrated by two examples from his young life. Three fingers were amputated from his right hand when he was 13, but he went on to become an accomplished pianist and organist. As he was too poor to enter high school, Arthur gained his education from library books with a teacher's help. This determination was supported by his family doctor, who arranged an exceptional admission to medical college. His trust was well founded, for Guedel graduated with honors.

Guedel's first experience with anesthesia came during his internship. He gave chloroform and ether without formal training and little supervision. Determined to learn all that he could, he began intensive studies of the literature of anesthesia and started a life-long habit of verifying and extending the observations of other authors. Eager to safeguard his patients, he began to correlate eye signs with anesthetic depth in an attempt to avoid unnecessary anesthetic dosage.

Arthur Guedel began medical practice in 1909 and gained some of his first income by providing occasional anesthetics in hospitals and dental offices. He created a device for the self-administration of nitrous oxide, which was the subject of his first publication in 1912 [1]. In 1913 he began a series of lectures, including one on pediatric

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practice that introduced the phrase "steal the child", which is still a popular induction technique.

The Motorcycle Anesthetist

He served in France during World War I. He and his fellow anesthetists performed heroically, but, even by working 72 h without rest after a major battle, could not attend the thousands of wounded men needing surgical attention. Guedel developed an anesthesia training school in Chaumont. Based on his genius for practical simplification he instructed his students in airway management and monitoring of anesthetic depth by his description of the signs and stages of anesthesia. To supervise anesthetic care in several hospitals he dashed about by motorcycle.

The World War I experiences of the anesthetists of the Western Allies at base and front-line hospitals were assembled by Dr. Frank McMechan and published in the *Year Book of Anesthesia and Analgesia 1917–18* [2]. This fascinating volume presents many vivid accounts of the response of the anesthetist to the demands of war. Guedel's rapid induction closed technique for minor surgery and dressing changes was included [3]. He devised a rubber hood with a central hole for fresh gas exchange onto which he placed a large cotton pad. The anesthetic mixture contained 24 ml diethyl ether, 0.5 ml chloroform and 5.5 ml ethyl chloride flavored with 0.125 ml oil of orange to render the mixture more pleasant. The liquid was applied to the gauze and the apparatus immediately placed over the patient's face with the pad lifted initially to lessen the pungency of the concentrated vapor. Each patient was rapidly induced with ethyl chloride, after which the small amount of chloroform sustained anesthesia until the effects of ether supervened. Guedel reported that induction was completed within 2 min, and up to 20 min of anesthesia might be achieved. The hood was lifted to allow fresh air to enter the system during use and, if anesthesia were protracted beyond 10 min, the hood was removed and ether given by a semi-open technique. Guedel described its repetitive application for as many as 15 consecutive days in a single patient and reported a successful series of 2000 administrations. This primitive device was unsophisticated, but is was the best that could be fabricated with the drugs, resources, and personnel available.

Guedel was challenged by the special requirements of providing anesthesia in darkened fluoroscopy suites for the removal of shrapnel. Since field avoidance was a frequent requirement, Guedel developed a versatile technique of auscultatory control of ether anesthesia which allowed monitoring of anesthesia continuously, even in a darkened environment [4]. This act of improvisational genius was an extension of the auscultatory technique of Franz Kuhn, of which Guedel was unaware at that time [5].

Years of Discovery

After demobilization Capt. Guedel returned to Indianapolis with his prewar savings exhausted to learn that his service in France had cost him his position as an anesthetist. Despite difficult financial circumstances, he published his classic guide to the planes of surgical anesthesia in 1920 [6]. Even at a time when the prior observations of Snow [7] and Plomley [8] were forgotten, Guedel never claimed that these assessments were his alone. As he told Albert Miller, who later extended Guedel's observations, "I do not feel that these stages of anesthesia are my work. They are rather the work of my friends and mine all run together" (A. E. Guedel, personal correspondence).

Even though he was a very skilled clinical anesthetist, always ready to learn from mistakes and failures, he realized that anesthetists must enter the laboratory to prove clinical observations by animal and volunteer experimentation.

Guedel became a popular instructor of anesthesia at midwestern medical schools. He was a founder of the Anesthesia Travel Club, the American Society of Anesthesiologists, and other societies which brought the limited number of North American specialists together in regular meetings. At one convention he met Ralph Waters, who became his friend, counsellor, and confidant. Each stimulated the other. Since they never lived in the same city, many of their discussions can be followed today through existing correspondence. So regular and intimate were their letters that the reader can imagine joining these two great men in their work and personal lives. On some occasions, if all prior points of contention had been set aside, a challenge "Teach me something!" might promote months of discussion and a research project. They supported each other's independent studies of the central effects of carbon dioxide and shared interests in newer anesthetic agents. Guedel supported and edited Waters' first papers on cyclopropane, but his own study of that anesthetic was the first scientific report to appear in the journal *Anesthesiology* [9].

Their partnership is most widely remembered for the successful introduction of the cuffed endotracheal tube [10]. Guedel initiated these studies in the basement laboratory of his home. He was disturbed by the leakage of gas from uncuffed tubes and set about creating the inflatable cuff. Guedel's dexterous hands fashioned the first cuffs from rubber gloves. From 1926 to 1928 he continued to experiment in a search for the best combination of features. Every modification was the result of continuing experimentation. Points that had to be resolved included: (1) the composition of cuff and tube; (2) the site of the cuff above, below, or at the vocal cords; (3) the distance the tube should extend beyound the cuff; and (4) inflation techniques and inflation pressures.

Ralph Waters joined in the latter stages of this enterprise. Guedel first attempted to demonstrate the safety of his technique by filling an intubated patient's mouth with water, but a second demonstration failed. As he wrote to Dr. Waters on 7 April 1928: "If you try it, be sure to aspirate all the water before you remove the catheter. I left it to an intern and he didn't. Result, annoying laryngospasm..." In the same note Guedel proposed the "dunked dog" demonstration. This featured an anesthetized and intubated dog, popularly believed to be his household pet, "Airway," who was immersed in an aquarium at the beginning of a lecture. After the demonstration was complete, the dog was retrieved from the water, allowed to awaken, shake himself, and exit to the applause of the audience. His mission accomplished, "Airway" enjoyed an honorable retirement with the Waters' family.

After Guedel and Waters had published their first article, they remained dissatisfied with the tubes available in North America. When Sir Ivan Magill introduced his mineralized red rubber tubes to North Americans in Winnipeg in 1930, Waters sent a tube to Guedel. They endorsed it as better than any product manufactured in North America and encouraged the introduction of Magill tubes as the best available in the age before plastics. They also wrote a fine review of the history of endotracheal techniques, which saluted earlier physicians who had experimented with endotracheal tubes and cuffs, but whose inventions had not met with the popular support that came to Guedel and Waters [11].

Immediately before the Great Depression Guedel migrated for reasons of health to Los Angeles, California. For many months he had few cases and little income. The Guedel pharyngeal airway was designed in his free time and was the result of anatomical studies combined with Guedel's mechanical genius [12]. The Guedel laryngoscope and other innovations came from work in his garage and laboratory. He studied with Prof. Chauncey Leake in the laboratory of the University of California, San Francisco, investigating divinyl ether, carbon dioxide narcosis, and ether apnea. Guedel's classic text *Inhalation Anesthesia* [3] was published in 1937 and enjoyed a continuing international popularity for many years.

During a particularly hectic period, and without realizing the seriousness of his situation, Guedel developed an unknowing dependence on barbiturates to secure sleep, which then became complicated by a companion abuse of amphetamine. The dark days passed as he showed the strength of character to overcome both addictions. Deeply disturbed by the effects of this dangerous habit, he was earnest in his efforts to warn other physicians of this great risk.

Teacher and Counsellor

Dr. Guedel's last years were rich with rewards and honors, including the Henry Hill Hickman Medal and the Distinguished Service Award of the American Society of Anesthesiologists. Angina, arthritis, and emphysema crippled him, however, and forced his retirement from clinical practice in 1941. For years thereafter he and his wife showered hospitality on hundreds of professional visitors. So thorough was his dedication to anaesthesia, that his workshop became not only the place where he perfected cunning contrivances of plastic and metal, but a meeting place of anesthesiologists and residents in training. His Wednesday afternoon seminars are remembered by many now distinguished clinicians as the high point of their instruction. Professional visitors, both great and unknown, always enjoyed warm hospitality [4]. Private problems were resolved in his study, which was a welcome refuge for many in times of trouble. Even in the last years, when he required supplemental oxygen each day, he continued to visit laboratories and hospitals where he punctuated his tours with incisive questions and helpful suggestions. His lifelong commitment endowed every element of our specialty.

Dr. Guedel is remembered with great affection. Many appreciations have been written by his students and distinguished colleagues, but a particularly perceptive tribute is a sonnet by his neighbor and friend, Mrs. Tacoma Winkler Ford. She wrote of him from the perspective of a patient:

Arthur E. Guedel, MD

Down the forbidding corridors of pain
He moved indomitably, touching new lights
To probe their devious ways. And yet again
He came with curious gifts, born of long nights

Of wondrous wizardry. Never the mind,
The great enquiring mind, at rest – the hands
Numb to their task. Yea, though his path must wind
At length down the dark valley's slopes, he stands

Once more in wait against the urgent need,
The clear, insistent call of the untried.
And ever, always, like an unsung creed,

His kindly wit and wisdom, side by side.
Who once has faced the dread hour of distress,
Harken his name with quiet gratefulness!

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2.11 Dr. Cornelis R. Ritsema van Eck: A Many-Sided Pioneer

J.C. Dorlas

J.C. Dorlas

It was not until after 1945 that the shaping of anaesthesiology began on the Continent. In the Netherlands, Cornelis R. Ritsema van Eck was one of the first to introduce anaesthesia as a specialty and might be considered one of its national pioneers. Internationally also he soon became a prominent protagonist of the new specialty.

He was born in 1905, into a family which for generations had lived in the Dutch East Indies. He studied medicine in Utrecht and graduated in 1930, when he also married. He trained in bacteriology and tropical hygiene and in 1931 he produced a thesis on this subject [1]. The family than moved to the West Indies, where Cornelis R. Ritsema van Eck worked as a bacteriologist and taught at the Medical School of Paramaribo. He also trained in surgery and gynaecology. After he had completed this training, his family moved again in 1937, this time to the Dutch East Indies, where he served as an army surgeon. The low standards of anaesthesia, detrimental for patients and surgeons, made him aware of problems in this field of medicine.

During World War II he was taken prisoner by the Japanese and was transferred to Singapore. On the way there his ship was sunk by a torpedo Ritsema van Eck was not wounded. He reached Singapore together with the badly wounded. In the camp, he managed to help thousands of his fellow men, many of whom still remember his capacity for guidance, personal dedication and confidence.

After the war, the family was re-united and stayed in Singapore for some time. C.R. Ritsema van Eck was appointed the head of the Dutch Medical Services and gained considerable administrative and organizational experience. This served him well when, after returning to the Netherlands, he was asked to set up a Department of Anaesthesia for the University Hospital in Groningen (1947). He attended training courses in London and Oxford, during which period he made many friends, partly by being a freemason. At his Department, where he now had trainees, he started experimental research in cooperation with the Institute of Physiology [2, 3]. The clinical research performed at his Department made him internationally renowned and was the beginning of modern monitoring procedures [4]. In 1954 he was appointed as lecturer in anaesthesia at the University of Groningen [5].

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He was also engaged in the national and international promotion of anaesthesia. In 1948, the Dutch Society of Anaesthesia had been founded, and a year later C.R. Ritsema van Eck was elected as President. As a government delegate he took part in the preliminary discussions in London and Paris in 1950 and 1951 about the international cooperation in anaesthesiology. For these purposes, his many professional and social relations proved to be very useful. Several countries wanted to participate in a new international anaesthesia society. (It must be mentioned here that Dr. H. Griffith from Canada was strongly in favour of a World Society of Anaesthetists.) Of course, there were many impediments to be overcome and several discussions followed. It was decided that the founding of an international society was to take place at the first world congress of anaesthetists.

The young Dutch Society offered to organize the first world congress in the Netherlands, and the proposition was accepted. The task was difficult, as the Dutch Society did not number more than 50 members at that time. After tremenduous efforts by a small but enthusiastic group of people the First World Congress of Anaesthesiology took place at the Kurhaus at Scheveningen from 5 to 11 September 1955 with C.R. Ritsema van Eck as Chairman and President. Her Majesty the Queen Juliana had graciously accepted the patronage, and the Congress was opened by the Minister of Health in the same *Ridderzaal* (Hall of Knights) where the Dutch Parliament meets annually on the occasion of the Queen's speech (Fig. 1). Anaesthesiolog-

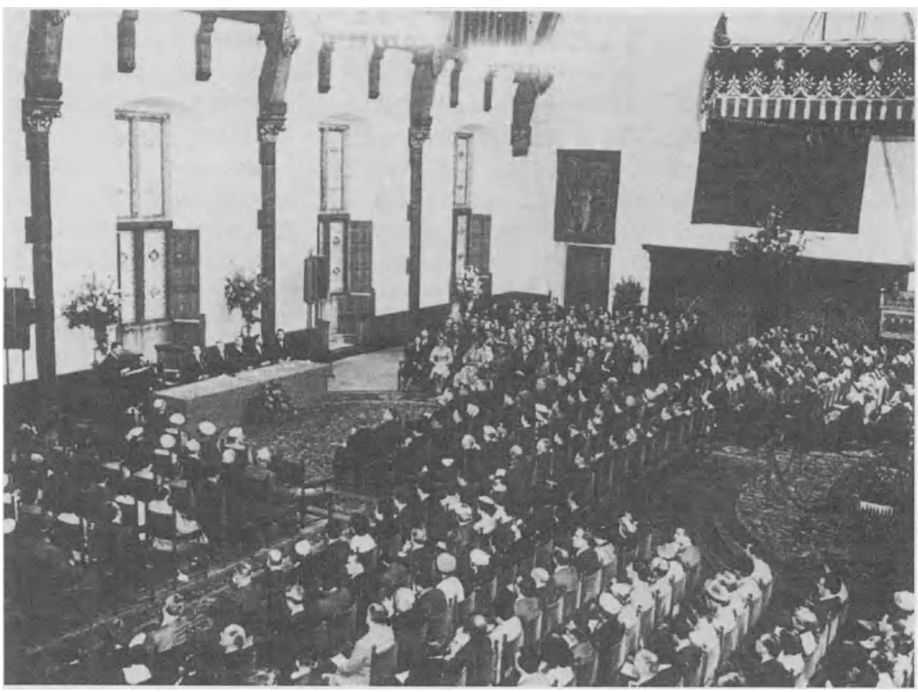

Fig. 1. Inaugural ceremony of the 1st World Congress of Anaesthesiologists on September 5, 1955, in the Throne Hall of the House of Parliament in The Hague, The Netherlands, (courtesy of Mrs. Van't Oever, Rotterdam)

ists numbering 600 from all over the world attended this Congress, at a fee of 30 Dutch guilders. During the Congress delegates and observers from all attending countries had several meetings, with the ultimate result that on 9 September 1955 the World Federation of Societies of Anaesthesiologists (WFSA) was founded [6]. Dr. H. Griffith was elected its first President and C.R. Ritsema van Eck became one of the Vice-presidents. (The World Federation is still legally registered in Amsterdam.) This Congress was an enormous stimulus for the development of anaesthesia, especially in Europe.

In addition to the organizational success, Dr. Ritsema's department was also very productive in experimental and clinical anaesthesia. Involvement in hypothermia and cardiac surgery was fruitful and resulted in several publications [7–12]. A respiratory care unit was started in 1956 and the heart-lung machine was used for the first time in Europe in Groningen in May 1957 [13–14].

During this period Dr. C.R. Ritsema van Eck travelled abroad a great deal, accompanied by his wife. He invited trainees to travel also in order that they should increase knowledge on special subjects and widen their views beyond the national borders. At Groningen, the Ritsema van Eck family lived in a modest appartment, furnished, as was customary in the Dutch East Indies of the old days, with a few wicker and rocking chairs and numerous plants and souvenirs. Many friends enjoyed their hospitality.

In 1959 his Department had been in existence for 12½ years, and the fact was commemorated amidst all his pupils. On that occasion he followed the old guild tradition by founding the "Groningen Anaesthetists' Guild". Later, recognition of his merits and capabilities followed (early 1960) with the appointment of a professorship [15]. That same year the Second World Congress of Anaesthesiology took place at Toronto, where C.R. Ritsema van Eck succeeded Dr. H. Griffith as President of the WFSA [16]. He fulfilled his office with great ambition. Together with his wife he attended most international congresses and other events, paid several official and non-official visits and propagated the idea of the WFSA, especially on behalf of those anaesthesiologists who had little support from their governments. C.R. Ritsema van Eck and his wife formed a team for the promotion of anaesthesiology all over the world.

His Department continued to expand. A separate monitoring room was installed next to the thoracic theatre, and in 1961 the surgical clinic was the first in the Netherlands to be equipped with a recovery room. His wish for a separate intensive treatment unit with the appropriate facilities was only fulfilled in 1970. The laboratory was rebuilt into a real intensive treatment and surveillance laboratory.

Despite his great reputation, C.R. Ritsema van Eck remained a modest man (Fig. 2). As leader of his Department, he established general principles, but was also precise in details. The syringes, for instance, always had to be arranged in strict order with the needles headed in one direction. In spite of the great many new drugs and developments, which came and went, his philosophy was rather conservative. His basic principle in administering a safe anaesthetic was to use as few drugs as possible in order to obtain a differentiated approach to the separate components of an anaesthetic. Under the all-seeing eye of the master these simple rules were taken to heart by his pupils, and his philosophy had many faithful followers. Even the surgical trainees could learn from him, and many of them will remember his admonition, "Don't wipe

Fig. 2. C.R. Ritsema van Eck

but dab". In other respects also he set an example which his pupils will always remember. Patients were, in his eyes, primarily human beings who needed help and assistance. In his daily life he devoted himself to all those who were in need of help or roused his sympathy. He was active in the Dutch Red Cross Organization and he rose to a very high position in freemasonry. No wonder that many honourary memberships and other distinctions fell to his share [17]. The crowning of his career was the nomination for *Ridder in de Nederlandse Leeuw* (Knight of the Dutch Lion). He always maintained his admirable philosophy of life and met all his problems with great wisdom.

On 23 August 1976, aged 71, this many-sided pioneer, who certainly deserves a place in the history of anaesthesia, died [18].

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2.12 The Pioneer Anaesthetists of Australia

G. Wilson

Extensive investigation of the shipping records in 1847 has shown that the news of anaesthesia came to Australia from England, where the first public demonstration of pain relief took place at University College Hospital, London, on 21 December 1846.

In 1847, a passage from England to Australia of 100 days was regarded as "splendid". It is also known that the first anaesthetists copied their apparatus from the drawing in the *Illustrated London News* of 8 January 1847. Thus, approximately 100 days after 8 January it could be expected that the news of anaesthesia would be published in Australian newspapers. This proved to be so, as paragraphs appeared in the papers in several Colonies in early May. By the first week in June anaesthetics had been administered both in New South Wales and Tasmania. This was a quite remarkable feat. To equal it, today's anaesthetists would have to be using a new and revolutionary technique within 33 h of its demonstration in London. Many hours of research have failed to answer the question as to who administered the first anaesthetic in Australia, and perhaps we shall never know, but certainly there can have been no more remote place in the world where anaesthesia was adopted with such speed.

John Belisario (Fig. 1), a dentist of Sydney, New South Wales, was the first person documented with certainty as having administered anaesthetics. He was a remarkable man, who was later known affectionately as the "Father of Australian Dentistry". His aptitudes and methods of practice were such as to make his early use of anaesthesia a matter of no surprise, for he had great mechanical ability and could manufacture or adapt apparatus with ease. He was also interested in all kinds of new equipment, for he had standing orders with firms in Great Britain and the United States for the latest appliances to be sent to him immediately. His first anaesthetics were given in late May or the first week of June 1847, for by 7 June, when the Editor of the *Sydney Morning Herald* visited his surgery to observe the new method, one of the patients to be anaesthetized had already received an anaesthetic on a previous occasion. Though Belisario's pratice was large and his day leisurely (his surgery hours were 10 a.m. to 12 noon and from 2.30 to 4 p.m.), he lost no time in advertising his new method of pain relief.

His apparatus was constructed from the drawing in the *Illustrated London News,* and for his first anaesthetics he had medical supervision and assistance from Dr. Charles Nathan, one of the first surgeons to Sydney Hospital. Dr. Nathan's letter to the Editor of the *Sydney Morning Herald* is the only slight indication of resistance to acceptance of anaesthesia in Australia, save the forcefully expressed opinions of the

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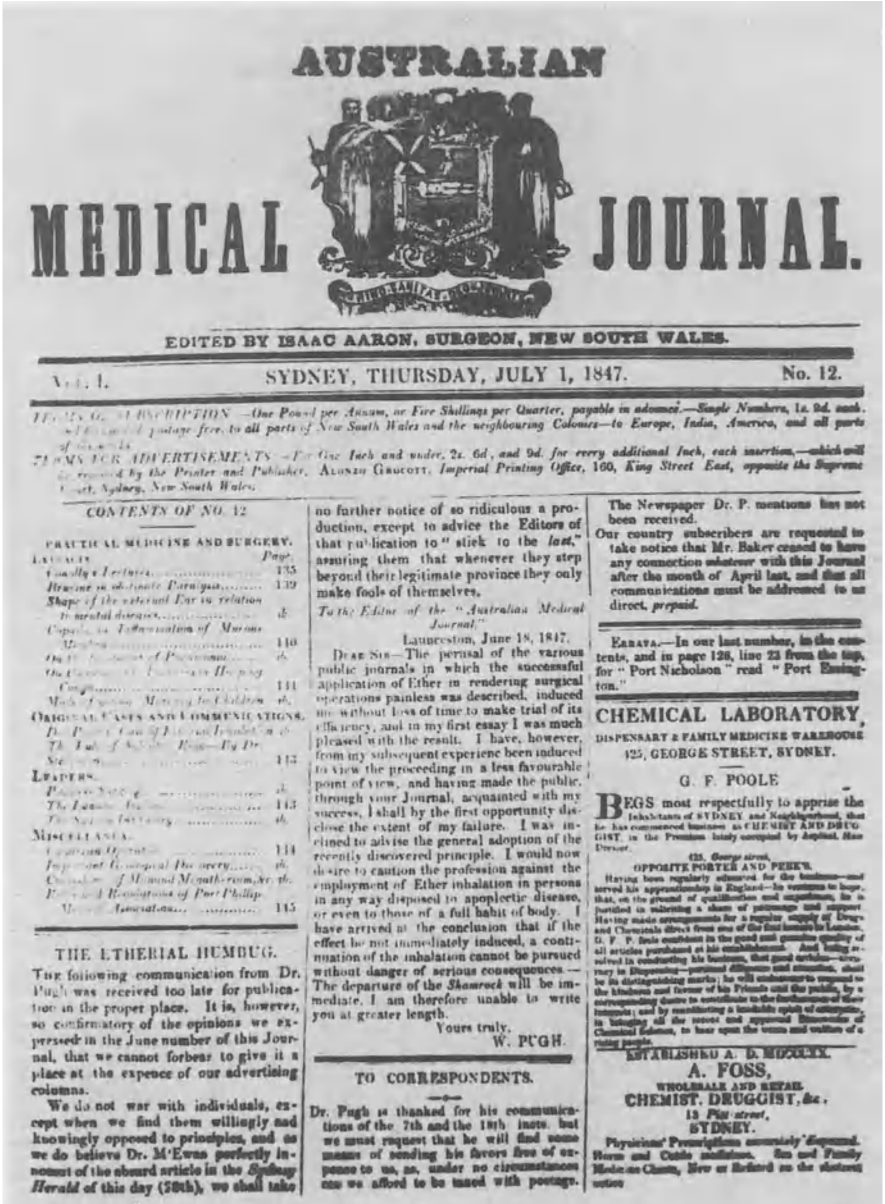
Editor of the *Australian Medical Journal,* who regarded it as a dangerous ephemeral fad.

The title page illustrated in Fig. 2 is that of an issue of the *Australian Medical Journal* of historical importance. It contains an article describing three anaesthetics given on 7 June, 1847 by Dr. William Russ Pugh (Fig. 3), Surgeon of Launceston, Tasmania, then called Van Diemen's Land. This account is unique, for it was written by the Administrator on the same day as the anaesthetics were given, which was not usual for the authors of the early articles in the medical journals.

For a long time I was puzzled as to why a doctor in a small settlement like Launceston, remote even from mainland Australia, would so rapidly undertake the administration of anaesthetics. The vessel the *Lady Howden* arrived at Hobart Town, Van Diemen's Land on 27 May, having left England on 29 January. Though Hobart was 2 day's coach journey from Launceston, by 7 June Pugh had distilled his ether, constructed his apparatus and chosen his patients. It is possible that the answer to this puzzle lies in a footnote in Dr. Frederick Cartwright's book *The English Pioneers of Anaesthesia* [1]. In the section on Henry Hill Hickman, Dr. Cartwright comments that Hickman's visit to France and his direct approach to King Charles X with his pamphlet on suspended animation may have been arranged through the auspices of a favourite artist to the French royal family, the Englishman John Glover. John Glover had

Fig. 1. Dr. John Belisario, Dentist, of Sydney, who gave the first ether anaesthetics in Australia, for dental extractions in Late May and the first week of June, 1847

Fig. 3. Dr. William Russ Pugh, who gave the first anaesthetics for surgical operations in Launceston, Tasmania, on 1 June, 1847



AUSTRALIAN MEDICAL JOURNAL.

EDITED BY ISAAC AARON, SURGEON, NEW SOUTH WALES.

Vol. 1. SYDNEY, THURSDAY, JULY 1, 1847. No. 12.

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THE ETHERIAL HUMBUG.

The following communication from Dr. Pugh was received too late for publication in the proper place. It is, however, so confirmatory of the opinions we expressed in the June number of this Journal, that we cannot forbear to give it a place at the expence of our advertising columns.

We do not war with individuals, except when we find them willingly and knowingly opposed to principles, and as we do believe Dr. M'Ewan perfectly innocent of the absurd article in the Sydney Herald of this day (28th), we shall take no further notice of so ridiculous a production, except to advice the Editors of that publication to "stick to the last," assuring them that whenever they step beyond their legitimate province they only make fools of themselves.

To the Editor of the "Australian Medical Journal."

Launceston, June 18, 1847.

Dear Sir—The perusal of the various public journals in which the successful application of Ether in rendering surgical operations painless was described, induced me without loss of time to make trial of its efficiency, and in my first essay I was much pleased with the result. I have, however, from my subsequent experienc been induced to view the proceeding in a less favourable point of view, and having made the public, through your Journal, acquainted with my success, I shall by the first opportunity disclose the extent of my failure. I was inclined to advise the general adoption of the recently discovered principle. I would now desire to caution the profession against the employment of Ether inhalation in persons in any way disposed to apoplectic disease, or even to those of a full habit of body. I have arrived at the conclusion that if the effect be not immediately induced, a continuation of the inhalation cannot be pursued without danger of serious consequences.—The departure of the *Shamrock* will be immediate. I am therefore unable to write you at greater length.

Yours truly,
W. PUGH.

TO CORRESPONDENTS.

Dr. Pugh is thanked for his communications of the 7th and the 18th insts. but we must request that he will find some means of sending his favors free of expense to us, as, under no circumstances can we afford to be taxed with postage.

The Newspaper Dr. P. mentions has not been received.

Our country subscribers are requested to take notice that Mr. Baker ceased to have any connection whatever with this Journal after the month of April last, and that all communications must be addressed to us direct, *prepaid*.

Errata.—In our last number, in the contents, and in page 128, line 23 from the top, for "Port Nicholson" read "Port Essington."

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G. F. POOLE

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Fig. 2. Title page of the *Australian Medical Journal* containing an article concerning the three anaesthetics given in 1847

Fig. 4. St. John's Hospital, Launceston, Tasmania, where Dr. Pugh's anaesthetics were given on 1 June, 1847

emigrated to Tasmania and lived 5 miles (8 km) from Launceston in a house called "Patterdale". He and Pugh undoubtedly knew each other, for they both belonged to the Launceston Group of the anti-transportation lobby. Perhaps Pugh had been indoctrinated and was prepared to accept the principle of suspended animation being produced by a gas or vapour; this would explain his early administration. His first anaesthetics were given at St. John's Hospital (Fig. 4), Launceston, which is today used as a Red Cross blood bank collection centre; thus it is possible that our modern anaesthetists in Launceston have a remote connection with Hickman.

The first anaesthetists in Melbourne, Victoria and Adelaide, South Australia were pioneers both in anaesthesia and in the small settlements, for in 1847 Melbourne had been established for only 12 years, and Adelaide for only 11. David John Thomas (Fig. 5), who gave the first anaesthetic in Victoria on 6 July 1847, has left vivid descriptions of the medical practice of the day, when a call to a country patient might mean 12 h of horseback riding. Indeed the first patient he anaesthetized, a man with a frightful gunshot wound, had been carried about for some 3 days on a rough cart before a doctor was found. He must have accepted the anaesthetic with sighs of relief. Thomas was one of the first surgeons appointed to the Melbourne Hospital and a member of the first medical society to be founded in Australia. The paper describing his first anaesthetic was the first to be read before this society [2]. He was also involved in the planning of the curriculum for the Medical School of the University of Melbourne and was a lecturer in the new school.

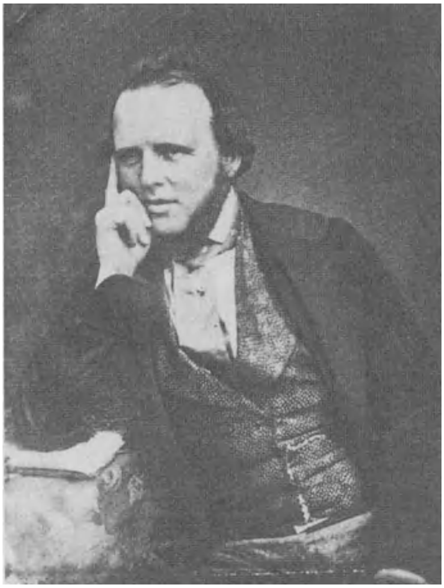

Fig. 5. Dr. David John Thomas, who gave the first anaesthetic in Victoria on 6 July 1847

Fig 6. Dr. Benjamin Archer Kent, who gave the first ether anaesthetics for surgical operations in South Australia in September 1847

Benjamin Archer Kent (Fig. 6), who gave the first anaesthetic in South Australia on September 30 1847, combined colonization with medicine. He arrived in Adelaide, as most settlers did, with a tent, a prefabricated house and the equipment for a brick-making business. The block of land he purchased was next door to the hospital, which still stands on the same site, and the area is known as Kent Town. His brick-making business did not prosper, and with the adaptability of the early settlers he converted it into a flour mill, which the colony lacked.

Although South Australia was the first Colony to receive the news of anaesthesia, when the ship *Lightning* arrived at Port Adelaide on the 3 May 1847, the first anaesthetic, as has been discovered, was not given until September. Kent appears to have been awaiting the arrival of some ether vapourizers from England, for as soon as Messrs. Beck, Importers, notified the Governor of the Colony of their availability, the first anaesthetic was given. It is interesting that there were two machines, one of which, even at that early stage, had an attachment for the administration of oxygen. It was more expensive than the other, and the Governor, in usual administrative fashion, directed that the cheaper machine be purchased for the hospital. On checking, it was even more interesting to find that oxygen was *available* in South Australia in 1847.

These then, were the known pioneers of anaesthesia in Australia, However, mention should also be made of Dr. Buchanan, Medical Officer of the Australian Agricultural Company's settlement at Port Stephens, 120 miles (190 km) north of

Sydney, New South Wales. Dr. Buchanan wrote a most remarkable letter, part of which was published in the *Sydney Morning Herald* of 6 July 1847. In it he refers to a previous letter of the "21st" and goes on to describe an ether anaesthetic given several days later. He states that he had no idea of the apparatus to use and so used "an ordinary bladder, such as is used for the administration of nitrous oxide". What was he doing with nitrous oxide, and did he write that letter referring to the 21st day of May, which would make him Australia's first anaesthetist, or was it written on 21 June, by which time he should have known of Belisario's apparatus? Much study has produced a good deal of information about communications between Port Stephens and Sydney, including the fact that the mails were faster in 1847 than they are today, but Dr. Buchanan and his anaesthetic are mysteries yet unsolved.

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2.13 Anesthesia and Resuscitation Equipment I Happened to be Involved With

H. Ruben

H. Ruben

In 1948 the American journal *Anesthesiology* showed a diagram of the Stephen–Slater nonrebreathing valve. Unable to acquire it quickly I tried to make a copy of it. I misinterpreted the drawing, so by chance I introduced changes in the design, which resulted in my very first anesthesia valve [1]. I showed that with it one could also introduce what now is called positive end-expiratory pressure (PEEP) [2]. Using the valve during controlled respiration needed two hands; therefore it did not comply with the demand of continuously monitoring the pulse. So in 1952 I devised another valve [3] in which the expiratory part was automatically closed when the bag was compressed. It contained two springs, made from watch balances and rubies, which supported its moving shaft. This valve, which a watchmaker helped me to make, is still manufactured with the same working principle, although its appearance has often changed. The early AMBU valves adhered to the same functional principles [4], and so did the E-valves which appeared in 1960, in which I had substituted silicone membranes for the valve discs and the springs. More than 1 million of these valves are in use – not including copies, of which one also carried the name "Ruben valve".

My valve was introduced long ago – before many of today's anesthesiologists were born. That may be the reason for the funny reactions I have experienced when meeting younger colleagues. Asked whether the "Ruben" of the valve was my father, and admitting to my own paternity, I several times got the reaction: "I thought you were dead." Once a confused anesthetist even addressed me as Dr. Valve. I like to confess to the personal thrill which I as a young anesthetist felt when I read the book on thoracic anesthesia by the famous professors William W. Mushin and L. Rendell-Baker [5]. It predicted that carbon dioxide absorption would remain essential, for example for thoracic anaesthesia, because its absence would mean much tiresome manipulation of spill valves. Shortly after, I proudly showed Prof. W. W. Mushin my valve, making the statement obsolete.

When improperly used, particularly when lung compliance is low and with hesistant bag release, backlash of gases my occur with the valve. As a result, some friends of mine teased me by calling the early nonrebreathing valve the "Ruben rebreathing

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valve." They stopped doing so when a change to the silicone rubber in the valves, even with stupidly slow bag release, practically eliminated backlash.

In April 1953 I took part in a meeting in Copenhagen of anesthesiologists and otologists. The latter often administered anesthesia themselves for minor operations at patients' homes. The anesthesiologists scolded them for neither having a suction-device nor bag-and-mask with oxygen available. The otologists pleaded that it was impossible to carry around heavy equipment. The controversy impressed me and led to the construction of my first resuscitator, a concertina-shaped device. This apparatus additionally allowed for administration of anesthesia as well as for suctioning of secretions. I tried to convince dr. H. Hesse, the founder of AMBU-TESTA company, that he ought to manufacture my very "useful piece of equipment." Unfortunately, the apparatus was very clumsy, being neither very practical for artificial respiration, nor for administering anesthesia, or even for suctioning. He asked me to delete from it all the not really essential functions. First the anesthesia part of it went. Next I admitted that artificial respiration might be done without it. But I remained firm on the need for a portable, independent suction apparatus. As a result, the foot-operated suction pump was constructed [6]. Soon several copies of it were marketed by other manufacturers.

One year later something of particular consequence happened. The Danish truck drivers bringing gasoline to the service stations went on strike. As a result, the lorries bringing oxygen to the hospitals were forced to a standstill by lack of gasoline. When the strike was finally called off, almost no oxygen was left in several hospitals. This inspired me to the construction of the self inflating bag resuscitator. I went to my bicycle mechanic, had him weld four bicycle spokes together, then manipulated the joined spokes into an anaesthesia bag. With the aid of an attached string, I obtained a globe-shaped frame, which kept the bag expanded. When manual compression of the bag was interrupted, their reexpansion made the bag self filling. It was followed by different metal frame constructions, filling the bag entirely with lumps of foam rubber – finally ending up by lining the bag with foam rubber, thereby leaving the center of the bag free. With it my nonrebreathing valve was used as an inflating valve, and an air inlet valve was put onto its tail. And that was it [7]. Apparently my idea of the self-inflating bag was also considered a good one by others. I have been shown copies of it from almost everywhere in the world.

Outside Scandinavia many anesthesiologists did not know of my paternity of the bag, which had quite funny consequences. Shortly after its appearance on the market, when I was visiting Dallas, I was shown a critical care ward and afterwards asked by the senior doctor to join him in his office. He wanted to show me "something". He showed me the AMBU resuscitator, explained its function to me and went on telling me about its usefulness and even its ingeniousness. I let him convince me. Another anesthesiologist told me, that he had guessed why the resuscitator is called "AMBU". It results, he told me, from combining the first letters in Air-Mask-Bag-Unit. Anyway, I was very happy when in 1964 my bag was declared by the American Medical Association to be among the most significant medical advances in anesthesiology of the last 25 years [8].

By the way, in 1958 I introduced occlusion of the oesophagus with a blocked inflated tracheal tube, thereby making lung inflation without gastric inflation possible in calves [9].

In 1957 I constructed the first manikin on which the proper use of the resuscitator could be trained. Apart from imitating facial anatomy, I incorporated an airway mechanism which only allowed lung inflation when forward movement of the jaw and backward tilting of the head was accomplished. I tested it with the local Red Cross Chapter in my own cummunity, Søllerød Røde Kors. One of its members, a painter, who was good in modeling, helped me to make its plaster head. In making the airway mechanism I was helped by the bicycle mechanic who had helped me with my valves, as well as by the watchmaker. Half a year later, hearing about experiments on expired air resuscitation, I also started using the manikin to teach mouth-to-mouth respiration. I began demonstrating and using it whenever I got a chance; for example, in October 1958 at the meeting of the Swedish Anesthesiology Association [10], as well as at an international NATO meeting in Copenhagen. In November when I began an appointment in Buffalo in the United States, at the Roswell Park Memorial Institute, I took the manikin with me. James O. Elam, the Direktor of the Anaesthesiology Department, was convinced of its essential teaching value, so we went together to a number of places in the United States to demonstrate it, including the Walter Reed Hospital in Washington, where they had started making a manikin which still had no airway mechanism. After my return to Denmark we modified its construction in order to protect against cross-contamination during use. A picture of it was shown. It was again demonstrated at the annual meeting of the American Society of Anesthesiologists (ASA) in Miami, on 7 October 1959. In 1959 we together suggested the nasal route of inflation as the first choice – experimental evidence had shown that the risk of gastric inflation then was lowered compared to mouth-to-mouth breathing – and introduced the head tilt method published [11]. The manikin was additionally supplied with a gastric mechanism, so that it could be used for the training of technique which lowered the risk of gastric inflation [12]. In 1960 the manikin had further mechanisms added for the training of closed chest cardiac massage [13]. Another teaching aid which I introduced, the sagittal airway model [12] had already been shown on Danish television in 1958 in a course on expired air resuscitation.

In addition, in 1977 the "Suction Booster" was presented [14], which speeds up suctioning, from three to ten times, depending on fluid viscosity. This effect is obtained without increasing the pressure of suction by moving the point of maximum suction – its vacuumbottle – closer to the patient, and by lowering resistance between it and the patient, namely by substituting a short, wide tube for the usual narrow suction tube. When the tracheal tube is attached to the bottle, preparedness for suctioning is maintained until the very last moment before the tracheal tube enters the trachea.

My interest in anesthesia systems started with my first valve [2]. My inflating valve was also used to improvise absorption circuits [3]. In the mid 1960s I devised what I called the "intermittently closed circuit" [15], because a new type of overflow valve which I had constructed stayed closed during bag compression but was wide open during expiration. After further developments it has now become a circuit with new properties [16]. The essential difference from other circuits is that the overflow valve now never requires adjustment, neither when changing between closed and semi-closed anesthesia systems nor between spontaneous and controlled respiration. The only circuit adjustment ever made is adjustment of the fresh gas flow rate. The risk of lung rupture, even with huge gas flows, is eliminated.

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3 Development of Techniques

3.1 Foreword

J. Alfred Lee

Those anaesthetists who attended the recent meeting in Rotterdam devoted to the history of our specialty will be pleased to have a second chance of familiarizing themselves with the contents of some of the papers read there. This chapter deals with the development of techniques. There is some evidence that the art of anaesthesia and the many aspects of anaesthetic administration are receiving less attention today than in the earlier years of the great anaesthetic renaissance which commenced in the 1930s and extended into the 1950s. If this is so, it is not reflected in our wishes when we or members of our families become patients ourselves. Then we all tend to ask a colleague to look after us whose technique is both skillful and applied with the greatest care. Technical excellence is what we then seek.

It has been brought to our attention that many ideas are introduced into practice by workers who genuinely believe them to be new, only to find out later that these same ideas have been described before. Some of the papers in this section outline the development of new concepts and thus we learn of "dissociative anaesthesia". On the other hand it is interesting to read a paper pointing out some of the advantages of simple inhalation of a volatile agent without the use of either relaxants or tracheal intubation as a viable technique for minimising the grave effects of the inhalation of stomach contents, especially in obstetric patients. Should this be regarded as a return to simplicity and common sense or merely a retrogression to the outdated practices of former times?

Practice usually follows theory after an interval of time, depending on how deeply held the theory is. This is shown in the changes in intravenous fluid infusion pre- and post-operatively. The history of some of these changes is well described from the times when normal saline was the only infusion fluid commonly used. We are also reminded of the advantages of warming blood during massive transfusions and on the beneficial effect which this practice has on cardiac function.

In many clinics the burst of activity in the 1950s in the use of phenothiazine drugs and the theories which sanctioned this, especially in France, has now died down. It is instructive to read about the approach to the control of "aggressology" by the employment of what were antiparkinsonian drugs, and associated with this, the beginnings of psychopharmacology. The concept of the "lytic cocktail" and of "artificial hibernation" has been much modified over the years, although we also read that it still has its friends.

General anaesthesia for bronchoscopy often caused difficulty before use of the Sanders injector technique was decribed in 1967. One way in which anaesthesia could

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be managed was by the cuirass ventilator, in 1957. Both it and the tank respirator used for the management of respiratory paralysis resulting from poliomyelitis in the 1930s were important innovations in their time. The development of the management of respiratory failure due to poliomyelitis is the subject of another paper. One of modern anaesthesia's greatest therapeutic triumphs was the introduction of intermittent positive pressure ventilation for poliomyelitis patients in the Copenhagen epidemic in 1952, when at the height of the scourge there were 92 patients being ventilated by hand by medical students and others. Following the successful management of the respiratory problems of these cases, the circulatory problems were studied and some of them elucidated. All would agree that the technique of induction of anaesthesia by intravenous barbiturates was an enormous boon both to patients and to anaesthetists.

The origin and progress of these techniques is well described and it is interesting to note that methods of intravenous anaesthesia introduced in Germany in 1932 and in the U.S. in 1934 are still widely used today. The story of the origin and development of halothane and of the amide-linked local analgesic drugs, both of them highly important as technical advances, is described. The progress in the use of various techniques of regional analgesia in the U.S. is well documented as is also, over the years, of pain relief in labour and the development of infant resuscitation. There is also an interesting description of the development of pediatric anaesthesia and of induced hypothermia in open heart surgery in Japan. We can read that a heart-lung machine was used in humans in Europe in the 1950s independently of the better-known models in the U.S.

The historical development of anaesthesia for neurosurgical operations is comprehensively set out here from the days when in the U.S. the anaesthetic was the responsibility of the surgeon, although administered by nurses or technicians under his direction, or as in the U.K. by anaesthetists who were forced to spend part of their time, for economic reasons, in general practice. Today, tracheal intubation with IPPV is the standard method in many neurosurgical clinics, world wide.

Years ago, it was not uncommon for an anaesthetist assembling his equipment, sometimes in an emergency, to find that a vital component might be incompatible with another equally important piece of apparatus. The history of the measures taken to minimise this state of affairs is herein recorded.

The development of scientific measurements has not been neglected in this section of the book as a perusal of the article on blood-gas and on acid-base measurements will confirm, but one contributor has made a timely plea to anaesthetists, warning them against relying exclusively on mechanical monitors and electronic read-outs for his information concerning the continued well-being of his patients. There is still wisdom in the old adage emphasised by one of our most senior and distinguished colleagues that throughout the time that a patient is being looked after by the anaesthetist, at least one of the anaesthetist's special senses – sight, hearing or touch – should be receiving its specific information. A visiting anaesthetist recently spent a month watching anaesthetics being given in a university teaching hospital without once seeing a colleague put his finger on the carotid pulse of a patient! As the science of the administration of anaesthetics develops, the art must not be neglected, and if eternal vigilance is the price of safety then that vigilance must be directed to the patient and not exclusively to the monitoring systems.

It is perhaps understandable that a compulsive scribbler like Virginia Woolf should write that nothing can be said to have truly existed until an account of it has been written down. If this is so, and there is something to be said for the dictum, then we have here ample proof of the many interesting happenings which have taken place in the development of the techniques of anaesthesia in the recent past. Max Planck's law states that a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it. It has been stated that each generation imagines itself more intelligent than the one that went before it and wiser than the one that comes after it. Close attention to the many excellent papers in this book will convince readers that neither of these statements is completely true when applied to modern anaesthetists.

3.2 The Forgotten Foundations of Modern Closed-Circuit Anesthetic Technique

R. W. Patterson

Modern closed-circuit anesthesia employs the technique of introducing a variable mass of anesthetic agent into the rebreathing circuit sufficient to maintain a constant anesthetizing tension at the central nervous system active sites. This method has both a theoretical and a physical foundation. An understanding of anesthesia uptake, the distinction between volume saturation and anesthethetic tension equilibration, and a means of precision administration of volatile vapors are required.

This review will cite early studies leading to comprehension of these concepts of ventilatory mass movement of the anesthetic, its transfer into the blood, and subsequent circulatory mass movement to the tissues for selective uptake. This knowledge enabled the thoughtful design and construction in 1913 of an automatic machine that encompassed all of the modern-day concepts of uptake, distribution, overpressure, and equilibration. The aims of closed-circuit administration could scarcely be more succinctly stated than those expressed by Karl Connell, the inventor of the "Anesthetometer". "With the data at present in hand the most advantageous anesthetization can be plotted in advance for the type of individual and for the nature and stage of the operation, and maintained after the preliminary stage entirely automatically" [1].

The period of accurate administration of any desired concentration of a volatile anesthetic began with the preliminary experiments of John Snow in 1847 to determine the quantity of ether vapor taken up by air at different temperatures [2]. In 1858 he published calculations of the volatilized volume of chloroform vapor, derived from the molecular weight and density of the liquid anesthetic.

Clover continued the practice of precision administration by having his patients inhale a known chloroform concentration from a large reservoir bag. For instance, a 4% mixture of chloroform in air would be prepared in advance by injecting with a syringe 1 ml of liquid chloroform into a vaporizing chamber heated by hot water. Then he pumped with a bellows 7 liters of air through the vaporizing chamber and collected the air/ether vapor mixture in a bag for dispensing. He was well aware of the differing patient responses obtained by varying the inhaled concentration [3].

In similar fashion Spenzer in 1893 performed experiments by which he determined the percentage volume of inspired ether that would induce and maintain narcosis in cats and dogs [4]. An ether and air mixture containing, according to calculation, 6.7% by volume produced complete anesthesia in 25 min, and this mixture could be inspired indefinitely without untoward symptoms. With refinement this concentration that produced immobility and could be indefinitely respired would be later equated with anesthetic tension at the active site, anesthetic potency, and minimal alveolar concen-

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tration (MAC). Thirteen years after Spenzer's initial investigations the anesthetic and lethal blood concentrations for chloroform were reported [5].

Spenzer's experiments substantiated two effects observed during clinical practice. If the inhaled concentration was such that muscular activity was quickly (immediately) suppressed, the longer the administration the "weaker" the patient became. On the other hand, if onset was slower because of a lesser concentration, absence of motion could be achieved with time.

Insight into this quandary was given in 1897 by Zuntz, who was concerned with the progression of the saturation of the body with nitrogen after sudden exposure to high pressure of air [6]. He formed a rough general idea of the average rate of saturation by assuming as a basis of calculation that the blood (5% of body weight) is evenly distributed throughout the body and that the tissues are similarly constituted in all parts (assumes tissues = water = blood). Hence the amount of nitrogen held in solution in the body when it is completely saturated at any given pressure will be about 20 times (100%/5%) as great as the amount present in the blood alone. If, therefore, the blood distributed itself evenly and at the same rate throughout the body, the latter would have received, at the end of one complete round of blood after sudden increase in air pressure, 1/20 of the excess of nitrogen corresponding to complete saturation. The second round of the circulation would add 1/20 of the remaining deficit in saturation, i.e., 1/20 × 19/20 of the total excess. The third round would add 1/20 (19/20 × 19/20) of the total excess, etc. Thus the progress of the saturation of the body with nitrogen (and other inert gases, including volatile anesthetics) is a logarithmic curve.

By 1907 Vernon had made a number of determinations demonstrating that body fat at body temperature takes up about six times as much nitrogen as an equal weight of blood [7]. Hence it may be estimated that the body fat – assumed to be 15% of the body weight in a well-nourished man – will, when saturated at any given pressure, take up on average, weight for weight, about 70% more nitrogen in simple solution than the blood under the same conditions, and that the whole body of a man weighing 70 kg will take up about 1 liter of nitrogen for each atmosphere of excess pressure.

Haldane then recalculated the logarithmic uptake on the basis that the amount of nitrogen held in solution in the body when it is completely saturated at any given pressure will be about 35 times as great as the amount present in the blood [8]. His findings that half the total excess of nitrogen would have entered the body after 23 rounds of the circulation, three-quarters after 46 rounds, seven-eights after 69 rounds, etc. demonstrated a marked slowing of uptake as a result of the fat stores. He estimated the volume of blood passing through the lungs of a resting 70-kg man to be 3.5 liters per minute. He further assumed the total blood volume to be 3.5 liters, so that a volume of blood equal to the total blood volume was assumed to pass through the lungs about once a minute. Therefore minutes may be substituted for rounds of circulation, and the body of a man exposed to an increase in nitrogen pressure would be half saturated with the excess in 23 min, three-quarters saturated in 46 min, etc.

However, he noted that this calculation affords at best only a very rough general idea of the actual rate of saturation, since other determinants would be the by then known variable distribution of blood per unit of body weight through various parts of the body, the variable rate of circulation through any given part according to whether the part is at rest or in a state of activity, and the variable proportion of fat and fatty material in the various parts of the body. Reports already existed from two laboratories which afforded direct experimental evidence for far more rapid (and slower) saturation in some parts of the body [8, 9].

Far more important than these refinements to the conclusions of Zuntz, Haldane demonstrated a process for rapid safe decompression of divers without the lengthy procedure that would be required by the logarithmic constraints just mentioned. His decompression graphs resemble the mirror image of what we refer to as overpressure and provide insight into methods for accelerating the lengthy process of anesthetic uptake [8].

Concurrently there were additional determinations of blood gas partition coefficients [10, 11], of the effect of ventilation on alveolar gases [12], of blood volume, and of cardiac output. A value of 0.146 ml of oxygen per ml of dogs, arterial blood was obtained by Sheffer, working in Ludwig's laboratory. Arbitrarily combining this dog value with the total carbon dioxide output per minute for man, Adolph Fick published in his 1870 textbook an estimate of 4.6 litres/min for the resting cardiac output of man. There was a considerable hiatus between the enunciation of the value and its experimental demonstration. In 1886 there was a short paper in the *Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences (Paris)* by Gerhart and Quinquand describing measurements of the blood flow in dogs, and in 1898 Zuntz and Hagermaun described measurements of the cardiac output of the horse. Nathan Zuntz, who had trained in Pflüger's laboratory, went on to discover the nitrous oxide method for measuring cardiac output. This method, published in 1911, was based on the absorbtion into the pulmonary bloodstream of an inhaled foreign gas, on the principle that the faster the blood flow the more gas is taken up [13].

By 1913 Connell was able to summarize the knowledge and the state of the art by enumerating the facts relating to ether dosage that he considered in designing "automatic, unwearying, impersonal machine delivery of the anesthetic agent ... for ideal anesthesia" [1].

First, the ether tension in the arterial blood to the sensorium is the determining factor of anesthetization.

Second, this tension is established by maintaining in the alveolar air during preliminary narcosis an ether content of from 35 to 45 per cent by weight to air (equivalent of from 130 to 182 mmHg). For the first 20 to 40 minutes of the early stage of anesthesia this tension must be maintained by percentages from 26 down to 15%. This latter percentage, the equivalent of an ether pressure of 48 mmHg in the alveolar air, is continuously maintained following the etablishment of anesthetic saturation of the body.

Third ... the variable factors seen in ordinary etherization being these: (a) the rapidity with which the body is brought to complete anaesthetic saturation, as determined by the efficiency with which the ether tension in the alveolar air is maintained by fresh delivery, by diffusion and by tidal movement; (b) the rapidity of blood circulation; (c) the bulk of the particular body to be saturated and the capacity of that body for storage and destruction of the ethyl radical.

Fourth, the zones of anesthesia above and below this saturation or anesthetic tension point are already well established for man. With absolute certainty as to the outcome man may be placed in an ether atmosphere of that percentage of vapor pressure as to produce deep, medium or light anesthesia.

Fifth, the zone of surgical relaxation, i.e., an ether pressure of 45–50 mm is a zone for many hours devoid of danger by ether intoxication.

The principal design feature of the "Anesthetometer" as an ether vaporizer was to utilize the mechanism that metered the gas volume delivered to the patient to activate a unit that dispensed the proper amount of ether into that volume, thus maintaining an exact percentage by weight of ether to air [14].

Air or gas under pressure passed through a commercial dry type illuminating gas meter activating its usual recording dials. The same gear which drove the registering hand moved a revolving disc on which were placed a series of eccentric holes. One end of a ratchet assembly contained a pin to be inserted in one of the disc holes; the other end engaged teeth which rotated a central screw upon which a piston rode. Revolution of the disc (activated by the gas flow) activated the ratchet arm, thus causing the piston to descend. Descent of the piston displaced liquid ether out of the reservoir into a heated chamber.

From 1 tooth up to 16 teeth might be moved by the meter with each revolution, depending upon the set of the pin on the disc. The movement of one tooth displaced such a weight of ether (0.1 g) that this, when added to the air passed by the meter in one revolution (4 liters of air), resulted in a mixture of 2.18% by weight of ether vapor in air. The number of teeth moved with each revolution of the meter depended on the eccentricity of the hole on the disc. Thus the ratio of this feeding mechanism could easily be shifted (from 0 to 16 teeth) by replacing the pin on the disc so as to automatically add ether from 0 to 26% by weight to the air as it passed through the vaporizer.

This machine was easy to use (compared with the other available methods – measurement of explosibility and the Waller balance) and so accurate in its concentrations that it became the standard for investigations. Connell, however, had designed it for clinical work believing that it would "undoubtedly become the method of choice as a routine, when the length of operation warrants the establishment of a scientifically maintained ether balance, as for example in operations upwards of ten minutes in duration." This certainly described the 3 to 5-hour operations being performed at that time by the Boston neurosurgeon, Dr. Harvey Cushing; his anesthetist, Dr. Walter M. Boothby, reported in 1914 his experiences and technique using the Anesthetometer [15]. Dr. Boothby's clinical investigations had demonstrated that in man 50 mmHg ether is the "anesthetic tension", i.e., "the lowest partial pressure of ether vapor which, when continuously respired, will maintain an ideal surgical narcosis after it has been once established." His method of producing narcosis using overpressure was to manipulate the eccentric pin settings on the rotating disc mechanism of the Anesthetometer so to as to increase gradually yet rapidly over 4–7 min the vapor tension of ether to about 100 mmHg, holding it at this point for 2–4 min. By resetting the pin on the rotating disc the tension is gradually lowered, during the following 30 min, to a pressure of about 54 mm. "By this method, the patient is sufficiently anesthetized at the end of about 10 minutes to allow cleaning the skin and further preparation of the operative field. Complete anesthesia occurs in about 15 minutes, at which time the incision can be made without any reflex movements."

The precise anesthetic tension delivered to the patient is noted minute by minute on Dr. Boothby's anesthetic records [15]. His findings that the required anesthetic was decreased in some circumstances and not influenced by other factors preceded and predicted similar observations relating to MAC made 50 years later.

In June of 1913 Karl Connell, in reading a paper before the American Association of Anaesthetists, entitled "Accuracy in anesthesia", referred to the lack of scientific progress in administering surgical anesthesia in the previous 60 years [1]:

> While the art of Anesthesia advanced with the increasing demands of surgery; while the lore of the individual anesthetist was accumulated, yet each surgical narcosis was achieved according to the personal recipe of the given anesthetist. Largely because of the difficulties of confining and measuring matter in such an elusive state as the gaseous, that precision and accuracy of dosage which came to be deemed essential in the administration of liquid and solid drugs, secured no place with the volatile anesthetics. Anesthetization was accomplished according to certain empirical methods and formulae, guided by the reaction of the individual.... These methods permit of no formulation, uniform results cannot be achieved, nor can methods be standardized. Therefore, the trend of the present is towards that exactness of dosage and perfection of delivery, that will place anesthesia on the basis of an exact science. This dosage in its highest refinement can only be secured by automatic mechanical measurement and delivery.

The "trend of the present" he spoke of was an epitaph for the following decades and a prophecy only for the future, for it took 30–50 years to again achieve the precision that was recorded in the journals of 1913–1914.

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3.3 The Use of Alcohol for Anesthesia by Miguel García-Marín

J. A. Aldrete and J. Aldrete-Velasco

From unknown times, men and women have resorted to the effect of alcoholic preparations in order to alleviate their physical and psychological pains. Inebriation with wine and other fermented potions were favorites, but only when large quantities of them were ingested was there actual pain relief. In the early nineteenth century, Philip Syng, a physician from Philadelphia, recommended the use of intoxicating amounts of alcoholic beverages in order to allow for muscle relaxation and pain insensitivity before manipulating fractures and dislocations [1]. One of the first pharmacologic studies that assessed the effect of ethanol was conducted by Schmiedeberg in 1883, who thought that its action on the central nervous tissue was by extracting water and precipitating proteins [2]. In 1921, Nakagawa attempted to produce surgical anesthesia by infusing mixtures of 7% ethyl alcohol plus 5% ether in saline, or 0.63% chloroform in saline; however, the resultant effects were unsatisfactory. Although he proposed to double the concentrations in order to achieve the objective, he dared not to put it into practice [3].

Thereafter, several related publications have quoted the research findings of a young Mexican medical student who conducted a variety of observations during intravenous infusions which achieved surgical anesthesia with intravenous ethanol [4]. Interestingly enough, the opinion cited by all the authors [5, 6, 7] who subsequently wrote on the subject was that of the Mexican Academy of Mexico, who scrutinized the original work and condemned it because of what was thought at the time to be an undue amount of complications, are quoted by Adams [8]. However, the original thesis with which Miguel García-Marín graduated from the Medical Faculty of the National University of Mexico has not been available until recently, when an extensive search by one of the authors (J. A-V.) revealed the original manuscript.

Preliminary Laboratory Observations

Miguel García-Marín, while reading how in Roman times alcoholic inebriation was utilized to conduct amputations without pain, started thinking about the possibility of using the same drug by a different route. As a medical student in 1925 he had witnessed the prolonged induction and frequent complications that patients endured while being anesthetized with ether or chloroform by inexperienced personnel. With little laboratory experience of his own, and no encouragement from the professors from whom he sought advice, García-Marín proceeded to administer ethanol of 96

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proof (USP) to a variety of animals including: pigeons (90), hens (17), turkeys (8), and dogs (72). The experiment resulted in 30% mortality, 60% unsatisfactory anesthesia, and in only 10% of cases was anesthesia considered adequate. With a determination that characterized many of the anesthesia pioneers, the young student diluted the ethanol down to 60 proof, and, after giving it to pigeons (14), hens (10), turkeys (1), and dogs (75); the mortality was reduced to 15%; in 10% of the animals there was no

CUADRO QUE RFSUME LAS EXPERIENCIAS E INDICACIONES DE LOS RESULTADOS

INVESTIGACIONES	ESPECIES: PALOMAS	GALLINAS	GUAJOLOTES	PERROS	MONOS	TOTAL	MUERTES %	FALTAS ANEST. %	Anestesias Perf. %	OBSERVACIONES
Efects. Anests.	90	17	8	72	..	187	30	60	10	
Diluciones.	14	10	1	75	..	100	15	10	75	
Dosis.	8	2	..	90	..	100				1 de cc. por K. de peso en la indiferente; 2 a 3cc. por K. de peso es la anestésica; 6 a 8 cc. por K. de peso es la rápidamente mortal y 5 a 6 cc. por K. de peso es dósis mortal dentro de las primeras 24 horas.
Mezclas.				200		200	5		95.	Suero glucosado hipertónico al 250 por mil a partes iguales de alcohol es la mejor mezcla.
Ap. respiratorio.				110	2	112				Necesidad de inyección previa de atropo-morfina.
Ap. circulatorio.				3		3				
Ap. urinario.				2		2				
	112	29	9	552	2	704	50	70	180	

Fig. 1. Reproduction of the original series of animal experiments indicating the species, numbers, and totals. The percentages of deaths, unsatisfactory anesthesia, and "perfect" anesthesia are also listed. On the column on the extreme *right* are the observations describing doses, dilutions, and types of solutions used. The progress, as shown by a reduction of mortality and failed anesthetics reflects the remarkable intuition and persistance of Miguel García-Marín

apparent anesthesia, while in the remaining 75% it was considered successful (see Fig. 1).

In order to determine the "indifferent" (noneffective) anesthetic and lethal doses, he utilized another 8 pigeons, 2 hens, and 90 dogs, having arrived at the conclusion that anesthesia was achieved with 2–3 ml of 96 proof alcohol per kilogram of weight. Death within 24 h occurred when 5–6 ml/kg were given. Higher doses resulted in immediate death (see Fig. 1).

By this time he had noted that many of the experimental animals that survived developed hematuria, which he traced to the fact that he was using distilled water as diluent. After repeated attempts, an isotonic solution was prepared with equal parts of alcohol and hypertonic glucose, ending with a solution of 35 proof. These observations were carried out in 200 dogs with 95% success.

Further studies were conducted in 50 dogs and 2 monkeys with the purpose of assessing the effects on respiratory functions. Using pneumographs, García-Marín recorded a short period of excitation, tachypnea, and altered respiratory rhythm for about 5 min during early induction. He noted that this period could be shortened and the induction made smoother if 30 min before hand he gave to the dogs 10 mg of morphine and 1.0 mg of atropine (see Fig. 1). When one of these animals became apneic, he treated it by compressions of the thorax and rhythmic tractions of the tongue, about 60 per minute.

He also measured arterial blood pressure (carotid) and pulse, recording them by means of Ludwig's smoke chymograph, having observed only slight decreases on both during alcohol anesthesia. White and red blood cell counts, as well as blood smears, failed to show abnormalities. The bladder was noted to be consistently "plethoric" with urine, containing a concentration of "0.20 per litre" of ethanol.

Autopsies performed in the animals that succumbed revealed cerebral congestion, as well as slight pulmonary and marked hepatic, renal, and splenic congestion. The heart was found dilated and the bladder full of urine.

Various surgical procedures were performed in the dogs anesthetized with ethanol, including craniotomies, abdominal explorations, hepatic resections, mastectomies, vascular anastomosis, open reduction of fractured bones, and bowel anastomosis.

After the extensive experience gained in animals, García-Marín requested permission from his professors to try his technique on patients. Permission was denied repeatedly, so then he asked the government authorities if he could try it on a convict waiting for the death sentence to be carried out, with the condition that if the patient survived he would be sent free. While waiting for a volunteer, one of his teachers, Dr. Alejo Larrañaga, was kind enough to let him try it on a patient with carcinomatosis who was to undergo an exploratory laparotomy. On 26 July 1928, in the Sanatorio (Clinic) San Agustin of Mexico City, Miguel García-Marín, still a medical student, anesthetized an extremely ill patient with 40 ml alcohol of 60 proof for a period of 35 min; the operation lasted for 20 min. The patient recovered uneventfully, and the anesthetic was considered a success (Table 1). A second case was attempted a few days later on a comatose adult male with a fractured skull: 40 ml alcohol of 96 proof were given IV, diluted with 1/3 of distilled water. During the skin incision for a hemicraniectomy, the patient showed signs of feeling pain, so García-Marín suggested that the anesthetic be complemented with ether.

Table 1. Observations made during the first anesthetic given with intravenous alcohol

	Preoperative	Transoperative Induction	Maintenance	Postoperative
Pulse	92	120	92	92
Blood pressure	110/65		110/65	110/60
Temperature	?	unchanged		unchanged
Respirations	22	15	22	22
Pupils	reactive	dilated	constricted	reactive
Fluids	500 ml 5% dextrose SC	40 ml alcohol + 40 ml "25% dextrose" in water		–
Medication	morphine 10 mg			–

SC, subcutaneously

A summary of another 17 cases is shown in Table 2. All but one patient received 10 mg morphine between 90 and 30 min before surgery; case # 2 was not premedicated; case # 4 received Sedol. Alcohol of 60 proof was administered, having been diluted from the 96 proof with distilled water. All data were not available in every case. In addition, 23 more cases are reported in the thesis by García-Marín. It is worth mentioning that after 31 October 1928, when it was realized that by mixing ethanol of 60 proof with "25%" dextrose solution, clots were not formed and no more instances of hemoglobinuria were seen in the last 18 patients.

On several occasions, García-Marín mentioned the "improvement of the pulse" after the initiation of the alcohol infusion. In one specific case of severe hypotension from hemorrhage, the injection of 5 ml alcohol of 60 proof and 10 mg morphine "restored the blood pressure and pulse to normal levels."

Liver function studies, blood chemistries, blood smears, and urinalysis were performed in about 10 patients, before and after surgery; results showed little evidence, if any, of alteration that could have been attributed to the ethanol given.

Technique

Early in his animal experimentation García-Marín confirmed that, in vitro, alcohol clotted blood, a fact that was well known. So he concluded that the early deaths in some animals were due to the injection of clotted blood along with the alcohol. He noted that as the venipuncture was made with a syringe containing ethanol, the common practice of aspiration – in order to identify the vein's lumen by entry of blood into the syringe – produced an immediate clot that precipitated into the dependent portion of the syringe. Initially to overcome this difficulty, he pushed the syringe's plunger, thus injecting the alcohol into the vein, as soon as the stream of blood insinuated. Later on, he designed an ingenously simple combined infusion set that allowed him to start the venoclysis with a solution of glucose and water or saline, and then to infuse the diluted alcohol with an even more hypertonic solution of water and "25% dextrose" – puzzling indeed (see Fig. 2). Both connected through a "Y" that permitted the simultaneous drip of either one or both solutions. He mixed his solution, combining 150 ml alcohol of 96 proof (as purchased from drug stores) with 150 ml "25% hypertonic dextrose", totaling 300 ml. The initial dose was 2–3 ml/kg, but García-Marín noted great variability of response from patient to patient. His

Table 2. Summary of the first 19 cases anesthetized with alcohol

No.	Age	Sex	Physical status*	Diagnosis	Alcohol quantity	Transoperative complications	Operation	Postoperative complications	Duration of anesthesia	Date
1	43	M	IV	Carcinomatosis	40 ml	None	Laparotomy	–	35 min	7/26/28
2	?	M	IV–E	Fractured skull	40 ml	Patient moved; used ether	Craniectomy	–	10 min	–
3	30	F	IV	Fractured skull, clavicle, and femur	80 ml	Responsive[a]	IF of clavicle	Died 3rd postop. day, of ruptured liver	1 h 10 min	9/19/28
4	26	F	I	Perineal abscess	120 ml	–	Colpotomy	Hemoglobinuria	?	10/ 5/28
5	?	M	III–E	Stab wound of abdomen	120 ml	Responsive[a]	Repair of bowel lacerations	–	1 h 25 min	10/ 7/28
6	22	F	II–E	Vaginal laceration	100 ml	–	Repair of lacerations	Hemoglobinuria; emesis	–	10/ 1/28
7	13	M	I	?	60 ml	Felt pain used chloroform	Elbow's amputation	Hemoglobinuria	–	10/ 2/28
8	?	F	–	?	40 ml	–	D and C	–	–	10/ 3/28
9	?	F	–	Metritis	100 ml	–	D and C	–	–	10/ 4/28
10	38	F	III	Abdominal pain; liver disease	125 ml	Brief apnea	Lysis of adhesions	Died 10th day, of pneumonia	1 h 15 min	10/ 3/28
11	26	M	I	Forearm laceration	120 ml	–	Neurorraphy	–	–	10/ 1/28
12	26	F	I	Osteomyelitis of femur	120 ml	–	Femur curettage	Hemoglobinuria; emesis	–	10/ 8/28
13	27	M	I	Inguinal hernia	120 ml	–	Herniorraphy	–	35 min	–
14	16	M	II	Gunshot wound; nephritis	60 ml	–	Thoracotomy	–	–	10/16/28
15		F	I	PID	120 ml	–	Colpotomy	Hemoglobinuria	–	10/13/28
16		F	IV	Fractured clavicle; lung contusion	80 ml	–	Osteosynthesis of clavicle	Died 15th day, of respiratory failure	–	10/20/28
17		F	II	CA of cervix	150 ml	Overdose	Subtotal hysterectomy	Died 3 h postop. of vaginal hemorrhage	18 min	10/25/28
18	18	M	I	Varicose ulcer	?	–	Sympathectomy	–	–	10/24/28
19	20	M	I	Gunshot wound	?	–	Debridement	–	–	10/20/28

PID, pelvic inflammatory disease; IF, internal fixation

[a] Patients were responsive during surgery but without pain. – In cases 8 and 9, García-Marín was called to anesthetize the patients shortly before surgery

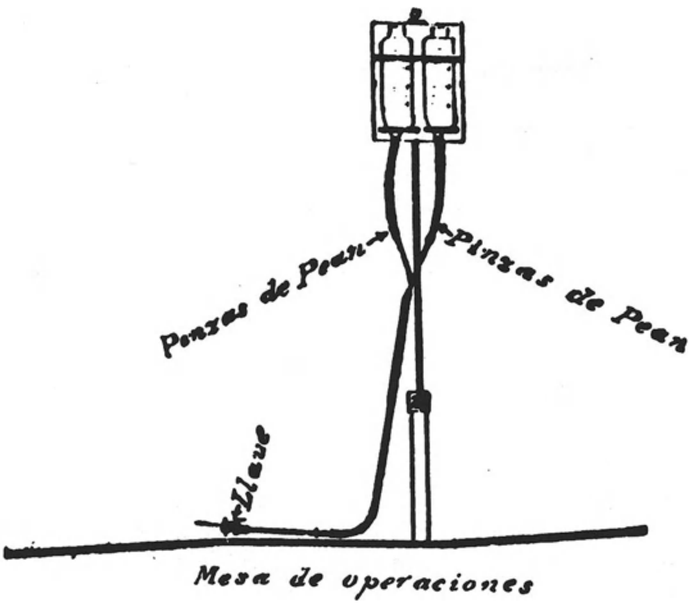

Fig. 2. Reproduction of the original intravenous set, with one bottle containing a solution of alcohol of 60 proof and another bottle containing 5% dextrose solution. The separate controls allowed the operator to keep the venoclysis open and administer glucose and fluids, a rare occurrence indeed in García-Marín's day

guidelines for supplementation were as follows. If pupillary dilatation appeared with stimulation, the infusion was started again. However, if instead of producing miosis, midriasis continued, the line of the ethanol was shut off and that of the 5% sugar solution was opened. Similarly, if some patients went to sleep and showed signs of anesthesia, even before receiving the initial dose in its entirety, the alcohol infusion was discontinued and the other fluid allowed to drip.

It was recommended that the bottles containing the infusions were placed about 125 cm higher than the operating table and that a needle "not too large or too small, in other words, about the gauge of those used for spinal anesthesia" should be used. If a very small gauge needle was utilized, the patients took a long time for induction; however, if a larger needle was used, then it was noted that respiratory disturbances (probably apnea) would occur.

For preparation of the patient, 4 g chloral hydrate po was given the night before. One hour before surgery, most patients received 10 mg of morphine. Profound silence was imposed on the theatre, the patient's eyes were covered with a towel, and the ears filled with cotton.

Iodide, as antiseptic, was not applied until the anesthetic state was achieved, and during the infusion unnecessary questions or noises were avoided, otherwise a greater amount of ethanol was required.

In the case of apnea, the mandible was dislocated and rhythmic tractions on the tongue were applied; if necessary, artificial respiration was given, followed by 0.25 mg adrenalin IV. If the pulse became "weak," 5 ml Alcanfor were given. On the next day, patients could have tea, and diuretics on the following day.

Advantages

As means of persuasion, Miguel García-Marín listed the following as advantages of his technique:

1. Simplicity – no need of anesthesia apparatus, thus freedom from the inherent dangers of machine malfunction or incompetent operators.
2. Elimination of one of the assistants, since the same individuals in the surgical group could administer the infusion.
3. Elimination of the mask necessary for general anesthesia, which was a hindrance when operations were performed on the face or neck.
4. Possibility of utilizing the properties of dextrose and water as diuretic, disinfectant, and nourishment, combined with the diffuse stimulating effect of ethanol.
5. Alcohol had no toxic effects on kidney of liver function and did not irritate the mucosas, as did some of the anesthetics then used.
6. By administering dextrose and water, acidosis and shock could be avoided.

According to the author, intravenous alcohol would be indicated as anesthetic for operative procedures on the head; for debilitated elderly patients, without tuberculous lesions; as well as for any other patients, especially those who had sustained blood loss. However, it should not be given to children under the age of 10 because they are highly sensitive to the alcohol and the morphine that has to be given before hand. It was also contraindicated in advanced pulmonary tuberculosis with cavitary lesions, as well as for patients with heart failure.

Lastly, as recommendation, García-Marín called upon anyone interested on trying his technique to remember the wise phrase of Tillaux, that it "is best to let them die, than to kill them", a maxim still applicable today.

Corollary

It was indeed remarkable how a young medical student with little research background, without sophisticated apparatus, and without government grants conducted what was in his time a revolutionary approach to anesthesia. In spite of enormous odds, he systematically arrived at a dose of alcohol that would anesthetize animals with little mortality, noticing that he could manipulate the depth of anesthesia. With a rather unusual determination, he eventually persuaded one of this teachers to allow him to administer it to a patient. Upon apparent success, he was then called upon to anesthetize up to 42 patients, with various results. This experience was summarized in his thesis, with which he graduated as physician and surgeon from the National University of Mexico some 31 years before I did. It is of personal interest that some of his classmates, who were mentioned as "assistants" in some of the operations performed, were my professors; thus the characters are real, though I knew little then of their relationship. The achievement of García Marín, albeit limited in its current application, shows that ingenuity and perseverance – qualities shared by Wells, Morton, and Koller, to mention a few – can come to fruition.

Later, the Mexican Academy of Medicine [9] scrutinized and perhaps too severely criticized the work of García-Marín because of the high incidence of phlebitis and phlebothrombosis produced by IV ethanol. This report came about when the National University of Mexico asked the Academy whether García-Marín deserved a special award for his work. With undue wrath, a Commission charged with investigating the matter was harshly critical because information had been given to the news media, and the merits of the technique had been openly discussed at a session of the Chamber of Representatives. The Commission also disapproved of García-Marín's presentation of his results before the Fifth International Congress of Military Medicine and Pharmacy at London. Subsequently, a report of two cases of anesthesia using the García-Marín method appeared in the *Lancet,* written by D. Constantin, an anesthetist from General Miller's Hospital of Greenwich [10]. During the same European venture, *Le Siècle Médicale* published an encouraging article signed by Dr. Mathe, containing García Marín's photograph. In Brussels demonstrations of García Marín's method were made at Dr. L. Mayer's clinic, and two of four patients anesthetized in this manner died [11]. One more fatal case occurred in Paris at an operation performed by Dr. Tierry du Chastel.

Upon his return from Europe, Miguel García-Marín enjoyed a brief period of popularity, although success and failures alternated as results of the administration of ethanol as anesthetic. Another professional thesis was written on the subject by Avenamar Yañez, who reported 15 cases, with 3 failures; 2 had respiratory difficulties; and oliguria was noted in 2, and albuminuria in 4 cases. Although his intention was to support the technique, he suggested that the hepatic and renal lesions he had noted could be ameliorated by diluting the infusion. One more thesis appeared in January 1930, this time by José de Jesús Herrera from Guadalajara. Of 18 anesthetics, 10 were unsatisfactory; 1 patient died; 1 remained asleep for several hours after the procedure; and urinary abnormalities were noted in 4 other instances.

Therefore the reply by the National Academy of Medicine recognized that an anesthesia-like state could be achieved by the administration of intravenous alcohol, a procedure which had been already tried and abandoned by Professor Abalos from Santa Fé, Argentina. As advantages, it recognized that it permitted operative procedures to be performed on the face and head without the need of a mask and the "abdominal silence" that was noted in some cases. However, it was considered to be contraindicated in children, as well as in the presence of thyroid, myocardial, renal, and hepatic disease. Interestingly enough, they severely criticized the need to administer intravenous infusions of dextrose and water, as described by García Marín, since the technique may produce a "glycemic wave" and "vascular plethora." They forecast that alcohol would be a temporary fad that would not substitute the inhalation agents; in that, they were correct. So the final act in this saga was the delivery of an inquisitional edict.

How this condemnation by the supreme academic body of Mexican Medicine influenced the career of García Marín is not known. But it is obvious that eventually even his enthusiasm was dampened and finally exstinguished. One can only wonder what might have been, if, in spite of this attack, García-Marín had been advised to devote his knowledge, interests, and efforts to conventional anesthesia research and practice. However, such wishful thinking must remain a chimera.

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3.4 Early Problems in Establishing Intravenous Anaesthesia

J. W. Dundee

J.W. Dundee

"In the beginning...". While there are those who would ascribe divine origins to anaesthesia (Genesis 3, verse 21), intravenous anaesthesia cannot boast of such beginnings. The names of Sir Christopher Wren, architect of St Paul's Cathedral in London, and of Oré from Lyons are normally associated with the beginnings of anaesthesia. Wren successfully injected wine into an animal using a quill and a pig's bladder, but it is unlikely that this had any real influence on the development of intravenous anaesthesia.

Indeed, intravenous anaesthesia could not be developed until an effective syringe had been invented, and credit for this achievement must go to Alexander Wood from Edinburgh. His syringe, which is currently placed in the Museum of the College of Physicians in his native city, was not designed for the intravenous injection of drugs. The title of a paper which he produced in 1853 was "New method of treating painful neuralgias by the direct application of opiates to painful points" [1]. He seemed to favour a local action of morphine, which was contrary to what was believed for many years about that drug. However, it is of interest to note that the pendulum seems, to have swung in the other direction, and recent work on extradural morphine is confirming that it has a local action. Perhaps those of us who sneered at the rectal use of morphine suppositories as an analgesic after haemorrhoidectomy may have to think again. A contempory advertisement listed "Dr Alexander Wood's narcotic injection syringes" and stated that these could be obtained from Archibald Young, Queen's Cutler, Princes Street, Edinburgh.

The Drug

Having evolved a method for giving intravenous anaesthetics, the next step in its development was the discovery of a proper drug. Diethylbarbituric acid (barbitone BP) had been synthesized by Fischer and Von Mering in 1905. Barbituric acid, otherwise known as malonylurea, had been prepared in 1864 by Berlin – born Von Baeyer (1835–1917), who at that time was a research assistant in Ghent. He was later

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to achieve fame and be awarded the Nobel Prize for Chemistry "in recognition of his services to the development of organic chemistry and the chemical industry through his work on organic dyes and hydroaromatic combination". This does not seem to be connected with the work on barbiturates. There is an interesting anecdote associated with the trade name of the first sedative barbiturate, Veronal. Fischer had recently holidayed near Verona in Italy, and this is thought to have been why he chose the name. Incidentally, he was also a German chemist and at one time had been an assistant to Von Baeyer in Munich, although he was too young then to have played any part in the initial synthesis of the barbituric acid. He was also awarded the Nobel Prize for Chemistry, an honour which he achieved in 1902, before his former chief; again this award was unrelated to his work with the barbiturates but was "in recognition of his services in connection with ... synthetic experiments in the sugar and purine group of substances".

Barbituric acid itself was hypnotically inert, and with the discovery of the first hypnotic compound – diethylbarbituric acid – there was a profileration of these drugs over the next 20 or so years. Some of these were given by intravenous routes, but none of them was to be the drug which was to find a lasting place in intravenous anaesthesia. They all had the problem of delayed onset of action and prolonged duration.

To hexobarbitone (Evipan, Evipal) we can ascribe the honour of being the first rapidly acting drug. An acid form of this had been introduced in Europe under the trade name of Evidorm, but the sodium salt of the drug, which was produced by Knott and Traube under the direction of Helmuth Weese, was to open a new era in intravenous anaesthesia. The first report on its use was by Weese and Scharpff in July 1932 [2]. Helmuth Weese was Professor of Pharmacology in Dusseldorf and later became Director of the Pharmacological Section at the Bayer works at Wuppertal-Elberfeld, in which post he succeeded Eicholtz, who incidentally had pioneered the use of tribromoethanol (Avertin).

Rapidly Acting Drugs

Drugs with rapid action were what anaesthetists had been looking for; yet at the same time this was the property which led to many early tragedies with their use and which almost threatened their continuing survival in the pharmacopoeia. As will be discussed elsewhere, hexobarbitone was not an ideal drug and it was later replaced by thionembutal, which later became known as thiopental and is still, almost 50 years later, the world's most widely used intravenous agent.

Early Problems

The early problems experienced with rapidly acting drugs are best exemplified by a horror story – a paper entitled "A critique of intravenous anaesthesia in war surgery", written by F.J. Halford in the January 1943 issue of *Anesthesiology* [3]. In this are described the events when the drug was given to American casualties following the Japanese raid on Pearl Harbour on 7 December 1941. The opening remark in that paper sets the scene: "Every advance in anesthesia has been marked by its tragedies." Perhaps even more poignant are the final comments: "Then let it be said that intravenous anesthesia is also an ideal method of euthanasia."

A few quotes from this paper will highlight the problems.

It would appear that not only are there dangers intrinsic in any anaesthetic but there are dangers inherent in its administration and in the immediate condition of the patient.

All reports to date deal with the usage of the drug in routine civilian practice. ...

While intravenous anaesthesia would seem to be ideal for war injuries because of its compactness, ease of preparation and non-explosive characteristics ... it cannot be given by highly skilled anesthesiologists ... but by doctors etc. to whom its ... pharmacological actions are unknown.

In several cases ... as small an amount as 0.5 g of pentothal sodium had been administered ... irremedial predecessor of death.

These wounded were healthy young adult males. ...

We were attending patients in severe shock ... prepared with perhaps a minimum of plasma.

Incidentally the last page of that paper was followed by an advertisement calling for anaesthesiologists to join the US Armed Forces.

Behind the Problems

What lay behind these problems? From an analysis of this and other reports one can place the blame on several points:

1. Up until then anaesthetists had been generally used to giving a "complete anaesthetic" and often used mono drug techniques or, at the most, employed two agents, for example nitrous oxide oxygen and ether. Thiopentone was also looked upon as a complete anaesthetic; it was not then appreciated that this drug was any different from inhalational agents, nor that it could not safely replace such agents as the sole drug for major surgery.
2. By virtue of the route of administration one had an opportunity of observing the side effects of inhalational agents; if patients became hypertensive or developed respiratory depression, then stopping administration would soon rectify the matter. However, this did not apply to intravenous agents, as the above paper pointed out fairly forcibly.
3. As a group, the barbiturates were completely devoid of analgesic action, and this led to the administration of very large doses in an attempt to achieve complete anaesthesia.
4. Reference has already been made to the fact that administration has often been by untrained personnel who were unaware of the pharmacology of the drugs they were using.
5. These drugs have more than average toxicity because of their rapid onset. Not only does anaesthesia affect the parts of the brain concerned with consciousness but also involves vasomotor centres etc. When used as the sole anaesthetic agent their profound peripheral dilating effect was often disastrous for shocked patients.

Rescue and Survival

Why then has thiopentone survived today? Three factors seem to have played a part in this:

1. The same issue of *Anesthesiology,* which contained the report of the Pearl Harbour incidents also contained a paper by R. Charles Adams and Harold K. Gray [4] from the Section of Anesthesia at the Mayo Clinic in Rochester, Minnesota. This paper was entitled "Intravenous anesthesia with pentothal sodium in the case of gunshot

wound associated with accompanying severe traumatic shock and loss of blood: report of a case." The authors described the successful use of small doses of thiopentone (as little as 1 ml of 2.5%) given with oxygen, in which time was allowed for the onset of the action and due attention was paid to the decreased tolerance of the patient for the agent. Perhaps even more important was an editorial in the same issue of *Anesthesiology:* "The question of anesthesia in war surgery" [5]. The unnamed author mentioned

> the field of greatest usefulness and safety for pentothal sodium will be operations of brief or moderate duration ... small doses administered slowly with intervals between injections of sufficient length to allow the full effect to take place is the only rational scheme of dosage. It is amazing how little of the drug will provide anesthesia and relaxation for such (shocked) patients.

This was probably the "saviour" of intravenous anaesthesia.

2. Little credit is given to a very short paper which appeared in a 1938 issue of the *Lancet* by Organe and Broad from Westminster Hospital, London [7]. This demonstrated the synergistic action of thiopentone with nitrous oxide oxygen and undoubtedly played a major part in the universal acceptance of thiopentone as an induction agent.
3. The development of balanced anaesthesia. Here one must pay tribute to J.S. Lundy, who, in his book *Clinical Anaesthesia* [6] first used this word in its current context and recommended that anaesthesia be induced with one drug for muscular relaxation and maintained with another, and that muscular relaxation be provided by local nerve blocks.

This combination of factors has led to the present-day acceptance of intravenous anaesthesia and the numerous advantages which it offers, particularly to the patient but also to the anaesthetist.

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3.5 Dissociative Anesthesia

G. Corssen

G. Corssen

Laborit's concept of "neuroplegia" was, perhaps, the first attempt to move away from total central nervous system depression by employing a combination of tranquilizing agents and narcotic analgesics for the selective inhibition of cellular, autonomic, and endocrine systems known to be activated in response to stress. Unfortunately, this drug-induced homeostatic imbalance frequently resulted in circulatory disturbances, which explains the reluctance of many physicians to accept this new concept of pain control during surgery.

The concerted efforts of industrial and clinical investigators, in which we played a major part, led to the development of phencyclidine (PCP). It was synthesized by a medicinal chemist, Victor Maddox of Detroit, Michigan, and underwent general pharmacologic testing by Graham Chen of Parke Davis in Ann Arbor, Michigan [1]. PCP appeared similar to a cataleptoid agent called bulbocapnine, a very old compound coming from a plant called "Dutchman's Breeches". In cats, low doses of PCP produced a state of catalepsy associated with remarkable analgesia; in rhesus monkeys a small dose of PCP produced serenity, tranquility, and peace, which provided the trade name Sernyl or Sernylan. Subsequent toxicity studies conducted by Edward Domino of Ann Arbor, Michigan showed that PCP had a remarkable margin of safety. In 1957, clinical trials were performed at Wayne State University, Detroit by Greifentstein, who found that the drug, when properly administered by an anesthesiologist, was far safer than most anesthetics of that time. However, an unusually high percentage of patients unpredictably developed emergence delirium. Quite frequently the volunteers would describe the sensation of feeling as if they had no arms or legs or they were "floating in outer space."

In synthesizing some ketone analogues of PCP, Stevens, of Wayne State University, Detroit, found a PCP derivative, ketamine, which appeared to have considerably less side effects and was of shorter action than PCP. Edward Domino and I were asked to conduct human trials with this analogue and without any delay we began human pharmacologic studies in volunteers of the state prison in Jackson, Michigan, in 1964 [2]. We were soon able to confirm that ketamine was an excellent analgesic and anesthetic and caused less emergence delirium than PCP. We were fascinated by

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the appearance of the volunteers under the effect of ketamine, who did not seem to be asleep or anesthetized, but appeared disconnected from the surroundings. By means of neurologic methods for testing central responses to specific stimuli we established that under the effect of ketamine the subject was pharmacologically isolated. We observed that both visual and somatosensory impulses traveled unimpaired from the periphery to the primary sensory cortex, indicating that the sensory isolation occurred within the brain, presumably in the association area. We postulated that under the effect of ketamine the patient's brain is unable to interpret impulses and make the appropriate response; therefore there is no reaction to light impulses introduced into the eye or to pain impulses that would ordinarily be evoked by surgical stimulation.

The results of EEG studies in cats indicated that the cataleptic anesthetic state produced by ketamine is accompanied by hypersynchronous delta-wave bursts, alternating with low-voltage fast-wave activity in areas of the neocortex and in the thalamus, while simultaneously theta "arousal" waves appear in the hippocampus. This dissociation between neocorticothalamic and limbic system activity was especially prominent during emergence from the ketamine effect. After these studies, there was little doubt that our findings were in distinct contrast to EEG changes produced in animals by traditional anesthetic agents, notably the classic general anesthetics chloroform and ether, but also of volatile halogenated agents: These suppress the entire central nervous system aselectively. Later studies, conducted at the University of Alabama, strongly supported our theory that the diffuse thalamoneocortical projection system is a primary site of action of ketamine and that the profound analgesic action of ketamine results from the functional disorganization of nonspecific pathways in midbrain and thalamic areas. Behavioral observations in combination with the electrophysiological dissociation of thalamoneocortical and limbic systems prompted us to introduce the term "dissociative anesthesia."

Our initial human pharmacologic studies of the central effects of ketamine included observations and recordings of drug-induced alterations in the EEG. The most consistent and typical EEG effect induced by ketamine is the abolition of alpha-wave activity with occurrence of theta-like activity. Emergence from the anesthetic state is accompanied by a gradual return of typical low-voltage fast-frequency activity. Continuous alpha waves do not reappear for 30 min to 1 hour after the drug injection. Interestingly, the onset of analgesia which coincided with the appearance of theta activity subsided before theta rhythm disappeared.

Since we introduced the concept of dissociative anesthesia with ketamine in 1964, this new approach to pain control during surgery has evoked more interest and spirited discussion than any other previously introduced anaesthetic agent or technique. Ketamine has gradually been accepted by anesthesiologists and anesthetists throughout the world and has found its proper use in clinical anesthesia as a safe and effective anesthetic agent for specific surgical procedures. Dissociative anesthesia with ketamine has been found to be particularly useful and suitable in pediatric surgery and emergency surgical manipulations involving skin, bone, and joints. In the anesthetic management of burn patients of all ages, dissociative anesthesia is now considered superior to any traditional anesthetic technique. Use of ketamine in surgical patients with a history of bronchospastic disease is now generally accepted for its bronchodilating properties. It has been recommended as an excellent agent for anesthesia in mass casualties.

The illicit consumption of ketamine for its psychedelic effects has been a growing concern of law enforcement agencies, since its congener phencyclidine is a major representative of street drug subculture and is sold als PCP, Angel-dust, or Hog. On the west coast of Florida, for example, emergency departments and free clinics have recently been receiving numbers of overdose patients who are "snorting" ketamine or ingesting it orally. A major attraction of ketamine is seen by street users in the rapid onset and relative short duration of its psychedelic action, and the drug can easily be manufactured in illicit laboratories.

The search for ketamine isomers continues, and it can be expected that soon more selectively acting dissociative agents will be available for clinical trial. During the past 18 years we have devoted considerable time to our concept of dissociative anesthesia. These years were full of excitement and challenge. We are in total disagreement with the famous German surgeon, August Bier (1862–1941), who, at the beginning of the twentieth century, made this amazing statement: "In America exist professional anesthetists. This specialty is also praised in Germany. I cannot think of anything more dull."

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3.6 Open Drop Ether Versus Relaxant Techniques in Obstetrics

D. A. Buxton Hopkin

D.A.B. Hopkin

Open drop ether anaesthesia had a well-earned reputation for safety, provided one avoided respiratory depressant premedication. Acceptable operating conditions for elective or emergency surgery were always possible, even in humid tropical climates like Malaysia, as I discovered 45 years ago, long before the days of intravenous drips, relaxants and endotracheal tubes.

Patients in acute haemorrhagic shock from ruptured ectopic gestation could always be approached confidently, even though pulseless. Once the blood clot had been removed from the peritoneal cavity the pulse always returned (presumably from relief of reflex vasoconstriction) and remained adequate after relief of dehydration by intraperitoneal saline before closing the abdomen. Still more remarkable (and lost sight of since barbiturate induction became a routine) was the absence of gastric reflux under open drop ether once anaesthesia had reached the third stage. Admittedly, vomiting sometimes occurred during induction, but, as protective reflexes remained active, withdrawal of the anaesthetic, lowering of the head and rapid turning onto the side allowed patients to clear their own pharynx by active coughing. Even if the stomach did contain fluid, vomiting was rare during induction and gastric reflux during anaesthesia just did not occur.

(One illustrative case remains vividly in mind. Whilst still a student, I once anaesthetized a vigorous young man for relief of an obstructed hernia. He was vomiting before induction, but no vomiting occurred during induction. Once in the third stage, I suggested to the surgeon that a stomach tube should be passed to empty fluid from the stomach. Before doing this I put the patient in a steep head-down tilt, but no regurgitation took place. However, after passing a large-bore stomach tube into the stomach, there was a brisk flow of coffee-ground vomit, sufficient to fill more than half a bucket.)

The absence of gastric reflux under open ether was well known to obstetric anaesthetists, but the introduction of the Boyle's machine for nitrous oxideoxygen and minimal ether altered things and, in their point of view, was a retrograde step. Although in skilled hands good operating conditions were possible, with much reduction of atmospheric contamination by ether, in unskilled hands the method was difficult and dangerous. This became evident when it replaced open drop methods for obstetrics, especially when preceded by a barbiturate induction. Those skilled in its use were never available in obstetric units, and it was left to an inexperienced junior to

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conduct the anaesthetic. In some American hospitals there was even a printed card attached to the machine, giving instructions to the operator; these included induction of unconsciousness with 100% nitrous oxide, relieving the inevitable cyanosis with 100% oxygen and opening the ether vaporizer to the full. This involved the return of consciousness, followed by intense coughing, laryngospasm leading to hypoxia, and vomiting, which was usually concealed by a large black face mask securely fastened with a harness. Under these conditions pulmonary complications were inevitable from aspiration of stomach content. Mendelson, reported a syndrome: pneumonitis, following aspiration of acid gastric content during obstetric anaesthesia under nitrous oxide oxygen and ether [1]. This became known as the Mendelson syndrome, and reports of similar complications soon appeared in North America [2,3] and in the United Kingdom [4,5]. Two factors were common to all incidents, namely, they all occurred in hospital practice and with nitrous oxide oxygen ether.

These reports were a source of serious concern to anaesthetists. The then Ministry of Health in the United Kingdom began publication of 3-yearly reports of confidential enquiries into maternal deaths in England and Wales, including anaesthesia, and the first of these cover the years 1952–1954, inclusive [6]. It was said that 32 out of 49 maternal anaesthetic deaths were the result of aspiration of stomach content during anaesthesia. Dr. Marston, the first Dean of the newly created Faculty of Anaesthesia, of the Royal College of Surgeons of England and Wales, was the author of the section dealing with anaesthesia. In his *Report* he made significant observations, which, had they been given more serious consideration, might have changed the history of the development of obstetric anaesthesia. He noted that "Intravenous injection of barbiturates and relaxants may relax the cardiac sphincter and cause regurgitation into the naso-pharynx with inhalation. This ... is recognised as a *definite risk.*" Gas-oxygen and ether were used in 11 fatal cases and were he said, "commonly regarded as safe". However, "in the hands of the insufficiently experienced, sudden exhibition of a too high concentration (of ether) can lead to anoxia (from laryngeal spasm) with sudden vomiting". It also became clear that, when the duration of childbirth exceeds 12 h, some degree of gastric stasis is always present. Childbirth exceeded 12 h in all of 13 patients who aspirated stomach content during childbirth over a period of 1 year, and in 9 of these it exceeded 24 h. Thus, gastric stasis is to be expected in all patients requiring anaesthesia for forceps or caesarean deliveries, since interference before this time is extremely rare.

In such circumstances, is it wise to abolish completely the protective laryngeal reflexes before passing an endotracheal tube? This question was widely put by older established and respected anaesthetists after the introduction of relaxants into clinical anaesthesia. Such senior colleagues had mastered the art of passing an endotracheal tube under relatively light inhalational anaesthesia. The study of subsequent confidential reports on anaesthetic mortality justified such a view point. However, improvements in staffing, training and equipment took place over the succeeding years, and a consensus amongst anaesthetists was in favour of endotracheal intubation.

Nevertheless, patients continued to die from aspiration of stomach content during anaesthesia. In the two periods 1955–1957 [7] and 1958–1960 [8], 35 out of 62 anaesthetic deaths resulted from aspiration. In most instances intubation was not planned as a routine, and the writer of the reports consistently advises intubation, in spite of recording two deaths from attempted intubation and two from misplaced or kinked tubes. The practice of intubation received strong support after H. Hodges and his colleagues published a paper showing improved Apgar Scores (compared with other techniques) from a technique of preoxygenation, induction with thiopentone and intubation after suxamethonium [9]. This technique was well approved and called "crash induction"; it became compulsory in all large obstetric units, to such an extent that juniors in training became convinced that no other method was safe and that failure to intubate obstetric patients was tantamount to criminal negligence – an attitude of mind that has persisted with many to this day. The *Report* of 1961–1963 records 16 deaths from aspiration out of a total of 28 and again condemns failure to plan intubation as the principal factor in every case [10]. However, better things were expected in the following *Report,* where the benefits of the widespread adoption of crash induction should have become demonstrable. The next *Report,* however, was even worse [11]. The total of anaesthetic deaths had risen to 50, 31 of which were the results of aspiration, in spite of the fact that in every case, intubation was planned beforehand. Taking these figures at their face value it cannot be argued in any way that intubation is the solution to the problem of gastric aspiration.

In almost all the series, the relaxant used was suxamethonium. The author (Sir Geoffrey Organe) commented: "The practice of inflating lungs after paralysing the vocal cords with suxamethonium encourages entry into the lungs of regurgitated material"; a classic understatement, if ever there was one. However, this observation does go right to the heart of the matter, for inflation, whilst waiting for the onset of ralaxation after the suxamethonium accounts for almost all fatalities from aspiration. It may have escaped the notice of many anaesthetists that in 20% of patients who receive suxamethonium, intragastric pressure rises sufficiently during muscle fasciculation to open the cardio-oesophageal junction and decant any fluid there into the patient's pharynx [12]. Since most patients requiring anaesthesia, have already been in childbirth for 12 h, they will almost certainly have gastric stasis, and therefore regurgitation is most likely to occur.

Apart from admitted hazards, there are valid reasons to suggest that endotracheal intubation is by no means necessary for the safe conduct of obstetric anaesthesia. In 1956, R. B. Parker, Lecturer in Obstetrics at Birmingham University, reported that in the city of Birmingham between 1942–1952, 3048 general anaesthetics were given in patients' homes for forceps delivery using open drop methods, without either morbidity or mortality [13]. Over the same period at the Birmingham Maternity Hospital, there were 215000 deliveries with general anaesthetics; 8 patients died from aspiration, all of whom had received nitrous oxide oxygen and ether. The explanation for the poor showing of the hospital anaesthesia was that the patients were a greater risk. This argument is fallacious because we are only discussing gastric reflux and its aspiration into the lungs as a complication; the incidence of gastric content would have been similar in the two groups of patients, possibly somewhat higher in the domiciliary group, being under less direct nursing supervision. Correspondence in various journals following Parker's article confirmed the superior safety of simple open drop methods. My own practice, between 1936 and 1946, included constant and regular obstetric anaesthesia. Inhalational methods were the commonest techniques (though spinal was also used). Although intubation was never practised, there were no pulmonary complications. Similar results were seen at the Kandang Kerbau Hospital, Singapore, a large hospital with several hundred deliveries a month, where all anaesthesia was carried out by newly qualified housemen using open drop ether. There were no pulmonary complications. Indeed, old-time anaesthetists know that absence of protective laryngeal reflex is not necessary for any obstetric anaesthesic, including that given for Caesarean section.

Whilst not advocating a return to open drop ether, I am suggesting that greater consideration should be given to simple draw-over methods using an EMO inhaler or similar modification, with a non-irritant agent like halothane, methoxyflurane or ethrane; if these are thought too costly, trichlorethylene can give perfectly satisfactory conditions for vaginal procedures.

Those who still have doubts about the hazards of relaxants should consider the mortality figures of Mendelson's series. Only two patients died, and both of these died on the operating table having vomited a full meal. In the United Kingdom there is almost 100% mortality after aspiration.

Could it be that Mendelson's patients, receiving no relaxants, retained their laryngeal and tracheobronchial activity sufficiently to prevent entry of acid gastric juice into the alveoli, and that the resulting pneumonitis was the result of reflex vascular changes following irritation by the acid gastric juice of the nerve endings of the upper respiratory tract?

In patients who receive relaxants there is nothing to prevent the acid gastric contents from reaching the alveoli during pulmonary inflation.

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3.7 Massive Blood Transfusions – Warming of Bank Blood

C.P. Boyan

C.P. Boyan

In the early 1950s in the United States the radical surgery for cancer was in full swing. Aggressive surgeons like A. Brunschwig, G.T. Pack, T. Miller, and others were trying to conquer the disease by extensive excision of the tumors. New operations – total pelvic exenteration, hemicorporectomy, hemipelvectomy, liver resections, etc. – were introduced. The Memorial Sloan-Kettering Cancer Center in New York City was the front-runner of this type of surgery.

During excision of tumors many large vessels were opened, causing profuse hemorrhage. When these vessels, expecially deep in the pelvis, retracted, hemostatis was very difficult and the ensuing hemorrhage life threatening. The hospital blood bank was able to provide the anesthetic team with unlimited quantities of stored blood and new techniques for massive transfusions were designed. At that time the bank blood came in glass bottles; oxygen from a tank was introduced by a needle through the rubber stopper and was able to propel the blood through the infusion set in a few minutes. The danger of air embolus was great, and a trap bottle with normal saline was introduced between the patient and the unit of blood to catch any oxygen left under pressure in the blood bottle. The anesthesiologists were using diethyl ether as an anesthetic agent. A brief experience with cyclopropane led us to believe that, in spite of the claim to be the best agent for patients in shock, it should be avoided. The incidence of cardiac arrest in patients receiving massive blood transfusion and anesthetized with cyclopropane was greater than those receiving diethyl ether. The anesthesia teams who were responsible for the blood transfusion were able to watch the profuse hemorrhage and were able to administer 10–12 liters of blood in a short time. However, in spite of all efforts, the operative mortality of radical surgery was quite high. A casual remark by one surgeon, who had lost two patients in one day as the result of bleeding in the operating room, that "somebody is poisoning my patients" gave us the stimulus to study intensively the problems with massive blood replacement.

Our first step was to find the characteristics of a unit of bank blood preserved in acid-citrate-dextrose media (ACD): The pH was low (6.6), due to the accumulation of carbon dioxide (130 torr), lactic and pyruvic acid from the anaerobic metabolism in

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the red cells, and citric acid; the Ca^{++} were very low, while the K^{+} were higher than normal; and the temperature was 4–5 °C. Next, we studied the same parameters in the patients who were receiving large amounts of bank blood in a short period of time. We found that the amounts of blood Ca^{++} and K^{+} were not significantly changed. In order to find what happens to the ACD-solution we infused large amounts of it in normotensive patients; after reaching 80 mg per cent the infusion was stopped, and the patients were able to metabolize the citric acid rapidly without any adverse effects. Then we decided to stop administering calcium gluconate as a routine during massive blood replacement. The reason was that a hypoxic, hypothermic ventricle can easily be made to fibrillate by the Ca^{++}. Following this change in policy the incidence of cardiac arrest during massive blood transfusion fell.

At that time a thermocouple thermometer was made available to us. It was introduced into the esophagus behind the heart in order to measure the core temperature during the infusion of large amounts of bank blood. The very first patient in whom we used this thermocouple showed that the temperature at a point very close to the heart fell rapidly with the rapid administration of cold bank blood. When the temperature reached 29 °C we saw changes in the ECG (prolonged S-T segment, VPC's bradycardia), and when it reached 26 °C the heart fibrillated and the patient could not be resuscitated, although 17.5 liters of lost blood were properly replaced at that time. It was evident that the low temperature caused the cardiac arrest. Based on this observation a decision was made that the cold bank blood should be warmed to body temperature when given in large amounts.

In the beginning we warmed the bottles of citrated blood ahead of the surgical intervention, but this method was wasteful and often impractical. A better way had to be found. After 2 weeks of work in the laboratory a mechanism was devised to warm the bank blood while it was transfused. In essence, this apparatus consisted of 8 m of sterile plastic tubing, 4.5 mm in diameter, wrapped around a coil and immersed in a 20-liter waterbath, the temperature of which was maintained at 37 °C by adding warm water. This device can warm cold bank blood from 4 °–5.8 °C to 30 °–36 °C at transfusion rates of 50–150 ml per minute. This blood warmer is easily incorporated into the transfusion set during massive blood replacement. The first blood warmer was a wastepaper basket in which the warming coil was immersed, and a simple bath thermometer indicated the temperature of the water. The esophageal temperature behind the heart was again measured in patients receiving large amounts of warmed bank blood, and it was found to be maintained within the normal range. This was true even in a patient who received 15 liters of bank blood in 4 h. In addition, these patients did not show the changes in the ECG, which had been previously seen with administration of large amounts of cold bank blood.

A physician who attended patients receiving multiple transfusions of warmed bank blood was impressed by their clinical appearance. Those patients were warm, dry, pink, with readily obtainable blood pressure and pulse, and regained consciousness shortly after the end of the operation. This was in sharp contrast to patients who received cold bank blood: They were cold, shivering, with mottled skin; blood pressure and pulse rate were difficult to measure because of the extreme vasoconstriction; and some had prolonged recovery from anesthesia.

Further proof of the value of warming bank blood was sought. Therefore, the incidence of cardiac arrest in the operating rooms at the Memorial Sloan-Kettering

Table 1. Cardiac arrest in the operating room among patients receiving massive blood transfusions

Warm bank blood Rate of transfusion			*Cold bank blood* Rate of transfusion	
> 100 ml/min	50–100 ml/min	Blood transfused, ml	50–100 ml/min	> 100 ml/min
	65 (2)	3000 – 6000	6 (3)	
9 (3)	34 (1)	6001 – 12000	14 (6)	10 (8)
4 (2)	6	12000	5 (3)	1 (1)
13 (5)	105 (3)		25 (12)	11 (9)
118 (8)		Total # of patients	36 (21)	
6.8%		Incidence of cardiac arrest	58.3%	

Cancer Center was compared in two groups of patients receiving 3000 ml or more of citrated bank blood at a rate of 50 ml or more per minute. One group received cold blood; the other group received the blood through the blood warmer. Patients in these two groups represented comparable hospital populations who underwent radical surgical procedures for cancer and were attended in the operating room by surgeons and anesthesiologists with similar competence and experience. The incidence of cardiac arrest in the cold blood group of patients was closely related to the speed of transfusion. When 3000 ml or more of bank blood were administered at a rate of 50–100 ml per minute, there were 12 cardiac arrests among 25 patients. With blood transfusion in excess of 6000 ml at a rate of more than 100 ml per minute, the number of cardiac arrests was 9 in 11 patients. The total incidence was 58.3%. Table 1 shows a further breakdown of the total amount of blood transfused, the rate of transfusion, and the number of cardiac arrests. In the warm blood group there were 118 patients who had received 3000 ml or more of warmed bank blood at a rate of 50 ml or more per minute; 8 cardiac arrests were observed among these patients, representing an incidence of 6.8%. The statistical difference between the incidence of cardiac arrest in the cold blood group – 21 out of 36 patients – and the warmed blood group – 8 out of 118 patients – is highly significant ($\chi^2 = 44.5$ $P < 0.01$). An important finding is the decrease in the incidence of cardiac arrest among patients receiving blood at a rate of 50–100 ml per minute. In the cold blood group 12 out of 25 patients developed cardiac arrest, while in the warmed blood group there were only 3 among 105 patients. This again is a significant statistical difference $\chi^2 = 35.7$ $P < 0.01$). This rate (50–100 ml per minute) represents a clinically manageable speed of transfusion, leaving the temperature of the transfused blood as the main variable factor. If a higher rate of transfusion is necessary, there are usually surgical difficulties present, which, coupled with errors in rapid estimation of the exact amount of blood loss, may affect the end result.

The warming of cold bank blood to body temperature during massive blood transfusions produced a dramatic reduction in the immediate mortality from 58.3% to 6.8%. This new technique was accepted rapidly throughout the world, and reports from various medical centers confirmed its usefulness. Modern technology did improve the warming devices, but the basic principle remains the same as postulated in the late 1950s.

3.8 History of Fluid Administration During Anesthesia and Operation

M. T. P. Jenkins

M. T. P. Jenkins

In the historical development if intravenous (IV) fluid administration, three events in the remote past have been epochal [1]: in 1628, Harvey's description of the circulation of the blood [2, 3]; in 1875, Lister's proposal of the germ theory [4]; and, in 1879 Bernard's physiological treatise on the "milieu interieur" [5]. In the recent past, in 1959, a fourth epoch began with the publication by Shires and his colleagues of a paper, "Changing concept of salt water and surgery" [6].

Knowledge of the extracellular fluid (ECF) is not recent. Bernard appreciated it as the immediate environment of the organism [5]. Gamble presented an excellent description ot the ECF as an anatomical force lending stability to physicochemical conditions within the organism [7]. Until recent years it was thought that anesthesia and operation invariably cause a renal intolerance to salt or a renal inability to excrete administered salt. Based on present knowledge of sequestered edema, however, the etiology of hyponatremia and oliguria is more likely the failure to administer sufficient balanced salt solutions to replace that lost from the dynamics of the circulation through translocation into edema sites and perhaps also into muscle cells.

The intravenous injection of drugs and fluids became a rational procedure after 1628, the year in which William Harvey published his findings on the circulation of the blood. For 12 years, from about 1616, Harvey had been propounding his views in lectures and demonstrations and probably had put them into practice in his wards at St. Bartholomew's Hospital, London. The history of intravenous infusions is closely tied to the first experiments on injection of drugs performed by Christopher Wren, mathematician and architect, who first injected drugs into the veins of animals in 1656 [8].

Johann Sigismund Elsholtz in the seventeenth century, State Physician to the Great Elector of Berlin, was intrigued with the new art of injecting solutions into veins; he called the procedure "The New Clyster," combining the word "clysis," the washing out of a cavity, with the Greek word *klyster*, a syringe [9]. Many decades then elapsed before these developments were intimately related to the treatment of diseases, e.g., cholera (1831), diabetic coma (1874), and infantile diarrhea (1915–1916).

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In 1831, O'Shaughnessy analyzed the blood of patients with cholera and proposed a new method of treating the disease by the injection of large volumes of "highly-oxygenized salts" into the venous system [10]. O'Shaughnessy recognized in his proposal of therapy that venesection, the standard of the age, might possibly help to oxygenate arterial blood, but he rejected this modality, proposing injection of powerful oxygenating salts directly into the veins. As knowledge of the epidemic of 1831 faded, so also the efficacy of saline therapy in cholera was forgotten in England. When cholera reappeared in London in epidemic form 20 years later, the lessons from O'Shaughnessy, Lewins [11], and Latta [12] were not recalled, although they had been published in a prominent journal. Galenic treatment – bleeding, sweating, and purging – became the fashion again, with the predictable dire results.

Forty-three years after the chemical changes in cholera were described, Fagge in 1874 employed those earlier observations in the treatment of diabetic coma [13]. In 1915 is was recognized that another deadly disease, infantile diarrhea, had many of the features of cholera. As noted by Moyer [14], pediatricians have been preeminent in the field of fluid balance since the stimulating work by Holt et al. in 1915 [15] and by Howland and Marriott in 1916 [16], who infused salt solutions to restore the circulatory dynamics of infants ravaged by diarrhea.

A second epochal event in the history of intravenous infusions occurred in 1875 with the publication of Lister's germ theory, though it was not recognized as epochal at that time, when sepsis was thought to be part of the natural course of diseases being treated. No great argument is required today, however, in establishing Lister as the Father of Antisepsis. The question of sterility of intravenous solutions developed many years after the germ theory had been circulated and accepted [4].

In 1879, only 4 years after Lister's disclosures, a third epochal event occurred, as Claude Bernard wrote of "that bit of primeval sea within us" [5]. He described it as the "milieu interieur", so isolated from the world that atmospheric disturbances cannot alter it or penetrate beyond it. Nearly all studies of the complex biochemical system of the patient relate to the internal milieu described by Bernard and to the attainment of the state of balance known by the happy term "homeostasis." Since Bernard's publication the human body has been described as a delicately balanced system involving fluids, hormones, and electrolytes, recognizing that the individual cannot be freed from an aquatic heritage.

Since 1905 there have been numerous investigations to show the depressant effects of general anesthesia upon renal function, as expressed by urine formation. Early references to the depressant effect of ether anesthesia on renal function include no recordings of the preanesthetic preparation or of the administration of fluids, if any, during the anesthetic course [17–21].

Saline solutions proved a boon to military physicians during World War I particularly after a semi-closed system of administering 0.9% sodium chloride was devised [22]. As transfusions of blood were infrequently given, there was an effort to use colloidal solutions of gum acacia to bolster intravascular volume. With its high molecular weight, acacia was slow to pass through the capillary wall into interstitial fluid and it did exert a definite osmotic force [23, 24]. After the report in 1922 of sudden death in two patients following intravenous injections of acacia, articles on acacia seemed to drop from the literature [25]. Of course, the thesis of infusing substances which will stay in the circulation is misdirected. The true dynamics of the circulation involves the interstitial fluid as well as the intravascular fluid. Water passes through the capillary wall, as do all the electrolytes, urea, and glucose. During states of capillary stasis, albumin, with a gram-molecular weight of 69000 and with an ellipsoidal, cigar-like shape, can pass through intercellular pores into the interstitial fluid, where it is also found in a concentration one-third of that in serum. Water and electrolytes return to the circulation through the venous end of the capillary wall because the oncotic pressure at that location exceeds the hydrostatic pressure. Albumin returns to the circulation through lymph channels to the thoracic duct.

Safety from bacterial contamination and from chemical pyrogens was not achieved until the years immediately following World War II, when hospitals began purchasing solutions in sealed disposable bottles prepared by pharmaceutical manufacturers. Disposable sterile intravenous administration sets also became available and gradually supplanted the reusable equipment.

Enthusiasm for parenteral alimentation was tempered with beliefs that the patient would develop chills if the room-temperature solutions were administered too rapidly. Consequently, much effort was devoted to keeping solutions warm with hot-water bottles around the reservoir jars or by use of hot-water jackets [26]. Monitoring the temperature of infused solutions excited only a brief flurry of activity and was forgotten until the hazards of transfusing cold blood rapidly and/or in large volumes were widely implicated in the 1960s in causing cardiac arrhythmias.

In the recent past, principally in the 1940s, there were many reports of specific effects of anesthesia upon renal function; these were reported to cause a decreased excretion of sodium in the postoperative period [27, 28]. There was a widespread reluctance to administer salt-containing solutions, other than blood, until recent years, when it has been established that the kidney responds to functional extracellular fluid volume, which is a major determinant of sodium excretion [6, 29–31].

Attitudes which were definitely against the use of salt solutions during anesthesia and operation pervaded surgical practices during the years immediately following World War II as a consequence of various interpretations of extensive research findings and clinical impressions dealing with postoperative salt intolerance, the depressant effects of operation and anesthesia on salt and water excretion because of changes in renal function, and fluid translocations [32].

In 1950, Moyer authored an article based on data from clinical investigations [33]. In describing acute renal function changes associated with a major surgical procedure he interpreted a clinical study to show that a salt solution is avidly retained intra- and postoperatively. Over a short period of time in the summer of 1950 Moyer's anti-salt solution attitude underwent a change. It was altered because of postmortem findings in a series of trauma patients operated upon while in states of hemorrhagic, hypovolemic shock for whom only whole blood was used as the resuscitation fluid [34]. The resultant congestive atelectasis stimulated Moyer and Jenkins to reproduce the findings in laboratory procedures involving anesthetized dogs in which pulmonary red cell mass was shown to increase while the pulmonary plasma volume decreased. As a result of this combination of clinical experience and experimental measurements, Moyer reversed his previous caveats against intraoperative administration of salt solutions and directed that a regimen for fluids be implemented to include balanced salt solutions [34].

From this evolved an intraoperative fluid regimen for adult patients on the elective surgical schedule. For the years 1950–1959 the plan was to administer lactated Ringer's (L/R) solution, alternating liters between plain L/R and 5% dextrose in L/R, 10 ml/kg body weight per hour plus L/R two times the measured blood loss, tempered with reason as influenced by urine output. The tempering, or moderation, came in 1959 during the investigational work by Shires and associates, members of Moyer's department, which resulted in the provocative article, "Changing concept of salt water and surgery" [6]. The formula of ml/kg body weight was continued but only for the first 2 h. Longer cases were guided by urine output (50–100 ml/h, or about 1 ml/kg body weight per hour). Blood loss was no longer employed as a guide to a specified quantity of balanced salt solution.

Based on several articles by Shires, the term "third-space shifts" of fluids was coined, an extrapolation from precise language not advocated by his reports. It does indicate the functional loss of ECF from the dynamics of circulation, sequestered as edema or translocated into muscle cells. For example, during an intraabdominal operation in which adequate exposure is difficult to achieve and there is considerable necessary manipulation of the viscera, there may be an ECF loss equivalent to 25%–30% of the preoperative volume. Such functional losses are essentially of isotonic fluid, as indicated by serum electrolyte determinations. The losses represent internal redistribution. Part of the internal loss is into the tissue adjacent to the surgical wound in the abdominal wall. Additional ECF is translocated into areas where salt water tends to be sequestered as edema in response to trauma, including, in this example, the splanchnic bed, mesentery, the gut wall, and even into the lumen of the bowel as ileus sets in. Particularly in shock, there may also be an intracellular shift of fluid, with skeletal muscle cells being the major site of fluid and electrolyte sequestration [35–37].

Edema of the abdominal wall (or any other surgical operation site) and ileus with distension of the bowel have long been recognized, but the magnitude of the loss of functional extracellular fluid has been elucidated only within the past three decades by the reports made by Shires and his research and clinical associates. Another early publication of Shires et al. described the distrubutional changes in ECF during acute hemorrhagic shock [38] and established the rationale for fluid therapy in shock [35, 39, 40].

Shires and his associates continued this work and delineated a depression of transmembrane potential difference and an elevation of interstitial potassium in hemorrhagic shock [37]. Increasing interstitial potassium reduces the efficiency of an active ionic pump mechanism or a selective increase in muscle cell permeability to sodium, related to the shock state. These latter studies utilized an ultra-microelectrode to measure directly the difference in electrical potential between the inside and the outside of a muscle cell. The data suggest that muscle cells may be a principal site of fluid and electrolyte sequestration after severe, prolonged hemorrhagic shock [41].

No one regimen for fluid administration will apply to all patients with varying physical status and disease processes scheduled for a variety of operations. It is acknowledged that, throughout the world, many differing routines for intraoperative fluids are followed. These routines may range from no fluids at all to blood only, and some may include albumin or mannitol on a definitely timed basis. Under any regimen it seems that a majority of patients survive, some because of fluid administration and others despite it.

Central to modern precepts is that homeostatic mechanisms in the anaesthetized patient are best maintained if fluid administration helps to preserve normal renal function while replacing ECF translocated from the dynamic pool. This regimen, therefore, is strongly influenced by recent developments in the history of sequestered edema [38].

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3.9 Birth of Neuroplegia and Artificial Hibernation in France

P. Huguenard and N. Dufeu

Background

The principal goal of resuscitation is restoration of breathing. The French expression *réanimation* also denotes restoration of vital vigour. It is reasonable, then, to spare the body's energies before having to restore them.

Economizing the energy pool of an organism requires the attenuation of its reactions to aggression. Attenuation of excessive reactions is equal to sedation, which can be achieved by means of anaesthesia. However, deep anaesthesia may necessitate intoxication, which should be limited. In order to limit the intoxication one should use diversified molecules, each having very different pharmacokinetic properties, and efficient sedation shoud act on several neurotransmitters: adrenaline, noradrenaline, acetylcholine, histamine and others. At present, the targets are the receptors sites for morphinomimetics, diazepine and dopamine (neurotransmitters and neuromodulators). A mixture of several drugs which act differently was rapidly named a "cocktail". As such drugs were supposed to have a destructive effect, or at least a destructurizing effect on the nervous system, they were classified as neuroplegics or neurolytics, and their mixtures as lytic cocktails. They were then re-classified as neuroleptics; however this group included other drugs that did not have much in common with them, thus provoking a certain confusion. That is why it was necessary to define which drugs were sedative neuroleptics (antinoradrenergics) and distinguishable from the antidopaminergics.

In some extreme situations, the organism's energy expenditure is not lowered enough by sedation alone. Metabolism decreases with temperature, and it is possible to associate refrigeration with sedative drugs. Such association is facilitated by the fact that neuroplegics, by attenuating the reactions to cold, limit thermogenesis and increase thermolysis by their vasodilating effects.

Developments Before 1950

The idea of diminishing nociceptive reflexes in an organism subjected to agression was not very new. It can be attributed to G.W. Crile, who described the use of a morphinomimetic and of a peripheral block to complete general anaesthesia. Several ganglioplegic agents were tried, followed by the intravenous administration of local anaesthetics [1–3]. But the essential event was the introduction of phenothiazines in

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anaesthesia: The first one to be introduced was promethazine (Phenergan), recommended by H. Laborit in 1951. The drug had been used by H. Laborit and P. Huguenard since 1950 for its antihistaminic and hypnogenic properties, and for its action on neurovegetative stabilization [4]. Furthermore, Laborit's idea was to recommend the use of an antiparkinson drug for anaesthesia: diparcol or diethazine. In combination with pethidine (Meperidine) it was called Dipdol. The Dipdol mixture causes a particular state of euphoria, tranquillity and indifference, and the first patient to receive this mixture was a nurse undergoing rhinoplasty. She declared after the operation, "I perceived the hammer strokes as if they hit somebody else's nose." This remark interested a psychiatrist, Mrs. Cornelia Quarti, and was important in the early development of psychopharmacology.

Research in the pharmacological laboratories of the Rhône-Poulenc-Spécia firm produced a vasodilating and hypotensive agent (4560 RP) that was just what we were looking for. The 4560 RP was chlorpromazine, later named as Largactil [5]. Clinical experimentation was done in less than a year. We were indeed most enthusiastic about the product's neurovegetative effects, and only observed " a certain tendency to sleep and an indifference of the patient to everything occurring around him". We used the expression "pharmacological lobotomy", created by J. Lassner for Dipdol, and arrived at the conclusion that "4560 was destined also for use in obstetrical analgesia and psychiatry" [6, 7].

For anaesthesiologists, the main advantage of phenothiazines consisted in their antireflex and antishock effects, and the drugs were used for this purpose all over the world [8, 9]. The use of vasodilating antireflex drugs was discussed for a long time, and the need for improvement of tissue perfusion was finally admitted by the majority of authors [10]. Quite rapidly it became clear that the favourable effects observed were only due to chlorpromazine and not to antinociceptive sedation; other molecules were successively tested, first alone, and then combined in lytic cocktails [11].

The combination of neuroleptics and analgesics, called neuroleptanalgesia, was introduced in Belgium as early as 1958 by J. de Castro. It must be recognized that the efficiency of lytic cocktails of "potentiated anaesthesia" or "vigil anaesthesia" – according to the terms also occasionally used nowadays – owes a great deal to the new analgesics, for the most part developed by P. Janssen. The first mixture we produced (1951 – M 1), which we still prescribe regularly in our intensive care unit, consisted of chlorpromazine,promethazine and pethidine (Dolosal). The next mixture (1955 – M 2) was Hydergine, promethazine and pethidine. The third (1959) was acetylpromazine + Xylocaine, and one of the last (1960) was Taractan + dextromoramide. Benzodiazepines, with their action on the limbic system, could be combined with neuroleptics and sometimes served as hypnotics [12, 13, 14, 15]. Lytic cocktails, at high doses, depress ventilation and induce an overproduction of carbon dioxide. It very soon became apparent that efficient ventilation had to be ensured [16].

Artificial Hibernation

Hypothermia potentiates the decrease of metabolism in neuroplegia. We first used the technique in 1949–1950 [17]. It became quite easy to add general refrigeration to the administration of a lytic cocktail, as no vegetative reactions occur. That is what we did for the first time in 1951, on an elderly woman, suffering from biliary peritonitis, hyperthermia, cyanosis, marbling, cardiovascular collapse and oliguresis. Looking back, it appears that luck and intuition compensated for a relative lack of preliminary experimental studies. This first success stimulated continuation in the same direction, and the ten following years saw a succession of studies and publications on this method, which rather resembles the hibernation of some homothermic species [18–20]. The technique and the use of artificial hibernation soon became widely recognized [21] and enjoyed considerable popularity in intensive care and surgery [22–25].

Epilogue

Nowadays (1982), it is difficult to determine with precision what remains of these ideas concerning the "protection" of the organism by a neuroplegic or a neuroleptanalgesic sedative, associated or not with refrigeration. It seems that the methods derived from these theories are still in use. Sometimes they remain unaltered, such as Ml or Taractan-Palfium; on other occasions they have been modified by the use of new products. However, one must, with modesty, recognize that the terms "lytic cocktail" and "artificial hibernation" have disappeared from daily use in anaesthesia. Sometimes, an antiadrenergic sedative is still used, coupled with hypothermia, but the name is different.

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3.10 The Treatment of Shock with Vasodilating Agents

Bjørn Ibsen

Bjørn Ibsen

It is a great honour for me to have been asked to describe the medical field in which I worked in the early 1950s, which led to a medical change in the approach to the treatment of shock. In those years change in more than one respect took place in the treatment of severely ill patients. It was obvious that the problems these patients presented were mainly respiratory and circulatory.

In 1950 Bower et al. published the results of their treatment of respiratory insufficiency in bulbar poliomyelitis cases [1]. Within 3 years the mortality was brought down from 88% to 20% by the early use of tank respirators. At the same time, in Europe – I think it was in Lübeck – a 10-year-old boy with poliomyelitis had been kept alive for 2 weeks with artificial ventilation by the Holger-Nielsen-method, given by the doctors involved.

The maintenance of free airways in clinical medicine was a neglected problem. I have often been surprised how obvious clinical observations could be given a terribly wrong explanation. As an example of this I can mention the case of a patient at that time with a cerebral haemorrhage and snoring respiration who became cyanotic. The conclusion was: When there is enough blood in the brain the patient becomes cyanotic. Similarly when patients under ether anaesthesia became cyanotic, it was concluded that when there is enough ether in the brain patients become cyanotic. When I was called upon in August 1952 at the beginning of the great polio epidemic in Copenhagen I asked, "Why are the patients cyanotic?" And the professor said, "When there is enough virus in the brain the patient becomes cyanotic." As a matter of fact, he was right.

Nevertheless, it was possible at that time to maintain a good colour in patients during anaesthesia, in spite of what was in the brain. This was due to endotracheal intubation and assisted or controlled ventilation. It was therefore easy to suggest an anaesthetic approach to the management of polio patients in respiratory insufficiency. Furthermore, it turned out that the clinicians in charge of the polio patients had not been aware of an elementary factor in respiratory physiology. When one of their patients became cyanotic, oxygen was administered without a change in ventilation. The anaesthetists knew by experience that this would lead to an accumulation of

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carbon dioxide, and although the clinical signs of this were observed in the polio cases, they were blamed on the polio virus in the brain.

Tracheostomy and manually controlled ventilation with a "to-and-fro" system and a Waters' cannister was the treatment recommended and performed. To illustrate the situation I can recall that when I first suggested a tracheostomy I was informed that this had been done in 17 cases before with the result that they all had died. When the epidemic was at its peak, 90 patients were receiving the mentioned treatment at the same time. The artificial ventilation was given manually by medical students. After the acute respiratory problems had been solved, as a result of the new technique, most of the patients were then found to be in a condition of clinical shock.

The Danish professor of pharmacology, K.O. Møller, had published a monograph in 1936, entitled *The Treatment of Shock* [2]. It was based on the concept that it was of primary importance to maintain a reasonable blood pressure. If necessary, this had to be done with the help of a vasoconstricting agent in an intravenous drip. This often led to a lavish use of these drugs in the polio patients as well. I could therefore observe the results of this treatment carried out for, say, 3–6 weeks. The patients developed hyperthermia and pulmonary oedema, and some had gangrene of the fingers and toes, before they finally died.

I have mentioned the polio epidemic because the observations on the patients in shock convinced me of the inadequacy of the conventional treatment given at that time. Later on I realized that we had been thinking then in terms of blood pressure and not in terms of flow. That kind of treatment can now be characterized as blood-pressure cosmetics.

In 1951 I had seen a publication by H. Laborit and P. Huguenard about their lytic cocktail – a completely new approach [3]. We were then running the international course in anaesthesiology in Copenhagen under the World Health Organization. Some of the most outstanding British and American anaesthetists were working with us as instructors. I discussed the new approach with them. They could not, for some reasons I do not recall, accept the explanations given by Laborit and Huguenard. My reaction to this was that maybe there could be some difference of opinion as far as the explanations were concerned, but that did not necessarily exclude the possibility that the authors' observations from a clinical point of view could be valuable and correct.

I studied the literature about the circulatory effects of chlorpromazine when this was given alone. I especially remember a series of experiments in which a shock condition had been inflicted in rabbits. On those which had received chlorpromazine beforehand, no pooling of blood was found in the splanchnic area at the autopsy; whereas the animals which had received no chlorpromazine showed a marked pooling of blood – an observation which could be compared with the effect of a spinal analgesia. During major abdominal surgery the bowels would be pale and constricted when a spinal was given.

In December 1953 I had opened the first intensive therapy unit run by anaesthetists in Denmark, and there the interest in temperature measurements was initiated in a rather peculiar way. (I shall not recall how here.) In 1936 Johannes Ipsen, a Danish surgeon, had written a thesis about skin temperature measurements [4]. Ether had previously been administered as the main anaesthetic agent. When he was about to operate, the skin temperature of the patient's feet was measured. The operation was not started until this temperature had risen. Ipsen also measured the changes in skin temperatures during spinals. In 1954, after finishing the literature studies, I was ready to try the use of chlorpromazine in the treatment of shock, where conventional treatment had not led to a satisfactory result. I was therefore inclined to follow the possible effects on different temperatures on the patients. Before an attempt was made in the first cases, I had demanded a written statement in the record by the surgeon, confirming that the patient was moribund. Then, later on, when the patient was out of shock as a result of the radical change of treatment, I was in a position to ask, "Why didn't we start this treatment earlier?"

I hope I have now given you a picture of the considerations which caused me to continue using vasodilating agents followed by further infusions in the treatment of shocked patients not responding to conventional treatment. It is very easy to conclude that shock with peripheral vasoconstriction blocked the distribution of heat and that chlorpromazine re-established this distribution. As one may see, in the previous respiratory problems with the polio patients an elementary physiological function had been neglected, namely the elimination of carbon dioxide. In the treatment of shock another fundamental physiological function had been overlooked, namely heat regulation.

Heat regulation in man involves two prerequisites: (1) that the heat can be carried to the surface; and (2) that the patient is in climatic conditions where the heat can be eliminated. This, then, was the background for the installation of air conditioned rooms in our department. They served two purposes:

1. To maintain the patient in a constant climatic environment in order to make sure that a change in skin temperature was not due to a change in the climatic conditions in the environment.
2. To ensure a sufficient elimination of heat in the environment. We installed cool ceilings to enhance the heat elimination by radiation.

In conclusion in the primary treatment of shock with peripheral vasoconstriction, inhalation of oxygen and conventional intravenous treatment should be given with the patient in a slight head-down position. When filling of the external jugular vein is observed, stop and think. If the blood pressure has not risen and the rectal temperature is still high and the toe temperature still low, further infusions may provoke pulmonary oedema. To avoid this, one can change the regimen and give 2 mg chlorpromazine IV, followed with fluids, then 5 mg and further fluids, continuing with this until the peripheral temperature goes up. This allows the patient's, circulation to be re-established and consequently allows his body heat to be carried to the surface. Thus the primary step in bringing the patient out of shock has been reached. Later, Lord Brock et al., in an article in the *British Journal of Surgery,* summarized their impression of my work as follows: "Open up and fill up. Stop when the feet get warm" [5].

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3.11 The Lytic Cocktail, 20 Years On

D. A. Buxton Hopkin

D.A.B. Hopkin

The early claims that, the lytic cocktail produced autonomic disconnection and a state akin to hibernation are not unreasonable, when one considers how much emphasis was laid on the hypothermic and the metabolic and central nervous system depressant properties of chlorpromazine in the early accounts of its pharmacological properties [1]. The passage of time has modified some of the more esoteric claims, especially concerning its action on metabolic processes. Whilst it has to some extent been overshadowed by neuroleptanalgesia, there is general agreement that chlorpromazine is the real active constituent, although many misconceptions continue to exist about its exact mode of action. In this paper I will attempt to clarify the position, in the hope that a better understanding will encourage wider use of chlorpromazine in anaesthesia, as well as in the prevention and treatment of all shock states, irrespective of their origin.

Most textbooks of pharmacology classify chlorpromazine as a mild, peripheral/alpha adrenergic blocker, because it prevents or reverses the hypertensive action of both adrenaline and noradrenaline, as well as protecting experimental animals against lethal doses of these agents.

There are, however, sound reasons to believe that these effects are not the result of peripheral alpha blockade, but of an action on the central nervous system. First, the reversal of the effects of adrenaline and noradrenaline only occurs after intravenous injection. After intra-arterial injection the constrictor action of adrenaline is only reduced [1]. Second, in human subjects the vasodilator action of chlorpromazine is much more pronounced after intravenous injection than after intra-arterial injection [2]. In other words, if chlorpromazine passes through the brain before reaching the periphery its effects are more marked. Third, Rogitine, a typical alpha adrenergic blocker, controls the hypertensive crises of phaeochromocytoma caused by the action of catecholamines of alpha receptors, whereas chlorpromazine is ineffective. Fourth, Rogitine does not prevent centrally induced vascular responses, the result of irritation of sympathetic nerves (phenomenon of Reilly and Selye's acute stress), which chlorpromazine prevents in 60% of susceptible animals [3]. It is the only compound so far produced which has this effect. The pathological vascular changes, known as the

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phenomenon of Reilly, are indistinguishable from those occurring in human subjects dying from overwhelming bacterial infections [4].

The central action of chlorpromazine has not attracted the attention it deserves, mainly because the research work has been carried out by neuropsychiatric specialists, whose interest was aroused by the successful use of this drug in the treatment of schizophrenia.

It was soon established [5] that chlorpromazine had no action on cholinergic mechanisms in the cerebral cortex but depressed activity in the brain stem reticular formation, which a few years previously had been shown to have a regulatory influence on the alert state of the cerebral cortex. Stimulation, either directly or indirectly through peripheral nerves, converted an EEG of sleep into one of wakefulness, accompanied by the appropriate behavioural changes [6]. Furthermore, it was shown that a wide variety of anaesthetic agents, deprivation of oxygen by the action of cyanide and deprivation of glucose by the action of insulin were accompanied by a total blockade of this particular effect [7].

But to return to chlorpromazine: The depressant effect of chlorpromazine was shown to arise through interruption of activity at the point where collaterals entering the reticular formation from the specific sensory pathways made synaptic junction with reticular neurones. Since it was already known that chlorpromazine had no action on cholinergic transmission in the central nervous system, it was agreed that the neurotransmitter at the point between the collaterals and reticular neurones was non-cholinergic in nature and probably related to a catecholamine [8]. Confirmation of this supposition was obtained when microiontophoretic studies revealed that chlorpromazine was capable of antagonizing the excitatory effects of noradrenaline on reticular neurones [9], which, in the opinion of some pharmacologists, would justify a classification as a central nervous alpha-receptor blocker.

How the indirect depressant action of chlorpromazine on reticular neurones differs from that of an anaesthetic (thiopentone) is well shown in the following experiment, which recorded activity through a microelectrode placed in an isolated reticular neurone [9]. Spontaneous and undepressed response to stimulation of fore- and hindlimbs and tip of the nose were more than halved following a small 2 mg/kg dose of chlorpromazine. (It is worth noting here the response of a single reticular neurone to stimuli of varying origin, including somatic and cranial nerves, illustrating an outstanding characteristic of this part of the brain, namely the non-specific nature of its response to external stimuli.) The depressed activity arising from the chlorpromazine could not be increased beyond a certain point, no matter how large the dosage of the drug was given. In no circumstances was activity ever abolished. However, after a small dose of thiopentone (known by previous experiments to be less than a sleep dose for the normal animals) reticular activity was completely abolished for 20 min, after which it returned to its depressed state.

This experiment demonstrates quite distinctly that chlorpromazine (although without direct activity on the neurones of the reticular formation) can, through an antagonism to noradrenaline, induce a deafferenting effect which reduces the intensity of response to incoming stimuli. This is reflected not only in its effects on the activity of wakefulness but on many other vital bodily functions, almost all of which, in one way and another, concern homeostasis.

For over a 100 years the pontine and medullary part of the brain (which contains the reticular formation), has been referred to as "Le Noeud Vital", although how or why this was so remained a mystery. Certainly no other part of the brain intervenes in so many vital functions. Besides respiratory and vascular activity, vomiting, muscle tone, cerebellar coordination and intestinal movements come under its control, whilst temperature control and endocrine activity do so through upward connections to the hypothalamus and pituitary.

The possible consequences of noradrenergic synaptic transmission in the central nervous system has been much expanded by histological fluorescent techniques, which have revealed the existance of an extensive noradrenergic neuronal system in the reticular formation [10, 11]. Noradrenergic neurones in the region of the locus coeruleus pass upwards to the hypothalamus, receiving rich contributions from specific sensory pathways, cranial nerves and visceral sources, including the gastrointestinal tract, the lungs and the cardiovascular system. Axones from this area also pass downwards to the lateral sympathetic outflow of the spinal cord, thereby influencing directly the peripheral circulation through the noradrenergic terminal varicosities of the sympathetic nerves, which are found most abundantly round the entirely muscular terminal arterioles, thus conferring on them what has been described as "a sphincterific function" and complete control of the peripheral circulation. All recent research into the mechanisms of shock implicates the hypothalamus and the central nervous noradrenergic activity. Disturbance of temperature regulation is an early sign [12]. In established shock histological changes, have been demonstrated in terminal axones of the noradrenergic neurones, originating in the locus coeruleus, accompanied by increased turnover and reduced concentration of noradrenaline in exactly the same areas [13].

This recent addition to the knowledge of the neurophysiological mechanisms of the reticular formation and hypothalamus in response to injury offers an explanation of how a substance like chlorpromazine, by reducing response to incoming stimuli without abolishing them, could regulate vascular response to injury and prevent the "vascular decay" characteristic of irreversibility, whilst at the same time allowing the body's natural defence mechanisms to build up resistance and initiate the process of healing. This type of action has important relevance in the treatment of shock, which, hitherto, has been directed towards the reversal of vasoconstriction by blockade of all outgoing nervous activity. Apart from some success in cases of early haemorrhagic shock, this treatment has not been successful [13]. Indeed, the recent demonstration that total chemical sympathectomy increases rather than decreases mortality from experimental shock explains why this should be so. It does, however, justify the conclusion that sympathetic responses (including cardiovascular) to injury are protective and deserve control rather than suppression. This justifies an approach of prevention by deafferentation. The deafferenting action of chlorpromazine on the brain stem reticular formation accounts for all of its divergent pharmacological actions, as well as its undoubted value in the prevention and treatment of shock states.

In conclusion, here is a simple, well-established explanation of how deafferenting action prevents shock. It is a fact that although chlorpromazine has no direct action on the posterior pituitary, it does reduce the antidiuretic response to pain and injury – by a deafferenting action [14]. It is a fact that destruction of the posterior pituitary, and, with it, reduction in the secretion of antidiuretic hormone prevents the onset of irreversible haemorrhagic shock [15]. It is an agreed fact, both from clinical and experimental experience, that chlorpromazine can prevent irreversible haemorrhagic shock [16]. It is finally a fact that when chlorpromazine is used as part of anaesthetic technique for major surgery, or in the prevention and treatment of shock states, urinary suppression never occurs and urinary output always exceeds 1 litre in 24 h. These facts alone justify a much wider use of chlorpromazine in anaesthesia and surgery, and I shall never understand why more interest has not been shown in this compound over the past 20 years.

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3.12 The Use of the Cuirass Ventilator, Belt Type

I. McLellan

I. McLellan

The use of cuirass belt ventilation developed from a case of progressive muscular dystrophy; the patient had periods of inability to breathe, and was treated by manual artificial respiration. Sir William Bragg suggested the use of a football bladder strapped to the chest and connected by a tube to another bladder fixed between hinged boards which could be compressed by hand or foot, thus giving forced expiration and passive inspiration. As no electricity was available at that time, Sir William asked Mr. R.W. Paul to make a hydraulically operated machine. It was used for 17 h a day (the patient not liking the constriction) during the remainder of the period the manual method was used. The football bladder was replaced by a rubber hot-water bottle and later by a belt containing a rubber bag covered with strong linen. This worked well for 3 years, with one problem during a hard winter, caused by the water supply freezing in the pipes. Mr. Paul then developed the machine to utilize the mains electricity supply or even batteries, and by 1935/1936 this apparatus was available for use in hospitals [1].

The apparatus consisted of a rubber bellows, 22 cm in diameter; the upper end of the bellows was fixed, and the lower end was connected to a plate which was raised and lowered to compress the bellows by a crank mechanism driven from an electric motor by a belt drive. At the upper end of the bellows was a large nozzle for connecting to the patient's belt, a small nozzle through which air could be introduced and a manometer connection. On later models there is also a built-in hand pump to fill the bellows and belt. The belt was made of heavy rubber of a rectangular shape. The outer surface had canvas straps with chain clips, and at each end of the belt was a rubber tube, both of which came to a T-connecting joint and fitted to the outlet part of the bellows. There were three sizes of belt. In use the belt was fitted round the patient's lower thorax and upper abdomen. The belt was filled with air up to a pressure in an adult of 30 or 40 mmHg and the apparatus was then switched on. The motor would give by adjustment a rate of 13–27 compressions per minute. The pressure required was monitored by the manometer gauge and was up to 25 mmHg for children in the age group 4–5 years, but up to 35 mmHg in an adult. As the belt is filled by the machine, the patient's lower thorax and upper abdomen are compressed and

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air is forced out of the lungs; as the belt empties, the pressure is released and inspiration takes place passively.

In the Medical Research Council Report in 1939 on breathing machines and their uses in treatment it is stated that the Drinker tank respirator and the Bragg–Paul pulsator were the only machines in widespread use in Great Britain and Ireland. In all, 120 patients approximately had been ventilated using the Bragg–Paul pulsator, of whom 56 survived. Discussion took place at this period as to which was the best form of ventilation, particularly in relation to the diphtheria and poliomyelitis epidemics which occurred in 1938/1939. At first sight it appeared that the tank ventilator was more successful, as the survival rate associated with its use in poliomyelitis was higher. However, the Medical Research Council pointed out that as the Bragg–Paul pulsator was more portable, it was more likely to be used in the utmost emergency situation and therefore had the potential of being used by less skilled operators, whereas the tank respirator would tend to be used in a centre which had the necessary expertise. When institutions which only dealt with one case were analysed, it turned out that the mortality was the same using either method of ventilation [2].

At this time, Lord Nuffield offered to supply the Both modification of the tank respirator free to any hospital in the United Kingdom and the British Empire. This offer represented a considerable benefit to the hospitals, as at that time the Both modification of the tank ventilator cost about £ 100, and the Bragg–Paul pulsator about £ 80. If the widespread use of the negative-pressure tank ventilator had not been facilitated by this offer, it is probable that the pulsator would have been further developed and kept in widespread use. When World War II started, the British Navy purchased all available supplies of the belts and pulsators. Little was then heard of the positive-pressure cuirass until 1957, when Herbert Pinkerton of Glasgow developed a manual cuirass belt for use during upper respiratory tract endoscopy. Because of the problems of oxygenating patients during bronchoscopy in particular, some workers used cuirass shells, but these were not totally satisfactory.

Pinkerton's cuirass was a modified sphygmomanometer cuff strapped around the chest just below the nipple, with the distensible part extending on each side of the patient to the posterior axillary line. The original models were filled by squeezing the bag on the Magill circuit that was connected to this belt; however, the later production model hat its own bag. The bag and belt were filled before the procedure started. Once the patient was paralysed, the bag was squeezed to produce active expiration, and on its release passive inspiration occurred. The side tube of the bronchoscope was fed with an oxygen supply of 5 litres/min, and the case quoted shows that the oxygen saturation during a 25-min bronchoscopy fell only on two brief occasions to 80% – during induction and when the bronchoscope was deep in the left main bronchus. This technique seems to have been widely used, but there was little further information. However, I discovered a Pinkterton cuirass tucked away at the back of a cupboard in our departmental office. It had presumably been replaced by apnoeic oxygenation and then by the introduction of Sanders, Venturi. In our brief study of the positive-pressure cuirasses, we have been impressed by the ease of fitting and apparent comfort in wearing. It would seem that this very simple method of artificial respiration has been undervalued, and I would suspect that in the future we may see a further resurgence of its use.

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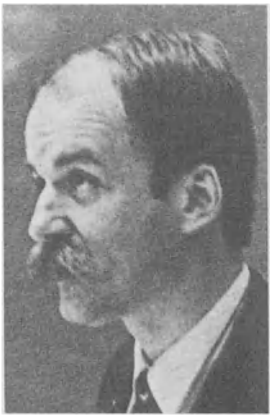
3.13 A Mechanical Heart-Lung Machine for Use in Man

M. P. Theunissen



M.P. Theunissen

In the past, heart surgery – open or closed – lagged far behind surgical advances in other fields. This was partly due to the long-held belief that the heart was the seat of the soul; even today it retains something of a magic aura. Moreover, the surgeons were also restrained by the threats and warnings of their colleagues. For example, Billroth wrote in 1883, "Any surgeon who should ever attempt to stitch a wound of the heart can be certain of losing the respect of all his colleagues for ever"; and Paget wrote in 1896, "No new method and no new discovery can overcome the natural difficulties that attend a wound of the heart."

Nevertheless, interest in, and the medical necessity for, heart surgery continued to increase to an extent which finally stimulated the search for a means of arresting the heart beat for a period of time with out permanent damaging any part of the body. Cooling of the whole organism was employed to depress the metabolic demands, combined with the use of a mechanical substitute for the heart or for a part of it. An example of the latter method was a pump which replaced the right or left side of the heart while the lungs continued to function.

In 1948, Prof. J. Jongbloed, Professor of Physiology at the University of Utrecht, expressed the opinion that only complete replacement of the heart and lungs was likely to be successful. He was the first person in the world to present his viewpoint. Although others were at that time engaged in experiments with exclusive perfusion of the brain in animals, Jongbloed thought that this still imposed too great a limitation on the operating time and he found non-perfusion of the spinal cord and of the heart itself unacceptable. It occurred to Jongbloed that such a heart-lung machine as he envisaged could be extended in its use to cases of diphtheria, where it could replace and rest the heart for a few days or, alternatively, to allow inflammation of the lung to subside after a pneumonectomy.

Prompted by a cardiologist and one or two surgeons, Jongbloed began the development of his machine. The early trials in dogs were so encouraging that he felt able to announce, "We will proceed to construct a mechanical heart for use in man" [1]. By the end of 1948 he had succeeded in developing a machine with the capacity required for an adult [2] and in the same publication he described for the first time a new type of

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artificial lung, the spiral oxygenator. In an extensive, illustrated article Jongbloed described his machine in great detail, ending with the words, "We believe that our apparatus, from a technical standpoint, can be considered ready for trial in Man" [3]. He was the only person in the world at that time who has produced a heart-lung machine with such a capacity.

In 1950, Jongbloed and his colleagues made a film showing the filling and the functioning of the apparatus and its use during an operation on a dog. The machine worked as follows: Via cannulae in both vena cavae, venous blood was continuously suctioned off by six air-driven Dale–Schuster pumps and conducted by means of a series of valves into six spiral oxygenators which rotated continuously. The blood was oxygenated by converting it into a film and bringing it into contact with a stream of oxygen – the "open oxygenation" method. The total minute volume was approximately 4 litres/min and the oxygen intake 250 ml/min. According to Jongbloed, this was sufficient for an adult under basal resting conditions. The oxygenated blood was collected in a glass reservoir suspended by spiral springs so that it rose and fell according to its weight and therefore to the amount of blood it contained. The oxygenated blood was sucked out of the reservoir and pumped into the patient. In order to prevent air entering the arterial cannulae, the six arterial pumps, also of the air-driven Dale–Schuster type, stopped automatically if the blood in the arterial reservoir fell below a certain level, the reservoir being elevated as it became lighter by the spiral springs. The pumps pumped the oxygenated blood into cannulae inserted into the femoral arteries, from which it flowed along the aorta in the reverse direction from normal.

Oxygenation proved satisfactory, and the artificial blood pressure was maintained at 80–100 mmHg; however, there was too great an elimination of CO_2 so that either CO_2 had to be added to the oxygen or a form of "closed oxygenation" had to be used. This consisted of allowing the oxygen to circulate in a semi-closed system from which the CO_2 was removed by soda lime to an extent sufficient to maintain a normal CO_2 tension in the blood. The quantity of CO_2 in the semi-closed system was measured by means of a diapherometer, a sort of capnograph.

The results of the animal experiments continued to be so successful that in 1951 Professor Jongbloed consented to the construction of a number of heart-lung machines for commercial distribution by Van Doorn, a manufacturer of apparatus in de Bilt, near Utrecht. After very extensive trials in animals, one of these machines was used for the first time in a patient on 5 December 1956, by Professor Nuboer, Professor of Surgery at the University of Utrecht. This machine worked in the following way: Venous blood was sucked off and the spiral oxygenators were used as already described. The blood was cooled and rewarmed during oxygenation. The prevention of air emboli had been improved. Instead of the arterial pumps being arrested when the reservoir emptied, the pumping mechanism of the (now two) arterial pumps was slowed down until the reservoir had refilled. The heart-lung machine had thereby acquired a pulsatile character. The level of haemolysis and foaming of the blood was acceptable for the first 30 min. A filter was only used within the apparatus during recirculation and never when it was connected to the patient. The machine could be hand-operated in case of a power failure.

Professor Jongbloed gave a large number of lectures on this subject and, as a physiologist, he displayed considerable foresight when he wrote in 1953, "I believe that an artificial circulation and respiration combined with cooling will prove to be the ideal method for intracardiac surgery" [4]. About ten of his heart-lung machines were built and sold to France, Japan and China. A prototype of this original heart-lung machine was on display during this Symposium, and a second version is at present on view in the Museum Boerhaave in Leiden.

In conclusion, this first heart-lung machine was a significant technical achievement at the time of its construction, but heart surgery was insufficiently advanced to do it justice. Therefore, the results were less satisfactory than desired. Over the years the machine has been improved and simplified in its design. The results with today's model do ample credit to the man who pioneered it.

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3.14 The Development of Cardiothoracic Anaesthesia – The International and Local Experience

I. McLellan

The development of cardiothoracic anaesthesia has been, in my opinion, one of the most exciting events in anaesthetic practice over the last 50 years. It has been a combination of great skill and technological advancement. Thoracic anaesthesia has developed since 1900, with the vast expansion of practice dating from 1930. Cardiac anaesthesia, despite `and early operation in 1925 for mitral stenosis, has largely developed since 1950.

In thoracic anaesthesia a major problem has always been dealing with the open pleura, with the additional problems associated with wet lung. Early pioneers developed the use of continuous positive-pressure airway apparatus, a later version being the Tiegle–Henle. The technological predecessor of modern apparatus was the Janeway Green Pressure Box in 1909. Like the constant positive-pressure apparatus, this box was placed around the patient's head while he was being anaesthetized; however, instead of a constant pressure being applied to the box, it was rythmically changed so that it gave intermittent positive-pressure respiration and was the first predecessor of modern ventilators. The use of intratracheal catheters for insufflation techniques was another method of dealing with the positive pressure for the open lung; the use of a second catheter for expiration also allowed for aspiration of secretions. This catheter technique was superseded by endotracheal intubation.

In the period up to 1940 surgery and anaesthesia was largely concerned with the problems of tuberculosis and involved the problems of dealing with artificial pneumothorax and thoracoplasty. At that time the possibility of invasive pulmonary surgery was not considered because of the problems of infection.

As a consequence of the problems of wet lung, anaesthesia was often a combination of general and local, enabling a patient to maintain a cough reflex but to be peacefully asleep. In our hospital, where Dr. A. I. Parry Brown was visiting anaesthetist and the then Mr. Thomas Holmes Sellors was surgeon, the technique for thoracic surgery was a light general anaesthetic of thiopentone, followed by nitrous oxide and oxygen while the surgeon used a paravertebral block. Perhaps it was during his time in our unit that Dr. Parry Brown developed his thoughts on posture during surgery.

Investigative procedures were also carried out, such as bronchoscopy and bronchograms. The technique used for bronchograms in our hospital was for an ether induction followed by nitrous oxide with trilene or chloroform using an endotracheal tube with a small catheter inserted for spreading the radiopaque oil. Chloroform was considered the best anaesthetic, but the cardiovascular sideeffects were often common in this situation. For bronchoscopy, thiopentone, nitrous oxide/oxygen and ether

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anaesthesia was used. Trilene was not common in our cardiothoracic unit, although chloroform was and remained popular, being used for some procedures into the late 1950s. Parallelling the rise of thoracic anaesthesia in the late 1930s was the experience gathered by physicians treating diphtheria and poliomyelitis with artificial ventilation, which led to important research into ventilator development.

Two important pharmacological events occurred in the 1940s: the use of curare and the introduction of penicillin. The first permitted a light relaxant anaesthetic to be used, so that the problem of the pleura was largely solved. With the introduction of effective antibiotics invasive pulmonary surgery became more common. Curare was not used in our unit until 1948, and at that time there was great interest in the use of high spinals using a hypobaric technique for thoracic surgery. The use of intravenous procaine as an adjunct to general anaesthesia was also popular and became standard practice for a number of years. A standard technique for major thoracic surgery which developed in the 1950s was thiopentone induction followed by curare, nitrous oxide and oxygen with a little intravenous analgesia, and this technique has remained popular. Inhalational agents were popular in our unit. Endoscopies of course, have been revolutionized by the use of suxamethonium: The spontaneous breathing technique, using oxygen and ether or nitrous oxide/oxygen and ether followed by trilene of chloroform, has changed to suxamethonium and apnoeic oxygenation or the use of some form of insufflation or cuirass ventilation and then the Venturi.

Later developments in thoracic anaesthetica were the introduction of endobronchial blockers and also double-lumen tubes. Many types were developed following the use of the Carlens tube for bronchospirometry and then later in anaesthetic practice. The tubes could be used in a variety of conditions, thus allowing great flexibility for the thoracic anaesthetist and removing a number of problems, although the complexity of positioning some of the tubes created others. Further developments with these tubes have continued and are regarded in the very recent history of thoracic anaesthesia.

Cardiac surgery had a slightly staggered start from the early operations prior to 1940 to tie the ductus arteriosus and to implant omentum or intercostal muscles onto the myocardium of patients with ischaemic heart disease. These cardiac patients, of course, still had the same problem of the open pleura, and in 1938 the anaesthetic for implantation of omentum onto the myocardium was thiopentone, oxygen and ether delivered by face mask using the Tiegle–Henle apparatus. The first dry open heart operation using an inflow-occlusion for repair of an atrial septal defect took place in 1952. Further developments in anaesthetic practice involved great technological advancement, as it was during this period of early open heart surgery with or without hypothermia, that the development of the pump oxygenator in all its various forms was being carried out by many pioneers. In our unit, open heart surgery using inflow-occlusion was carried out for a number of years up to the early 1960s, to be replaced by today's normal open heart surgery using the pump oxygenator.

One of the biggest advances in cardiac anaesthesia is that now the patient expects to live, having had a routine operation rather than a last-ditch attempt with a high mortality. Another real advance in cardiac anaesthesia is the use of drugs to regulate circulatory responses, thus allowing procedures to be carried out on patients whose general condition would not previously permit.

3.15 Regional Block: Its History in the United States Since World War II

D.C. Moore

Institutional Teaching in and Significant Contributions to Regional Block Prior to 1945

In 1933, J.G.P. Cleland, a general practioner in Oregon, had defined the pathways of pain during labor and was using continuous (intermittent) caudal block to control them [1]. In 1949, he also described the double-catheter technique for vaginal delivery [2]. However, it was the missionary work and use of these techniques by R.A. Hingson, who started touring the United States in 1942, that popularized them [3].

Following World War II few institutions taught regional block techniques. Those that had the reputation of doing so were: Bellevue Hospital, New York City, New York – E.A. Rovenstine; Charity Hospital, New Orleans, Louisiana – J. Adriani; Hahnemann Hospital, Philadelphia, Pennsylvania – H.S. Ruth; Huron Road Hospital, Cleveland, Ohio – R.J. Whitacre, J.K. Potter, B.B. Sankey; The Lahey Clinic, Boston, Maryland – P.D. Woodbridge, U.H. Eversole, M.J. Nicholson; The Mayo Clinic, Rochester, Minnesota – J.S. Lundy, L. Mousel, J.W. Pender, T.H. Seldon, E.B. Tuohy; and the University of Pennsylvania, Philadelphia, Pennsylvania – R. Dripps, L.D. Vandam. All these institutions were located either in the eastern or mid-western United States.

Development of Teaching Programs of Regional Anesthesia in the Western Part of the United States (1945–1981)

During our "tours of duty" in the US Army in World War II, J.J. Bonica and I (who were never at the same hospital nor acquainted prior to 1949) became interested in regional block, for we believed then, as now, that when applicable it was far safer than general anesthesia. By coincidence, he became director of the Department of Anesthesia at Tacoma General Hospital, Tacoma, Washington early in 1947, and I took a similar position 9 months later, 35 miles (56 km) from Tacoma at the Virginia Mason Hospital, Seattle, Washington. In 1949, we met, and we and our families became close and dear friends, much to the amazement of many, because of our intense interest in, as well as our differences regarding, regional block. Regional anesthesia flourished in both hospitals, which eventually developed residency training programs and became recognized as training centers for regional block techniques. This was possible because the choice of anesthesia was ours and not made by the surgeons, although

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from time to time we were confronted by the "captain of the ship doctrine" by the surgeons. Furthermore, Bonica became intensely interested in pain and pioneered the concept of a multidisciplinary pain clinic. Also, in 1952 we established the first 24-h coverage of obstetric deliveries by physician-anesthetists in private hospitals in the United States, and within a year over 90% of the obstetric deliveries in the hospitals in which we practiced were performed with regional block techniques.

During this same period, P.C. Lund at Connemaugh General Hospital, Johnstown, Pennsylvania, was promoting regional anesthesia. Then, as the years went by, more and more physicians became interested in regional block and its development. Those who have contributed constantly and significantly, to mention a few, are: L.D. Bridenbaugh, R.H. de Jong, A.P. Winnie, P.O. Bridenbaugh, P.P. Raj, S.M. Shnider, B.G. Covino, and G.E. Thompson. Also, since he had recently immigrated to the United States, we can recognize P.R. Bromage, who has made significant contributions, as one of our number. It is hoped that others who have contributed but whose names are not mentioned will not be offended by the naming of these outstanding physicians.

The American Society of Regional Anesthesia

In 1976, with A.P. Winnie as the prime instigator, the American Society of Regional Anesthesia was reborn. (It had existed in the 1920s, but was slowly absorbed into other societies and eventually lost its separate identity.) From 412 members in 1975, it consistently grew, until in 1981,it numbered 3498 members. The inaugural issue of the journal *Regional Anesthesia* (H. Carron, Editor), was October–December 1976. From then until the January–March 1981 issue, it was financed by contributions from companies producing regional anesthesic drugs and equipment. Now it is published by J.B. Lippincott and financed only by the Society and its advertisers.

Significant Publications

Since 1945, many articles regarding regional block have appeared in medical journals (too many to list), and many books devoted solely to regional block have been written by anesthesiologists in the United States (see references 4–23).

Local Anesthetic Drugs in the United States

In 1952, chloroprocaine, a drug with a rapid onset and a short duration, which is rapidly metabolized, was introduced. Unfortunately, this valuable drug has recently been implicated as a possible cause of myelopathy, particularly when unintentionally injected into the subarachnoid space while performing epidural block.

In 1972, etidocaine, a long-acting local anesthetic drug, became available for clinical use. Unfortunately, it has a strong motor, but a weaker sensory component, and its use is therefore restricted to specific procedures usually involving the lower extremities. It is the only local anesthetic drug whose plain solution immediately precipitates on contact with cerebrospinal fluid. It is not known whether this is of any significance in humans should an unintentional subarachnoid injection occur during an attempted epidural block. At least in rabbits and sheep there have been no untoward results from its placement subarachnoidally.

Techniques of Regional Block Introduced by Physicians in the United States

In 1948, V. Apgar introduced the anterior approach to the stellate ganglion, and in 1954 the paratracheal approach was introduced by D.C. Moore. In 1964, A.P. Winnie and V.J. Collins described the subclavian approach for brachial plexus block, and in 1970 Winnie described the interscalene approach for this block. Whether these are original or a rebirth of techniques previously described has yet to be conclusively documented.

In 1964, G.T. Tucker (joined in 1965 by L.E. Mather) started to study in depth the pharmacokinetics and toxicity of local anesthetic drugs; in 1970 J.J. Bonica and colleagues extensively investigated in humans the cardiovascular effects of spinal and epidural block; and in 1982 D.C. Moore and co-workers showed in humans the severity of the hypoxia and acidosis which occurs concomitantly with local anesthetic-induced convulsions.

Equipment

In approximately 1970, single-use (disposable) regional block trays and equipment began to appear in the United States. This equipment is now used worldwide. However, most components of these trays were developed for parenteral therapy (intravenous infusions, single injections of medications, drawing of blood, etc.). Therefore, with the exception of a few specific single-use items designed especially for regional block (the Pitkin introducer, the Abbott connector for plastic tubing, and the Becton–Dickinson 3.8 cm, 22-gauge, security bead, short-beveled, needle with a transparent hub), reusable equipment is still preferable when learning or teaching regional techniques. However, when it is used, it must be meticulously cleaned and sterilized. Therefore, since single-use equipment is guaranteed sterile and free of neurolytic contaminants, it is used by most anesthetists.

Present Status

The use of regional anesthesia had its rebirth in the United States after World War II. It is used to greater extent there than in any other country and is on the increase. However, complications from regional block are increasing along with its use. If they continue to result in catastrophic sequelae, the death knell of regional analgesia, regardless of its many advantages over general anesthesia, may sound in the not too distant future. Therefore, it behooves all of us who use regional block to be able to recognize the onset of its complications and prepare to treat them immediately and correctly.

Regardless of where it is used, its conduct should be the same as general anesthesia, that is, intravenous fluids should be running, a blood pressure cuff and electrocardioscope should be applied, and perhaps the patient should be preoxygenated. In addition, oxygen, airways, a laryngoscope with a blade attached, suction, and drugs in syringes with needles attached should be available for immediate treatment of complications. They cannot be down the hall, in drawers, in an anesthetic machine, or elsewhere. Immediate ventilation of the patient and correction of hypotension prevents encephalopathy and death from complications.

Epilogue

It is to be hoped that the "golden age" of regional block is just starting and has not passed. Since I began to perform regional block in January 1942 as an extern in anesthesia at Wesley Memorial Hospital, Chicago, Illinois, as a sophomore medical student under M. Karp, director of the Section of Anesthesia, Department of Surgery, Northwestern University, and have devoted my entire career to regional anesthesia, its demise would be difficult to tolerate. Nonetheless, the opportunity to participate in it for 40 years, to know personally all those mentioned in this presentation, as well as to meet, know, and understand my colleagues in other countries, would have made it all worthwhile. Sincere thanks is extended to Erasmus University, Rotterdam, for inviting me to participate in this symposium on the history of anesthesia.

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3.16 The History and Development of Obstetric Anesthesia

Paul J. Poppers

Paul J. Poppers

The quality of obstetric care can be considered a criterion for the level of civilization that a particular society has attained. It is in this light that obstetric pain relief must be viewed. Practiced in one crude form or another throughout the ages, modern obstetric anesthesia as a medical endeavor began within a few months after the first successful administration of surgical anesthesia. It happened almost simultaneously on both sides of the Atlantic. On 19 January 1847, 3 months after William Thompson Green Morton had demonstrated his ether anesthetic at the Massachusetts General Hospital, James Young Simpson, Professor of Midwifery in the University of Edinburgh, Scotland, administered ether to a patient in labor. He reported the case in the March issue of the *Monthly Journal of Medical Sciences* [30]. On 7 April 1847, Nathan Cooley Keep (like Morton a dentist and physician, who progressed to become the first Dean of the Harvard Dental School) gave ether anesthesia for childbirth. It was reported 1 week later in the *Boston Medical Surgical Journal* [16]. Actually, it had been Crawford Long, a young physician in Athens, Georgia who had preceded all others in administering ether for surgical and obstetric anesthesia. Because he did not publish his experiences until much later, he did not contribute to the development of the specialty.

A few weeks after the report by Keep, Walter Channing, Professor of Midwifery and Medical Jurisprudence in the University of Cambridge (better known to us as Harvard University in Boston), took up the use of ether in childbirth and became its champion in the United States. He described several successful administrations of sulfuric ether [3].

Meanwhile, Simpson, not entirely satisfied with ether, discovered the anesthetic properties of chloroform. He published his experiences on 15 November 1847 in a monograph entitled *Account of a new Anaesthetic Agent, as a Substitute for Sulphuric Ether in Surgery and Midwifery* [29]. On the frontispiece he quotes Bacon als follows: "I esteem it the office of a Physician, not only to restore health, but to mitigate pain and dolours." His example was again followed in the United States when Augustus Gardner of New York first employed this agent in obstetrics in February 1848 [11]. That same year, Channing published his classic, *A Treatise on Etherization in Child-*

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birth, in which he described 581 collective cases of ether and chloroform anesthesia in obstetrics, stressing their safety for mother and child [3].

Obstetric anesthesia took hold quickly. At the American Medical Association meeting of 1848 the Committee on Obstetrics reported the use of ether and chloroform in about 2000 patients with no deaths and few, if any, untoward results. One year later the same Committee urged the use of anesthetics in obstetrics, preferably chloroform, since this was justifiable for the purpose of alleviating the pain of labor. It also stated that "in all difficult and instrumental labors their application could not be rightfully withheld."

Simpson continued to experience objections and disapproval, not only from his medical colleagues but especially from the powerful Calvinist Church of Scotland. His opponents quoted the Bible to show that, as penalty for eating the forbidden fruit in Paradise, women had to suffer pain at childbirth. Simpson countered this argument with the account of the birth of Eve as related in Genesis. He suggested that the Good Lord himself had been the first anesthetist.

Simpson's pioneering efforts were not in vain [30]. He was major influence on John Snow, the English epidemiologist noted for eradicating the source of cholera from London. Snow had become the first full-time physician-anesthetist and advocated the cause of obstetric anesthesia [31]. He made a great impression upon Queen Victoria with his results, and was invited to administer chloroform for the birth of the eighth royal infant. Now also Her Majesty became subjected to veiled criticism. But she, obstinate and quite determined as usual, pronounced, "*We* are going to have this baby, and *We* are going to have chloroform." Indeed, she did. On 7 April 1853 she had a painless delivery of a boy, Prince Leopold. As he had done before, Snow poured the chloroform on an handkerchief in 15-minim doses and administered the anesthetic intermittently, during the uterine contractions only. The term "Anesthésie à la Reine" was coined for this method. Queen Victoria gave lavish thanks for the new drug and the pain relief it had provided. Moreover, she gave obstetric anesthesia the seal of respectability.

The Queen's endorsement fostered wide acceptance of obstetric anesthesia throughout the English-speaking world. Thomas Wakley, founder and editor of the *Lancet,* wrote that in no case could it be justifiable to administer chloroform in perfectly ordinary labor. This oracular pronouncement fell on deaf ears. Victoria again requested the anesthetic services of Dr. Snow in 1857 at the birth of her last child, Princess Beatrice. That the Queen was cared for by two midwives and an anesthetist with names as pure as Mrs. Lilly, Mrs. Innocence and Dr. Snow must have been further evidence that obstetric anesthesia could not be the devil's work. Anecdote has it that Snow, upon being called to the palace, posted a notice on his door: "Out to Attend the Queen," whereupon an irreverent medical student is said to have penned underneath: "God Save the Queen."

In retrospect this can be considered a very wise comment. Snow administered chloroform intermittently in analgesic concentrations for childbirth [31] and in a scientifically determined and carefully controlled concentration for surgical anesthesia. In contrast, later practitioners were not as circumspect or knowledgeable in the physics, pharmacology, and physiology of anesthesia [21]. Many anesthetic fatalities could have been prevented if Snow's principles had been heeded and his techniques emulated.

When obstetric anesthesia had become a socially and medically acceptable practice, concern was expressed about the exposure of the fetus to anesthetics and the adverse effects this could have upon the neonate [21]. This concern stimulated several inquiring minds towards scientific investigation of the entire area of obstetric anesthesia. It may have started with Channing [3]. He wondered about the passage of the anesthetic across the placenta and could detect the smell of ether on the cutsurface of the umbilical cord. Snow noted in 1858 [31] that infants born after their mothers had received chloroform did not appear as vigorous as was usually observed. The presence of chloroform in umbilical cord blood and in the urine of newborns was demonstrated by Zweifel in 1877 [33]. He was also able to prove the transfer of oxygen from mother to fetus through the umbilical cord by means of a spectroscopic technique [32]. Gusserow administered benzoic acid to pregnant women; he found hippurate crystals but no benzoic acid in the neonatal urine. He concluded that benzoic acid crossed the placenta and was broken down in the fetal kidney. Preyer reported in 1885 that he had injected curare into pregnant rabbits and guinea pigs [27]. The animals subsequently became paralyzed, but the offspring, delivered by uterine incision, were not affected.

During the next several decades the development of obstetric anesthesia reflected more of an evolution of new anesthetic and analgesic agents. Klikowitsch of St. Petersburg (Leningrad), Russia, used 80% nitrous oxide in 20% oxygen for obstetric pain relief in 1880. In fact, he was more revolutionary than evolutionary; he measured the intensity and duration of uterine contractions with a balloon that was introduced into the uterus, and thus anticipated the modern techniques of monitoring the progress of labor. He observed in 1881 that nitrous oxide did not change uterine activity but that chloroform had a tendency to cause uterine relaxation to such an extent that intrauterine maneuvers, such as manual removal of the placenta, could be performed easily [17]. He also noted that this could not be done under nitrous oxide/oxygen anesthesia.

A wave of enthusiasm for obstetric pain relief followed the introduction of a combination of scopolamine and morphine by Steinbüchel of Graz in Austria in 1902. The term *Dämmerschlaf* (twilight sleep) was given to this state of combined amnesia and analgesia. It remained very popular until quite recently and underwent some modification when on occasion meperidine was substituted for morphine and barbiturates were used in conjunction with it. Actually, administration of morphine to control the pain of labor had already been suggested in 1868 by Kormann of Germany [15, 18], but problems associated with the use of narcotics were soon recognized and their administration to pregnant or nursing women was discouraged. It was therefore Gauss, a German obstetrician in Freiburg, who suggested a single injection of morphine, followed by repeated injections of scopolamine [12]. This method remained popular until about 40 years ago, despite the excitement and uncontrollability of the laboring patient, the frequently observed protracted labor, and the consequent respiratory depression of the neonate.

These problems could seemingly be overcome with the use of local anesthetics for regional anesthesia. Its origin can be found in the application of cocaine for topical anesthesia in ophthalmology, for which not only Carl Koller but also Sigmund Freud, both of Vienna, must be credited. Corning, a New York neurologist, injected cocaine near the spinal cord to relieve the pain of severe ailments. That was in 1885 [4]. Corning suggested that a similar procedure be used for surgical anesthesia [4], a suggestion that was soon implemented in Kiel, by August Bier [2a], who deserves to be known as the Father of Spinal Anesthesia. This method of pain relief was first used for operative vaginal delivery by Kreis in Germany in 1901. Pitkin promoted spinal anesthesia in obstetrics in the United States [23], but was preceded by George Gellhorn, who in 1913 had advocated the local infiltration of the perineum with local anesthetics for obstetric and gynecologic purposes [13]. Sicard and Cathelin, both from France, independently discovered the sacral epidural (caudal) block, which was subsequently performed in obstetrics by Von Stöckel in 1909. The lumbar epidural block, first suggested by Pagés in 1920 [22], found application in obstetrics after a proper technique had been devised by Dogliotti in 1933 [6]. Regional anesthesia techniques earned their deserved popularity with the introduction of continuous caudal and lumbar epidural block by Hingson and Edwards in 1942 [7,14], first by means of a malleable needle, and later by the placement of a flexible catheter through a large-bore needle.

The last several decades have been marked by significant progress in obstetric anesthesia as a medical science. The major impetus towards this development must be ascribed to Virginia Apgar. She is best known for having introduced a simple scoring method to evaluate the condition of the neonate [2]. More importantly, she applied this score to the objective evaluation of the quality of obstetric and anesthetic management of the parturient. The Apgar Score also allowed a reasonably accurate determination of the safety of particular anesthetic agents and methods. It was the precursor of more precise investigative techniques.

Virginia Apgar was a graduate from the College of Physicians and Surgeons of Columbia University in New York City. Following graduation she was appointed to the surgical house staff at the Columbia Presbyterian Medical Center. Though she performed admirably, her professors felt that as a female she would have no great future in surgery and convinced her to enter the very young specialty of anesthesiology. As was the case with everything she undertook, she became very successful in this discipline and, serving as the Chief of the Division of Anesthesiology in the Department of Surgery, became the first woman ever to attain the rank of full professor at Columbia's College of Physicians and Surgeons. With the subsequent development of an independent Department of Anesthesiology at Columbia University and the appointment of Emanuel Papper as its first professor and chairman, Virginia Apgar had the opportunity to devote full attention to obstetric anesthesia, the area of her major interest. She gathered around her young pediatricians and anesthesiologists, who, with the later addition of obstetricians, formed the nucleus of a perinatal research group. A systematic study of the effects of anesthetics and related drugs administered for obstetric pain relief upon mother and fetus gave rise to the specialty of perinatology. Here, the clinical interests of pediatricians, obstetricians, and anesthesiologists converged. A firm scientific basis had been developed.

Initially, the Apgar Score was used to study the effect of inhalation anesthetics upon the newborn. It then became evident that potent drugs, such as cyclopropane [28], increased the incidence of depression among newborns if administered for more than 5 min prior to delivery. It was also shown that this incidence increased pari passu with the duration of such administration. No such increase was apparent when a nonpotent anesthetic, such as nitrous oxide or ethylene, was used, nor if potent anesthetics were administered in low, i.e., analgesic concentrations. It could be demonstrated that neonatal depression did occur following administration of nitrous oxide if the gestational age was less than 36 weeks. The depressant effect became more pronounced with increasing prematurity.

In 1968 Finster and Poppers reported their cesarean section study in which nitrous oxide did affect the mature neonate [8]. An interval of more than 10 min between the induction of general anesthesia and delivery of the infant was associated with a lower Agpar Score and a higher degree of acidemia in the neonate. The authors questioned whether nitrous oxide might be the depressant factor in question, and Marx and her co-workers subsequently postulated that this was indeed so [19]. However, they only showed that, as the duration of anesthesia increases, there occurs a gradual equilibration of nitrous oxide concentrations in umbilical artery and vein blood. Poppers and collaborators reported in 1975 that prolonged nitrous oxide anesthesia without prolonged surgery (i. e., anesthesia was begun well before surgery) was not associated with a significant deterioration in Apgar Score or acid-base status of the newborn, suggesting that aortocaval compression was a more important factor [25]. It was finally demonstrated by Datta and the Harvard group of obstetric anesthesiologists that interference with normal uterine and placental perfusion is the critical determinant, and that this is related to the duration of surgical manipulation and the length of time the patient is kept in the supine position.

The question of induction of general anesthesia, a source of contention, was resolved on the basis of Apgar Score, acid-base status and pharmacokinetic studies. The history of intravenous barbiturates in obstetric anesthesia is an interesting one. Obviously, the advent of ultra-short-acting intravenous barbiturates meant a quantum jump forward in surgical anesthesia. Therefore, the drugs were used for obstetric anesthesia as well. Their safety in terms of the fetus was questioned, and in 1944 Hellmann and co-workers investigated whether thiopental was transmitted across the placenta. Their studies showed that this was indeed the case and that fetomaternal equilibration was obtained in about 12 min. The absence of neonatal depression was ascribed to the circumstance that most deliveries were completed within 8 min, at which time equilibration was supposedly quite incomplete. McKechnie and Converse showed 11 years later that thiopental transmission occurred much more rapidly and that in fact fetomaternal equilibration was complete within 3 min. As a result, barbiturate induction of general anesthesia for obstetric delivery was abandoned for many years [19 a]. The fallacy of both investigations was that no attention was paid to the actual plasma concentration of the thiobarbiturate.This was first done by Price in his computer simulation of 1960, which indicated that drug distribution in the tissues was responsible for a very rapid decline in plasma thiopental concentration, and, moreover, that administration of an intravenous bolus resulted within 2–3 min in a very low, nonhypnotic plasma level [27 a]. Baux in France postulated that therefore the fetus at complete equilibration would only be exposed to a plasma concentration that was too low to cause neonatal depression. Finally, the classic study by Finster and collaborators of the Columbia group provided the definitive answer [9]. Safety of a single bolus of thiopental for induction of general anesthesia was convincingly demonstrated. No correlation between drug concentration and neonatal condition was apparent. Those few neonates who where depressed at birth invariably showed low plasma levels of barbiturate. Their poor clinical condition was due solely to intrauterine asphyxia of rather long duration, as evidenced by a fetal base deficit exceeding 10 mEq/litre. Finster and his co-workers at Columbia subsequently showed that the liver is interposed in the fetal circulation as a filter or sink; it removes and stores, by means of a first-pass effect, large quantities of drugs that have crossed the placental barrier.

Circulatory studies by Dawes and others at Oxford suggested an additional cause of delay in fetomaternal equilibration of drugs. The peculiar fact is that only 55% of the fetal cardiac output goes to the placenta, where it is equilibrated with maternal blood. Thus, when this blood returns via the umbilical vein it is serially diluted by that other 45% of the circulatory volume which perfuses the fetal tissues.

Subsequent studies by members of the Columbia group have indicated that repeated administration of small boluses of thiobarbiturate are well tolerated by the fetus, so long as the total dose does not exceed 7 mg/kg maternal body weight. However, at most institutions a single injection of no more than 3–4 mg/kg is preferred. Others combine small amounts of ketamine and thiopental [1], in dose ranges of 0.2–0.4 mg/kg and 1–2 mg/kg, respectively.

Curare, first described in western literature by Sir Walter Raleigh in an account of his travels published in 1596, was the subject of physiological studies by Claude Bernard around 1850. Subsequently, and as previously mentioned, Preyer showed the lack of effect upon the fetus, when pregnant animals received a paralyzing dose of curare. It had therefore been believed for many years that muscle relaxants were unable to cross the placenta owing to their poor lipid solubility, their high degree of ionization, and their high molecular weight. Much later, autoradiographic studies performed by a research group headed by Crul showed that succinylcholine crosses animal placentas similar in structure to the human placenta. By adapting the radioimmune assay technique, Horowitz and collaborators at Columbia were able to demonstrate that *d*-tubocurarine also crosses the placenta. However, the transfer is so slow that equilibration occurs when the drug, to a very large extent, has been distributed in the tissues of the mother. Therefore, the fetal circulation reaches equilibrium when the maternal blood levels are clinically insignificant. Thus, the safety of commonly used muscle relaxants was demonstrated on the basis of actually measured neonatal plasma concentrations.

Virginia Apgar's inspiration also found expression in the pharmacokinetic studies of local anesthetics undertaken at Columbia University. It had long ago been oberserved that the neonate was generally in better condition if regional anesthesia rather than deep general anesthesia had been administered to the parturient. This was then explained as follows: The fetus became exposed to the inhalation anesthetic, but not to the local anesthetic. Whereas the observation was undoubtedly correct, the explanation was not.

Bromage in 1962 was the first to indicate that local anesthetics were able to cross the placenta. In a study published in 1966, Morishima and other members of the Columbia perinatal group shed light on the pharmacokinetics of local anesthetics used for epidural anesthesia in childbirth [20]. Mepivacaine could be detected in the maternal circulation within 7 min following epidural injection, and placental transfer followed immediately. Peak maternal plasma levels were reached within 20–30 min, averaging 3µg/ml, with a fetomaternal plasma concentration equilibration ratio of 0.6. Similar values were found for lidocaine. More importantly, there was proof that excessively high blood concentrations of local anesthetic were depressant to the infant.

Moreover, it seemed that the fetus and neonate were good models for clinical investigation of local anesthetic toxicity. This was convincingly shown by Poppers and collaborators in a study of prilocaine [24]. Animal investigations had already indicated that the systemic toxicity of this compound was 40%–50% lower than that of lidocaine. Indeed, when explored for epidural block, prilocaine did not cause neonatal depression when similar quantities of mepivacaine and lidocaine had done so. The low protein binding of prilocaine allows more rapid tissue distribution and more steeply declining plasma levels. It also accounts for equal fetal and maternal prilocaine plasma levels, but again, equilibration ratio's are not necessarily synonymous with actual brain tissue concentrations.

Thereafter, long-acting local anesthetics gained major interest among obstetric anesthesiologists when it was shown that the offspring of mothers who had received bupivacaine for epidural anesthesia had considerably better neurobehavioral scores than those of mothers who had received either lidocaine or mepivacaine. High protein binding ratios, as high as 95% for bupivacaine and etidocaine, were thought to diminish placental drug transfer to a great extent. Preliminary studies by Morishima have indicated, however, that the amount of local anesthetic that ultimately accumulates in the fetal tissues bears no relation with the drugs's protein binding. Obviously, another explanation for the observed difference, whatever its clinical significance, must exist. It is likely that the high lipid solubility of the long-acting local anesthetic agents is responsible for rapid drug removal from the circulation, thus preventing their accumulation in the central nervous system of the fetus. Whether a high pK_a could also become a positive factor in this respect is doubtful. A much simpler explanation is that long-acting local anesthetic agents do not necessitate a topping-up dose immediately preceding delivery. Thus, a sudden increase in plasma level in mother and fetus is avoided at the critical moment, i.e., birth.

Many other interesting historical developments in obstetric anesthesia could be related and expanded upon. However, certain limitations must be observed. What has been attempted in this paper is to demonstrate a link between the earliest practitioners and the obstetric anesthesiologists of today, who all contributed to the gradual development of obstetric anesthesia from a purely empirical practice into a fully fledged anesthetic subspecialty that rests on strong scientific foundations. The frequent mention that has been made of the recent work done by Columbia University's obstetric anesthesia and perinatology group is meant to render homage to Virginia Apgar, outstanding pioneer of modern obstetric anesthesia.

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3.17 History of Resuscitation of Newborn Infants

A. I. Hyman

This is a short account of the history of resuscitation of newborn infants. Our current methods and approach to resuscitation now seem to us so reasonable and straightforward that we may find it hard to understand why our current methods were so long in becoming established, and – stranger still – why, even today, crude and ineffective measures of resuscitation are still being practiced.

Even in antiquity, we presume, it was known that the infant might be suffocated either in utero or in the birth process. In the eighteenth and nineteenth centuries, attention was given by pulmonary physiologists to understanding acute asphyxia in adults. This works was commissioned by owners of coal and metal mines whose workers often became asphyxiated by poison gases. There was growing appreciation of the similarities in the chemistry and behavior of asphyxiated infants to adults suffering suffocation. Unfortunately, this appreciation often led to the many dangerous and ineffective practices that were applied to adults now being given to newborns.

Fundamental to their notion of treatment of asphyxia at that time was that asphyxia could be reversed by a strong counter stimulus. Immersion in cold or hot water, electric shock, anal dilation, and other painful practices were applied to both asphyxiated adults and newborns. Some of the particularly stressful stimuli applied to infants included traction of the tongue, dilation of the anus, slinging of the baby, and hypothermia.

A century ago, a body of knowledge was growing that showed an association of birth asphyxia with the subsequent development of serious neurologic disabilities which we call cerebral palsy. This concept was introduced by Little in 1842 [1], but unfortunately, it was generally forgotten and had to be relearned again in our own time.

It is basic to the appreciation of the importance of effective infant resuscitation that we are able to prevent the development of discrete brain lesions resulting from asphyxia by early and vigorous reversal of hypoxia and acidosis. The experimental work of Windle and Dawes was most convincing [2].

We should note that there are important differences in principle between the newborn and the adult in the problem of resuscitation. The adult usually has suffered cardiac failure. His lungs contain air, and therefore first attention should be given to circulatory support. In contrast, the newborn's lungs are airless and poorly perfused. While his cardiac output may be impaired, with adequate ventilation, heart activity usually rapidly picks up and pulmonary blood flow almost immediately increases. The

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Edited by Joseph Rupreht, Marius Jan van Lieburg
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asphyxiated newborn therefore requires primarily artificial ventilation. Dr. Henderson, of Henderson-Hasselbalch equation fame, wrote, in 1928:

> The first quarter of an hour is the most dangerous period of life. Its mortality is as great as that of any subsequent month. No single discovery in medical science or improvement in practice could do more to save lives than would measures to avoid the losses that now occur within the first few minutes after birth.

A similar admonition could have been written even a generation later. Added to the noxious stimuli just listed were the introduction of analeptic drugs to excite the newborn.

Several explanations underlie this lag in development of modern concepts of resuscitation, even until the middle of this century. First was the mistaken idea that babies can withstand asphyxia without injury. "Everest in utero" was a euphemism wrongly implying that hypoxia is the normal state of the fetus. Second, obstetricians and midwives were the only medical personnel in attendance at most deliveries. Even cesarean sections, usually an emergency procedure, were performed under local anesthesia without the benefit of an anesthesiologist, nor were pediatricians present in the delivery suite. The lone obstetrician, whose primary attention and concern was to the mother, rarely had the time, training, or inclination to provide the infant with the benefits of sound principles of resuscitation. Third was the great dearth in our basic knowledge and understanding of the pathophysiology of the birth process. Circulatory adjustments, initiation of the first breath, and metabolism of the newborn were poorly understood.

By 1950 it had gradually became apparent that the most effective means of resuscitation of the newborn was the application of basic, sound principles used by anesthesiologists in their daily practice. These principles included monitoring of vital functions, measuring blood gases, clearing and securing the airway, oxygen therapy, and ventilation with mask or endotracheal tube.

A pioneer was Joseph Kreiselman, an anesthesiologist from Washington, DC. Beginning in 1920, and for the next 20 years, he developed and improved the first device to incorporate all the means of resuscitation designed for the newborn infant [3]. It provided warmth, oxygen, suction, and a safe method of intermittent positive pressure ventilation (IPPV), either with a mask or, in more seriously depressed infants, with a tracheal catheter. Gradually, the predominant opinion was becoming established that IPPV was the most effective means of resuscitation. Furthermore, animal experiments designed to compare methods of resuscitation confirmed the clinical impression of the advantages of positive pressure ventilation. However for the most part, only anesthesiologists had acquired the skills of endotracheal intubation, and too few of them were present in the delivery rooms.

The endotracheal tube, and therefore the role of the anesthesiologist, has been the focus of controversy and attention for 100 years. The management of diphtheria croup was long delayed because of the reluctance to learn intubation. Similarly, predominant chest surgeons at the turn of the century preferred cumbersome chambers and negative pressure rooms, rather than to rely on a technique – tracheal intubation – that they had not mastered.

More recently, internists and pediatricians have also lagged in their willingness to accept respirators and respiratory care because their patients would require intubation. It is not surprising, therefore, that a variety of techniques designed to oxygenate the apneic infant without intubation were introduced and avidly attempted.

One of the first of these was designed by Bloxsom. In 1953 he reported the use and value of the so-called air lock [4]. The infant was enclosed in a chamber into which pressures developed between 50 and 150 torr. Cycling occurred once or twice a minute. The apparatus was based on the principle introduced in the early 1920s by Thunberg that describes the increase in ventilation associated with passive compression of gas in the lung [5]. But Bloxsom's device was soon recognized to be ineffective, particularly in the infant's fluid-filled lung, and it was discarded.

Later, body-tilting devices were used in the belief that they would cause ventilation by shifting abdominal contents against the diaphragm. Other worthless systems of infant resuscitation included phrenic nerve stimulation, and intragastric, and later hyperbaric, oxygenation. It was claimed by Hutchinson that asphyxiated and apneic infants would be rapidly resusciated in a hyperbaric chamber, thus avoiding the need for endotracheal intubation [6]. However, in animal experiments, hyperbaric oxygen failed to resuscitate severely asphyxiated newborn rabbits, while most comparably depressed animals were successfully resuscitated by artificial ventilation.

The past two decades have witnessed a remarkable advance in attitudes towards infant resuscitation. It has been recognized that the acidosis commonly found in the blood of newborn was not the same as the blood of the normal fetus, but rather a reflection of fetal distress. Reversal of acidosis with alkaline infusion in the delivery room has become routine, and most significantly endotracheal intubation and controlled ventilation are now established techniques.

All professional personnel involved in the care of infants are trained to be able to intubate, aspirate, and ventilate the infant. The infant laryngoscope and endotracheal tube have become essential devices in the delivery suite. Probably no single apparatus has had more important effect. It is indeed ironic that anesthesiologists, who once led the way, have now stepped aside in the delivery room. In academic medical centers, it is often the pediatrician who has taken responsibility for the resuscitation of the newborn. It is at once a compliment and an admonition to our profession.

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3.18 History and Development of Pediatric Anesthesia in Japan

M. Satoyoshi

Pediatric surgery, especially for neonates and infants is now widely practiced in Japan, although it was not accepted as a subspecialty of surgery until 15 years ago. Pediatric surgery actually started in 1955 with the first report of successful operation on a newborn with congenital intestinal obstruction. This momentous case was performed under local anesthesia by Suruga, a pioneer of this field in Japan, at one of the charity hospitals in Tokyo. He endeavored to advance pediatric surgery in 1957 in collaboration with his anesthetist, Satoyoshi. Surgeons, however, did not generally understand the place of the anesthetist. In 1959, pediatric anesthesia was first adopted as one of the topics of symposia at the 15th General Assembly of the Japan Medical Congress. A paper entitled *"Neonatal anesthesia"* was presented by Satoyoshi which aroused considerable attention as to the importance of anesthetic management and postoperative care [1].

In 1960, two cases of successful primary anastomosis of congenital esophageal atresia with tracheoesophagel fistula under general anesthesia were independently reported by Wakabayashi in Tokyo and by Ueda in Osaka. These reports stimulated public interest a great deal, and in 1964 the Japanese Society of Pediatric Surgeons was established. The following year (1965), the National Children's Hospital was opened in Tokyo, and Iwai was engaged as head of the division of anesthesia. He made the utmost efforts to propagate neonatal anesthesia and to train not only anesthetists but also nursing staff for this purpose. In 1968, the first independent department of pediatric surgery was established at Juntendo University School of Medicine in Tokyo under the chairmanship of Suruga. Pediatric cases requiring surgery had rapidly increased in number, and there was an urgent need for education and clinical training for special pediatric surgical teams, as well as the establishment of the new children's hospital.

Compared with the rapid advance in pediatric surgery, the development of pediatric anesthesia was rather gradual, and pediatric anesthetists were only later available. In 1971, a Society for the Study of Pediatric Anesthesia was organized, with the purpose of educating and encouraging young anesthetists to meet a shortage of specialists [2].

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Status of Pediatric Surgery and Anesthesia (October 1981)

There four three departments and eight divisions of pediatric surgery among 80 medical schools in Japan. There are ten children's hospitals, and two more hospitals are in process of construction. During the period from 1965 to 1970, five hospitals were established in large cities such as Tokyo, Osaka, Kobe, and Yokohama. After 1975, another five hospitals were established, mainly in regional areas of the northern and western parts of Japan. At all the hospitals, beds are not fully utilized because of a shortage of nurses. The actual number of beds ranges from 40 in one of the newest hospitals to 500 in a regional hospital combined with a protective institute where half the beds are used for disabled children.

The anesthetist's job is not limited to the theater, despite the small number of full-time anesthetists. Cases of anesthesia average from 400 to 2700 a year per hospital depending on the staff numbers and their responsibility outside the theater. At the Juntendo University Hospital pediatric anesthesia cases account for about one-third of a total 5500 anesthetics per year for all kinds of surgery. Among them total 300 cases are infants under 12 months of age, of which from 40 to 50 are neonates. Most pediatric anesthetists are not only liable for respiratory care in the intensive care unit (ICU), but also participate in pre- and postoperative management of the patients.

An advance of pediatric surgery and anesthetic management undoubtedly contributes to a marked decrease in neonatal deaths. According to the statistics of neonatal births and deaths by the Ministry of Public Health and Welfare, the overall mortality has progressively declined from 1.2% in 1965 to 0.5% in 1980. However, the actual number of deaths due to anomalies did not markedly decrease compared with those due to pneumonia or other causes, including causes of uncertain origin. These figures may suggest that there has been improvement in the diagnosis of neonatal disorders and more understanding of the causes. Among the anomalies, there has been a gradual increase in cardiovascular anomalies and a decrease in gastrointestinal anomalies. This tendency suggests that anomalies of the digestive organs have responded to treatment, and anomalies of the cardiovascular system remain a sole or contributory factor in neonatal death.

The mortality associated with neonatal surgery at the Juntendo University Hospital has been very low for the past 5 years [3]. As factors reducing mortality, preanesthetic stabilization of the babies and early postoperative intravenous nutrition and exchange transfusion in cases of septicemia have all been important, in addition to the improvement of respiratory care.

For several years, nitrous oxide combined with nondepolarizing muscle relaxants have been supplanting halothane's position in pediatric anesthesia in Japan. Its use has progressively increased for neonates and poor-risk infants and children, especially for those who require mechanical ventilation postoperatively. However, halothane has still remained a very useful agent for teaching as well as practicing. In every third-year analysis of anesthetic agents carried out at the Juntendo University Hospital, halothane always accounts for over 60% of all infant cases, though other inhalation anesthetics are changing from ether to methoxyflurane, then to enflurane.

At some university hospitals, a team is organized by obstetricians, pediatric surgeons, and anesthetists, and serious fetal anomalies diagnosed by ultrasonography are scheduled for elective surgery following cesarean section. Recently, more clinical work has been done on the artificial surfactant therapy for hyaline membrane disease [4, 5]. Severely ill preterm infants with hyaline membrane disease have been treated with intratracheal instillation of artificial surfactant followed by manual oxygen and mechanical ventilation. Early surgical closure of ductus arteriosus is also performed in cases developing patent ductus arteriosus during this therapy. Out of 28 premature cases 18 survivals are reported by the Neonatal ICU team of the Akita University Hospital.

Brain damage caused by cardiac arrest or severe hypotension during anesthesia and surgery has been treated with controlled phenobarbital coma therapy combined with ventilatory support and mild hypothermia at the National Children's Hospital [6]. Excellent results have been obtained in 15 open heart surgical cases with early postpump critical condition: eight recovered completely and two with some neurological sequelae.

A new type of respirator capable of both conventional and high-frequency ventilation utilizing a jet principle was devised by Miyasaka of the National Children's Hospital [7]. Four premature infants with severe respiratory distress syndrome who did not respond to any ventilatory treatment were successfully cured by means of high-frequency oscillation (HFO) without pulmonary complications.

Unbearable pain in children resulting from metastases of malignant tumor is effectively relieved by caudal injection of a small dose of diluted morphine. In 50 cases, including other postoperative pain relief cases, at both the Juntendo University Hospital and the Kiyose Children's Hospital. No side effects were seen, except for urinary retention.

In conclusion, pediatric anesthesia in Japan is still developing, and these clinical trials need further careful investigation. However, the most important problem to be solved is the training of qualified anesthetists for poor-risk neonates and infants and for routine daily care alike.

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3.19 History of Neurosurgical Anaesthesia

A. R. Hunter

A.R. Hunter

It is difficult to define the point a which neuroanaesthesia evolved into a recognizable subsection of the specialty of anaesthesia. Perhaps it is better related to the development of the specialty of neurosurgery itself. There is, however, one important difference. Harvey Cushing, a pioneer in this field, was performing neurosurgical operations before World War I. In the United States at that time, however, almost all the anaesthetics were given by technicians – usually nurses – who were directly responsible to the surgeon. They were not encouraged to think for themselves, only to keep the patients immobile, to report immediately to the surgeon if anything occurred amiss, and to use whatever drugs or techniques the surgeon felt might best facilitate his operation.

At the time at which Cushing worked, however, neurosurgery was a viable specialty at least in London, where it was practised at what is now the Royal National Hospital for Nervous Diseases in Queen's Square. Victor Horsley had been appointed as surgeon as far back as 1886 and he died in Mesopotamia in the middle of the World War I. Percy Sargent and Armour who joined him were also performing major neurosurgical operations in the early years of the present century. In Great Britain at that time major anaesthetics were given by qualified medical practitioners, though they were often also in general practice, for the pecuniary rewards which could be earned even by those associated with the most outstanding surgeons were so small that a man or woman working solely in the specialty of anaesthesia could not hope to make even a modest livelihood.

Even so, the surgeons at Queen's Square were able to command the services of the most outstanding anaesthetists of the day. From the point of view of neuroanaesthesia, however, there was one individual who stood out head and shoulders above all the others and who can – if the title belongs to anyone – be dubbed the Father of Neuroanaesthesia. This is Dr. Zebulon Mennell, who, already an outstanding anaesthetist on the staff of St. Thomas's Hospital, London, was appointed in 1911 to Queen's Square as an anaesthetist. It was he who first appreciated just how great a contribution the anaesthetist could make to the success or failure of an intracranial operation [1]. He also made some of the early observations concerning the effect which disturbances produced by the surgeon on the brain stem might cause in pulse

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rate, and how anaesthesia might cause respiratory failure in the extremely compressed patient. Mennell tried all sorts of techniques for anaesthesia for intracranial surgery, and on balance seems to have preferred intratracheal ether blown down a rigid gum-elastic catheter of too narrow a gauge to allow rebreathing [2]. Like most of his contemporaries he used a vacuum cleaner-type motor to provide the motive power to drive the air through an ether vapourizing bottle. Why he never blew himself or his patient up I can't imagine! Perhaps it is a tribute to the relatively low inflammability of ether and air as compared with ether and oxygen.

In the years after World War I there were important developments. First a small number of surgeons travelled from Great Britain to the United States to learn something of Harvey Cushing's techniques and themselves returned to set up their own full-time neurosurgical units. Such were Dott in Edinburgh, Cairns at the London Hospital in London, and Jefferson in Manchester, to name but three of the more outstanding. In each of these places there emerged during the succeeding years anaesthetists specializing in neurosurgical work. Dott's main anaesthetist was Dr. G. Maxwell Brown, though Dr. John Gillies also worked in this field. At the London Hospital Dr. N. A. Gillespie, Dr. John Challis [3] and Dr. Olive Jones worked with Cairns. Gillespie made anaesthesia the subject of his doctoral thesis in Oxford in 1935. It is entitled *Endotracheal nitrous oxide – oxygen ether anaesthesia for neurological surgery* [4]. This must be the first major work ever on the subject. It is a pity it was never published in book form. For a time much of Jefferson's work in Manchester was done by the late Dr. H. Brennan, and in 1943 this work devolved on me.

The history of neuroanaesthesia on the North American continent is shorter, for until World War II there were few specialists in anaesthesia in general, and none in neurosurgical work. Furthermore, in the United States the bulk of the anaesthetists were technicians. However, in 1947 Penfield, the neurosurgeon in Montreal, acquired the services of Dr. C. R. Stephen [5]; neuroanaesthetists also appeared at the Mayo Clinic, Rochester, Minnesota to work with Adson, and others took up the work, especially in places like Boston, Massachusetts and in Toronto, Canada, where more recently the late Dr. Brian Marshall has been an outstanding neuroanaesthetist. Today there is a very large society which brings together all those involved in work related to neurosurgery, including neuroanaesthesia.

Similar developments have taken place on the continent of Europe, where Torsten Gordh was, and Emeric Gordon still is, involved in neuroanaesthesia, and Dr. Guy Vourch has done pioneer work in France.

This was an era of uncertainty about the best technique of anaesthesia for intracranial surgery. Mennell's early techniques of insufflation of ether had been largely abandoned. However, I feel that this was one of those so-called improvements in the practice of medicine in which the baby was thrown out with the bath water, for the Magill rebreathing attachment was substituted. As I shall presently show, the Magill attachment tends to cause patients to develop expiratory abdominal muscular activity which raises the central venous pressure and the intracranial pressure [6].

Just how uncertain neurosurgeons, and anaesthetists, were about the best way of anaesthetizing patients for intracranial surgery will be realized from the list of different forms of anaesthesia used by Mr. Norman Dott, Edinburgh neurosurgeon during the years from 1923 to 1933 [7]. In a word, his conclusions can be summarized by saying that the best form of anaesthesia was local anaesthesia produced by Novocain (procaine hydrochloride), but of course this did not last for more than about a hour and the operations lasted for many hours. The use of Avertin, which is tribromethanol, certainly produced quiet patients, but they were liable to move in response to a painful stimulus unless morphine was incorporated in the premedication – and the use of morphine in this way carried with it a risk of respiratory failure produced by the combined effects of raised intracranial pressure and the depressant effect of the drug.

By the time I was directly involved in anaesthesia for neurosurgery the use of the Magill rebreathing attachment was general in the United Kingdom, and indeed it had been used for something like the previous ten years at the Neurosurgical Unit in the London Hospital. To begin with, nitrous oxide, oxygen and ether were administered with this apparatus, again with near-total disregard of the explosion risk. (It was assumed that the patient's head was so wrapped up in wet towels that the possibility that a spark might spread from the operation area to the anaesthetic mixture was too remote to be worthy of consideration – and indeed I am unaware of any patient in which an explosion did occur from this cause.)

In the United States and in Canada about this time, the Magill attachment was not in general use. Neurosurgeons seem to have thought that the best technique of anaesthesia was local, involving infiltration with Novocain. When this would not suffice, the best technique was one of open ether anaesthesia, that is to say the administration of a liquid ether dropped onto a mask which was then held over the patient's face until the ether was vapourized. This technique of anaesthesia was exceedingly laborious and extremely difficult to conduct satisfactorily, for it involved the holding up of the patient's jaw by the anaesthetist, a manœuvre which threatened always to encroach on the surgeon's aseptic field.

The Magill rebreathing attachment did away with the problems of maintaining an airway, but the then current method of passing such tubes was to give the patient carbon dioxide to inhale until overbreathing occurred. It was then relatively easy to introduce the tube through the nose and to pass it blindly through the larynx, which was kept open by the overdriven respiration. Unfortunately, as you all know, hypercarbia seriously increases cerebral blood flow, and the brains of these patients must have had an almighty squash when this method of intubation was employed. The alternative was to anaesthetize the patient deeply with ether, to perform the laryngoscopy and pass the tube under vision – a procedure which took a good 20 min and sometimes longer. This interval could be shortened by substituting chloroform for ether, but this drug had its own not inconsiderable risks.

Such endotracheal tubes, however, provided a clear airway at the price of a deeper maintenance level of anaesthesia, for the tube was a powerful stimulus to coughing, and coughing in a patient undergoing an intracranial operation was, and still is, potentially disastrous for the brain, which is liable to bulge through the wound and damage itself on the hard edges of the bone flap. Such deeper anaesthesia over a long period – when the choice lay between ether and chloroform, even when they were used only as a supplement to nitrous oxide – must have greatly added to the postoperative misery of the patient, if not to the likelihood of more serious complications. Some of these risks were eliminated when the less toxic trichloroethylene became available in the early 1940s [8], but even so it made patients groggy and miserable after its prolonged administration, especially when it was given from the only vapourizer then available, the chloroform bottle on the Boyle's apparatus. Trichloroethylene had the added advantage of being non-explosive and non-inflammable. It was, however, a drug without serious toxicity and could be given for long periods without causing too much postoperative discomfort to the patient.

The subsequent history of inhalation anaesthesia, as far as anaesthesia for intracranial surgery is concerned, relates to the introduction of halothane [9]. This was first available towards the end of 1956, and the ease of its administration, especially from a calibrated vapourizer, and its profound anaesthetic potency led to its substitution for trichloroethylene, and it has remained the agent of choice for this type of anaesthesia in the spontaneously breathing patient with a neurosurgical lesion right up to the present date. Whether enflurane or isoflurane will usurp this position remains to be seen.

I soon became dissatisfied with the results of nitrous oxide and oxygen anaesthesia supplemented by a volatile supplement and administered with the Magill attachment. The intracranial pressures of many of the patients were extremely high when the brain was exposed at operation and I sought for other means of dealing with such patients. I had found in other fields of anaesthesia that it was possible to supplement spinal anaesthesia with sufficient barbiturate, usually hexobarbitone or thiopentone, to have the patient asleep during the procedure without any very serious risk to the airway. Within about a year of my embarking on neurosurgical work I endeavoured to adapt this technique for work in this field. Where it was successful, as it was in the vast majority of the patients who were anaesthetized lying on one side, the operating conditions were very much better. Where, however, the patient lay in a nose-to-ceiling position it was often difficult to maintain a clear airway in the absence of an endotracheal tube. Various manœuvres were tried in an endeavour to hold the tongue forward from the back of the throat, but none were entirely satisfactory. Even so, this technique eliminated the tendency of the patient to strain on an endotracheal tube, and I and my surgical colleagues were convinced that intracranial pressures were lower in such cases, although we never had any figures to prove the point. However, when in 1948 Kety and Schmidt demonstrated that barbiturate reduced cerebral blood flow there seemed to be a sound justification for this conclusion [10].

When suxamethonium became available for intubation I pursued this matter further and anaesthetized the inside of the patient's trachea with a long spray and 2% amethocaine or 4% lignocaine. By this time I was satisfied that the raised intracranial pressures in the patients anaesthetized with endotracheal nitrous oxide, oxygen and trichloroethylene were due to the Magill attachment and not to the endotracheal tube itself, so that I brought out the endotracheal tube through the patient's mouth into the open space underneath a Schimmelbusch frame and into this space I blew nitrous oxide and oxygen. If such patients did not have gross cerebral compression or disease potentially affecting the medullary respiratory centres, they were given heroin for premedication and supplementary doses of it until the respiratory rate was between 12 and 16. In addition, supplementary doses of thiopentone were given; as much as 3 g of the drug might be used in the course of a four-hour operation. The problem with this technique of anaesthesia was that the local anaesthesia within the trachea sometimes did not persist for the whole procedure, and coughing occurred occasionally. Nonetheless, my surgical colleagues preferred this type of anaesthesia to almost any other anaesthesia I had hitherto offered them and, if truth be told, to many types of anaesthesia offered to them subsequently.

In the year 1952 induced hypotension became a necessity during neurosurgical anaesthesia, especially during the surgery of aneurysms. One of my main anxieties in using this technique was that the blood pressure might fall below that level at which the cerebral oxygenation would become inadequate. I believed that a change in rate of rhythm of respiration might indicate that a brain was becoming anoxic. With this in mind I returned to the use of the Magill attachment, which, by virtue of the bag movement which occurs, gives a breath-to-breath indication of the pattern and rate of respiration; indeed, in the early days of hypotension there were one or two cases where respiratory signs did in fact indicate that the blood pressure had been lowered too far. However, with this technique of anaesthesia I also returned to trichloroethylene-supplement nitrous oxide and intracranial pressures which were often uncomfortably high.

One might have hoped that the introduction of halothane in 1956 would have eliminated these raised intracranial pressures, because by this time I had become convinced that the primary cause of the raised intracranial pressure during semi-closed anaesthesia was expiratory straining on the flat muscles of the abdomen, a phenomenon which has been more recently observed by Kaul and others [11], who incidentally ascribe the change to the action of nitrous oxide and not to the manner of its administration. I sought a means of eliminating this expiratory contraction of the flat muscles of the abdomen. I noted that it was absent during T-piece anaesthesia in young children [12] and adapted a larger T-piece for use in adults. The method was satisfactory up to a point, but did not afford complete elimination of the phenomenon. I tried various drugs for its elimination, including the phenothiazines. Again I had some success, and the most satisfactory of all the phenothiazines from this point of view was pecazine, a drug which unfortunately proved to be capable of producing agranulocytosis during long-term administration and was promptly dropped by its manufacturers as soon as this information became available. Why I never at this stage decided to curarize the patients, and thus to eliminate the contractions of the flat muscles of the abdomen, I do not know. I suspect, however, that I was at this time so convinced of the importance of respiratory signs as an indication of the satisfactory oxygenation of the medulla that I was not willing to eliminate spontaneous respiration. It was left to Dr. Furness in Brisbane, Australia to describe controlled respiration with curarization in neurosurgery, which has become the standard technique of today [13].

The elimination of expiratory straining, however, did not wholly solve the problems of anaesthesia for intracranial surgery. Two simple experiments involving the addition of halothane to the anaesthetic mixture in a patient with a cannula already in the lateral ventricle served to emphasize very clearly that this manœuvre could grossly raise the intracranial pressure, and for this reason I largely abandoned halothane. In fairness to the drug, however, it should be stated that it as been shown more recently that provided a very small concentration of the order of 0.5% is used, and the patient is hyperventilated before it is added to the mixture, intracranial pressures need not be excessive in those receiving this drug. In this connection it is perhaps important to remember the work done by McDowall and his colleagues [14, 15]. They showed that where halothane was given to a patient without intracranial pathology, as for example a patient undergoing a disc operation, the rise in intracranial pressure to which it gave rise was transient, disappearing after some 30 or 40 min. On the other hand, when halothane or indeed any other volatile supplement to nitrous oxide and oxygen was given to a patient who already had a raised intracranial pressure, very dramatic rises in intracranial pressure could occur with the potentiality at least of cell destruction by the increased compression which was an inevitable consequence.

As a result of meditating on these findings I was led back again to the idea of Kety and Schmidt's work [10] and with it the supplementation of nitrous oxide and oxygen anaesthesia for intracranial surgery with the aid of repeated doses or a drip administration of either thiopentone [16] or, more recently, methohexitone [17]. I do not know which is the better of the two drugs from this point of view. With thiopentone the occasional patient does not fully recover consciousness until an hour or two after the end of the anaesthetic. When methohexitone is used, recovery of consciousness is more rapid, but there is always the risk that a patient given methohexitone may develop epileptic fits, and quite a number of patients undergoing intracranial surgery already have a tendency to this.

Perhaps I ought briefly to mention hypothermia. Some 30 years ago induced hypothermia was acclaimed as the technique of choice for anaesthesia for intracranial surgery, especially for intracranial surgery for aneurysm. However where controlled studies have been carried out it has been shown that hypothermia does not in fact contribute to good results in such cases. Indeed the main factor which determines the outcome of a patient who is having surgery for a subarachnoid haemorrhage is the interval between the haemorrhage and the operation. Operations on "hot" patients who are semi-comatose or have neurological deficits rarely produce good results, whatever is done. Those who have fully recovered from the effects of the bleed do well. There is, however, a niggling belief at the back of my mind, of which I am totally unable to offer any proof, that perhaps postoperative oedema is less likely to occur in the hypothermic patient. Of this much I am reasonably clear: At the time at which hypothermia was introduced a large number of neurosurgical units were using semi-closed nitrous oxide, oxygen and trichloroethylene anaesthesia (or subsequently halothane-supplemented nitrous oxide). The early procedures used for inducing hypothermia involved the administration of considerable doses of chlorpromazine and pethidine. As a result there was little or no need for the addition of volatile supplements to nitrous oxide and oxygen. The result was that intracranial operating conditions were much better in those patients submitted to hypothermia. However, the improvement in conditions was not due directly to the lowering of the body temperature: It was the result of the substitution of non-volatile for volatile supplements to nitrous oxide.

In summary, I have endeavoured to trace the development of neurosurgical anaesthesia from its early days in the Royal National Hospital for Nervous Diseases in London through the various vicissitudes which have beset it up to the present. You will perhaps have noted that there is one major omission, and that relates to neuroleptanalgesia [18, 19]. It has always been my view, and I received many sharp warnings on the point in my early days in neurosurgical anaesthesia, that some patients, albeit only a very small minority indeed of those who come for a neurosurgical operation, are already suffering from damage to vital centres brought about by their disease. Indeed, it might almost be fair to say that patients come for surgical relief of the effects of rising intracranial pressure at a much earlier stage than they used to 30 or 40 years ago. Nonetheless, the idea that an opiate drug may produce unexpectedly profound respiratory depression in such a patient is so firmly ingrained in my memory that I am unwilling to use an opiate in a potentially compressed patient or in one who might have damage to the vital centres in the medulla oblongata, and this of course is what neuroleptanalgesia involves. It may be that now that Narcan (naloxone) is available the potential risk associated with such a procedure is indeed negligible, especially if patients are to be ventilated electively after operation. It will remain for others who use these techniques to prove the point one way or the other. I await the results of their studies with an open mind.

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3.20 The Origins of Three Important Changes in Anaesthetic Practice

J. Alfred Lee

J. Alfred Lee

When asked what, in my opinion, are the most outstanding advances to have taken place during my professional lifetime in anaesthesia, I reply that there are five; tracheal intubation, muscle relaxants, intravenous induction, halothane and the amide-linked local analgesic agents. In this communication I shall deal with the circumstances leading to the introduction of the last three of these.

Intravenous Induction

When I was a medical student and house officer and started to give anaesthetics in 1926 at the Royal Victoria Infirmary in Newcastle upon Tyne, the induction of general anaesthesia was always by inhalation, by means of either an elementary Boyle machine, or the more common open drop method using a gauze-covered metal mask onto which was poured a volatile liquid anaesthetic such as ethylchloride, ether, chloroform or a mixture of the last two. To remove the displeasing and objectionable sensation associated with this induction, various drugs had been given intravenously over the years. For example, Pierre Cyprien Oré (1828–1889), a French surgeon and physiologist who worked in Bordeaux and was interested in the injection of drugs directly into the circulation, employed chloral hydrate intravenously for both minor surgery and for the treatment of tetanus in 1872 [1]. This technique achieved some popularity in France, but since it caused several deaths, it was soon forgotten.

Barbiturates

The credit for the chemical synthesis and clinical use of the barbiturates must go to the famous German organic chemist, Emil Fischer (1852–1918), and to his colleague, Baron Joseph Friedrich von Mering, an experimental pharmacologist and physician, working in Halle. Both were to become Nobel prizewinners. Their first synthetic success was diethyl barbituric acid to which they gave the name Veronal [2]; this was in 1904. Soon, derivatives of the new agent were injected into the veins of disturbed

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psychiatric patients, notably a combination of diethyl and diallyl barbiturate known as Somnifaine, which was injected intravenously before surgical operations by Fredet and Perlis in 1924 [3]. The real breakthrough came in 1932 when Kropp and Traube, working in the Bayer works at Wuppertal-Elberfeld, synthesized the first of the so-called ultra-short-acting barbiturates, *N*-methyl-cyclohexanyl-methyl-barbiturate, which they first named Endorm and later Evipan. This at once aroused the curiosity of Helmut Weese, who with Scharpff used it clinically in 1932 [4, 5]. They found its effects to be more evanescent than those of other similar drugs tested and showed that it was relatively non-toxic and safe. They hoped that it would turn out to be the intravenous anaesthetic they had sought for so long.

Evipan, or, as we were soon to call it, hexobarbitone could have had a splendid future had it not been for the work of two American chemists who, stimulated by the success of Evipan and supported by the wealthy American firm Abbott Laboratories, were hard at work trying to better it. They were Ernest Henry Volwiler and Donalee Tabern and at the San Francisco meeting of the American Chemical Society in 1935 they made their preliminary report on the synthesis of a large number of sulphur-containing barbiturates [6]. All were tested pharmacologically, and out of two short-listed, the sulphur analogue of pentobarbitone or Nembutal was recommended for clinical trial; this was sodium-ethyl-methyl-butyl-thiobarbiturate. A supply of the new agent was given to Arthur Tatum, Professor of Pharmacology at the University of Wisconsin at Madison, while it was agreed that J.S. Lundy would investigate another batch at the Mayo Clinic, Rochester, Minnesota. Ralph Waters, Head of the Anaesthesiology Department at Madison and a colleague of Tatum, used his sample first in March 1935 [7] and was soon followed by Lundy in June of the same year [8, 9]. Lundy was more impressed by the new drug than was Waters and found it to be more potent and to be associated with fewer side effects such as coughing and unwanted muscular movements than Evipan. He found it to be relatively non-toxic and reasonably safe, and it soon became, as it has remained for the past 47 years, the standard by which all other intravenous anaesthetics are measured.

Perhaps we should remind ourselves of the lives and careers of these three pioneers of intravenous anaesthesia, all of them outstanding names in the history of our specialty, and all of them, I am afraid, unfamiliar to many of the younger anesthetists. Helmut Weese (1897–1954) was born in Munich, the son of an academic art historian and lecturer at the University of Bern in Switzerland. He studied medicine, qualified at the University of Munich and decided quite early in his career to become a pharmacologist. Before long he wrote a monograph on digitalis, which made his name internationally known. In 1928 he succeeded F. Eicholtz, who had just described the pharmacological effects of bromethol or Avertin [10], as head of the pharmacology department of the Bayer works at Wuppertal-Elberfeld and later became professor of pharmacology, first at Cologne and then at Dusseldorf. Quite early in his career, Weese developed an interest in anaesthetic drugs, as well as in their clinical application. This was stimulated when, under his direction, the new short-acting intravenous barbiturate, Evipan, was synthesized. Weese undertook extensive laboratory and clinical investigations on the new agent, and his enthusiasm for it, which has been shown to have been entirely justified, caused it to used throughout the world. His name will always be associated with the introduction of intravenous anaesthesia. Later, with Hecht, he undertook, investigations on a new plasma volume expander polyvinyl pyrrolidone, known commercially as Periston or Plasmosan [11]. Although not used today, it undoubtedly saved the lives of many fighting men, on both sides, during and after World War II. Weese was a powerful influence for good in the field of pharmacology, as well as in what was then a relatively new field in Germany – clinical anaesthesia; in both disciplines he held an honoured place. In 1954, he, who was a skilled and daring mountaineer, fell 2 m from a chair and injured his head. He died a few days later without having regained consciousness [12].

Ralph Milton Waters (1883–1979) was an outstanding man who exercised great and beneficial influence on modern anaesthesia. Born in North Bloomfield, Ohio, he graduated in medicine at Western Reserve University in Cleveland in 1912. He settled first in Sioux City, Iowa, where he combined general practice with anaesthetics; however, as the years passed, his special interest took up most of his time. He read widely in the basic sciences and, to encourage trade, he opened a small private operating suite which he let out to surgeons and to dentists while he gave the anaesthetics. How different are the conditions facing the young anaesthetist today! In 1927 the new state hospital was built at Madison, Wisconsin and Waters, following a casual visit to a friend in the hospital, was appointed by the Professor of Surgery, Schmidt, to take charge of the new Department of Anaesthesiology. In 1933, he was appointed a full professor, the first university chair in anaesthesia in the world. His clinic soon became one of the leading centres of anaesthetic teaching, research and practice in the United States and, as such centres of excellence will, attracted many visitors from both the United States and from Europe. Many innovations resulted from Waters' activities, including full training programmes with laboratory facilities for young anaesthetists; the "to-and-fro" system of carbon dioxide absorption; the introduction and development of cyclopropane, a formidable advance in its day; endobronchial intubation and anaesthesia; and careful record keeping by means of punch cards, which facilitated rapid retrieval of information in those pre-computer days. He was an inspiring teacher, and many of his pupils were appointed to chairs of anaesthesia. He retired from his professorship in 1947 and went to live in Florida, where he grew citrus fruit and where he died in December 1979 at the age of 96. Prolonged inhalation of anaesthetic vapours may not be too toxic after all!

John Silas Lundy was not the first anaesthetist to use thiopentone but he was its leading popularizer and thus richly deserves a place in the annals of anaesthesia. He was born in North Dakota in 1894, the son of a doctor. He followed his father's profession and graduated at Rush Medical College in Chicago in 1919. Like most of us in those early days, he started in general practice, combining it with anaesthesia, in Seattle. In 1924 he was spotted by the famous Dr. William J. Mayo and invited to come to Rochester, Minnesota, to become head of the anaesthetic department of the world-renowned Mayo Clinic. He not only built up the Department but directed it until 1952 and continued working there until 1959. Because of his ability and his immense experience at the Mayo Clinic with its enormous turnover of patients, Lundy rapidly became recognized as one of the leading practitioners of his specialty in the United States. He developed the theory and practice of "balanced anaesthesia" in 1925 [13], established the first blood bank in the United States in 1935, and in 1942 set up the first postoperative observation room in the world, at St. Mary's Hospital, Rochester. Apart from his innovative work as the pioneer of Pentothal he is perhaps best known as the author of one of the early classic textbooks of our specialty, *Clinical*

Anesthesia, in 1942. John Lundy had an active post-retirement career as a consultant anaesthetist, first in Chicago and then in Seattle, where he died in 1973.

Having mentioned the clinicians and their achievements, it must be added that Volwiler, who synthesized thiopentone, became executive Vice President of Abbott Laboratories in 1940, President in 1950 and Chairman in 1958. It should also be remembered that when anaesthetists were presented with the new intravenous anaesthetics, intravenous injection was a skill possessed by few doctors.

Many newer agents for intravenous anaesthesia have been suggested since 1935. I have tried most of them but I have never been convinced that any of them has real advantages over thiopentone; this goes also for day-stay surgery and for dental outpatient work. During the nearly 50 years that I have been using this drug, it has never let me down, and I must have either given or supervised the administration of many thousands of doses. Like most anaesthetists, I have somtimes given too much or not enough, but I have never seen a single untoward result. I accept, of course, that histaminoid reactions do rarely occur, but rarely is the operative word [14]. Pentothal sodium, thiopentone – truly a milestone in clinical anaesthesia.

My next significant advance is halothane, which as a volatile agent has added a new dimension to inhalation anaesthesia. The search for the drug as we know it today commenced in 1950 when J. Fergusson, Research Director of the General Chemicals Division of Imperial Chemical Industries, started to review fluorine technology for reasons unconnected with anaesthesia [15, 16]. He showed that compounds containing fluorine were remarkably inert and soon built op a large experience in handling them in the manufacture of propellants for aerosols and refrigerants. It was at the same time hoped that an anaesthetic could be developed from these compounds. Another chemist, C.W. Suckling was brought in, and experiments were started at the I.C.I. laboratories at Widnes, Cheshire, in September 1950. As the work progressed and possible compounds were synthesized, the cooperation of the Pharmacological Division of the company was sought and J. Raventos was brought into the enterprise. He was a research pharmacologist, born in Barcelona, who qualified in 1929 and obtained a research fellowship under Prof. A.J. Clark in Edinburgh. In 1939 he was taken onto the staff of the pharmacological research laboratories of I.C.I. at Alderley Park, near Manchester. The sixth compound prepared by Suckling appeared to be promising [17] and careful pharmacological screening was commenced. Raventos sent his first report of the new agent to the Medical Research Council committee dealing with non-explosive anaesthetics in 1955 [18].

For clinical testing, Michael Johnstone of the Manchester Royal Infirmary was called in, because his previous work on the cardiac effects of various anaesthetic agents had attracted attention. He started by scrutinizing Raventos' results and watched him anaesthetise animals. If clinical trials were to be undertaken, Johnstone had to show that sufficient benefit to the patient justified the inevitable uncertainty accompanying the introduction of a new agent. His first anaesthetic to a patient was on 20 January 1956. His experiences with Fluothane, the name given to it by its manufacturers, showed it to be quite outstanding among volatile anaesthetics, and a report on the work appeared in the *British Journal of Anaesthesia* in 1956, describing 250 administrations [19]. It soon became evident that for its safe use an accurate and controllable vaporizer would be required, and this soon became available from a relatively new firm which was looking for such a manufacturing opportunity [20].

Then came a Manchester Royal Infirmary departmental report [21], soon followed by one from Oxford [22]. All those who used the drug soon realized that they were dealing with a most valuable new anaesthetic.

Michael Johnstone is a Belfast graduate who was in 1956 and still is today a consultant anaesthetist on the staff of the Manchester Royal Infirmary. Last year he received the Pask Medal from the Association of Anaesthetists of Great Britain and Ireland in recognition of his valuable services to the specialty. I have always thought that the extreme care he took and the risks he ran with his professional reputation deserve the highest praise. Halothane has been with us for 26 years and must surely be regarded as a significant advance.

My third choice of an outstanding advance leading to a significant change in direction may surprise some people, as it is the discovery of the local analgesic agent Xylocaine, or, as we call it, lignocaine. The reason is that it was the first reasonably efficient and non-toxic local analgesic drug to appear, so that when it became available after 1949 many techniques of local analgesia were taken off the shelf to which they had been banished, not because the techniques of injection were faulty, but because there was no really satisfactory drug on the market to inject. Cocaine, the first agent of this group to be used, was popularized by Carl Koller in 1884, in Vienna, but because it was too toxic for routine use it was soon replaced by a succession of substitutes; however, apart from their use in intradural spinal analgesia, none of them became widely employed. Lignocaine changed this.

The search for what eventually became the new analgesic commenced in the University of Stockholm in 1935 [23], and at last the xylidide was synthesized in 1943, although the results were not published until 3 years later [24–26]. In 1948 and 1949, Torsten Gordh wrote the first clinical accounts of what was then known as Xylocaine. It was shown to be the most stable of all local analgesic drugs then known, to be three times as active as procaine, superior to it in duration, and two to four times less toxic. Procaine was the standard drug in the 1940s [27]. As Gordh said in his paper, "... it comes nearer to the ideal local analgesic than any other drug". So was born the first of the amide-linked local analgesic agents. Others of a similar nature have been and will be synthesized, but the first use of Xylocaine was a great stride forward.

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3.21 History of Development of Standards for Anesthesia Equipment

L. Rendell-Baker

In World War II, Tovell reported that the US Army stationed in the United Kingdom used four different makes of anesthesia apparatus [1]. Two were British and used British cylinders and two were American made and used American cylinders. The latter were filled by British gas suppliers whose carbon dioxide cylinders were painted green – the same as the American oxygen cylinders. Inevitably some American oxygen cyclinders were filled with carbon dioxide and deaths occurred. None of these four makes of gas machines accepted the same size of hoses, masks, tracheal tube connectors, bags, etc., so that "when a sudden need for accessory equipment arose, nurses and corpsmen were likely to respond to it by bringing parts that would not fit."

In the United States every equipment manufacturer had a different fitting for his mask and mask adapter. The McKesson mask had a 20 mm male fitting with a female mask adapter; the Foregger mask had a 30 mm male fitting with a female mask adapter; and the Ohio had a 22 mm female mask fitting with a male mask adapter [2]. The British machines had a yet different size.

Colonel Tovell recommended to the Surgeon General that the work of the Committee on Standardization of the American Society of Anesthetists be supported and its functions be pushed to their logical conclusion to achieve uniformity of threadings, tapers, outlets, and valves, thereby permitting interchangeability of rubber parts, endotracheal equipment, and masks.

Unfortunately, no action was taken on Tovell's recommendations, and it was not until 1956 that the American National Standards Committee Z79 was formed. Their first projects were standards for tracheal tubes and tracheal tube connectors. It was felt more logical to mark the tracheal tubes with their internal diameter in millimeters, which would indicate the effective airway provided, rather than use the arbitrary Magill numbers or the French catheter gauge sizes, which indicate the external circumference of the tube. For tracheal tube connectors the 15 mm size was chosen in preference to the alternative 11 mm size as this was felt to provide a better airway.

In 1958 the American Committee found that the British Standards Committee SCG15 had already evolved a draft standard on anesthesia breathing system fittings which utilized metal male and female 23 mm diameter conical fittings throughout the breathing system. At the first joint American/British meeting in London in July 1958 the British Committee suggested that their US colleagues adopt this British standard. The draft was brought back to the United States for further discussion. From July 1958 all projects were pursued jointly until the formation of the International Standards Committee ISO/TC121 in London 1967, with the British Standards Organization as

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the organizing secretariat. At their second joint meeting in New York in December 1958 two American and one British different sized fittings were considered for adoption in both countries in a future standard breathing system. The two American sizes were the Foregger 30 mm and the Ohio 22 mm fittings. The British fitting had a diameter of 23 mm. After several days of discussion the 22 mm male fitting was adopted, and it was agreed that the face mask would have a 22 mm female orifice.

Satisfactory field trials of pediatric breathing systems were held in the United States in 1961, using the 15 mm size fittings previously used for tracheal tube connectors in a male/female sequence of fittings from the patient to the breathing bag. For the pediatric circle absorption system a sequence of female/male fittings in the direction of gas flow was used to minimize the hazard of the accidental use of two sets of directional valves in opposition to each other in the system. For the pediatric face mask the adult-sized 22 mm orifice was adopted at Ralph Tovell's urging, to permit anesthesia with adult equipment and a pediatric face mask in an emergency. Before this, most pediatric face masks had a smaller size orifice than the adult face masks, which prevented their use with adult equipment. To connect the 22 mm pediatric face mask orifice to the 15 mm fittings used troughout the rest of the pediatric breathing system a new tube/mask adapter was designed which had a 22 mm male with an internal 15 mm female fitting so that it could connect either a face mask or a tracheal tube to the breathing system. The pediatric breathing systems using 15 mm fittings with the 15/22 mm mask/tube adapter were adopted in the United States in 1963. Since then, the 22 mm male conical fitting used in the adult breathing system combined with the 22/15 mm tube/mask adapter have been adopted for a proposed ISO standard and have come into worldwide use.

In the United States in 1966 Y-pieces with valves were quite popular. Accidents had occurred as the result of the inadvertent assembly of a breathing system with two sets of valves with one set in the Y-piece and the other one on the absorber, in opposition so that it was impossible for the patient to take a breath or for the anesthesiologist to inflate the patient's lungs. Adult circle breathing systems from many manufacturers, which were fitted with male/female fittings in sequence in the direction of gas flow, designed to protect against this hazard, were tested in independent field trials in the United States in 1966. For convenience many American firms used in their breathing hoses male and female hard rubber fittings produced by a leading British manufacturer for their machines then being introduced with this "gas-flow-sequence" in the breathing system [3]. Unfortunately, these hard rubber fittings distorted in use, especially when heated during sterilization. Of 73 test centers in the United States, 21 reported that these fittings fell apart in use. Similar complaints surfaced from users in the United Kingdom, and the fittings were extensively modified until they eventually performed satisfactorily. However, by then it was too late, for the American "gas-flow-sequence" had been rejected with the faulty rubber fittings. Eventually, in 1978, a much simpler system was adopted by the International Standards Committee for the adult circle system. It was almost identical to that proposed by the British Committee to their American colleagues 20 years earlier at their first meeting in July 1958.

In 1964, Dr. Meyer Saklad, who had recently given up clinical anesthesia practice to devote himself to research, was persuaded to chair the Z79 ventilator standards subcommittee. In 1967 he also assumed the chairmanship of the ISO International Ventilator Standards Committee. Not only did Dr. Saklad and his committee determine for the first time the appropriate performance criteria for ventilators, but also evolved standard test methods to determine the performance of a ventilator. The compliance models and the resistances used in testing ventilators today were very largely designed and built in Dr. Saklad's anesthesia research laboratory at Providence Hospital, Providence, Rhode Island. A US standard for lung ventilators was published in 1976, followed by a similar ISO standard.

Following reports in 1967 by John B. Stetson and others of tracheal necrosis in babies dying after prolonged intubation for ventilatory support [4], investigations by Wallace L. Guess and John B. Stetson indicated that this was due to the use of toxic organo-tin stabilizers in the polyvinylchloride (PVC) compounds used to manufacture these tracheal tubes [5]. At an emergency meeting called by committee Z79 in New York in December 1967 all manufacturers in France, the United Kingdom, the Federal Republic of Germany and the United States eventually agreed to withdraw these toxic PVC tubes from the American market and to supply tubes made with non-toxic compounds which would satisfy the USP rabbit muscle implant test for tissue compatibility already required by the US Army. The new tubes, marked "Z79 I. T.", for implantation tested, were available 3 months later, when a warning was mailed to all members of the American Society of Anesthesiologists to check the safety of the PVC tubes in their hospitals with their suppliers. Since then, all Z79 standards for items coming into contact with human tissues have required compliance with this USP test. Such items are now simply marked "Z79" to indicate that they satisfy this and all other requirements of the appropriate standard.

This inquiry also brought to light problems with many hospital's use of ethylene oxide sterilization for PVC tracheal tubes. Because of inadequate time for aeration they were not properly eliminating residues of this irritant gas from the plastic after sterilization. This problem was addressed in *Ethylene Oxide Sterilization, a Guide to Hospital Personnel* [6], produced by a subcommittee of committee Z79. For convenience this later became a committee of the Association for Advancement of Medical Instrumentation, as committee Z79 was limited to anesthesia and ventilatory equipment under American National Standard Institute rules. This AAMI committee has since issued guidelines and standards on gas, steam, and radiation sterilization. It has become a national resource of expertise on sterilization problems and has recently been cited by the Food and Drug Administration, the Occupational Safety and Health Administration, and the National Institute of Occupational Safety and Health in legal discussions on the levels of ethylene oxide that can be accepted with safety in the work areas [7]. This level is certainly below 10 ppm and probably below 1 ppm. This committee recommended that heated aerators always be used after ethylene oxide sterilization and that PVC items be aerated for between 8 and 12 minutes depending upon the temperature used in the aerator.

In 1979, committee Z79 published standard Z79.8 on the safety and performance on anesthesia gas machines [9], which represents a giant step forward in their safety. Among the items covered are the location of the oxygen flowmeter on the right hand side of the flowmeter bank, so that in the event of leakage from the flowmeters, oxygen, being nearest to the outlet, will be delivered and other gases will be lost through the leak, thus ensuring that an adequate percentage of oxygen will be delivered to the patient. The oxygen flow control knob now has a characteristic fluted configuration to provide tactile identification to the user. All the other knobs will be round. Each gas machine will be fitted with an oxygen analyzer to determine the percentage of oxygen being delivered to the patient. The analyzer will sound the alarm should the percentage of oxygen fall below the level chosen for whatever reason, such as failure of cylinder or pipeline supplies, cross connection of the pipelines or the pipeline's flexible hoses, or incorrectly filled cylinders or liquid oxygen reservoir. The vaporizers will be fitted with agent-specific filling devices to prevent the filling of the vaporizer with an incorrect volatile agent and also to prevent overfilling of the vaporizer. Control knobs on vaporizers will all open the same way as the gas flow control knobs. All machines will be fitted with Diameter Index Safety System (DISS) pipeline inlet fittings for the attachment of the flexible hoses from the pipeline supplies of medical gases. The DISS fittings utilize inch standard threads and will continue to be used in the United States and Canada. In metric countries a similar Non Interchangeable Standard Terminal (NIST) series of fittings which utilize metric standard threads will be used. These were designed by the Drager Company in Germany and the British Standards Committee.

Great advances have been made in tracheal tubes and cuffs for prolonged use in the last ten years. This is evident if one compares the red rubber tube with high-pressure, small-volume cuff that was the only type available in 1970 with the low-pressure, large-volume cuffs that are now routinely used for prolonged artificial ventilation. The influence of this work can be seen in the tubes now available for use in anesthesia which commonly have a resting volume of 7–10 ml and produce an airtight seal at 15–20 cm water pressure.

Standards have also been published on the control of anesthesia gas pollution, humidifiers and nebulizers, oxygen analyzers, oxygen concentrators, medical gas pipeline systems, etc. The AAMI Guidelines on the Human Engineering of Medical Devices were evolved as a result of experience in writing the standard on the safety and performance of anesthesia gas machines. These guidelines show how the apparatus should be designed to fit the user rather than vice versa. Standards have also been evolved by the Compressed Gas Association, including a Color Code for Medical Gas Cylinders for use in the United States [10], the ISO 32 color standard for medical gas cylinders, the Pin Index Safety System for small gas cylinders, threaded outlet connections for large cylinders, and the DISS for low-pressure gas connections [3].

Meetings of the International Standards Committee's working groups now take place approximately every 6 months, and rapid progress is being made towards publication of satisfactory international standards which are being adopted by many countries as a basis for their own national standards. However, much essential work remains to be done.

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3.22 Possible Hazards of Technical Progress in Anaesthetic Practice

D. H. G. Keuskamp*

D. H. G. Keuskamp

What is the so-called modern anaesthesia? And what changes of fashion made it "modern"?

In my opinion the significant change took place in 1942, when Griffith and Johnston introduced the use of muscle relaxants into anaesthetic practice. The consequences of this introduction are two-fold: first, the necessity of artificial ventilation; second, the possibility of the so-called balanced anaesthesia to attain the three objectives of anaesthesia – unconsciousness, analgesia and relaxation – with the help of different drugs. This was a challenge to the pharmaceutical industry. The pharmaceutical manufacturers soon filled the gap in the years following. The drugs should have less side effects and should act more specifically on certain systems in the body, and this action should be as short as possible – all the wishes of the anaesthetist. The synthesis of better antagonists was also their object. The pharmaceutical industry as a whole did a tremendous amount of work; and as a result we now have a large range of newer products from which it is difficult to make a choice.

These developments, however, did not result only in facilitation of the anaesthetist's work; the profound action of the drugs forces us to make continuous observation of the patient. The drugs acting on the neuromuscular system may act in an unpredictable way. In anaesthesia there is no dose/body weight relation; we do not have to deal with standard patients or standard surgical procedures. Clinical experience is more and more important; the training period for anaesthetists should be lengthened (especially in Holland). The more sophisticated the anaesthetic technique, the more necessary is the preoperative evaluation. Continuous observation during surgery is a compelling necessity.

Now to the technical developments concerning anaesthesia. Thanks to modern relaxation methods and ventilation the surgeon is no longer in hurry; the art of precisely timed handwork is declining. Operations last longer, of course, and modern anaesthesia has made operations possible which take much too much time, especially the microscopic procedures. The anaesthetist looked to mechanical means to take

* Adapted from the audio tape by J. Rupreht

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over the tiresome handwork of ventilation; this in turn introduced the first mechanical assistant into the operating theatre – the breathing machine. However, this also introduced a potential danger. The anaesthetist was no longer patient bound; he could walk around the theatre and attend to infusions, measuring blood pressure etc., leaving the ventilation work to the machine. He could even leave the observation of the patient to a well-trained nurse or to a trainee in order to enjoy a cup of coffee. This development led to a dangerous trend whereby one anaesthetist could supervise more than one operating theatre with the help of less qualified people.

If we are honest then we must admit that the majority of anaesthetists have no idea how a ventilator works; and they are incapable of interpreting the cause of machine failure. The majority of fatal cases in anaesthesia are due to failure of respiration and is mostly caused by stupidly occurring events: loosening of tube connections, kinking of tubing or false connections of oxygen or nitrous oxide supplies. Such errors could have been averted had the patient been continuously observed. The following procedure should be pumped into every anaesthetist: When the patient turns blue, you do not know the reason, immediately disconnect the anaesthetic and ventilating machine and ventilate the patient by Ambu and air. A machine cannot see if the patient turns blue or not.

I will tell you a short story I told yesterday in a meeting. It comes from a very experienced hospital anaesthetist from a foreign country, where one pays enormous amounts of money for medical insurance. Once, the anaesthetist had to replace his colleague who was ill and was to administer anaesthesia for simple gastrectomy. The operation went well and there were no complications. But later the surgeon asked him, "Tell me, what was the reason that you were squeezing the bag all the time in the old fashion, also measuring the blood pressure in the oldfashioned way every five minutes. I thought you were always propagating modern techniques and you have the most advanced equipment behind your back." The anaesthetist blushed a little and said, "I did not know enough of this man and I knew he was an asthmatic; I did not want to take any risks. You know I hate this man and everybody in the hospital knows it." This story does not recommend you to choose your worst enemy to give you anaesthesia when you have to be operated on; the meaning lies deeper. In spite of the fact that a modern anaesthetist is technically well equipped and has great know-how in this field it still may be safer to have the patient in his own hands. In this connection I should mention the excellent series of television programmes concerning anaesthesia by Professor Mushin, entitled *Your Life in Our Hands*.

All the modern gadgets, electronic and mechanical, are forced on an anaesthetist by industry. They do, of course, give more information concerning the physiological events in the body which we cannot observe by eyes and ears. However, the danger is pre-eminent that these technical means are the only reliable guides translating physiological events into digital numbers. When we have to be completely safe the primary sensor is amplified and fed into the computer to display it in digital numbers; however, this should be done in a triple way, otherwise controls may fail. When one of two controls goes wrong you do not know which one is right. Therefore the third control – as in space technology – is needed, so that a wrong display is cancelled. This is much too expensive for normal medical equipment and anaesthetic machines. For this reason our machines and their displays are inherently dangerous. In the now very sophisticated breathing machines there are endless possibilities of changing the ventilation rate, expiration, tidal volume, maximum inspiratory pressure, display of compliance, expiratory O_2 and CO_2 concentration, O_2 consumption and so on and so on. As I could observe in daily practice, not in a university hospital, all these possibilities were not used. The very expensive machine was preset on standard conditions, tidal volume and the ventilation rate being the only variables.

Now that the mechanical monitoring of these functions is done by electronic control, the inside of breathing machines is even more incomprehensible to every anaesthetist, and for maintaining the quality of action one is dependent on the manufacturer's service. The power of electronic devices which are growing in number may be an interface between the anaesthetist and the patient. The danger exists, however, that the anaesthetist is more busy checking all these instruments than he is observing the patient by his own senses. In many cases, a complicated and expensive apparatus becomes a status symbol, and the possibilities it offers are never used because this takes too much time in daily practice. The only instrument we cannot do without is the cardioscope, because it observes electric phenomena which we cannot observe with our own senses, and perhaps the CO_2 monitor, which guides the ventilation.

However, there is another danger not originating in the hospital: the authorities who control medical care have the idea that all these technical aids and monitoring instruments lead to reduction in hospital personnel. They believe that it should be possible for the anaesthetist to supervise several patients in different operating theatres with the help of less competent personnel because the monitoring equipment would give a warning signal when something goes wrong. Of course, such assumptions are ridiculous. People who propagate such ideas may be medical doctors, but doctors who have never had the dramatic experience of a patient dying in their hands, perhaps as the result of a failure of anaesthetic management.

I should like to advise my anaesthetist colleagues to buy only the technical equipment that they absolutely need and to choose the simplest and thus the most easily understandable instrument. Moreover, they must return to the patient, observing his colour, his respirations, feeling his pulse, feeling dryness and following the surgical procedure to adjust the anaesthetic level needed. Remember, that in a case of monitoring failure when the outcome is damaging to the patient the anaesthetist is responsible and not the apparatus or the manufacturer.

Finally, may I repeat the title of Professor Mushin's television programmes, *Your Life in Our Hands:* machines may have hands but they have no brain and no concern for the deliberately intoxicated human being who is being operated on.

3.23 Theodore Schwann and the Invention of Closed-Circuit Breathing

H. Reinhold

Most members of our profession know the name of Schwann, even if only for the cells that bear his name. What is almost ignored, is his pioneering work in the discovery of closed-circuit respiration in the 1850s, which was applied to anaesthesia only much later, in the 1920s, first in the laboratory and afterwards in the operating room.

Who actually was Schwann? First, the general career of this scientist will be described, and then the aspects which are the particular subject of this paper will be dealt with in greater detail. Theodore Schwann was born in 1810 in Germany, in the city of Neuss, close to the left bank of the river Rhine, just opposite to Dusseldorf, in the famous Ruhr area. At present, the Ruhr is one of the largest and most concentrated industrial areas of the world, but in the beginning of the nineteenth century, it offered the view of a pleasing green landscape. During the adolescence of Schwann the industrial revolution completely changed the look of the countryside, the life of its inhabitants, and of human society in general. At the time of Schwann's birth, the city of Neuss was not politically speaking, in Germany: The moving of political borders, caused by the alternating fortunes of warfare, meant that Neuss belonged to the extended France of Napoleon, so much so that Theodore Schwann's birth certificate was surprisingly drafted in French.

His father, a printer, sent him to school in Cologne. He became known there as an excellent pupil, but also as a shy boy, lacking confidence in himself and frequently taking refuge in deep thought. This remained an important trait of his personality. He started medical studies in Bonn, where one of his masters was the famous Johannes Müller. He later joined Müller in Berlin, and it was under Müller's direction that he wrote his doctoral thesis, dealing with the necessity of air for the development of the chick embryo from the incubating egg. This was still controversial. Schwann demonstrated that, in a vacuum, or in an atmosphere deprived of oxygen, the egg starts developing up to the initial stage of embryonic layers, for about 15 h, and is then destroyed. Up to that point, the readmission of air allows further development. However, after more prolonged anoxia, survival is uncertain; it is excluded after oxygen deprivation lasting more than 30 h. Schwann thus gave evidence of the existence of aerobic metabolism. The word "metabolism", so widely used in medicine, was indeed invented by him.

Schwann went on working with Müller and had a highly productive scientific career. He studied muscular physiology and showed that the strength of a muscle's contraction increases with its elongation. At the time, medical papers were still largely philosophical. Schwann somehow introduced an innovation by analysing muscular

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activity as a physical phenomenon, with accurate measurements, as we now do in medicine.

In 1834, he did research on gastric digestion. At that time, the stomach was looked upon mainly as a muscular pouch. Its juice was known to be acid and able to dissolve certain foods. Schwann showed that coagulated egg white was not digested by neutralized gastric juice nor by acid alone, but was well digested by the mixture. He succeeded in precipitating the active agent and named it "pepsin". He described the action of pepsin on egg white as comparable to the production of alcohol from sugar and of vinegar from alcohol and suggested that these were all similar phenomena of fermentation.

He then further studied alcoholic fermentation, which was not yet understood. At that time, yeast was still considered to be not a source of fermentation but a product of it. Schwann showed that boiling stopped the whole process and that production of alcohol was due to the activity of a vegetable living organism. The contrary opinion of Liebig, that fermentation was a purely chemical change, was still accepted 50 years later, even by Claude Bernard, until Louis Pasteur definitely overthrew it in 1857.

The opus magnum of Schwann, the work that made him world famous, was his cellular theory of life, which he started to formulate in 1838 [1]. It was believed, by the whole scientific world, that what makes living beings different from minerals is their possession of something called "vital force", in addition to their chemical constituents. This was responsible for life, reproduction, growth and all physiological behaviour. Müller, Schwann's master, taught that if one mineral object was made to act on another, the results, physical or chemical, depended on the material nature of each of them, with a great variety of consequences. On the other hand, when an external chemical, mechanical or electric action was applied to living tissue, for example muscle, the reaction was governed by the mysterious vital force, which dictated that the response should be a contraction, regardless of the nature of the external agent. This was supposed to make all the essential difference between living and lifeless matter.

Schwann had been struck by the fact that all living organisms, vegetable and animal, had a similar cell structure, with cytoplasm, nucleus and nucleolus. He argued that the cell, as seen under the microscope, was not just a cavity with a membrane as boundary, but constituted the physiologic unit common to all living beings. Life was thus bound to the structures existing in the cell, making all biological reactions possible, and not to a vital force present in the living organism as a whole. From this concept, cell biology was later born. In our day, it has extended, with new means of observation and investigation, far beyond the structures which Schwann was able to see under the microscope. His mechanistic approach to physiological and biological problems enabled him to do most fruitful scientific work from 1835 to 1838. Then, in 1838, his scientific publications stopped suddenly and almost completely for the next 40 years.

In 1838, Schwann entered a critical period of his life, from which he never emerged completely. At the age of 28 he had become a famous man, but, for the rest of his life, he hardly added anything to his fame. This may be because he suffered repeatedly from terrible disappointments. Passionately interested in physiology, he tried in vain to get an appointment in physiology in the Faculty of Bonn. It may be that his rapid professional rise, overthrowing many accepted thoughts, had created much displeasure in the Faculty. He had to accept a Chair of Anatomy in Belgium, at the University of Leuven. Anatomy was not a branch that attracted him. In addition, he had to teach in French, which was difficult for him. Philosophically, he was in agreement with the strongly religious current of thought of the University of Leuven. However, politically, he was rather liberal minded, and this probably met with disapproval in Leuven also. In any case, he did not get on well with his colleagues and seems to have had fits of depression and to have become absorbed by theological problems. This is a paradoxical element of his personality. He had acquired a high reputation as a scientist because of his rationalistic attitude in research. The cellular theory of Schwann was revolutionary, but Schwann himself was not in fact a revolutionary thinker. In his deepest thoughts, he was rather a mystic.

In 1849, Schwann moved to the Universtity of Liège, still as a Professor of Anatomy. Finally, in 1858, he succeeded in obtaining the Chair of Physiology and Embryology at that university, although in his laboratory he hardly did anything but routine work. However, Schwann's stay in Liège was very important with regard to the discovery which is the core of this paper. Liège was the main industrial centre of Belgium and there Schwann was in contact with people in the industrial world, and able to discuss their problems with them.

On the 6 March 1852, a dramatic fire damp explosion occurred in the area of Liège. It was quickly asserted that there remained one practicable way of approach to the unfortunate casualties, but they could not be reached by the rescue party, because of the irrespirable atmosphere. As a result, 60 miners lost their lives. This aroused deep emotion in the population and in the government of Belgium. A month later, the Minister of Public Works wrote to the Academy of Medicine of Belgium, drawing attention to the lack of appropriate means of live-saving in such circumstances.

The Minister offered the large sum of 2000 Belgian francs, to be awarded by the Academy to the scientist who could invent an appliance enabling rescuers to enter underground passages containing toxic gases. The 2000 francs of 1852 would now represent about US $ 5000. It was decided to hold a contest for the award, and the final date for submitting projects was set for the end of the year 1853. A total of nine papers were presented. The Academy decided that none was of merit and the prize was not awarded. Schwann, a member of the Academy, had not entered the competition. However, in due course, he deposited at the Academy a sealed and dated envelope. There it remained, and nobody knew about its contents.

Twenty-four years later, in 1876, an exhibition was organized in Brussels concerned with hygiene and rescue appliances. It was on that occasion that Schwann mentioned for the first time the study he had made on the method of breathing in a closed circuit, on the principle of absorption of carbon dioxide and addition of oxygen which was, put into practical use only much later in closed-circuit anaesthesia.

The entries in Schwann's laboratory notebook show that in his first apparatus he tried to use peroxide of barium, manganese, potassium and mixtures of these chemicals, which absorb carbon dioxide and liberate oxygen. But, emission of oxygen started only after a delay of a few minutes in insufficient quantity. So he went on working on this project, continually introducing improvements. In 1856, he thought of using compressed oxygen. For that purpose, he had cylinders of appropriate size manufactured. He also designed a pressure-reducing valve.

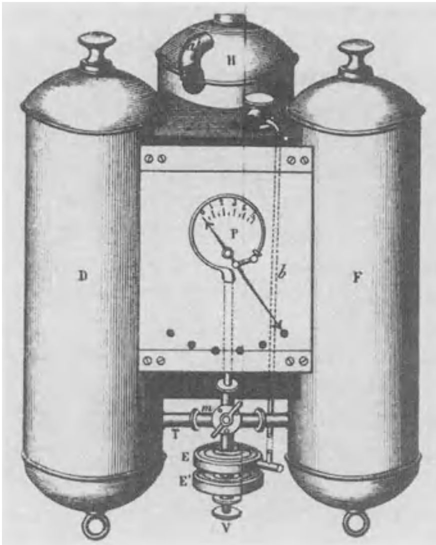

Fig. 1. Anterior view of the closed-circuit breathing apparatus of 1877. The symbols are defined in the text

The apparatus which he described in a paper of 1877 and which was shown at the exhibition, was a remarkable achievement [2]. A further improved model was described later in 1878. The model described in 1877 had 2 oxygen cylinders (see Fig. 1, D and F). They each had a capacity of 7 litres and could be loaded to a pressure of 5 atm. Together, they represented a reserve of 70 litres of oxygen. At the present time, we use cylinders filled to 150 atm. and, in the course of our work, when a cylinder has a pressure of 5 atm., we discard it and call for another one. But 100 years ago, a pressure of 5 atm. represented an attainable maximum.

As Fig. 1 shows, at the lower end of the cylinders, the transverse tube (T) led to a three-way stopcock (m). It allowed the connection of one or both cylinders to the pressure regulator. The regulator was also an invention of Schwann. It operated on the same principle as most reducing valves now in use (see Fig. 2). The upper wall was rigid and the lower was made of flexible corrugated metal with two compartments. Gas under high pressure entered at v. Distension of the low-pressure chambers (E and E') pulled the central rod down. When the pressure limit was reached, the cone (c) occluded the entrance. Flow was regulated by the valve (R) and the oxygen was led by tube (b) to the carbon dioxide absorption cannister. The transverse tube was also connected to a pressure gauge (P; Fig. 1), which was manufactured for Schwann by a watchmaker of Koblenz. This is another fine example of Schwann's inventive mind. Customary pressure gauges have a dial and a pointer, protected by glass, but Schwann's rescue apparatus was intended to be carried in dark underground galleries. To facilitate checking of the pressure in the cylinders, the pointer of the pressure gauge was left uncovered. One end of the pointer gave the usual normal reading of pressure on the dial. The other end was directed to a set of six buttons, disposed on an arc of a circle, enabling the operator to verify the oxygen pressure merely by finger palpation.

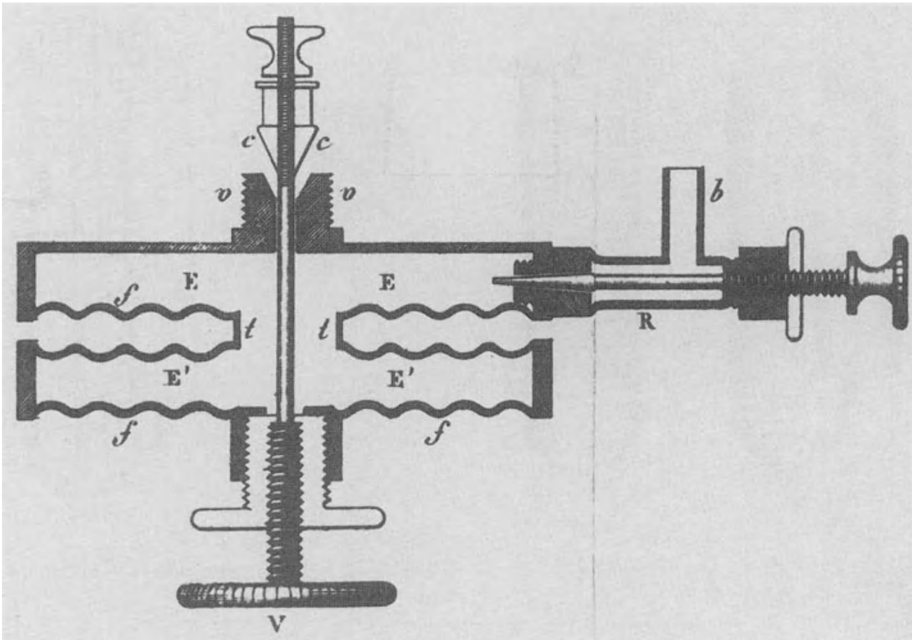

Fig. 2. Cross-section of the pressure regulator

Between the two oxygen cylinders, lay the carbon dioxide absorption cannister. It had a rather complex design. The reason for this is easily guessed. Schwann certainly tested his apparaturs thoroughly and he must have encountered difficulties in achieving effective carbon dioxide absorption. The soda lime of optimal composition, in granules of adequate size, was made available after the trials by the American engineer, Wilson, during World War I. Schwann, as long ago as 1877, had selected the same chemicals in the form of chunks of lime dipped in caustic soda. He wisely chose to make the expiratory gas take a lengthy route over the absorbent granules. In fact, the absorbing unit was made of elements, mounted in series. The first part (E; Fig. 3) was made of three superimposed compartments. Expiratory gas traversed them from top to bottom. From there, the gas passed into a cylindrical casing (Fig. 4) into which was fitted an inner cylinder, made of eight boxes containing absorbent. The gas had to go through all the boxes, along a lengthy helicoidal passage. Spiral springs were provided inside the boxes to keep spaces open for the circulating air.

Figure 5 shows the rescuer carrying the apparatus. In front of his chest lies the respiratory bag, from which a tube leads to the inspiratory valve and mask. The expiratory valve is connected to another tube, leading to the absorber. The breathing tubes to the absorber were made to pass over the left shoulder, leaving the right shoulder free to carry the casualty or other loads. On the rebreathing bag was fitted, a tap, through which oxygen could be supplied to the victim.

As can be seen, Schwann, who was a brilliant biologist and histologist, also proved to have a remarkable engineering talent. He designed his appliance with the greatest

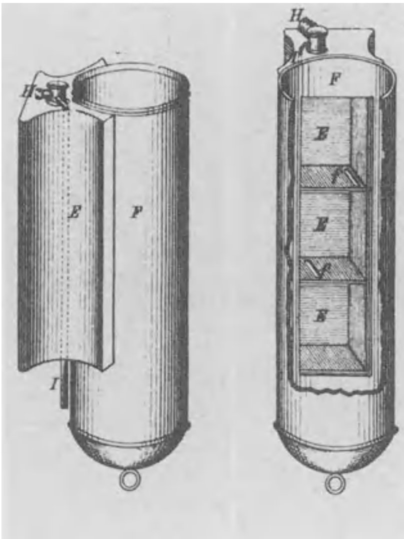

Fig. 3. CO_2 absorbing unit: 1st part fixed between the gas cylinders

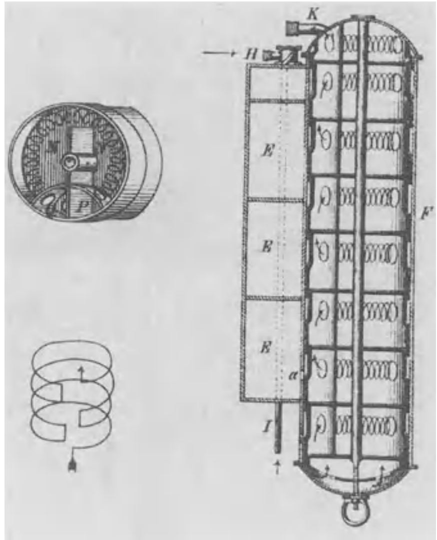

Fig. 4. CO_2 absorbing unit: 2nd part of cylindrical casing with 8 boxes

care, being attentive to many particulars. His apparatus comprised a reducing valve, a carbon dioxide absorber, a breathing bag and respiratory valves, in other words all the essentials of the closed circle circuit of an anaesthetic machine. It was the ancestor of a host of rescue machines. It also inspired the apparatus of Benedict, which has been used for a long time to measure oxygen consumption and diagnose the hypermetabolic states of patients with Graves' disease.

The question arises why Schwann, who had conceived and constructed his apparatus in 1853, did not make it known until 1876. Several explanations may be given. First, Schwann was a shy and proud character. As a prominent personality and a member of the Academy, he felt he could not enter a competition, rewarded by a prize. Second, he was a perfectionist, never satisfied with what he made. Third, but not least, after 4 years of outstanding work from 1834 to 1838, Schwann had become deeply depressed. He had gone through repeated disappointments. He also seemed to have been extremely tormented by philosophical problems.

For us, this may be difficult to understand. Schwann was a religious man. Religion, in his time, had a more important place in life than now. It influenced not only philosophy but also science. The concept of "vital force" in biology fitted well with religious thought. Schwann, with his rational mind, had found in the cell a common component of all living matter, vegetable and animal. The atom had already been identified as the basic common element of inanimate matter; the cell was now presented as the structural and functional unit of living matter. If not vital force, what else would fill the gap between mineral and living matter? Vital force had been an easy reply to the unknown. The work of Schwann, who in fact was not a revolutionary man, gave a revolutionary turn to the conflict between religion and science in his day. He was distressed by this. In his notes, he describes how inner tension, vague aching and

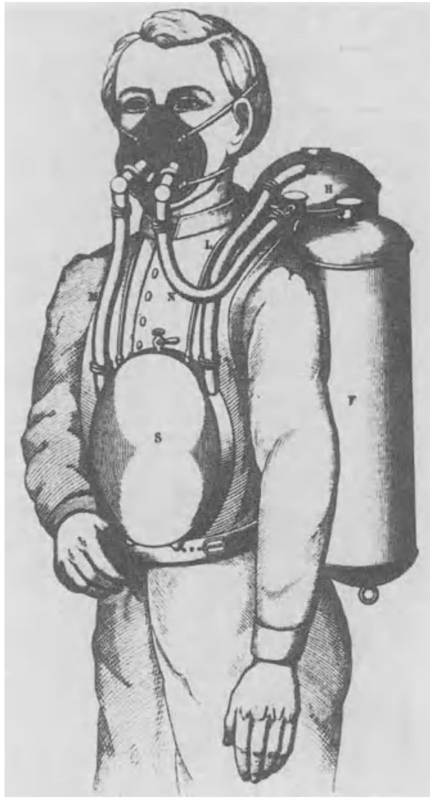

Fig. 5. Rescuer with equipment

constant weariness interfered with his work. Further comments are not required to explain how suffering can have an inhibitory effect on mind and on work. That probably was the reason why an important contribution to anaesthesia and resuscitation, by a man who did not practice either specialty, remained unknown at the time of its invention and still is seldom credited to its true inventor, Theodore Schwann.

Tribute should be paid to Schwann, not only because he was a great scientific mind. Born in Germany, holding a birth certificate written in French and having spent most of his career in Belgium, he also represents an early example and symbol of European citizenship, to which we have come close today. His professional life represents one historical step towards the day when we will all become citizens of one world; when every person will feel at home in any place on the surface of the earth.

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3.24 The Early Development of Blood Gas and Blood Acid-Base Measurements

P. Astrup

P. Astrup

History of Blood Gas Measurements

The existence of carbon dioxide was first demonstrated by Jean Baptiste van Helmont (1577–1644), who studied in Louvain, where he took a doctor's degree in medicine. He was the first to speak of "gas". In 1754, carbon dioxide was rediscovered by the Scottish chemist, Joseph Black, who was Professor of Chemistry (first in Glasgow, later in Edinburgh) from 1766 to 1797. He demonstrated that carbon dioxide was present in expired air.

Oxygen was first discovered by the Swede, Scheele, in 1773, and, in the following year, by the Englishman, J. Priestley. Scheele was a pharmaceutical chemist and managed his own chemist's shop. He made many chemical discoveries – more in fact, than any other chemist before his time. Priestley was a clergyman in England. He incurred the hatred of the masses because of his sympathies for the French Revolution, and in 1791 a furious mob burnt down his house and his church. He emigrated to America in 1795 as a disillusioned man, after resigning from the Royal Society.

Neither Scheele nor Priestley had any idea that oxygen played a part in combustion, transforming carbon into carbon dioxide and hydrogen into water. Even when Lavoisier demonstrated that this was in fact the case, they remained unconvinced; until their deaths in 1786 and 1804, respectively, they were both unwavering adherents of the so-called phlogiston theory – the "principle" of inflammability formerly supposed to exist in all combustible bodies. The hypothetical compound "phlogiston" disappeared in the air during the combustion. The simplicity of this theory appealed to the chemists of that age, since it was the only one which to some extent perceived a mutual relationship between the many chemical observations. However, the theory was soon abandoned after Lavoisier had demonstrated the true mechanism of combustion.

Antoine Laurent Lavoisier, France's greatest chemist, was born in Paris in 1743. He laid the groundwork for modern biological natural science by introducing the balance in chemical investigations, so that the object under study might be quantified; this led, among other things, to the discovery of the composition of water and air, and the nature of combustion. In 1777, he demonstrated that the lung takes up oxygen and

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gives off carbon dioxide during respiration and, in 1780, in cooperation with Laplace, that animal heat is due to combustion, which they assumed took place in the lungs. Lavoisier's discoveries marked a new era and revolutionized the biological, medical and chemical sciences. To find the money for his investigations, which called for the building up of expensive apparatus, Lavoisier allowed himself to be appointed to the government post of farmer-general. A French revolutionary tribunal found his wealth suspicious, however, and he was guillotined in Paris on 8 May 1794, at the age of only 51 years.

The combustion in animal organisms demonstrated by Lavoisier was assumed to take place within the lungs, inasmuch as the colour change of the blood from brown to red was thought to be attributable to oxidation of the carbon-bound hydrogen. In 1791, however, the mathematician Langrange transferred the site of combustion to the blood itself, a view that was shared by, among others, the famous Swedish chemist, J. J. Berzelius, who, in his lecture of 1803, stated that a goodly amount of oxygen must be absorbed by the blood during its passage through the lungs.

Naturally, such a hypothesis brought about a desire to measure the gases of blood. The first experiments, however, did not take place before the 1850s, at which time the German, Lothar Meyer, in Göttingen, and the Frenchman, Fernet, in Paris, simultaneously discovered that a vastly larger quantity of oxygen exists in bound form in the blood than that which corresponds to the physically dissolved oxygen. Fernet also proved that this was due to the presence of the red blood cells. Naturally, this discovery greatly increased the physiologists' interest, and in Carl Ludwig's laboratory in Vienna it was decided to investigate the matter more closely.

Carl Ludwig was the greatest experimental physiologist of the 19th century. He started his career in Marburg, where he became acquainted with, among others, the 5-years older Robert Bunsen. It was in Bunsen's gas-analytical laboratory that the foundation was laid for the analysis of all known gases, principally on the basis of volume/pressure measurements after elimination of the gas under study by some kind of chemical reaction. Thus, oxygen was eliminated by igniting it with an electrode after admission of hydrogen, and carbon dioxide was removed by absorption in sodium hydroxide.

After Marburg, Ludwig held appointments at other universities, including Vienna. In 1865, he became professor in Leipzig, where he remained until his death in 1895. In 1859, while still in Vienna, Ludwig constructed the first blood gas pump for evacuating gases from blood samples so that they could be collected over mercury and subsequently measured, in the method of Bunsen. Ludwig collaborated with the Russian, J. Setschenow, who is regarded as the Father of Physiology in Russia, and it was he who suggested that the evacuation should be accomplished by creating a Torricelli vacuum. However, their goal was not attained without its difficulties. The evacuation had to be repeated as often as 20 times before all the gas was evacuated. Leaks in the pump caused problems. The india-rubber stoppers had to be boiled in tallow for 7 hours before they were fit for use. The blood foamed during the evacuation process; the mercury could not contain air, but how could one be quite sure that air was not dissolved in glass? Coagulation posed a problem: The blood was collected in a receptacle over mercury and agitated to cause the fibrin to precipitate; a single analysis, which it took a whole day to perform, required the use of approximately 100 ml blood.

Besides Setschenow, Ludwig had many other pupils who, in the years to come, studied the gases of blood. When Ludwig left Vienna in 1865 to take up the professorship in Leipzig, the results so far might be summed up as follows: There was a fairly clear understanding of the commonly occurring amounts of oxygen and carbon dioxide in blood, and it was known that these existed in a dissociable form. The greater part of carbon dioxide was present in the plasma; oxygen, on the other hand, was essentially bound to the red blood cells. These did play a role both in the binding of carbon dioxide and in its liberation from the blood, however, because, for one reason, the uptake of oxygen promoted the release of carbon dioxide. Moreover, the terms gas tension and gas saturation had already been introduced at this time, the latter, of course, particularly in the sense oxygen saturation. By 1870, Ludwig was of the opinion that the gas exchange between the alveoles and the blood in the lungs could perhaps be explained by differences in gas tensions, but it remained for many decades an unsolved question within physiology whether or not active processes also played a part.

From Ludwig's laboratory, the interest in blood gases spread far and wide, and many modifications of the first blood gas pump appeared, all using a vacuum to evacuate the gases. Ludwig improved his own original pump considerably, and in collaboration with Alexander Schmidt, he constructed a greatly simplified version in 1867. All researches attempted to make improvements on existing apparatus. About 1890–1900, Christian Bohr's laboratory in Copenhagen became the most sophisticated laboratory within blood gas technology. Several physiologists came to Bohr's laboratory in order to learn his improved technique for determining the blood gases. Among the visiting scientists was Haldane, and he wrote in his book *Respiration* in 1935 about his visit to Copenhagen in 1892 as follows:

> When Bohr's original experiments on the question of secretion by the lungs were published in 1891, I was just beginning the serious study of mine gases and the physiological effects of vitiated air; and his results interested me greatly. A year or two later Lorrain Smith and I made a visit of several weeks to Copenhagen, and carried out some research work in the laboratory under Bohr's direction, thus learning a great deal which we could not have learned in England about existing methods of blood gas investigation, and, far more important, getting into personal touch with Bohr himself. I should like to take this opportunity of saying how much we, and indirectly other physiologists in Great Britain and America, have owed to Bohr and the Copenhagen School of physiologists.

Bohr improved the blood gas pump proper by introducing a water jet pump to regulate the movements of the mercury by either suction or pressure – a solution that was also adopted by, for example, Barcroft in his modification of the pump. Other improvements in blood gas technology were introduced: Coagulation of the blood was defeated in vivo by injecting hirudin or heads of medical leeches, or by giving the experimental animals peptone shocks. In vitro, the method used at first was the addition of hirudin, and later potassium oxalate. Saponins were used to produce haemolysis. According to Bohr, the accuracy was approximately 0.25%; however, according to Barcroft, who made comparisons between the various models, it ranged from 1% to 5%.

Not only did Bohr improve the pump itself, but also the tonometer described by Pflüger, so that it was now possible to measure blood gases in relation to previously known gas tensions, probably the most important progress to be made in Bohr's laboratory [2–4]. A microtonometer was developed by Bohr's pupil, August Krogh, which served to measure gas tensions in even very small volumes of air, and by means of this it was eventually possible to demonstrate that all gas exchange between blood and lungs was due exclusively to differences in gas tensions. Among other important results it may be worth mentioning that Bohr demonstrated that the dissociation curve for oxyhaemoglobin is sigmoid. Also, in collaboration with Krogh and Hasselbalch, he discovered that the position of the dissociation curve was dependent on the carbon dioxide tension in the blood – afterwards proved to be in the main a pH effect.

In the first decade of this century, Haldane and Barcroft, working in England, were the important investigators of blood gases [5]. They improved the gasometric methods considerably, and Haldane introduced a chemical principle for liberating oxygen from haemoglobin in a haemolysed blood sample by adding potassium ferricyanide. In 1902, Haldane and Barcroft described the first method for determining both oxygen and carbon dioxide in 1 ml of blood. And, in 1920, Haldane described an apparatus for measuring the components of gas mixtures which is still used [6]. Both were particularly interested in haemoglobin and its gas binding, first of all the binding of oxygen. As is well known, Haldane was also very interested in carbon monoxide, its occurence in mines and its competition with oxygen in binding to haemoglobin. Both were also interested in the position of the oxyhaemoglobin dissociation curve and its displacements. Barcroft discovered the influence of temperature [7], and Haldane studied its position in foetal blood and at high altitudes.

The technical advances in Great Britain gained a footing only in the physiological laboratories, and not before Donald D. Van Slyke's gasometric measuring equipment appeared was the time ripe for the clinical laboratories to begin measuring on blood from patients. His first apparatus for volumetric determinations was described in 1917, and later the more refined and precise manometric apparatus was added. This measuring equipment, which soon made its appearance in hospital laboratories throughout the world, was employed with no special view to characterizing the blood's gas tensions and the functioning of the lungs, but almost exclusively to characterize the blood's acid-base status. The pioneer in this field however, was not van Slyke, but the Dane, K. A. Hasselbalch.

Blood Gas Measurements and Medical Acid-Base Chemistry

Medical acid-base chemistry had been of interest to doctors many centuries before Hasselbalch. The word "alkali" is the Arabian word for vegetable ash. Also acids were known in antiquity, and the ancients learned how to tell one from the other by the difference in colour of certain vegetable dyes in acid and alkaline solutions. In the seventeenth century, the iatrochemical school was founded by Franciscus de le Boe Sylvius, who belonged to a Huguenot family that had emigrated to Holland, where he became Professor of Medicine at Leiden. He maintained that diseases were caused by abnormal fermentations in which acid or alkaline substances were generated in the body. If acid fermentations predominate, treatment must be effected with alkaline remedies, and vice versa. Acids and bases became the Yin and Yang of that age within medicine, supported by some philosophizing about the fact that blood is alkaline and urine is acid. Actual methods of measuring apart from those utilized in inorganic chemistry did not exist, and these were troublesome. Measurements on blood and urine were therefore not performed until the beginning of the nineteenth century; one of the very first published was actually an acid-base measurement on blood, performed by an Irishman, Dr. W. B. O'Shaughnessy, who practised in London during the great cholera epidemic of 1831–1832. His communication [8] appeared in the *Lancet* and stated the following points:

1. The blood drawn in the worst cases of the cholera is unchanged in its anatomical or globular structure.
2. It has lost a large proportion of its water, 1000 parts of cholera serum having but the average of 860 parts of water.
3. It has lost also a great proportion of its *NEUTRAL* saline ingredients.
4. Of the free alkali contained in healthy serum, not a particle is present in some cholera cases, and barely a trace in others.
5. Urea exists in the cases where suppression of urine has been a marked symptom.
6. All the salts deficient in the blood, especially the carbonate of soda, are present in large quantities in the peculiar white dejected matters.

Dr. O'Shaughnessy did not describe his methods, but an impression of their primitiveness can be gained from the following report by Dr. Clanny, which appeared 2 days after Dr. O'Shaughnessy's first report. In it he stated:

This blood, on applying the tongue to it, had no taste, nor any particular smell, I also tasted it again, sometime after it had been drawn. I afterwards tasted the colouring matter, the coagulated albumen, and the fibrin, but in them I found no taste, nor any smell. It contained no gases of any description; was black as tar.

Dr. Clanny then gave the results of analyses of blood from two cholera patients, and continued: "These results of the analysis are most instructive, and by the medical philosopher must be regarded with astonishment."

The medical philosopher of today will also consider these analytical results with surprise and great interest, being most of all surprised to learn that such simple instruments as the tongue, the nose, the eyes, a balance, a gas burner and some glass tubes were sufficient to show that the "soda" and the salt were decreased in the patients' blood and found in the patients' stools. There is no doubt, however, that Dr. O'Shaughnessy incinerated his samples from blood and stools, and subsequently employed methods from inorganic chemistry. It is specially remarkable that the results led to an understanding of the patients' electrolyte and fluid balance and had important therapeutic consequences. Thus, a general practitioner in Leith, Dr. Latta, who read the reports, hit upon the idea of giving the patients intravenous infusions of sodium chloride and sodium bicarbonate solutions. Dr. Latta reported in a dramatic way [9] in the *Lancet* on the first cholera case which he treated:

The first subject of experiments was an aged female, on whom all the usual remedies had been fully tried, without producing one good symptom; the disease, uninterrupted, holding steadily on its course. She had apparently reached the last moment of her earthly existence, and now nothing could injure her – indeed so entirely was she reduced, that I feared I should be unable to get my apparatus ready before she expired. Having inserted a tube into the basilic vein, cautiously – anxiously, I watched the effects; ounce after ounce was injected, but no visible change was produced. Still persevering, I thought she began to breathe less laboriously; soon the sharpened features, and sunken eye, and fallen jaw, pale and cold, bearing the manifest impress of death's signet, began to glow with returning animation; the pulse, which had long ceased, returned to the wrist; at first small and quick, by degrees it became more and more distinct, fuller, slower, and firmer, and in the short space of half an hour, when six pints had been injected, she expressed in a firm voice that she was free from all uneasiness, actually became jocular, and fancied all she needed was a little sleep.

This is the first description of an intravenous treatment with bicarbonate, based on the first published measurement of an acid-base status of blood. It is the most dramatic one I know of in the history of medical acid-base chemistry – actually in the whole history of medicine – where the use of such simple instruments led to a correct understanding of the clinical biochemistry of a disease and to a life saving therapy. It is also remarkable that the therapy was soon forgotten and was not used again for cholera until 1910, when Dr. Sellards, in the Philippines, rediscovered the value of bicarbonate infusions in cholera patients.

Towards the end of the 19th century, another disease, diabetes mellitus, initiated acid-base studies in Germany. Experimental studies led to the discovery, in 1877, by Walter in Strasbourg, of increased urinary excreation of ammonia in dogs infused with hydrochloric acid. A few years later, it was found that patients in diabetic coma excreted high amounts of ammonia in the urine, and this led to the discovery, by Stadelmann from Königsberg, of high excretion of organic acids in urine of diabetics. Stadelmann characterized diabetic coma as an acid intoxication, and he proposed injections of bicarbonate for such patients. However, the results were not too convincing at that time because insulin was unknown, and because clinical advance was retarded by the fact that venepuncture by means of a hypodermic needle to draw blood samples for analysis was not introduced before 1910 [10]. For a time, interest focused on measuring carbon dioxide tension in the patients' expired air so as to arrive at the diagnosis "acidosis", in accordance with Kussmaul's report on the vigorous respiration of this condition [11].

However, it was with K.A. Hasselbalch's measurements in Copenhagen that real progress within acid-base research was eventually made. The scientific soil for progress within this field was very fertile here. Not only had great headway been made in the measurement of blood gases in the physiological institute of the University of Copenhagen, under Bohr's leadership, but a big step forward had simultaneously been taken within acid-base chemistry, first and foremost attributable to S.P.L. Sørensen's investigations. Sørensen succeeded Kjeldahl as head of the Carlsberg Laboratories in Copenhagen in 1901. His scientific work dealt in particular with proteins and enzymes, and in 1909 he evaluated the an electrometric method for the determination of the hydrogen ion concentration, introduced the pH concept, and introduced buffers in order to control pH in enzymatic studies [12].

In 1912, Hasselbalch utilized Sørensen's hydrogen electrode to measure pH in blood and at the same time measured blood gases by the gasometric technique he had learnt at Bohr's laboratory. The method formed the basis of his subsequent physiological and clinical research work. In collaboration with S.A. Gammeltoft, he introduced and defined the concepts of compensated and uncompensated disturbances of the acid-base status of the blood which are still used; he was aware in particular of the low arterial carbon dioxide tension found in connection with pregnancy. In his work *Die "reduzierte" und die "regulierte" Wasserstoffzahl des Blutes* he also discussed how the interplay between the respiratory and non-respiratory acid-base components influences blood pH [13].

Hasselbalch's approach to the problem is still highly relevant for the interpretation of acid-base values in patients and has therefore been subjected to repeated reflections and investigations, especially concerning the practical performance of acid-base measurements and their clinical application. His way of presenting the problems has thus had a decisive influence on the works of the Van Slyke school, on the works of Singer and Hastings and on the theoretical and methodological approach in the more recent Danish contributions to acid-base research. In the medical world, Hasselbalch's name probably won the greatest renown when it was connected with the name of Henderson in the Henderson – Hasselbalch equation, in which Hasselbalch expressed Henderson's equation for the hydrogen ion activity of the blood in a logarithmic formula.

Hasselbalch was the first to describe displacements of the oxyhaemoglobin dissociation curve in pathological conditions. The studies were initiated by reports from Barcroft's laboratory where Peters had found a straight-lined correlation between the negative logarithm to the oxygen binding constant K in Hill's equation and the pH of a blood sample. This fact was then used in Barcroft's laboratory to calculate the pH of a blood sample by determining the K-value from corresponding oxygen saturation and oxygen tension values. Peters and Barcroft then supposed that the position of the oxyhemoglobin dissociation curve was constant [14].

To Hasselbalch it seemed awkward to determine the pH of blood in this way, and he wrote, "I presume that in the future everyone who wants to determine the reaction of blood will use the CO_2 binding and not the O_2 binding." As he did not believe that the straight line in Peters-Barcroft's curve had a constant position, he investigated six normal persons, but to his astonishment found lines very similar to the Peters-Barcroft's curve. However, Hasselbalch was not a man who gave up a fight when be was convinced that his option on a subject was the right one. He began to study patients. In three out of eight patients the position of the dissociation curve was normal, but the other cases had abnormal positions. One of the patients had pernicious anaemia, with a haemoglobin concentration 25% of the normal values, and here he found a displacement of the curve to the right. In a patient with uraemia, Hasselbalch found the curve displaced to the left, T_{50} was changed to approximately 23 mmHg. More pronounced changes were found in blood from a patient with diabetic coma and from a patient with gout. The T_{50} values were approximately 22 and 21 mmHg, respectively. The way in which Hasselbalch ended his paper shows what a brilliant scientist and good fighter he was. He stated that the necessary conclusion of his results was that "Barcroft's oxygen binding method was not generally applicable," but this has less interest than the nature of the mechanism by which the dissociation curve is displaced in the patients.

At the age of 43, and with a newly acquired master's degree in agriculture, Hasselbalch left medicine in order to devote himself to practical farming. However, his inquiring mind did not rest; he transferred his knowledge of acid-base chemistry to his new practical work and published results of pH measurements in soil as a measure of its calcium carbonate requirements. The very first pH measurements on soil had been performed some time before by Bjerrum and Gjaldbaek in Bjerrum's laboratory. Hasselbalch introduced the measurements in practical agriculture and proposed the term "reaction values" for soil pH that is still in use. He died in 1962 at the age of 87.

At the Van Slyke school of the Rockefeller Institute in New York, using the simpler manometric technique, Hasselbalch's results were proved right in every respect. In fact, there has not been much to add in the way of new developments since then. Time does not allow me to enter into details. However, I wish to point out that the discovery of abnormal bicarbonate values in plasma concentrated the clinicians' attention for several years exclusively on the non-respiratory acid-base disturbances, so that the respiratory disturbances were almost forgotten. I can illustrate this by telling you, as a matter of curiosity, that when the great poliomyelitis epidemic broke out in Copenhagen in 1952, the clinicians thought at first that the high bicarbonate values measured in the laboratories on plasma from patients with respiratory paralysis indicated a mysterious and inexplicable alkalotic state, and not an accumulation of carbon dioxide. This, however, led to new thinking and to new analytical developments in Copenhagen, where the equilibration method was introduced, based on electrometric measuring of pH on samples of capillary blood before and after equilibration at two known carbon dioxide tensions. Since then, new advances have been made in the field of electrometric measurements and in the use of carbon dioxide and oxygen electrodes.

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3.25 History of Hypothermic Anesthesia by Surface Cooling in Japan

T. Yonezawa and R. Wakusawa

Development of Clinical Application of Hypothermia by Surface Cooling

The modern clinical application of hypothermia by surface cooling originated from the experimental investigation by Watanabe [1] and others in the Second Department of Surgery, Tohoku University School of Medicine in 1954. They showed that, in dogs, the body temperature could be safely lowered to 20°C by the method of immersion in ice water under a deep level of ether anesthesia, and that open heart surgery, as well as transplantation of thoracic aorta, could be completed under circulatory arrest of 1 hour with the hypothermia. The results of these experimental studies were reported by Ishikawa and Okamura [2], at the Congress of General Surgery of West Germany in Munich. They demonstrated the experimental procedure of the hypothermia in the Department of Surgery in Heidelberg University. At that time the hypothermia, originated by Bigelow and his associates [3, 4], was widely applied to the clinical practice of open heart surgery. Many clinical cases of open heart surgery under hypothermic anesthesia were reported by Lewis [5], Swan et al. [6], and Derra [7], respectively. However, their method of hypothermia was dangerous in some aspects because of the high risk of ventricular fibrillation which could occur when the body temperature was lowered below 28°C. Furthermore, with this degree of hypothermia the maximum permissible time of circulatory arrest was about 6 min, or 10 min at the most. Accordingly, heart-lung machines, with or without extracorporeal blood cooling, continued to be used for cardiovascular surgery.

Renewered interest in hypothermia under deep anesthesia promoted some study by Spohn and Kolb [8, 9]. They reported that the hypothermic anesthesia was an excellent method for cardiovascular surgery and that they had applied this method to six patients. Taking the results of those experiments into consideration, a start was made at Tohoku University, Japan by Yonezawa, Okamura, Watanabe and others to apply clinically hypothermic anesthesia to thoracic and pediatric surgery, where the risk of anoxia was high. They further improved the anesthetic management of hypothermia.

Since 1958 Yonezawa and Okamura had applied hypothermic anesthesia to open heart surgery at Iwate Medical College. In 1960, at the Second World Congress of Anesthesiologists, they reported the cases of hypothermia, including 11 cases of open heart surgery with circulatory arrest within 30 min under a body temperature of approximately 25°C [10]. The number of cases of hypothermia for cardiovascular surgery in the hands of Yonezawa, Okamura, Seta and Niitsu in the Departments of

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Anesthesiology and Surgery in Iwate Medical College continued to increase. This hypothermic method was widely accepted by many surgeons in other universities and hospitals and was applied not only to open heart surgery but also to other types of surgical operations where temporary regional circulatory arrest was needed. The reason for this wide acceptance and wide application of hypothermic anesthesia was that this method needed little medical equipment and, very little blood during the course of the surgical procedure. Furthermore, it is also noteworthy that the postoperative general condition and outcome of the patients who had undergone surgery under hypothermic anesthesia were excellent.

At the 16th General Congress of the Japanese Medical Society in 1963, the symposium on hypothermia in the field of surgery was held, where Yonezawa [16], Kimoto, Virtue and Watanabe were among the speakers under the chairmanship of Katura. In this symposium hypothermic anesthesia using ether anesthesia was recognized as an excellent and effective method for surgery.

In Iwate Medical College 292 open heart surgical operations were performed under hypothermia by the end of 1965. The lowest point of the body temperature of each patient among these cases ranged from 27.1°C to 15.6°C, and circulatory occlusion time ranged from 6 min 23s to 134 min. The cardiac diseases of these patients included septal defect (VSD), septal defect (ASD), pulmonary stenosis, tetralogy and pentalogy of Fallot, and acquired valvular diseases. Out of 292 cases, 46 patients died postoperatively. The outcome was considered to be excellent at that time. The number of clinical applications of hypothermia using this method was increased every year by Wakusawa et al. [17, 20], and 1269 open heart surgical operations were performed at Iwate Medical College by the end of 1980.

The studies on the pathophysiology, anesthetic considerations, and clinical application of hypothermic anesthesia were reported by Iwabuchi and Wakusawa [21], Yonezawa [22], Muraoka [23], Tanaka and Horiuchi [24], Dillard [25], Mohri [26], Brawn [27], and Steward [28], respectively.

Recently hypothermia has been widely recognized to be a safe and effective method for cardiac surgery among infants. The present status of the clinical applications of hypothermia to cardiovascular surgery other than that in Iwate Medical College was reported by Mohri [29].

Besides being used in cardiac surgery, hypothermia was mainly used for cases of neurosurgery to protect the possible cerebral damage caused by temporary occlusion of regional cerebral blood flow. Yonezawa reported 229 cases of neurosurgery under hypothermic anesthesia [30]. In this study he reported that even though the use of operative microscope and normothermic hypotensive anesthesia had been replacing hypothermic anesthesia, hypothermia was still favorable when the interruption of regional or total brain circulation was needed for operative procedure. It was also reported that excellent results could be obtained with hypothermic anesthesia for the surgery of other organs, such as kidney, when a longer period of circulatory arrest was needed.

Yonezawa also reported the investigation of the application of hypothermia to some cases in which hypothermia was needed to maintain life under the condition of severe hemodilution and to cases of brain resuscitation [31].

Improvement in Anesthetic Method of Hypothermia by Surface Cooling

Several improvements in the anesthetic method of hypothermia by surface cooling have been made since it was first applied clinically by us in 1956. In classic hypothermic anesthesia, the anesthetic level used to be lightened when the body temperature was lowered. By contrast, in the hypothermic anesthesia developed by us, the anesthetic level had to be maintained in deep level by ether anesthesia throughout the course of cooling and rewarming to protect the hazardous physiological reaction of the patient against cold. In our method the ventilation had to be kept at approximately the same level as normal minute and tidal volume throughout the course of hypothermia. On the other hand, hyperventilation was recommended in classic hypothermia.

After 1958, ganglioplegic agents, which had been used for artificial hibernation by Laborit and Huguenard [32], began to be administered as a premedication. It was very useful to prevent hemodynamic alterations and irregularities during the induction of ether anesthesia prior to the hypothermia. It also prevented the undesirable reaction of the patient against cold in the longer period of cooling. Through much experience, we found that triflupromazine hydrochloride was the best among the ganglioplegic agents, for premedication and it was also given in the initial stage of cooling.

The ordinary method of hypothermia with ether anesthesia developed by us is as follows: After adequate premedication, anesthesia is inducted by the intravenous administration of thiopental sodium and succinylcholine chloride. Using closed circuit, 2–3 ml/kg of body weight of ether is administered from the time of induction of anesthesia and during the period of the cooling. The low molecular weight dextran, lactated Ringer's solution, and heparin are administered to prevent sludging and peripheral circulatory failure in cases such as open heart operation where circulatory arrest is necessary. The patient is cooled down by means of immersion in ice water. When the body temperature reaches 30°C, controlled ventilation is started manually following the administration of pancuronium bromide. Cooling is stopped when the body temperature reaches 2°C or 3°C above the desired temperature. In cardiac surgery Young's solution is used intraaortically and resuscitation is performed using manual pumping and/or cardiac massage after cardiac repair. Rewarming is performed by the immersion method using warm water of 43°C until rectal temperature reaches 35°C. Protamine sulfate is administered during the course of rewarming.

The suitable ether concentrations in arterial blood was investigated by Yonezawa [33, 34]. They are as follows: The ether concentration should be 90–112 mg/dl in arterial blood at 37°C, 102–132 mg/dl at 35°C, 114–168 mg/dl at 30°C, 124–180 mg/dl at 25°C, and 152–220 mg/dl at 20°C, respectively. The concentration of ether in the hypothermic state is toxic under normal temperature, but the vapor pressure of ether in the hypothermic state is equal to that of the surgical stage of ether anesthesia in normal body temperature. Moreover, the high concentration of ether is not only without risk but also necessary to maintain good hemodynamic condition during hypothermia. These suitable concentrations can be obtained by the administration of the agents with the method of nonrebreathing or semi-closed system using 4%–6% of ether through the course of cooling and rewarming, because the partition coefficient of ether in blood increases according to the degree of drop in the body temperature.

Ether is the best inhalation anesthetic drug among many anesthetic agents for hypothermic anesthesia by surface cooling, and the concentration in blood should be increased in the closed system when the body temperature is lowered. On the other hand, if cyclopropane is used for hypothermia, it is not necessary to increase the range of suitable blood concentrations, even when the body temperature is lowered, because the vapor pressure of this drug is not as lowered as ether, even when the body temperature is lowered. These theoretical considerations are proved by the experimental studies, and have been found to be useful for the anesthetic management of simple hypothermia under the different inhalational anesthetic agents.

Since the first clinical application of hypothermic anesthesia in cardiac surgery in 1958, it still remains the main method of anesthesia for open heart surgery and other field of surgery where temporary circulationry arrest is a requirement of the surgical procedure.

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4 Regional Developments in Anaesthesia

4.1 Foreword

J. Rupreht

Somebody who is interested in the development and spread of anaesthesia as we know it nowadays may get a strange impression that this speciality, together with most of modern medicine, has been chiefly a product of the western world. From the so-called West, anaesthesia seems to have spread to the rest of the world. However, and the present chapter tends to confirm this, little information is available to increase our understanding of the fate of anaesthesia in extensive areas of the world with enormous population masses. Reasons for this may be political, linguistic or economic. The tragedy is that, most probably, much pioneering work is currently being performed in many areas of the world and if this is not recorded now it will soon be too late to do so.

There is no doubt that the degree of development of anaesthesia is drastically different in various parts of the world. Even in the highly developed countries the progress of anaesthesia followed strange courses. Whereas in the USA scientific research started before World War II, it took much longer before any such development occurred on the continent of Europe. Anaesthesia is originally a product of North America and somewhat later took a fruitful parallel course in Britain and its colonies. The papers concerning the contributions made by the Edinburgh anaesthetists, on anaesthesia during the Blitz in London, or on the work of regional anaesthetic societies in the United Kingdom, give insight into the consolidation period of our speciality in these areas.

It is intructive to consider the relative value of communication. While most medical developments rapidly spread from English-speaking countries to continental Europe, this was not the case with anaesthesia. Advanced continental cities had not acknowledged the value of specialized doctors for the administration of anaesthesia. Germany, a country of most remarkable achievements in surgery, did not feel the need for highly specialised anaesthesiologists and as late as the fifties vegetated on the need for better trained anaesthesia-administering nurses "considering that there was no need to train doctors for this job". Professor H. Killian, a surgeon by vocation, was one of many who saw the historical dissonance, the dead patients, and fought for changes in German medicine. However, it took many more unnecessary anaesthetic casualties before political pressure forced the conventional mode of medicine to recognise anaesthesia as a valuable speciality in its own right.

After the War, many countries developed their own form of national anaesthesia. Some incorporated it very readily into their Corpus Medicinae, as documented by the papers dealing with anaesthesia in Scandinavia. It is interesting to read, however, that in some countries surgeons who were trained in anaesthesia, but never practiced it, became an additional cause for developmental problems of the speciality.

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The great nations of the Far East had practiced medicine for several millennia. Modern anaesthesia, however, has been promoted in by the West. Papers on the development of anaesthesia China and Japan indicate that, like most of "western medicine", anaesthesia was influenced there by German and, after the War, American thinking. The British genius has been highly esteemed there in the lecturing function but has apparently left only faint imprints in thinking, if any at all. It is interesting to read that acupuncture has not gained the importance in Chinese anaesthesia which had been anticipated. Has this to do with the unpredictability of the success of the technique or with its inherent inadequate efficacy?

Maturation of anaesthesia as a recognised part of medicine has been accompanied by the growth of journals on anaesthesia. The reports on the evolution of the British Journal of Anaesthesia and the Acta Anaesthesiologica Belgica are first-hand records of the history of media without which contemporary anaesthesia would have lost its momentum. Surprisingly, anaesthetists from many countries still delay the production of national journals of anaesthesia. Such publications not only fulfil a scientific function but also serve as the most efficient means for organization of anaesthesiologists. A specialist should not forget that organizational strength is just as important as knowledge of medicine.

This chapter on the development of anaesthesia also speaks through its unwritten parts. Communication among anaesthetists throughout the world must improve if we are to profit from the intellect and efforts of our colleagues in vast areas of the East, Africa, Asia and Latin America. We are celebrating a centennial of local anaesthesia in 1984. In 1884 it took only a few weeks before Koller's information reached every interested doctor.

How long would this take nowadays?

4.2 Anesthesia Research Interests in the United States, 1940–1980

H. T. Benzon, H. W. Linde and E. A. Brunner

The journal *Anesthesiology* was first published in July 1940 and is now among the most prestigious journals published [1]. Original articles published in *Anesthesiology* over the years represent current interests in the specialty at the time of publication; they are frequently cited [2], and became forerunners of developments in anesthesia. A review of the original articles published in the journal is therefore a review of the history and developments of the specialty in the United States.

Methods

Original articles published in *Anesthesiology* from 1940 to 1980 were examined and assigned to one of several arbitrary topics or anesthesia subspecialties. After two trials of subdivision with the first 10 years of *Anesthesiology* publication, most articles fell into one of the following categories:

1. Anesthesiology (the journal and the specialty), anesthesiologists
2. Anesthetic agents and action
3. Anesthetic equipment
4. Biotransformation and pharmacokinetics
5. Circulation
6. Conduction anesthesia and pain
7. Critical care
8. Endocrine
9. Hazards, complications, and anesthetic mortality
10. Neuromuscular transmission and muscle relaxants
11. Obstetric, gynecologic anesthesia, and perinatology
12. Pediatric anesthesia
13. Preoperative medication and visit
14. Research methodology, education, and epidemiology
15. Respiration
16. Specialties:
    a) Cardiac anesthesia
    b) EENT, dental, and oral surgery anesthesia
    c) Neuroanesthesia
    d) Thoracic, urologic, and orthopedic surgery anesthesia
17. Temperature
18. Uptake and distribution
19. Other

The assignment of an article to a particular category was based on the title and abstract of the article. When necessary, the whole article was read.

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The survey was divided into 5-year periods with the exception of the 1940–1945 period. The 1940 publication was for 6 months, with only three issues, and this was added to the 1941–1945 survey period. An initial review of the first 10 years of *Anesthesiology* showed numerous articles dealing with more than one topic. When an article dealt with more than one topic, the two most important topics discussed were credited. The number of citations in Table 1 therefore exceed the number of papers published.

Articles were assigned to categories on the basis of their content. Some categories are self explanatory. The section on "Anesthetic agents and action" includes theories on anesthetic action; depth of anesthesia; new inhalation and intravenous agents; experience with anesthetic agents; effects of anesthetic agents on the liver, carbohydrate metabolism, prothrombin time, granulopoiesis, gastrointestinal motility, electroencephalogram, antidiuretic hormone (ADH) levels; or other effects not dealing with circulation, respiration, or muscle relaxation. Articles assigned to "Anesthesiology and anesthesiologists" deal with the journal, anesthesiologists, and anesthesia as a specialty. Examples include the lure, opportunities, and responsibilities in anesthesia; anesthesia study commissions; group practice; and malpractice suits. Presidential addresses and obituaries were also included. Articles classified under "Critical care" deal with coma, shock, recovery, and intensive care. Articles classified under "Cardiac anesthesia" could have been classified in the section on "Circulation", but we decided to make this a separate category. Articles classified under "Hazards, complications and anesthetic mortality" include transfusion reactions, X-ray exposure, anaphylaxis, nerve injuries, hazards of position, anesthetic poisoning, and mishaps. Articles assigned to "Research methodology, education, and epidemiology" deal with the instruction, training, and curriculum of anesthesia residents; clinical research in anesthesia; experimentation in anesthesiology; design, interpretation, and reporting of experiments; and statistics for anesthesists. Articles classified under "Temperature" included studies on the effects of hypothermia on the electroencephalogram, acid-base status, and whole body metabolism; bodily reactions to cold or hot temperature; and intra- or postoperative temperature changes. Articles on heat stroke and hyperthermia were also included. Finally, all articles that could not be assigned to the previous categories were assigned to "Others." These include articles on rare diseases such as Refzum's disease, Shy Drager syndrome, Stevens–Johnson syndrome, dystonia musculorum deformans, hypokalemic periodic paralysis, Prader – Willi syndrome, and topics like prostaglandins, which do not fit into the other categories.

Results

The results of the survey are shown in Table 1.

Table 1. Subject matter or original articles published in *Anesthesiology,* 1940–1980

Topic Year	1940–1945	1946–1950	1951–1955	1956–1960	1961–1965	1966–1970	1971–1975	1976–1980	1940–1980
1. Anesthesiology, anesthesiologists	24	11	3	6	5	3	6	7	65
2. Anesthetic agents and action	66	55	60	83	62	76	125	84	611
3. Anesthetic equipment	28	15	34	35	12	17	8	16	165
4. Biotransformation and pharmacokinetics	1	0	1	0	1	7	55	50	115
5. Circulation	32	31	78	56	86	114	108	97	602
6. Conduction anesthesia and pain	60	75	87	30	33	40	43	42	410
7. Critical care	10	2	9	6	10	7	4	17	65
8. Endocrine	2	3	7	5	16	4	2	2	41
9. Hazards, complications, and anesthetic mortality	35	34	35	23	37	16	34	45	259
10. Neuromuscular transmission and muscle relaxants	8	25	29	44	34	46	50	45	281
11. Obstetric, gynecologic anesthesia and perinatology	1	12	9	6	26	15	17	30	116
12. Pediatric anesthesia	0	17	12	11	16	14	20	7	97
13. Preoperative medication and visit	6	5	5	16	7	4	4	4	51
14. Research methodology, education, and epidemiology	4	5	5	2	4	3	6	2	31
15. Respiration	34	26	40	60	81	91	91	62	485
16. Surgical specialties:									
a) Cardiac anesthesia	0	0	4	15	5	10	9	8	51
b) EENT, Dental and Oral anesthesia	9	8	5	1	0	0	0	0	23
c) Neuroanesthesia	0	3	9	11	16	15	25	39	118
d) Thoracic, urologic and orthopedic surgery anesthesia	7	11	9	6	3	2	1	1	40
17. Temperature	5	2	2	9	15	8	11	17	69
18. Uptake and distribution	2	2	0	5	21	14	15	1	60
19. Other	9	3	2	6	2	8	1	3	34
Total number of citations	343	345	445	436	492	514	635	579	3789
Exact number of articles published	307	316	363	380	407	432	537	448	3190
Number of articles dealing with more than one topic	36	29	82	56	85	82	98	131	599

Discussion

Original articles reflect original research done on the topic discussed by the article. An analysis of the subject matter of the original articles provides a record of the growth, development, maturation, and decline of an area of investigation. If the articles in each area (see Table 1) are expressed as a percentage of the total number of original articles in a survey period, certain patterns emerge. Some areas declined or increased, while others maintained a stable growth. Articles dealing with anesthetic agents and action, circulation, and respiration have accounted for a high percentage of the original articles throughout the entire period of study. Articles on conduction anesthesia and pain decreased from 20%–24% in 1940–1955 to 8%–9% for each of the 5-year periods from 1956–1980. Articles discussing anesthesiology and anesthesiologists decreased from 8% in 1940–1945 to 3% in 1946–1950. Since then, they have accounted for only 1%–2% of the articles published, probably reflecting maturation and establishment of respect for the specialty, and its journal, after those early years. Articles on anesthetic equipment also decreased, from about 4.7%–9% of the articles from 1940–1960 to only 1.5%–4% of published articles after 1960. Equipment discussed in the recent articles, however, is more sophisticated than that discussed in the earlier period.

New areas of investigation have developed in the last 10 years. Articles on biotransformation were almost nonexistent until the 1971–1980 period, when they accounted for 10%–11% of original articles. Neuroanesthesia articles accounted for 0%–1% of the articles from 1940–1950, increased to 2%–4% in 1950–1970, and to 5%–9% in 1971–1980. Studies on neuromuscular transmission and muscle relaxants accounted for 3% of original articles in the 1940–1945 period. Since then, they have consistently accounted for 8%–11% of the articles published. The sustained growth is due to studies in search of new muscle relaxants, refinement of the quantification of neuromuscular and residual blockade, cardiovascular and anesthetic effects of muscle relaxants, relaxant interactions, and pharmacokinetics of the drugs.

Pediatric and obstetric anesthesia accounted for less than 1% during the 1940–1945 period. Articles on obstetric anesthesia then accounted for 1.6%–3.8% of the articles published since 1945; in 1961–1965 and in 1976–1980 it accounted for over 6% of the published articles. The increased number of articles on obstetric anesthesia since 1960 reflect investigations that laid the foundations for better management of the parturient and the fetus. Studies on the anesthetic effects on uterine action, physiologic changes during pregnancy, uterine and placental circulation, resuscitation of the newborn, regional anesthesia in obstetrics, perinatal pharmacology, and the evaluation of the neonate have appeared since 1960. Pediatric anesthesia articles accounted for 5.4% of the articles in 1946–1950, decreasing gradually to 1.6% of published articles in 1976–1980. This relative decrease may be due to the growth of new subspecialties or early maturation of the subspecialty. Articles published after 1950 primarily reflect refinements of older studies or pediatric applications of advances in other fields such as pharmacokinetics or new muscle relaxants.

Articles on uptake and distribution were most numerous in 1961–1965, when they accounted for 5.2% of the papers published. This decreased to 3.2% in 1966–1970, 2.8% in 1971–1975, and to an insignificant level in 1976–1980. Apparently, investigators in this area have elucidated a very important aspect of anesthesia in a short period of time and have exhausted currently available approaches to this subject.

An increasing percentage of the total number of articles dealt with more than one topic, from 9%–11% of the articles from 1940–1950 to 15%–22% from 1950–1975 and finally 29% in 1976–1980. Investigators have become increasingly aware of the interdependence between the subspecialties and the changes that one body system brings to another.

Conclusions

We have surveyed the subject matter of articles published in *Anesthesiology*. Based on the number of original articles published, anesthetic agents and action, circulation, respiration, conduction anesthesia and pain, and neuromuscular transmission are topics of sustained high investigative interests. The maturation of some topics as uptake and distribution and pediatric anesthesia, and the blossoming of new areas of investigation such as neuroanesthesia, and biotransformation and pharmacokinetics has been documented. Although future developments are impossible to predict, the specialty has matured [3] and should continue to develop along with other medical specialties.

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4.3 Anesthesiology and Pharmacology at Wisconsin in the 1930s

John E. Steinhaus

The anesthesia residency program at the University of Wisconsin at Madison was established by Ralph Waters in 1927 and was soon recognized as a pioneer and leader in the development of the academic discipline of anesthesiology in that period. The program initiated by Dr. Waters established an exceptional model for residency training in anesthesiology and, in fact, laid the basis for the pattern of our residency training programs today. Morbidity and mortality conferences, journal clubs, and anesthesia records (both individual and collective) were features of this program [1]. Waters emphasized a broad program encompassing not only surgical and obstetric anesthesia, but also therapeutic and diagnostic blocks. In addition, analeptic and fluid therapy, artificial respiration, and the management of postoperative complications – the elements of intensive care – were included and stressed.

Nevertheless, the most unique contribution made by Waters was the accumulation of new medical knowledge, including the discovery and development of new anesthetics and techniques, together with the research necessary for a better understanding of the physiology, pathology, and management of anesthetic problems.

A modest individual, who frequently disclaimed training or expertise in scientific investigation, Dr. Waters continually posed new questions and initiated projects with his scientific colleagues in pharmacology and physiology which expanded the medical discipline that we recognize as anesthesiology. Prior to his academic career, which began at the University of Wisconsin in 1927, he had actively pursued the study of carbon dioxide, its complications, and its relation to anesthesia. He had contacted Dr. Dennis Jackson, Professor of Pharmacology at the University of Cincinnati, Ohio, concerning the carbon dioxide absorption techniques which Jackson had studied and published in 1915 [13]. These interchanges led Dr. Waters to design and employ his carbon dioxide absorption canisters and to establish the place of carbon dioxide in anesthesia, especially its deleterious effects [2].

Waters' orientation toward pharmacology in this early period is evidenced by his modification of Guedel's signs and stages of anesthesia in the 1920s, with the addition of Miller's signs of respiratory changes. This was further refined in his Department, culminating with Gillespie's classic signs and stages of anesthesia that became the basis of anesthesia instruction in pharmacology texts for many years in the United States.

With the establishment of the academic anesthesia program at Wisconsin, Waters expanded his interest in collaborative research work with his colleagues from the basic sciences. Carbon dioxide became the subject of numerous cooperative studies starting

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with publication by Leake and Waters on the anesthetic properties of carbon dioxide, reaffirming Hickman's very early but unappreciated work. Dr. Chauncey Leake, an eminent pharmacologist who later became Professor of Pharmacology at the University of California, and still later the Vice-President for Medical Affairs at the University of Texas, maintained both scientific and personal interest in anesthesiology during his long and illustrious medical career [4]. The convulsive properties of carbon dioxide were studied with Loevenhart (Chairman of Pharmacology), Lorenz (Chairman of Psychiatry and Neurology), and Waters [5]. The early anesthesia machines commonly had a yoke for a tank of carbon dioxide which represented a prevailing, somewhat simplistic, notion that since carbon dioxide stimulated respiration in the awake and in many anesthetized patients, it would work in all circumstances. Administration of high levels of carbon dioxide, with the resultant depression and/or convulsions of the central nervous system, was vividly documented in motion pictures made at Wisconsin which were used in anesthesia education during this period. Waters' interest in more exact knowledge of carbon dioxide led to a number of studies with Seevers and Stormant, ranging from pharmacology to methods of gas analysis. Studies in the toxicity of local anesthetics by A.S. Loevenhart, the first chairman of pharmacology at Wisconsin, and also by A.L. Tatum, who succeeded him as chairman of this outstanding department, led Waters to his study of local anesthetic toxicity and its management [6].

The clinical introduction and study of cyclopropane by Waters was a consequence of his friendship and cooperation with Professor Henderson, Head of Pharmacology at the University of Toronto. Dr. Henderson had been unsuccessful in obtaining clinical tests of this new agent in Toronto because recent anesthetic accidents had produced an unfavorable climate at that time. The initial clinical investigation again spawned a series of investigations involving a number of pharmacologists and physiologists at Wisconsin [7]. Anesthetic concentrations were analyzed and biophysical constants of cyclopropane were determined in Seevers' laboratory. Cardiac arrhythmias, as a complication of both cyclopropane anesthesia and their mechanism, led to a large series of studies in the laboratories of Dr. Meek, Head of Physiology. The nature of this collaborative study is easily demonstrated in many papers. Not uncommonly, the four authors would include a resident and faculty member from anesthesiology, and a graduate student and Dr. Meek from physiology [8]. This early work on cyclopropane and its complications, cardiac arrhythmias, led to a series of studies in the physiology laboratory that persisted for 20 years and formed the basis of Dr. Meek's Harvey Lecture in 1941. Furthermore, it stimulated a greatly expanded use of the early string galvanometer electrocardiograph for studies of all anesthetics and their effect on cardiac rhythm. It was also a forerunner of our present-day use of the oscilloscope for monitoring the ECG.

The wide-ranging interests of Ralph Waters and his ability to work with the well-established basic scientists representing pharmacology and physiology at Wisconsin are demonstrated by many publications from the University of Wisconsin during this period. The paper on the pharmacology of the anesthetic gases which was published by Seevers and Waters in *Physiological Review,* was authoritative for that period [9]. A range of topics, such as cellular effects of anesthetics (erythrocytes), and diffusion of anesthetic through skin, is representative of many cooperative projects jointly published from the pharmacology and anesthesia departments in the 1930s.

The interaction of anesthesiology and pharmacology was a two-way interchange. It has been previously mentioned that the pharmacologists Loevenhart and Tatum were both nationally recognized experts in local anesthetics and had stimulated Waters' interest in the toxicity of local anesthesia in clinical usage. Tatum and Seevers were nationally recognized for their expertise in the pharmacology of the barbiturates, and devised the classification system for these drugs based on duration of action, which has served well up to the present time. The study of barbiturates for animal anesthesia by Seevers, especially the short-acting barbiturates, led to the initial clinical studies on thiopental in 1934. It was recognized that the older barbiturates, such as pentobarbital, would create adequate "anesthetic conditions" for experimental studies, but their long duration with very limited reversibility made them unsuitable as anesthetic agents for humans. The new short-acting anesthetic, thiopental, was found to be promising in these early studies; however, its lack of analgesic properties was noted. The authors concluded that the new drugs were satisfactory for short operations and should be investigated further. Again, the pattern of authorship was cooperative – a graduate student and Dr. Tatum from pharmacology, a resident in anesthesiology, and Dr. Waters – demonstrating a close cooperative working relationship which was mutually beneficial [10]. The clinical doses administered to patients reported in this preliminary study were from 6.34 to 24.77 mg/kg, giving a total dose of 600–1000 mg. This notation of dosage shows the strong influence of the pharmacology laboratory, since this expression of dosage was very uncommon in clinical medication.

The use of morphine for anesthesia was studied by both pharmacologists and anesthesiologists at Madison. On occasion, morphine anesthesia was employed for a selected patient; however, the necessity of an anesthesia resident sitting all night with the recovering patient limited morphine anesthesia to that of a "demonstration" status in this early period.

Studies in spinal anesthesia by Seevers and Waters illustrate the breadth of anesthestic problems addressed in this fruitful interaction [11]. Dr. Seevers, later the internationally known Chairman of Pharmacology at the University of Michigan at Ann Arbor, was especially recognized for his expertise in narcotic drugs and addiction. As a struggling assistant professor of pharmacology, he supplemented his basic science income by doing part-time work in clinical anesthesia and was a member of the American Society of Anesthesiologists when it was founded late in the late 1930s and a member of Dr. Water's "Aqualumni."

As one reviews the research studies coming from the University of Wisconsin School of Medicine during this period, it is not easy to classify some individuals with regard to their basic discipline, whether it be anesthesiology, pharmacology, or physiology. During the extensive studies of cyclopropane arrhythmias, O. S. Orth was a graduate student in the physiology laboratories of Dr. Meek, where the animal studies were conducted. Having completed his work for a PhD in physiology as well as an MD degree in a 6-year period, Dr. Orth took a position as Assistant Professor of Pharmacology in Dr. Tatum's department. Like Seevers before him, he did part-time anesthesia training and later clinical work in anesthesiology. He was certified by the American Board of Anesthesiologists in 1950, and 2 years later he was made Professor and Chairman of the Department of Anesthesiology at Wisconsin. Orth continued this pattern of interaction of basic science and clinical disciplines, and at one time during his tenure as the departmental chairman he had four department members with PhDs who were either on the faculty or in training. It was a common and continuing practice for the Department of Anesthesiology to support, on a part-time basis, a young faculty member from pharmacology. His responsibilities, in addition to pharmacological consultations both in conferences and the operating room, were to provide direction and leadership for the research in the anesthesia laboratories.

During this early period of the development of anesthesiology at the University of Wisconsin, which encompassed the decade of the 1930s, the role of Ralph M. Waters is a dominant force. Well-established basic scientists with national and even international reputations, namely, Tatum, Meek, Loevenhart, and Seevers, carried out extensive cooperative studies with this young an fledgling medical discipline. Waters' intellectual curiosity and his modesty enabled him to work successfully with many of the most eminent basic scientists of this great university. An exhibit prepared by Dr. Waters and co-workers describing a department of anesthesiology, showed the edifice built on the basic sciences, particularly pharmacology, physiology, and anatomy.

In this present time of intense competition for recognition, academic promotion, and the pursuit of research grants, there is perhaps a lesson to be learned from history, namely that dedication to the pursuit of medical knowledge is its own reward and that recognition by colleagues and the learned community will follow in due course. In any case, this precept seemed to work for Ralph Waters. A tribute by Dr. Geoffrey Kaye of Melbourne captures some of the unique attributes of Waters' Department in the following quotation (cited in [12]):

> I could begin by describing the atmosphere of activity and enthusiasm in Madison, the close cooperation between the Department of Anesthesia and the basic science laboratories, the pleasantly informal atmosphere which is yet compatible with true scientific discipline.

He goes on to comment that the above would be true of other departments in the United States, but that the situation at Madison reflects the personality of one man. Again I quote [12]: "The salient characteristic of Ralph Waters is his uncompromising scientific honesty."

Perhaps the less complicated, slower-paced life of this early period made virtue easier, in contrast to the multiple hospitals, large facilities, and institutional pressures of today. Nonetheless, the advancement of anesthesiology still depends upon anesthesiologists dedicated to "uncompromising scientific honesty" and the modest humility to work cooperatively with our scientific colleagues in the discovery and elucidation of new medical knowledge for our specialty.

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4.4 The Edinburgh Contribution

Alastair H. B. Masson

It is time to pay adequate tribute to those in Edinburgh who contributed so much to the development of the specialty of anaesthesia in the years following World War II. In particular, there was John Gillies – kindly, modest, good humoured, friendly – a gentle man who built up an embryonic department into one which had a considerable influence on anaesthesia in the United Kingdom and beyond. In his time, eight future professors passed through the Department – Vandewater, A. Gillies, Green, Robertson, Robson, Payne, McDowell and Millar. But John Gillies' influence and wise counsel were even more far reaching in medicopolitical and educational spheres, for he occupied a key post at a crucial time. He was elected Vice President of the Association of Anaesthetists of Great Britain and Ireland – the main body representing the anaesthetists in the United Kingdom – in 1946, and in the following year he became its President.

After the war, the shape of anaesthesia in the United Kingdom was determined by the National Health Service, which came into being in 1948. Of all the many important events of that most eventful time, two were of outstanding significance, for they were responsible for attracting men of ability and ambition and for raising the standards of entry into the specialty. The first was the decision that, in the new National Health Service (NHS), anaesthetists would be regarded as equal to other specialists in status and remuneration. The second was the agreement that a high academic standard would be mandatory for those entering the specialty. For these two far-reaching innovations we all owe a great debt of gratitude to John Gillies and to the members of the Council of the Association. The Faculty of Anaesthetists came into being as a direct result of negotiations between the Association, led by John Gillies, and representatives of the Royal College of Surgeons of England.

Among the talented young men who came to work in Edinburgh was Harold Griffith – universally known as "Griff" – an original thinker, a much loved and inspiring teacher and clinician extraordinary, whose practice and teaching were always based on careful observation and sound physiological principles. It was he who was responsible for one of the major clinical developments which marked the great divide between anaesthesia as it had been practised for the first half of the twentieth century and anaesthesia of the modern era. This was controlled hypotension, which was the second important form of "physiological trespass" (to use the felicitous expression coined by John Gillies), the other, introduced at about the same time, being control of respiration.

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When Dr. Griffith came to Edinburgh he worked with a brilliant though difficult, demanding and domineering surgeon, Prof. James (later Sir James) Learmonth, who was, at the time, interested in the surgical management of hypertension by thoracolumbar sympathectomy. This operation was made difficult by bleeding, and Learmonth insisted that the standard anaesthesia was not acceptable. After trying chloroform, with only a limited improvement in operating conditions, Griff turned to spinal anaesthesia, having observed in his army practice that bleeding was much reduced with spinals.

This introduction was immediately highly successful from the surgical point of view; there was virtually no bleeding, and although the blood pressure fell to very low, sometimes unrecordable, levels, the patients were warm and pink and otherwise well. Griffith then found that the fall in blood pressure was in two stages. There was an initial fall to about 60–80 mmHg (systolic) following the subarachnoid injection, but a further significant fall took place with posture when the patient was put in the lateral jackknife position. He also stressed the importance of maintaining spontaneous respiration, partly because he observed that intermittent positive-pressure ventilation (IPPV) tended to lower the blood pressure still further, but also because spontaneous respiration provided a valuable indication of a cerebral circulation. Over 800 operations were carried out with this technique on patients with severe hypertension in the years 1948 to 1952, and things reached the stage that, if there was any bleeding *at all* following the lengthy initial incision, Professor Learmonth would put down his scalpel and walk away saying, "I will return when the patient is asleep." The technique was refined with experience and led to the introduction of the ganglion-blocking drugs. It remains a landmark in the history of the specialty.

Following the pioneering work in the Copenhagen poliomyelitis epidemic in 1952, interest in further therapeutic applications of IPPV was stimulated in Edinburgh, as elsewhere. The particular contribution made in Edinburgh (in which Dr. Griffith again played a major part) was in the treatment of crush injuries of the chest, which were being treated by IPPV elsewhere but with varying degrees of success. Griffith analysed the results of the treatment of such patients admitted to Edinburgh Royal Infirmary and clearly laid down the principles of rational therapy based on his own observations of patients treated by himself and his colleagues.

The difficulties which faced the anaesthetists were formidable. There was considerable opposition to the idea that anaesthetists were capable of actually treating patients, let alone that they could improve on existing surgical methods of therapy. In consequence, patients were handed over reluctantly and often belatedly, when their condition had deteriorated. Nursing was not easy, for nurses had to be taught new skills and techniques. These skills were usually lost at the conclusion of each case, since patients were treated in the wards to which they had been admitted. In fact, it was this problem which led to the establishment in 1960 of the Assisted Ventilation Unit in Edinburgh Royal Infirmary, the second such unit in the United Kingdom. A situation arose when two patients in different wards required ventilation. The resources of neither the Anaesthetic Department nor the nursing staff would stretch to cover two different wards simultaneously, and so the two patients were brought together in Ward 19, a small ward which had until then been kept solely for the treatment of medical students.

Machines were crude, unsophisticated and unreliable. We used the ventilator designed by Professor Pask of Newcastle. The controls were clumsy (gate clips adjusted the gas flow along the rubber tubes), and it was not easy to maintain steady ventilation volumes. Monitoring of patients was simple and in the main clinical. Blood gases, for instance, were measured relatively infrequently. Intra-arterial and central venous pressure (CVP) lines and electronic gadgetry were in the future.

Despite the difficulties, good results were obtained, and this new role for anaesthetists became accepted. In the preventilation era, of 38 patients admitted with severe chest injuries, only 9 (24%) survived. Between 1961 and 1965, of 64 patients admitted, 54 (84%) survived. It is interesting to compare this rate with the last 64 such patients admitted between 1977 and 1981. They had exactly the same survival rate (84%), despite all the paraphernalia and expertise of a modern intensive care unit.

I am happy to have the opportunity of paying my own small tribute to the pioneers, and in particular to Griffith and Gillies, who helped to change the face of anaesthesia. Their influence on the practice of the specialty was enormous, but perhaps even more important in the long run was the inspiration they provided in their teaching to generations of students. We will not forget them.

4.5 The Yorkshire Society of Anaesthetists, Its Postwar Birth and Development

W. D. A. Smith

Dinnick described the first Society of Anaesthetists, founded in 1893 "... to encourage the study of anaesthetics, and to promote and encourage friendly relations among its members ... by ... debates, discussions ... and short papers" [1]. He identified anaesthetic mortality, and, because specialist anaesthetists were few, the anaesthetic education of medical students as the important contemporary issues. That Society became the Anaesthetics Section of the Royal Society of Medicine, in London. It begat the Association of Anaesthetists of Great Britain and Ireland, which begat the Faculty of Anaesthetists in the Royal College of Surgeons in 1948.

The inaugural meeting of the Yorkshire Society of Anaesthetists (Y.S.A.) was held in November 1947. Its Rule 2 aimed "to promote fellowship, mutual help and scientific advancement in the subject, and to make recommendations when necessary for the furtherance of the work of anaesthetists." The phrasing was probably influenced by Dr. Harbord, who had just been appointed Reader in Anaesthetics at Leeds. He had come from Liverpool. Rule 2 of the Liverpool Society of Anaesthetists, dated 1930, reads:

> The objects and aims of the Society are to promote among the members thereof fellowship, mutual help, encouragement, cooperation, professional discussion and scientific advance; to formulate organized policy and make recommendations for the furtherance of the work of specialist anaesthetists.

This seems to reflect the concern about the status and organization of the discipline of anaesthesia which, as Helliwell has recalled [2], motivated the establishment of the Association of Anaesthetists in 1932. By November 1947, many doctors had returned from the war, but specialist anaesthetists still tended to be general practitioners. The National Health Service was 7 months away and the examination of the Faculty of Anaesthetists and the Faculty's criteria for hospital recognition were in the future.

In May 1946, the anaesthetists at the Leeds General Infirmary had formed themselves into a committee, and they proposed revival of the Anaesthetic Club. Dr. Lawrence undertook its organization. He has recalled (R.C. Lawrence, personal communication): "Sykes and I did some work on Helium [see ref. 3] ... and we had one or two drab meetings. Then ... war came and we joined up". I wonder whether the Anaesthetic Club received inspiration from the Leeds Medical Sciences Club. It also lapsed during the war, and four anaesthetists joined it in 1947.

Anaesthetic education and mortality were still vital issues. In August 1946, this Committee of Anaesthetists submitted a memorandum on undergraduate teaching.

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The Infirmary Faculty responded by recommending the appointment of a professor or reader in anaesthetics. The University of Leeds appointed Harbord. He and Lawrence were immediately made joint secretaries of the Anaesthetic Club, but the inaugural meeting held was that of the Y.S.A. A Committee Minute of October 1947 noted that there had been six deaths in 6 months, four in children; that the attendance of residents at lists done by visiting staff was said to be unsatisfactory; and that a second senior resident was to be requested. Dr. Lawrence has since confirmed (R.C. Lawrence, personal communication) that "... the resident anaesthetists were grossly overworked".

Both residents and visiting anaesthetists lacked today's postgraduate educational facilities. Only three members of the Committee of Anaesthetists belonged to the Anaesthetics Section of the Royal Society of Medicine of London, which was the main anaesthetic forum. As expressed by Dr. Mackintosh, another founder of the Y.S.A.: "Coming back from the war we felt we had a lot to learn. We wanted experts to come to talk to us and expand our knowledge; for example we wanted to know more about curare" (F.G. Mackintosh, personal communication). Curare was the subject of Dr. Jean Hall's address to the inaugural meeting. She had visited Liverpool, where Professor Gray had demonstrated its use.

Since then, many Minutes have accumulated. Meetings were held in Leeds, at first quarterly. From 1950, additional meetings, at which members presented short papers, were designated "clinical". The designation was dropped after 1958, although meetings with this format continued. Recently the Leeds University Department of Anaesthesia has been allocated the January meeting. Annual all-day meetings at hospitals other than the Leeds Infirmary began in 1954. Sometimes they included a few commercial exhibits. By 1976, these had become formal trade exhibitions. Symbiosis between trade and the Society has helped to combat rising costs.

In the 35 years up to 1982 many distinguished speakers addressed the Society. Some departments of anaesthesia organized symposia. In 1957, a committee of the Y.S.A. initiated its own investigation, which culminated in a published report on training in dental anaesthesia [4]. Between 1953 and 1964, parties of Y.S.A. members visited Amsterdam, Paris, Copenhagen, Utrecht, Leiden, Brussels and Uppsala.

Occasionally minutes have noted poor attendance at meetings, for example, in 1967 the Honorary Secretary reported, "... many trainees do not attend ... Perhaps the explosion in postgraduate education in Leeds has led to this particular aspect of the Society's decline ... trainees have ... choice of many lectures." A previous Y.S.A. Committee Minute of July 1964, and its sequel, relate: "The Dean of Postgraduate Education had asked if the Y.S.A. could assist in organizing lectures to junior anaesthetists ... it was agreed that the committee was not empowered to commit the Society ... in this matter." At this point Professor Nunn came to Leeds. By January 1965, there were two postgraduate courses in anaesthesia.

The Y.S.A. was founded for specialist anaesthetists. Trainees attended meetings only as guests, although by 1950 it was suggested that attendance of registrars and residents might be encouraged. In 1948, the membership was 30. In ten years it doubled. From 1960, trainees were admitted as Associate Members at reduced subscription. By 1968, the total membership (Full plus Associate members) was 110, and it has continued to rise. There is no evidence of any decline here, although in the 1970s interest in the once-popular annual dinner-dance waned, and the last was held in 1978. Meanwhile a Newsletter came to life, and it has survived for 5 years. The latest issue (at the time of writing) advertises six regular meetings at the Leeds General Infirmary, an all-day meeting at Huddersfield, and, looking into the near future, a Charles Waterton Bicentenary Meeting to be held at Walton Hall in June 1982.

Acknowledgements. I would like to thank the following founders of the Yorkshire Society of Anaesthetists for the information imparted to me: Dr. Gwendolen Harrison, Dr. R. C. Lawrence, Dr. Jean Hall, Dr. A. T. Hawthorne and Dr. F. G. Mackintosh, who preserved the original Minutes of the Leeds General Infirmary Committee of Anaesthetists. Dr. Anne M. Florence kindly arranged my access to the Minutes of the Liverpool Society of Anaesthetists.

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4.6 Review of Modern Anaesthesia in South Africa

H. Grant-Whyte

H. Grant-Whyte

Modern anaesthesia in South Africa goes back to the year 1847, when Dr. Guybon Atherstone, assisted by his father (also a doctor), amputated the gangrenous leg of the Deputy Sheriff of Grahamstown, a village then 3 months away by ox waggon, the only form of transport, from Cape Town. This was but 8 months after Morton first administered ether in Boston, in the United States. Atherstone produced his ether from sulphuric acid and alcohol and administered it by means of a "hubble-bubble" type of apparatus he had constructed, which resembled a Turkish narghile.

Up until 1936 "splash" ether and "drip" chloroform administered by rag and bottle were almost universal techniques in South Africa. Nitrous oxide, because of its high cost of importation, was used but infrequently, and then only in one or two of the larger centres. However, this was radically changed by contact over the years with eminent anaesthesiologists, among whom were Frank McMechan, Ralph Waters, Harold Griffith, Wesley Bourne, Harry Shields, John Lundy, Isabella Herb, E.A. Rovenstine, Fred Clement, Sir Robert Macintosh, Arthur Guedel, Sir Ivan Magill, Sir Geoffrey Organe and Harry Churchill-Davidson. As the result of their guidance, new agents and techniques were rapidly adopted. Thus today the standards of anaesthesia in South Africa compare favourably with those anywhere in the world.

There are at present six medical faculties in South Africa where training is given in anaesthesia, including postgraduate training in this field. Furthermore, anaesthesia congresses are held, and continuing education in anaesthesia is available. Nevertheless, there is a shortage of anaesthetists, especially in the rural areas. A mere 500 specialist anaesthetists are registered. Anaesthesia in South Africa, however, suffers from limitations, common throughout the rest of the world, in that there has still not been discovered any anaesthetic agent or drug which can be regarded as completely safe and efficacious, no matter what claims are made for it. There is also no piece of apparatus upon which total dependence can be placed.

There is no doubt that important changes are necessary to safeguard patients from iatrogenesis, which may be superimposed on environmental and industrial poisoning, self-poisoning from the use and abuse of drugs etc. In this regard the main trouble

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springs from one or more of a number of factors. Sometimes prescribed drugs are to blame, resulting in serious alteration of the autonomic nervous system, the central nervous system and the cardiovascular system, as well as cardiodynamics, and other vital organs of the body. Then, there are non-prescription drugs, sold in cartloads in pharmacies and supermarkets and producing adverse reactions, such as the nephrotoxic action of phenacetin and gastrointestinal haemorrhage from aspirin. Perhaps alcohol, which can destroy both body and mind, should fall within this category. To all these must be added drugs of illegal abuse, e.g. psychedelics, the barbiturates and the sniffing drugs. Any one of these, or a combination of two or more, can produce serious psychosomatic problems for the anaesthetist before, during and after anaesthesia.

There are those in South Africa who view the future of anaesthesia in this country, as elsewhere, with some alarm. The present-day pollution of the human body (internal and external), as a result of polypharmacy, self-medication, the use of alcohol and tobacco, and the licit and illicit use of drugs, gives cause for concern. It is therefore recommended that before anaesthesia is administered for elective surgery, detoxification of the patient should take place. Furthermore, judicious selection of preanaesthetic drugs, anaesthetic agents and postoperative medication must all be carefully considered, as must the posture of the patient, preoperatively, during surgery and postoperatively – all this with the history of the patient in mind.

I fear that sometimes the posture of the patient receives inadequate attention, although today it is more important than ever, because surgeons tend to take their time, under the flattering but erroneous impression that anaesthesia in "our skilful hands is innocuous." Operative facility is vitally important. Nevertheless, it should not be attained at the cost of injuring a patient rendered far more prone to such injury by virtue of being unconscious.

Particular care must be taken of the cervical column, not only on the operating table but also in moving patients from the table to the stretcher and from the stretcher to the ward bed. Use of specifically trained personnel is necessary, but is by no means always available. This has resulted in a number of patient deaths and also in litigation.

The preoperative reassurance of the patient is of paramount importance – in short, the exercise of humanism. This can cut down the use of tranquillizers, another source of pollution. In my view, the monitoring of patients during anaesthesia and afterwards – not only during hospitalization but after discharge – to ascertain possible after-effects is too often neglected. I also consider that too much reliance is sometimes placed on the extrapolation of results of experiments on relatively unpolluted animals to polluted humans in determining the effects and bioavailability of drugs. Anaesthetic journals overflow with articles on drug action on animals, and too often the results are applied unthinkingly to humans. There is a tendency in certain quarters for anaesthesia to become too impersonal, as the God-given senses of touch, vision, hearing, even smell and taste, are replaced by instruments which, unfortunately, do not fail safe.

The world medical and anaesthetic journals are freely available in South Africa and are often very helpful. They should, however, refrain from publishing sensational articles lauding and advocating the use of "wonder drugs" and techniques which have in some cases been subjected to inadequate clinical testing and whose adverse reactions and dangers are not reported. All too often the media, which has free access to medical journals, report sensationally on so-called medical breakthroughs with no mention of many of the facts and a total absence of clinical statistics, thereby encouraging the public to demand the unproved and often the unattainable.

I believe that in South Africa, as elsewhere, more use should be made of regional anaesthesia and less of inhalation techniques. The latter are always problematical on account of pollution of the human body and brain, the results being exacerbated when surgeons demand extended periods of general anaesthesia with profound central nervous system depression, which can, without question, cause intractable damage to both psyche and soma, especially in the elderly and the very young. In combating pain and at the same time avoiding pollution by analgesics, it is to be hoped that attention will be paid to the secretion of beta endorphins by the brain and to the possible use of acupuncture. There can be no doubt of the advantage of having unpolluted patients. It removes a most worrying source of uncertainty, which plagues the anaesthetist.

In all branches of medicine it is only too easy to do harm inadvertently, to make the patient worse rather than better. With every medical advance, whether it be in pharmacology or surgery or anaesthesia, there arise new dangers, as well as new benefits, and it is essential that adequate steps be taken to avoid the former in order that we may benefit fully from the latter. I therefore consider that proper investigation and the training of doctors, dentists and nurses specifically in iatrogenesis is essential, in the best interests of our patients. I should therefore like to close with a plea that chairs in iatrogenesis be established in all medical faculties so that we, as a profession, may avoid doing harm and contribute to the greater good.

Let us anaesthetists not add more fuel to the fire which is keeping the iatrogenic pot boiling, by irrational and injudious polypharmacy, and use what my friend of long ago, Fred Clement, advocated, namely the "KISS" technique (Keep it simple, stupid.)

Finally I would like to conclude by quoting a tribute to anaesthesia, written by my late wife, Denoon Grant-Whyte, in 1955:

Anaesthesia Hail.
The soul's and mind's dear ease,
Brief respite from travail,
From pain, all peace.
Slumber sweet and dreamless, heavenly calm,
Release from this our wilderness,
Fleeting entrance into nothingness,
Perfect Balm.
Rest, dear heart, awhile.
Impenetrable veil,
Life is with you still,
Anaesthesia Hail.

4.7 The Impact of the Introduction of Curare in Australia

G. Wilson

Australia is a long way from anywhere, and it is a very big country. Not only did modern anaesthesia have to spread *to* Australia; it had to spread *around* Australia. Thus the spread of modern anaesthesia to my country can be conveniently summed up in one word – travel: Travel by the early specialist anaesthetists in the decade from 1930 to 1940; travel by medical officers of the armed forces in World War II; travel to Australia by a number of distinguished anaesthetists from other countries; and, during the last few decades, when the specialty has been appropriately recognized and renumerated, travel by Australian anaesthetists, not only for training in specific subjects relative to anaesthesia, but to all the international meetings of their colleagues.

The journeys of the early specialists were of particular importance, and it is of significance that they came from several states of the large continent – New South Wales, Victoria, South Australia and Western Australia. Dr. Daly and Dr. Hatten of New South Wales, Dr. Brown of South Australia, Dr. Kaye of Victoria and Dr. Troup of Western Australia all made extensive tours overseas in the early 1930s. During these tours, which for the most part lasted a year or more, they met, talked with and observed the work of all the noted anaesthetists of their time.

Upon their return they introduced techniques, agents and apparatus they had seen in daily use in Germany, the United Kingdom, Canada and the United States, and interest in and recruitment to the specialty began to be apparent in their particular states. It was our good fortune that Drs. Daly, Brown and Kaye were inveterate correspondents and maintained the friendships thus made; the introduction of curare into anaesthesia in Australia is an example of the results of these travels.

Curare was first used in anaesthesia in Australia by Dr. Harry Daly (Fig. 1), assisted by Dr. Stuart Marshall, on 11 August 1945 at St. Vincent's Hospital, Sydney. Daly had met and later continued to correspond with Dr. Harold Griffith of Montreal. When Dr. Lewis Wright (former Anaesthesiology Consultant to E. R. Squibb & Sons and one of the catalysts in the introduction of curare into anaesthesia) became Commander Wright of the United States Navy during World War II, he came to Sydney in late 1942. He carried with him first-hand knowledge of Harold Griffith's success with curare in anaesthesia earlier that year, some ampoules of Intocostrin, and an introduction from Harold Griffith to Harry Daly.

At that time the specialty of anaesthesia in Australia was tottering in its infancy, and surgeons were wary of new techniques; thus Daly was forced to carry his intocostrin about for nearly 3 years, receiving rebuffs to his suggestions that it should be

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Fig. 1. Dr. Harry J. Daly, who first used curare in anaesthesia in Australia at St. Vincent's Hospital on 11 August 1945

employed. Eventually, as befits the early history of anaesthesia, it was the Honorary Dental Surgeon to St. Vincent's Hospital, Mr. Frank Canberry, who approved of its use in an especially difficult case. He was delighted with the result, and lost no time in spreading the news along the surgical grapevine; thus arousing the curiosity and interests of surgeons at St. Vincent's and other hospitals.

The introduction of curare was, I think, the beginning of real acceptance of the specialty of anaesthesia in Australia. It separated the general practitioner anaesthetist and the specialist in a way which not even the use of the gas machines by the specialists had been able to do. It was of real benefit to a surgeon in the course of operation, as well as to his patients postoperatively. Beside these benefits, the wish of a referring general practitioner to administer the anaesthetic personally could no longer be of such importance.

It will be recalled that the early specialists were spread widely over the map of Australia. Regular communication between them came about as a result of the travelling done by Dr. Geoffrey Kaye of Melbourne, between 1929 and 1931. Dr. Kaye, a recent graduate (1926), but already with a special interest in anaesthetics, made an extensive journey to observe anaesthetics and meet anaesthetists. In the

United States he met Dr. Francis Hoffer McMechan, at that time editor of the *Anaesthesiology Supplement* of the *American Medical Journal.* In this capacity McMechan knew the publications of Gilbert Brown of South Australia and he urged Kaye to write to Brown suggesting the formation of an Australian Society of Anaesthetists.

At that time the only medical meeting of any dimension in Australia was that held every 5 years by the Australian Branch of the British Medical Association. Papers on anaesthesia were read either in the Section of Surgery or the Section of Medicine. After much correspondence with the organizers, Brown managed to have a Section of Anaesthetics included in the 1929 meeting held in Sydney. To his credit, McMechan attended this historic meeting, though crippled with arthritis and in a wheelchair. His papers created enthusiasm and inspired discussions, and were, for most members of the Section, their first personal contact with a wider world of anaesthesia.

At the next meeting of the Section, in 1934 in Tasmania, over drinks at the end of the day at Hadley's Hotel, it was decided to form the Australian Society of Anaesthetists. Dr. Gilbert Brown was elected as its first President, Dr. Kaye (Fig. 2), the first Secretary, arranged for the first meeting to be held in Melbourne in 1935. There was, of course, no passenger air transport, and so the founding members made long journeys by rail and by sea. Dr. Zebulon Mennell, then President of the Association of Anaesthetists of Great Britain and Ireland, came all the way from England for this auspicious occasion.

Fig. 2. Dr. Geoffrey Kaye, first secretary of the Australian Society of Anaesthetists and founder of the Geoffrey Kays museum of the Faculty of Anaesthetists receives the Orton Award for meritorious services to anaesthesia in Australia from the Dean of the Faculty, Professor Teresa Brophy, on 1 June 1974

Communication between the few individuals in the various states with a special interest in anaesthesia was now established and was maintained not only by the Annual Meetings held in the various states, but by the Newsletters sent out monthly by Dr. Kaye. The Society began to grow. With the travels of the founding members and the formation of the Society there was an upsurge of interest in the new specialty, and what might be called the second wave of enthusiasts departed for training in the United Kingdom and the United States. These anaesthetists were now able to obtain the Diploma in Anaesthetics newly instituted by the Association of Anaesthetists of Great Britain and Ireland (AAGBI), and on their return, together with the founders, they formed a nucleus of teachers of new and up-to-date methods.

Then came World War II. Interested medical officers in the armed forces were sent to England to attend the courses instituted by Sir Robert Macintosh at the Nuffield Department in Oxford. Most became specialists in anaesthesia in Australia when they returned after the war. Meanwhile, the anaesthetists who perforce remained at home were not idle. There were few of them, and their services were thinly spread over many hospitals. Interns at the hospitals were also depleted, and those remaining gave large numbers of anaesthetics. Many of them, like myself, developed an interest in specializing and a thirst for further knowledge of our subject. Thus the Post-graduate Committee in Medicine at the University of Sydney instituted a diploma in anaesthetics in 1944. The tutors in the course were those who had had overseas training, and so modern methods reached an ever-widening group of intending specialists.

When meetings of the Australian Society were resumed after the war, a problem had arisen. Melbourne University in Victoria had instituted a diploma in anaesthetics, and the Adelaide University in South Australia proposed to follow suit. Standards of training and examinations varied greatly from state to state, and it was felt that an Australia-wide standard must be inaugurated and maintained. It was considered that the newly founded Faculty of Anaesthetists of the Royal College of Surgeons of England could serve as a model for solving this problem. Dr. Daly, who journeyed to England in 1949 and had discussions with the College and Faculty, became convinced that this was so. On his return, the wheels were set in motion; an approach was made to the Royal Australasian College of Surgeons, and the Faculty of Anaesthetists within the College was inaugurated in 1952. During the early postwar years more intending specialists journeyed to the United Kingdom, either to obtain the English diploma or to work at Oxford in Professor Macintosh's postgraduate school, or both.

In 1951 Professor Macintosh paid us an informal visit. He was, of course, personally known to many, and to many more through the work of the Nuffield Department. He attended the Annual Meeting of the Society and lectured at a number of hospitals. Such was the stimulus of this visit throughout Australia that the South Australian Section, prompted by Dr. Mary Burnell, proposed to the Society that an annual overseas visitor be invited, who whould visit all the States and be present at the Annual General Meeting of the Society. A number of distinguished anaesthetistis in this audience have been such guest of the Society, and one can only hope that the obvious enthusiasm and stimulation aroused by their visits has outweighed their undoubted exhaustion at the end of thousands of miles of travel.

As a graceful gesture from the American Society of Anesthesiologists (ASA) to the newly founded Faculty, the first such visitor was Dr. Bernard Johnson, then Dean of the English Faculty. If anything was required to establish the principle of the overseas visitor, it was the success of the Annual General Meeting in Adelaide South Australia in 1953, which Dr. Johnson attended. An unexpected participant at the meeting was Dr. Virginia Apgar of New York, who was then touring Australia. If Apgar and Johnson had one common idea about the practice of anaesthesia, it was not obvious. Their differences were thrashed out in lively discussions, which were not only hilarious and edifying, but thought provoking for any insular Australian.

Not only have the Australian anaesthetists learned much from discussions with their overseas visitors, but liaisons have been established which have led to places in the visitors home departments for Australians wishing to make special studies.

Inauguration of the Faculty and examinations for its Fellowship meant the inception at many hospitals of departments of anaesthesia with a director and training posts for registrars. However, the universities have been slow to establish full professorial chairs in Anaesthetics. Through the generosity of Lord Nuffield, the first was established at Sydney University in 1962 with Prof. Douglas Joseph as the first incumbent. The only other one, in our large country, is at Flinders University in South Australia, where Prof. Michael Cousins is doing remarkable work with a lively young team.

Though recognition by the universities has been inadequate, anaesthetists and their organizations have high status among specialties and hospitals. Anaesthetists in Australia are travelling, teaching, writing for their Society's journal, which has worldwide circulation, and acting as members of a broad spectrum of committees with an influence so sagely envisaged and striven for by our early pioneers of modern anaesthesia.

4.8 History of Modern Anesthesia in Japan

H. Yamamura

H. Yamamura

Japan has a very long history of anesthesia. In 1805 a surgeon Seishu Hanaoka [1], used general anesthesia for the operation of breast cancer. He administered orally tsusensan, which was an extract of six medicinal plants. In 1850, Dr. Sugita [2], described various inhalors and vaporizers of ether or chloroform by making drawings of them. Five years later, in 1855 he used ether anesthesia for the operation of breast cancer. That was 9 years after Morton's demonstration of ether anesthesia in Boston, Massachusetts. In 1857, chloroform was introduced by the Dutch Dr. Pompe van Meerdervoort. There is a report that Dr. Hepburn [3], an American, used chloroform for the amputation of a leg belonging to Mr. Sawamura, a very famous actor of Kabuki, in 1867. In 1880, Dr. Roetz, an Austrian, gave chloroform with a mask to a patient for amputation of the left upper extremity [3]. There were very simple inhalors and vaporizers at that time, and the Roth–Dräger anesthesia machine was imported from Germany.

Until 1900, inhalation anesthesia with chloroform or ether was universally used. From 1900, spinal anesthesia was introduced, replacing some techniques of general anesthesia. According to one report [4] in 1914 of 582 instances of general anesthesia, 512 were with chloroform and 70 with ether. In 1922, it was reported that of 8542 operations 32% were done under spinal anesthesia [5].

I graduated from the Tokyo University School of Medicine in 1943 and entered a surgical department. At that time, lower abdominal surgery and other operations in the lower part of the body were done under spinal anesthesia. Upper abdominal surgery was done under either spinal anesthesia or local anesthesia with heavy premedication. Neck surgery and brain surgery were done under local anesthesia. If general anesthesia was necessary, ether was used by open drop method or by insufflation. There was no anesthetist, and surgeons were administering anesthesia. Everything was under the control of the professor of surgery.

In 1950, under the suspices of the Unitarian Service Committee, a joint meeting of American and Japanese medical educators was held in Japan. Dr. Meyer Saklad, who was the Chief Anesthesiologist of Rhode Island Hospital at that time, took charge of the Section of Anesthesiology. He delivered lectures on the pharmacology of anesthe-

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tics, inhalation anesthesia, endotracheal anesthesia, spinal anesthesia, and oxygen therapy. He stressed that anesthesiology covers clinical physiology and clinical pharmacology as well. Thus he greatly contributed by enabling the leading Japanese surgeons to appreciate the importance of anesthesia and also by stimulating interest in anesthesiology among young doctors.

Professor Shimizu, who was Professor of Surgery in Tokyo University at that time, thought that for the development of surgery it was essential to train anesthetists. He insisted on the establishment of an anesthesia department, and in 1952 the Department of Anesthesiology was established at Tokyo University. This was the first department of anesthesia in Japan and I was appointed the Associate Professor. By that time I had been studying general surgery for 9 years, and now I was sent to the United States to learn anesthesia. When I came back to Japan, there were only four positions in my department: one associate professor and three residents. My work was restricted to anaesthesia for patients of general surgery. I trained many young surgeons as well as my residents in anesthesia.

In 1954 the importance of anesthesiology was gradually being recognized by surgeons, and the time of establishing a anesthesia society had arrived. The Japan Society of Anesthesiology was established. The founder members included myself, but most of them were surgeons. In the same year the first general meeting was held in Tokyo. About 80 papers were presented, and 700 doctors attended the meeting. However, until 1960 anesthesia was not recognized as an independent medical specialty; thus we were not permitted to function as specialists.

In 1960, our Society became a member of the World Federation of Societies of Anaesthesiologists (WFSA) and as a representative of our Society, I attended the Second World Congress of Anaesthesiologists which was held in Toronto. In the same year anesthesia was added to the list of clinical specialties approved by the government and henceforth, we were allowed legally to advertise as anesthetists. It was decided that those who want to so advertise must satisfy certain qualifications before they are entitled to be called Registered Anesthetist *(Hyo-bo-i* in Japanese).

The minimum requirement for qualification as a registered anesthetist was: (1) medical doctor with more than 2 years' full-time training in anesthesia under an approved instructor at an approved hospital; (2) medical doctor who had experience of more than 300 cases of general anesthesia using gas machine, over 2 years; (3) medical doctor who was recognized as an anesthetist abroad. The second requirement is very lenient from the standpoint of the present level of anesthesia. However, the time when this was decided was the very beginning of modern anesthesia in our country and not as many doctors were giving anesthesia, even at the fairly large hospitals. By the end of 1981 there were 5754 registered anesthetists. Although this registration was a big step for the development of anesthesia in our country, a large number of registered anesthetists are surgeons who are practicing anesthesia as a part time or who have experienced anesthesia practice but no longer practice.

Meanwhile, we had to make provision for approving instructors, as written into the requirement for registration. In 1962, we thus established the Diplomate system of the Board of the Japan Society of Anesthesiology. This was the first board-certified system in medicine in Japan. To become a diplomate, the applicant should have at least 5 years, full-time training and must pass written, oral, and practical examinations conducted by the Board of the Society. About 30% of applicants fail the examination.

The number of diplomates are 806 at the present time. Most of them are working in teaching hospitals. They are taking a most active part in promoting anesthesia in our country.

It has been suggested that the position of nurse-anesthetist should be introduced in Japan. However, we are not going to train nurse-anesthetists. The objections are medicolegal, economic, or on the ground of maintaining standards. It is our policy that to take care of the patient during operation is a doctor's responsibility.

In spite of the great progress of anesthesia in Japan, we are still suffering from a shortage of anesthetists. At present, there are 1169 anesthetists, which corresponds to 1.1 anesthetist per 100000 population. Registered anesthetists are not necessarilly full time and some are not practicing anesthesia at all. However, if this number is included, there are 4.5 anesthetists per 100000 population in our country. On the other hand, the number of anesthetists in Australia, the United States, Canada, the United Kingdom, and New Zealand are 9.23, 5.30, 6.04, 6.41, and 5.40 per 100000 population, respectively. When these data are compared with ours, the anesthesia manpower of our country is far less than in other developed countries.

Anesthetists tend to practice in the larger communities where there are medical schools and large hospitals. They are working on a salary basis without the privilege of having private cases. In Japan it is difficult to do private practice in anesthesia because it is not permitted to charge the cost of anesthesia separately from the costs of operation. In this system the doctor's fee is not separated from the hospital fee but is included in it. Therefore, a medical fee is payed to the hospital from the Insurance Fund. If an anesthetist goes to the hospital and gives anesthesia to the patient, he should receive the money from the hospital. He cannot receive money directly from the patient or from the Insurance Fund. This limits the growth in popularity of private or group-practice anesthesia in Japan. We are now trying to amend such a regulation, and we are rather optimistic for the future of anesthesia in Japan.

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4.9 The Influence of Modern Anaesthesia of Other Countries on the Growth of Anaesthesia in Japan

A. Inamoto

Seishu Hanaoka's First General Anaesthesia in Japan (1805) and the Influence of Chinese Medicine

Under the title of the influence of modern anaesthesia of countries outside on the growth of anaesthesia in Japan, this first epidode may seem to be too classical, almost prehistoric, but I would like to start with the influence of ancient Chinese medicine, and Seishu Hanaoka's pioneering work in Japanese anaesthesia.

Japan was a closed nation for about 300 years during the Tokugawa Era, prior to the commencement of the Meiji Revolution in 1868. Seishu Hanaoka was born in 1760, at a time when international trade and intellectual exchange was forbidden by the government, and only one port, Nagasaki, was open for trade, between Japan and the Netherlands. The Dutch people who lived at this port taught Dutch language and medicine to Japanese interpreters. Thus Western medicine gradually spread amongst Japanese physicians through the Dutch language and literature. Seishu Hanaoka first learned Chinese medicine and then studied Dutch surgery. As a surgeon, he needed some form of anaesthesia for his surgery, but he could find no reference to anaesthesia in the Dutch literature of the time. Eventually he discovered Houa To's legendary method of anaesthesia in an ancient Chinese text. Houa To was a highly respected Chinese surgeon from the third century *A. D.* After 20 years of experimental trials with animals, Seishu succeeded in devising a new formula of Houa To's anaesthetic potion, which he named *tsusensan*. The active constituents were scopolamine, hyoscyamine, atropine from *Datura* or *Mandarake,* aconitine from *Aconitum,* and angelicotoxin from *Angelica.* Patients given this mixture by mouth gradually became unconscious from acute scopolamine-atropine intoxication, which persisted for many hours. It is said that he first tried the mixture on his mother and his wife, at their request, before administering it to patients. Using this technique he successfully performed over 150 mastectomies from 1805 onwards, mainly for malignant disease.

Seishu Hanaoka's method was, historically, the final appearance of oral anaesthesia in the Chinese tradition, and took place 40 years before the first demonstration of ether anaesthesia by Dr. Morton in Boston, Massachusetts, in 1846. This episode in the history of anaesthesia is portrayed on the wall of the Japanese room at the International College of Surgeons, in Chicago, in a large Japanese-style painting, depicting Seishu and his mother, anxiously watching over his wife, who is lying in a deep sleep after administration of *Tsusensan.*

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From the Meiji Revolution (1868) to the End of World War II (1945)

During this period, Western medicine had a considerable effect on Japanese physicians, who mainly followed the German school, both in medicine and in surgery. Regional anaesthesia was generally employed for adults, open drop ether and chloroform being reserved for paediatric surgery, and being administered by the surgeon or a nurse. Anaesthesia did not exist as a separate specialty. During World War II any development in the West could not reach Japan.

From 1945 to the Fifth World Congress of Anaesthesiologists, Held in Kyoto, Japan in 1972

Following the devastation of the war, it took almost 10 years to restore medical facilities and to catch up with developments in the West, during which time the importance of skilled anaesthesia to the advancement of major thoracic and abdominal surgery became apparent.

In this early period of restoration, the major influence on medicine in Japan came from the United States. During their visit in 1950, the late Dr. Meyer Saklad and his group introduced modern American medicine and surgery, and particularly emphasized the progress made in anaesthesiology. Stimulated by this visit, hundreds of young Japanese physicians took resident posts in various teaching hospitals throughout the United States, received training in anaesthesia, and returned to establish anaesthesia training centres throughout Japan. This meant that before the establishment of training programmes in Japan almost all the staff of the university departments of anaesthesia had been primarily educated in the United States. In the meantime, the World Health Organization Copenhagen Anaesthesia Training Centre also accepted one trainee annually from Japan for a period of 11 years. At present there are over 80 professors of anaesthesia in Japan. Of the 72 who replied to a recent questionnaire, 36 trained for at least 1 year in the United States, 3 in Copenhagen, 1 in Germany, and 32 wholly in Japan.

Since 1950, many leading anaesthesiologists from the United States have lectured in Japan, encouraging the further development of Japanese anaesthesiology, including the late Drs. Rovenstine and Dripps, and Drs. Artusio, Foldes, Harmell, Orkin, Virtue, Vandam, Jenkins, Bonica, Dillon and others. Set against the overwhelming numbers of Americans, the two visits of Sir Robert Macintosh, in December 1959 and Spring 1967, made a lasting impression. In every hospital that he visited, he demonstrated practical techniques utilizing the (Ether–Mushin–Oxford) EMO Inhaler, the Oxford inflating bellows and non-return valve, and the so-called open-circuit ether-air-curare method. He emphasized "safety-first" and "simplicity" in anaesthesia, and the importance of life support in emergency, and its relevance to the skills of anaesthesia.

In the aforementioned questionnaire, the question, "Who, of the foreign anaesthesiologists which have visited Japan, has made the greatest impression on you?" received the following replies:

Sir Robert Macintosh (UK)	12
Dr. J.F. Nunn (UK)	9
Dr. James Eckenhoff (USA)	8
Late Dr. Meyer Saklad (USA)	7
Dr. Francis F. Foldes (USA)	5
Dr. Leroy D. Vandam (USA)	5
Dr. J.J. Bonica (USA)	3
Dr. J.W. Severinghaus (USA)	3
Dr. Raymond Fink (USA)	3

This shows that although his visits took place more than 15 years ago, the great impression made by Sir Robert Macintosh still remains. Accordingly, together with Dr. Francis Foldes and the late Dr. Rudolf Frey, he was elected to honorary membership of the Japan Society of Anesthesiology – the first foreigners to be honoured in this way.

The Fifth World Congress of Anaesthesiologists, Held in Kyoto, Japan in 1972

In 1968, at the time of the Fourth World Congress of Anaesthesiologists in London, the Japan Society of Anesthesiology was still at a developmental stage, there being only 300 consultant anaesthesiologists in Japan. However, at the Second General Assembly of the World Federation of Societies of Anaesthesiologists (WFSA) in London, it was unanimously decided that the Fifth World Congress should be held in Japan, and that the Japan Society of Anesthesiology should be the host. This was a great honour, but also a great responsibility, as we had little experience in handling such a major international event. As the Fourth Congress had been managed so excellently by the staff of the Association of Anaesthetists of Great Britain and Ireland, we sought their advice. Dr. Wakai visited Drs. Enderby, Howat and Woodsmith when he was in London in 1969, and received a great deal of valuable advice.

Professor Yamamura, the President, and the organizing committee chose the Kyoto International Conference Hall as the congress site, as only in this magnificient building could the various activities planned, including five scientific sessions, film presentations, round-table discussions, and trade exhibitions, be held simultaneously. This was considered to be of paramount importance by our advisors from the Fourth Congress. An interesting and varied social programme was also of importance, and Kyoto and its environs provided a window to Japanese art and culture, and also some wonderful scenery, including many notable Japanese gardens.

After many unexpected problems, particularly in fund raising, we finally completed the organization, and the Fifth World Congress of Anaesthesiologists was opened by Crown Prince Akihito and Princess Michiko at the Kyoto Conference Hall on 19 September 1972. Their attendance was a great honour and one of the highlights of the conference.

Ten symposia were held, under the management of different chairmen, in the two larger session halls over the 5 days, and four round-table discussions and 233 free papers were presented in other rooms. Over 2900 delegates and associates attended, from 61 countries, and the standard of the material presented was of the highest order, enabling Japanese attendants to listen to and discuss with some of the leading authorities in the field.

Looking back, it is clear that the main requisite of a successful congress is well-organized management; however, the importance of a high standard of academic content cannot be overstressed, particularly as it allows assessment of the level of achievement of the host society and its members. An interesting social programme is also of value and encourages the cultivation of international friendship and collaboration. Thus the Fifth World Congress provided a great stimulus and inspiration for the many young Japanese anaesthesiologists who attended and who will shape the development of the next chapter in the history of anaesthesia in Japan.

4.10 History of Modern Anesthesia in China

S. Yung

S. Yung

It is interesting to note that half a year after the first demonstration of ether anesthesia by Morton (1846), a sample of "sulphuric ether" was sent to China by J. M. Forbes of Russel & Co. Dr. P. Parker, a missionary doctor, administered the first ether anesthesia in this ancient country in 1847 [1]. (Parker later became the United States Minister to China.) In the next year (1848) chloroform anesthesia was reported [2].

As surgical treatment was new to the Chinese, missionary doctors were keen to perform operations to meet such interest; hence the use of anesthesia was inevitable. The missionary doctors were from the United States, Great Britain and some other foreign countries. They used ether as the main anesthetic, while chloroform was also used to some extent. The lower cost and stronger potency of chloroform were appraised. Except for really minor operations, general anesthesia was used on most occasions. Amazingly, the pharmacists played an important role in the administration of anesthetics. They were temporarily called out of the pharmacy, and all they had to do was to pour the anesthetic over the mask and watch until the patients pupils did not dilate. The use of general anesthesia was fairly frequent. There was a report of 10000 administrations of ether and chloroform anesthesia in the Taiwan area in 1913.

The first anesthetic death was reported by Layll in 1889. This was a child who died of chloroform anesthesia, and the cause was thought to be "heart failure." The skill of anesthetic administration was understandably poor in the early years. It was reported in one article that "occasionally, the Chinese could not be anesthetized with chloroform."

After the initial enthusiasm, attention was drawn gradually to the risks and complications of anesthesia: "chloroform heart failure" (1889, 1892), "resuscitation during chloroform anesthesia" (1892), "convulsions during chloroform anesthesia", etc. were discussed extensively [1].

As regards the local anesthetics, the treatment of cholera infantum with cocaine was reported in 1887. Cocaine was the main local anesthetic from 1887 through 1895, in which period of time the potency and the untoward effects of cocaine were studied. A case of cocaine poisoning was reported in 1891 [3]. The patient was a 4-month-old

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infant who was fed with cocaine by mistake and had convulsive attacks thereafter. This patient was treated successfully by inhalation of chloroform and intramuscular injection of chloral hydrate. Cocaine was also used for spinal anesthesia before 1917, in which year tropocaine was used instead [4]. Caudal block with Novocaine was reported in 1928.

Rectal anesthesia with ether, chloroform, or a mixture of different general anesthestics and different solvents was reported frequently before 1900. This was a reflection of the trends of Western countries at that time. On the other hand, the rectal administration was much easier to handle than the inhalation method and there was less interfering with the airway. These were the main reasons behind its advocacy. However, the depth of anesthesia was often not sufficient, and it was suggested that supplementation with inhalation of a small amount of ether would solve this problem. This rectal technique was particularly advocated by the neurosurgeons, who used it as the anesthetic as well as the treatment for their neurological patients.

It is worthwhile pointing out that the advances of anesthesia in the Western world were reflected in due course in the Chinese medical publications and in the clinical works. Larocaine or bacaine was used for parametrial block in 1919 [5]. Tracheal anesthesia by instillation of cocaine into the trachea was reported in 1920. This was a technique in some way similar to the transcricothyroidal anesthesia. In the same year the clinical use of blood transfusion was reported. Typing of the blood group was emphasized, and sodium citrite was used as the anticoagulant. "Twilight anesthesia" with large doses of scopolamine and morphine was advocated in the 1920s, and it was used mainly for pain relief in childbirth. Oxygen inhalation, ethyl chloride general anesthesia, and various techniques of spinal anesthesia were reviewed, and our own experiences were reported.

It is apparent that both the skill and the knowledge of anesthesia were markedly improved in the 1930s. Spinal anesthesia was used safely in patients of 12–68 years of age [6]. A locally made anesthesia machine was produced [7]. Nerve blocks, including sacral, brachial, femoral, and various blocks, were used frequently. In a report of 2555 administrations of nerve blocks in 1926, the succesful rate of brachial block was 84% [8]. There were 11 118 administrations of spinal anesthesia in 16 hospitals from 1931 to 1935, with an overall mortality of 0.063% and a success rate of 99,31% [9]. A large amount of foreign publications dealing with anesthesia was translated or reviewed into Chinese. The pharmacology of Sodium Amytal, Sodium Evipan, Avertin, vinyl ether, thiopental and cyclopropane were translated or reviewed shortly after the first report in the Western journals.

Besides the clinicians, pharmacologists took a great part in the translation and reviewing. In medical centers or in hospitals in large cities, junior surgical staff members were designated to administer anesthetics. Anesthesia was one of the requirements in the training of interns.

In the 1940s the self-gained experiences of anesthesia constituted the great part of Chinese literature of anesthesia. Endotracheal techniques gained widespread use as a result of the development of thoracic surgery. The "to-and-fro" system (Waters' canister) was used extensively because of its simplicity and portability. Later on, some sophisticated anesthesia machines were also imported. Until the end of the 1940s, the circulating system anesthesia machine was produced in China. As an influence of Western trends, "painless birth" aroused much interest in the 1940s. Caudal, spinal, and paravertebral anesthesia was used for this purpose [10]. It was found that the anatomy of the sacrum of the Chinese is somewhat different to that of the Western woman [11]; the sacral hiatus in about 40% of the specimens studied was found at a higher level.

After The Liberation (1949), there was a great change in the status of anesthesiology in China. The specialty of anesthesiology was recognized. Professorships of anesthesiology were established in the medical centers, and departments of anesthesiology were set up in all large hospitals. These departments functioned as centers for the training of young anesthetists.

In the early 1950s an extensive discussion of the usefulness and limitations of local and spinal anesthesia appeared in the medical journals. It was proved that local infiltration anesthesia, if appropriately carried out, could be used fairly satisfactorily for most operations, including intraabdominal and intrathoracic ones, although its analgesic effect was not so complete. Spinal anesthesia, especially the continuous technique, was advocated in many centers for intraabdominal interventions. The reason for such a keen interest in local and spinal anesthesia was due to the smoother and quicker postoperative recovery and improved patient wellbeing, which were attractive to surgeons and ward personnel. However, the incompleteness of analgesia and the difficulty in maintaining a stable physiological status worried the anesthesiologists. It was clear that our anesthesiologists had to work out a regimen which would keep the advantages of local and spinal anesthesia and compensate for the disadvantages of them. In order to solve such a problem, efforts had been made to use continuous epidural block to replace local and spinal anesthesia and to use intravenous procaine anesthesia instead of ether anesthesia. With the accumulation of experience over many years, the skill and knowledge of continuous epidural and intravenous procaine anesthesia was very much improved. Epidural blocks had been in use for operations from the neck down to the toes and intravenous procaine anesthesia was the first choice of general anesthesia. At the present time, epidural blocks are used for about 60% of all operations in the average general hospitals, and intravenous procaine anesthesia is still the main technique of general anesthesia [12, 13, 14].

Anesthetic risk was ever a hindrance for the development of pediatric surgery. Very often pediatric operations were delayed because of the fear of anesthetic risk. It was clear that a technique which is safe and easy to master was demanded. In 1953, we developed a technique which made the situation much safer. The basis of this technique is to use the intramuscular injection of thiopental to achieve a state of basal anesthesia. This maneuver had, for a long period of time, been considered as contraindicated, and the intramuscular thiopental anesthesia [15, 16] was not familiar to Western anesthesiologists. As a matter of fact, the use of intramuscular thiopental anesthesia had explored the possibility of using local infiltration, spinal, epidural anesthesia in the pediatric cases without difficulty and psychic trauma. Most operations can be carried out on children under a combination of basal anesthesia and local infiltration or nerve blocks. Children who have undergone minor operations, such as herniorrhaphies, can be brought home right after recovery from anesthesia.

It seems that there were quite a number of new techniques developed in the 1950s. In 1954, the Chinese anesthesiologists started experimental studies of hypothermia, and it was used for open heart surgery in later years. Controlled hypotension was used rather extensively in 1956. It was initially hoped that the use of the hypotensive technique would save a large amount of bank blood. It was realized afterwards that this technique is nothing more than the knowledge which anesthetists ought to have about how to manipulate the circulatory function during anesthesia. The theory of "artificial hibernation" was attractive, and the procedure was interesting at that time. After extensive clinical trials, it was realized that the drugs used in "artificial hibernation" are much more useful than the theory.

The problems of cardiopulmonary resuscitation were discussed extensively in the 1950s. It is worth mentioning that there were two operative cases of cardiac arrest resuscitated with closed chest massage. These two patients recovered uneventfully. The anesthetist had to call public attention to the usefulness of external thoracic massage, with emphasis on its simplicity and effectiveness. Unfortunately, there was not enough experimental or theoretical evidence to support his view, and it was thought to be an "old technique and hardly useful."

For centuries, the Chinese acupuncturists had been treating pain conditions with acupuncture. The use of acupuncture to provide surgical anesthesia started after 1958. Extensive research work has been done on this project, and more work is still under way.

The development of modern anesthesia in China after the 1960s could be summarized into three categories, as follows: There is a rapid increase of specialized young and energetic anesthetists; better anesthesia service is provided in most hospitals; and research work has become a necessity for the departments of anesthesiology in the medical centers. The first national congress of anesthesiologists was held in 1979, and two journals of anesthesiology have appeared since 1980. This indicates that the specialty of anesthesiology is growing to its maturity.

Acknowledgment. The author wishes to thank Dr. Xin-min Wu for his assistance in preparing this manuscript.

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4.11 Reminiscences of Anaesthesia During the Blitz and 10 Happy Years in India

R. Mansfield

R. Mansfield

Anaesthesia During the Blitz

In 1939 plans were being made in the United Kingdom to form the Emergency Medical Service (EMS) and the country was divided into Sectors, each controlled by a teaching hospital. The "base" in the Kings College Hospital Sector was in a partly converted mental hospital in Surrey, while other hospitals in the area acted as "Field Hospitals" for casualties, who were treated as emergencies and transferred to a relatively safer area as soon as possible. What I describe will be personal experience of anaesthesia at that time, illustrated by cases one can not forget. Many municipal hospitals had no visiting or staff anaesthetists then, and the house physicians, with or without experience had to cope with any cases needing anaesthesia. In teaching and voluntary hospitals anaesthetists had honorary appointments, usually part-time, and could only earn a living with private cases or in general practice. The E. M. S., however, did employ specialists with an option for whole-time or part-time work. During this period I was posted to a 600-bed municipal hospital in Croydon, but was informed that I was not needed – until the Blitz started in earnest in 1940. One fine afternoon, looking towards Croydon, we noticed a "dog fight" over the aerodrome, and within half an hour there was a telephone call – we had started, and it was time to don my tin hat.

Facilities and Apparatus

At that hospital two ground-floor wards were fitted up to receive casualties, and the day rooms opposite, which were sandbagged on the outside, provided sleeping quarters for the staff. The sandbagging was no help when a bomb fell down the lift shaft and exploded on the ground floor, producing casualties on the spot and leaving only one receiving ward. Operating theatres were a converted ward and a delivery room, both on the ground floor.

The apparatus consisted of a Boyle's machine in each theatre, fitted with oxygen, nitrous oxide and carbon dioxide cylinders and Endurance reducing valves, but no

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pin index system at that time; a Magill circuit with red rubber rebreathing bag, respiratory valve and corrugated tubing and catheter mount for continuous flow; an ether bottle with a waterbath; and smaller chloroform bottle which could be adapted with a scale for trichlorethylene.

On one occasion the Endurance valve on the oxygen cylinder ignited, although no one admitted using grease. The patient, a small boy, fortunately not yet anaesthetized, was wheeled rapidly into the corridor while the fire was put out with a fire extinguisher. On visiting a chest hospital in Sussex a week later, I noticed a similar valve and pointed out the danger to the administration. However, nothing was done until a week later; the same thing happened when an oxygen cylinder was forcefully turned on as a patient with bilateral tuberculosis needed oxygen inhalation while having a thoracoplasty under regional block. This time we wheeled the machine out into the corridor and directed the flames towards the Medical Superintendent's office. It took 20 min for the oxygen to burn out and the flames to subside, and this time something was done to replace the faulty valve.

Masks for open ether, airways, a few plain and cuffed red rubber Magill endotracheal tubes and a straight-bladed laryngoscope, electrical and foot-operated suckers were also available. We were fortunate in having a very devoted retired naval sick-bay attendant as technician, who stored the endotracheal tubes in a biscuit tin to keep their shape. The tin was labelled "Tubes for Incubation".

Drugs

As well as oxygen, nitrous oxide cyclopropane (available in some hospitals), soda lime for carbon dioxide absorption, ether, chloroform, ethylchloride, vinesthene and trichlorethylene could be used. For intravenous use there was Evipan and thiopentone but no relaxants. For local, regional and spinal analgesia there was procaine, amethocaine, stovaine and nupercaine (hyper- or hypobaric). After each air raid the medical team examined the casualties in the receiving room, where they were resuscitated and premedicated, and an operating list was drawn up. Things were very difficult on the night when the Maternity Isolation Block had been hit, knocking out all the hospital lights; we had to manage with torches and hurricane lamps. Most patients were shocked but quiet, and we soon found it was better to give analgesics slowly by the intravenous route rather than intramuscularly with slow absorption because of shock and vasoconstriction. Blood at times was scarce, but intravenous fluids were available.

Routine Cases

In the meantime, routine work in Croydon and other centres continued. For example, at the Brompton Hospital chest operations were done in a temporary theatre in the Outpatient Department, while some patients were transferred to the country branch. Lung resections using endobronchial tubes or blockers induced under direct vision (as taught by Sir Ivan Magill) were done without relaxants. Topical analgesia, as for a bronchoscopy, was carried out before intravenous thiopentone was given and any secretions aspirated. Even if a closed-circuit technique with a Waters' canister and carbon dioxide absorbtion was used, with ether and cyclopropane for maintenance (as recommended by Nosworthy), the surgeons could not use diathermy because of the risk of explosion. Thoracoplasties, usually at the country branch, were done under regional block, using a mixture of "weak" amethocaine and procaine with added adrenaline for haemostasis, before lignocaine was introduced.

Emergency Cases

Teams of thoracic surgeons and anaesthetists worked at the sector headquarters in a partially converted mental hospital in Epsom, and at weekends chest work continued at sanatoria in Surrey or Sussex, or at Sully Hospital, South Wales. I will never forget when we were faced there with three Army cases of cardiothoracic trauma. We approached the problem with some anxiety as it was a new experience in the 1940s, but found that the heart in young, fit adults was quite a tough organ. One of the cases was of particular interest: Radiography revealed a bullet in the left chest. However, at left thoracotomy performed by the local staff, there was a massive haemorrhage and the patient only just survived; no bullet was found. Repeat radiography revealed the bullet in the right chest. Later, at a right thoracotomy the pericardium was opened and blood was aspirated, releasing a tamponade with a rise in blood pressure to 200 mm Hg systolic. The bullet was found in the right lower lobe artery. With the right pulmonary artery taped, the foreign body was removed with little blood loss, and the patient made an uninterrupted recovery.

The E.M.S. sector hospital in Epsom was organized for D-Day; local teams, supplemented by surgeons and anaesthetists from Scotland, made ready for the Army casualties expected from the Normandy beaches. However, few were admitted at first as the fly bombs (V-1s) started, causing many civilian casualties, particularly in Croydon and other parts of London. Army casualties bypassed Epsom and were taken further afield, and the Scottish teams returned home. The anaesthesia at my hospital in Croydon had to be done by one of the physicians, except when I could be spared from Epsom. At this time there was one memorable case in Croydon, of an elderly women who was buried when a "parachute bomb" fell on the geriatric unit. When admitted she was unrecognizable, covered in dust, with fractures of the pelvis and all limbs except the right arm, concussed and almost scalped. After resuscitation we were able to anaesthetize her the next evening with endotracheal oxygen and used the only visible vein in the right arm for an intravenous drip. She recovered but did not remember anything for a month.

At the sector headquarters the head of the group to which I was attached arranged that the surgeon on duty should tackle anything, regardless of his specialty. In a case involving a bomb splinter in the mediastinum, the gynaecologist, who was the surgeon on duty, removed the foreign body in a few seconds with Volsellum forceps, I being much more worried about the anaesthesia for such a case.

Forgive me for reminiscing about personal experiences in those exciting times. In spite of the difficulties, such as driving in the "blackout" with dimmed headlights, the bombing, and the relative shortage of equipment, personnel, drugs and blood from time to time, there was a happy team spirit of cooperation no matter how many hours were worked.

Anaesthesia in India

I feel now that I must mention something about the history of modern anaesthesia in India from my recent happy experiences in that country, since retirement, especially as it is a rapidly growing speciality there.

During the British Raj, government hospitals were run by the Indian Medical Service. For example, in Madras, Colonel M. Roberts was anaesthetist at the General Hospital, later followed by Professor Rajagopalam. Anaesthetists at the General Hospital were expected to supervise four operating tables, except in special cases such as cardiothoracic patients. With low salaries, private cases were dealt with in the early morning or after the operation lists were over.

Of the hospitals in India, 12% are mission hospitals, many situated in remote areas. Anaesthesia was originally given by overseas personnel who trained Indians to take over. As an example I can mention Dr. Gwenda Lewis, who organized the Anaesthesia Department at the Christian Medical College (CMC) Hospital, Vellore, where she worked for 17 years. In spite of contracting poliomyelitis after one of her furloughs she continued working from her wheelchair and before leaving completed a survey of facilities at surrounding small mission hospitals.

Some Indian nationals trained abroad, as, for example, Professor Tandon, who served in the British Army during World War II. He became President of the Indian Association of Anaesthetists and then first Professor of Anaesthesia at the All India Institute of Medical Sciences, which formed a training centre so that more Indians from departments in main teaching centres could be trained in their own country. Some stay in India after qualification, but some go abroad, attracted by greater facilities and salary. Other Indian pioneers one might mention are Dr. Pritam Singh in Amritsar, in the north, Dr. Prior at the CMC Hospital Ludhiana, Dr. Nalini Kalle at the All India Institute of Medical Sciences, Kalyan Singh MD at the cardiothoracic centre at the Railway Hospital, Madras, among many others.

A Diploma in Anaesthesia and an MD degree in the specialty are offered by different universities, but training time and standards vary from place to place. Recently a national examination has been introduced for all specialities, for Membership of the National Academy of Medical Sciences (MNAMS), to standardize experience and skills.

An example of the growth of the specialty is given by Kerala, one of the smaller states: In 1970 there was only one trained anaesthetist, whereas in 1980 there were ten. With the increase of specialized units (e. g. neurosurgical; cardiothoracic, including open heart cases; and plastic and urosurgical, including kidney transplants), the need for trained anaesthetists has increased. However, in a country as large as India, the distribution of anaesthesia is very patchy. Although the standard is now relatively sophisticated in university hospitals, in remote and isolated mission hospitales it is still much as it was years ago when "compounders" nurses or ward boys gave general anaesthesia – open ether or at one time chloroform under the supervision of the surgeon – or the surgeon himself gave a spinal, local or regional block when possible. Now there are a few centres where nurses are trained by American nurse-anaesthetists, although in university centres and at such hospitals as at Vellore more doctors apply for postgraduate training than the establishment can take.

Until 1965 the Indian Society of Anaesthetists joined their surgical colleagues in their Annual Conference, but as their numbers had so increased, they separated and formed their own independant conference, meeting at the same time but at a different venue. In 1979 they were proud to host the Fourth Australasian Conference in Delhi, which was attended by delegates from many countries.

There are a few teaching hospitals and others that have piped oxygen, nitrous oxide and suction, but in remoter parts delivery is slow and haphazard, so that the more primitive methods, or spinal or local anaesthesia have to be used. The introduction of Ether Mushin Oxfordapparatus (EMO) or Flagg Can have made it possible to give endotracheal anaesthesia so that not all cases have to be cancelled. At times there has also been a shortage of drugs, particularly in government hospitals.

I should like to add a personal note about the nearly 10 happy years I spent in India after retiring in 1969, during which time I made many Indian friends who have made me feel that I have found a second home among them. At first I helped with anaesthesia for the cardiothoracic department in Vellore, as part of the Anaesthesia Department organized by Dr. Gwenda Lewis. This Department was continued by Dr. George Varkey (now in Canada), and then by Martin Isaac. It is at present led by Dr. Valerie Major, who has a completely Indian staff of six with 34 trainees and technicians, serving 14 theatres, with an anaesthesia room for each two theatres. Trainees gain experience in anaesthesia for all types of surgery, many being pioneered at Vellore. The first open heart surgery – an aortic valve replacement with a calf valve – was done in 1966. With the presence of much rheumatic heart disease, closed mitral valvotomy is done where possible, many patients being in the younger age group. The details published in a recent review of 700 cases under 20 years of age show that the youngest patient was 6 years old. There were also many congenital cardiac defects treated at Vellore by Dr. Stanley John, for example over 400 patients with tetralogy of Fallot. All these cases needed specialized anaesthesia and aftercare in the intensive care unit. Now such units have developed in other parts of India, some served by anaesthetists or surgeons trained in Vellore.

More Recent Advances in Anaesthesia

The introduction of Na-nitroprusside to induce hypotension has facilitated surgery. It is used in resection or aortoplasty, for coarctation of the aorta, and division and suture of a patent ductus.

With the special necessity for economy in India, IV fluids are now made up in the hospitals, which have rigid testing for sterility. Central sterilizing departments and intensive care units have been formed in some parts of the country. Ventilators and endotracheal tubes are now manufactured in India, but standards need to be improved. There is a great shortage of disposable equipment such as IV sets and cannuli. On my return home I was horrified at the extravagance and wastage of such things.

Communications have improved, but some remote places are still only reached by bullock cart. Therefore, it is not surprising that the availability of anaesthesia in India varies from place to place, being concentrated mainly in the towns. More might be done by the collection of "cold" cases in various centres, with a team of surgeons and anaesthetists going from place to place. One small mission hospital I visited had only two and sometimes only one doctor. They said they could not afford an anaesthetist, so the Matron gave anaesthesia when a general was required.

However, anaesthesia is a fast-growing specialty in India, and training and experience in other disciplines such as intensive care and pain control, as well as routine theatre work, are now needed.

4.12 History of Modern Anesthesia in Lebanon

Fouad Salim Haddad

The history of anesthesia in the developed nations is documented and established, but the history of modern anesthesia in the Middle East is still vague, and in some countries it is completely unprobed yet. The purpose of this paper is to present the history of modern anesthesia in Lebanon, one of the Middle Eastern countries. Western medicine in Lebanon is a product of a medical renaissance brought about by the political events that dominated the Middle East in the nineteenth century. The beginnings of modern anesthesia in Lebanon will therefore be discussed within the context of the politicomedical events that took place between 1800 and 1860. Gaps of information still exist because of lack of documentation.

The medical renaissance of the Middle East was instigated following the invasion of Egypt by Napoleon in 1798. Napoleon had brought with him doctors, astronomers, naturalists, and others, in order to win the cooperation of the Egyptian people [1]. By so doing, Napoleon had started a new wave of Western knowledge in Egypt, which later spread to many parts of the Middle East, including Lebanon. When the defender of Egypt, Mohamed Ali, assumed power, he continued the efforts to propagate knowledge and education by bringing from France and Europe doctors to take care of the health of his army [1]. Dr. Antoine Berthelemy Clot (1793–1868) was one such doctor. He introduced the then modern ways of health care and in 1835 established the Kasr El-Aini Medical School [1, 2, 18] in Cairo, the first medical school in the Arab East [3].

In Lebanon, the medical renaissance and subsequent introduction of modern anesthesia can be traced back to three events:

1. The invasion of "Syria" (here meant to include Lebanon) by Ibrahim, son of Mohamed Ali in 1832. Dr. Clot accompanied this campaign [1], and his presence was instrumental in initiating medical renaissance in Lebanon. It was through him that the first five Lebanese students [1, 4] including Ibrahim Najjar, were sent to the Kasr El-Aini Medical School which he had established.
2. The permission given to Western missionaries to enter "Syria" after Ibrahim evacuated it in 1840. French, American, and British missionaries established free clinics, with the purpose of propagating their sects of religion [1].
3. The intervention of European powers following the massacres of 1860 in Lebanon. By 1867, the Americans established the first medical school in Lebanon, then known as the Syrian Protestant College (now the American University of Beirut). Sixteen years later, in 1883, the French founded their Faculté Française de Médecine.

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It should be noted here that prior to the establishment of the first medical school in Lebanon in 1867, Lebanese students received their medical education mainly in Cairo (because of the language facility) or in Istanbul [5, 6].

Era Before Surgical Anesthesia

Within the politicomedical framework presented, anesthesia in Lebanon will now be considered in two eras: the era before and the era after surgical anesthesia, i.e., before and after 1846 [7]. No direct information is available regarding relief of surgical pain in the era before surgical anesthesia in Lebanon. The conspicuous absence of medicine [1, 6, 15] in Lebanon during the Ottoman occupation (1516–1918), lack of hospitals, and absence of major surgery may have been the reasons. However, Dr. A. S. Al-Shatti writes (1970, personal correspondence) that anesthetization was known in the East during the Middle Ages; the anesthetic substance used to be placed either on a sponge ("the sleeping sponge") vaporized with some perfume, or taken by mouth. Of the medicinal plants used for this purpose were *Mandragora officinalis, Cannabis indica, Hyoscyamus niger, Papaver somniferum,* and *Conium maculatum.* Whether these same agents were used in Lebanon proper, is not established.

Some indirect information regarding the methods of pain relief probably used in Lebanon before 1846 is based on deduction and assumption. With the knowledge that Lebanese students used to go either to Cairo or Istanbul for medical education [5, 6], the assumption is made that methods taught in either of these two centers were the same methods carried back by Lebanese students and probably practiced in their homeland. Because of the language facility and the fact that the first Lebanese physician, Dr. Ibrahim Najjar, himself graduated from Cairo in 1842, only the available materials on the methods practiced in Cairo have been elected for consideration [2].

Two books on surgery which were used as textbooks in Cairo and published before 1846 come to the foreground: The first, by Dr. Antoine Clot [8, 18], already referred to, was published in 1835, and the second, by a prominent surgeon and Dean of the Kasr El-Aini Medical School, Dr. Al Bakli, was published in the famous year of 1846 [9, 18]. Whereas there is no mention of methods of relief of surgical pain in Dr. Clot's book of 1835 [8], we find the following statement (translated from the original Arabic) in Dr. Al Bakli's book, published in 1846 [9, 18] under the heading of "Methods of decreasing sensations and pain":

> The ancient physicians used many methods for analgesia during operations, like hyosciamus, mandragora, opium, used internally or externally, while others used compression either of an organ or big nerves. Nowadays, none of these are used because of the availability of sharp instruments and quick slices by the surgeon. However, one may now give antispasmodic medications before and during operation.

As Al Bakli put it, "... severe operative pain occurring during surgery might result in spasm and contractures in patients who are predisposed to severe excitement ..." The antispasmodic medications [10] in vogue then were ether, camphor, ambergris, misk, and jindibaster [11]. It is evident from the forgoing that in 1846 Dr. Al Bakli was not aware of the discovery of modern anesthesia. It is assumed, therefore, that the pain-relieving methods taught in Cairo were the same that were carried by Lebanese students and probably practiced in their homeland.

Era After Surgical Anesthesia

The arrival of the Lebanese physicians from Cairo, first of whom was Dr. Ibrahim Najjar [2], and the inflow of medical missionaries to "Syria", heralded the era after surgical anesthesia in Lebanon. The knowledge of the status of anesthesia in the initial 20 years of this era (1846–1865) is a blank, because of the absence of documentation. We know however, that Dr. Najjar, on his return from France in 1849 [2, 12], was appointed chief surgeon in the one and only hospital in Beirut, the Shahany military hospital of the Ottoman Army [2]. In 1929 a prominent Lebanese physician threw some light on how Dr. Najjar managed patients with bladder stones in that hospital [13]: "...Ibrahim was the first to remove stones (bladder) in Beirut at a time when anesthesia had not spread yet. He used to tie the surgical patient to the corners of the operating table ..." This quotation clearly shows that in 1849, and probably for the following unknown number of years, modern anesthesia was not used in Lebanon. Instead, the methods carried back from Cairo, i. e., antispasmodic agents and medicinal plants, were probably used [10].

In 1865 we find a reference to the first actual use of a modern anesthetic in Lebanon [14]. The agent was chloroform, administered to a dog, by Dr. George Post in a small village in the mountains of Lebanon. Dr. George Post was an American missionary surgeon who had helped in the foundation of the American University of Beirut [14, 15, 16]. The first documented evidence of the actual use of chloroform on man, however, comes from Dr. Post's book of surgery, written in the Arabic language and published in 1873 [17]. Chloroform was used for the release of a dislocated shoulder of a man at the Johanniter Hospital in Beirut.

Dr. George Post is credited as the pioneer of anesthesia in Lebanon [7]. In his book of 1873, in addition to the chapters on clinical application, there was a chapter on general anesthesia in which he described five stages of anesthesia [17]. Moreover, in a Lebanese medical journal which he initiated in 1874, he contributed and edited papers on anesthesia or the related sciences [5, 16]. In spite of his varied interests and preoccupations, he remained a prominent surgeon in Lebanon for 40 years and kept Lebanese physicians informed of new drugs, techniques and discoveries in anesthesia throughout the rest of the nineteenth century [7].

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4.13 Recent History of Resuscitation in Norway

B. Lind

B. Lind

Modern resuscitation does not owe Norway a vast number of contributions. Most important is probably the development of the training manikin "Resusci Anne" by Åsmund S. Lærdal, from Stavanger, which has been a "lady companion" to many resuscitation instructors throughout the last 20 years. Although the milestones are few, please allow me to begin with a remarkable one, even if it dates back to the beginning of the twentieth century.

In 1901, Dr. Igelsrud in Tromsø, Norway, successfully resuscitated a 43-year-old woman by open cardiac compression. Here is his report:

> The patient was a thin, lean, rather cachectic woman with cancer of the uterus. Total abdominal hysterectomy was performed (under chloroform anaesthesia). When the operation was almost finished, the patient passed into collapse; artificial respiration, lowering of the upper portion of the bed, faradization, and the other usual means were used for about 3–4 minutes. The heart was then laid bare by a resection of parts of the fourth and fifth ribs. The pericardium was opened and the heart seized between the thumb and four and middle fingers on the anterior and posterior surfaces. Quite strong and rhythmical pressure was made for about one minute, when the heart began to pulsate of itself. Then observing that the pulsations were becoming weaker, massage of the heart was practiced for about one minute more. From that time the pulse was perceptible and the contractions of the heart became regular. Of course, the estimate of time of the various stages is only approximate, as accurate observation of a timepiece is impossible under such circumstances. The patient was discarched from the hospital after five weeks.

This is probably the first successful case of open cardiac massage reported [1].

Dr. Igelsrud was chief medical officer in Tromsø and head of the county hospital. He was a devoted surgeon who paid a number of visits to well-known surgeons in Germany, Austria and the United States. His own hospital in Tromsø, however, was very modest. There was probably no proper operating theatre, and in 1901 his working light was two oozing kerosene lamps, and the room was heated by an old stove.

When modern resuscitation was introduced in Norway at the end of the 1950s, the ground was well prepared. Teaching first aid had been compulsory in Norwegian primary schools since 1929, and, probably because a large part of the population lived along the coastline, artificial respiration by means of Holger Nielsen's back-pressure/arm-lift method had been compulsory since 1939. The turning point came in 1958

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when the Scandinavian Society of Anesthesiologists arranged its Fifth Congress of Anesthesiology in Gausdal, Norway. At this meeting Peter Safar reported on his experiments comparing mouth-to-mouth ventilatoin with the back-pressure/arm-lift method in volunteers and concluded that mouth-to-mouth ventilation was the more efficient. At this time, the Norwegians were familiar with Holger Nielsen's method of artificial respiration, and repeated reports proved that they did not hesitate to take advantage of this knowledge. Whether the same would apply to mouth-to-mouth ventilation remained to be seen. Nevertheless, in 1959 the Norwegian Association of Anesthesiologists recommended that mouth-to-mouth ventilation should be generally taught. The same year all manuals and pamphlets distributed by the Norwegian Red Cross and the Norwegian Civil Defense, included mouth-to-mouth ventilation.

In 1960, the Norwegian Association of Anesthesiologists, which acted as an adviser to the Director General of the Health Services, agreed on the following plan of action:

1. Compulsory teaching of mouth-to-mouth ventilation in primary schools
2. Evaluation of the teaching program
3. Interviews with rescuers who had resuscitated asphyxiated victims by mouth-to-mouth ventilation, whether successful or not. The cases were to be traced through newspaper reports.

While steps were taken to introduce mouth-to-mouth ventilation in the schools, the necessary tool was launched in Stavanger. Åsmund Lærdal developed his "Resusci Anne" training manikin during the years 1958–1960. In September 1960, "Resusci Anne" was demonstrated to the Director General of Health Services in Norway, who at once realized the significance of such a training manikin and decided to support compulsory training of mouth-to-mouth ventilation in the primary schools. The following year, the Department of Education was ready to introduce mouth-to-mouth ventilation as a supplement to Holger Nielsen's method of artificial respiration. Thanks to a donation of training manikins by the Norwegian Savings Banks, the Norwegian Association of Anesthesiologists could design a program which, with the aid of anesthesiologists, school teachers and Red Cross instructors, would give training in mouth-to-mouth ventilation, including manikin practice, to all sixth and seventh grade pupils.

In September 1961, the Norwegian Association of Anesthesiologists instituted the First International Symposium on Emergency Resuscitation. Present at the Stavanger meeting were pioneers of emergency resuscitation from Europe and the United States, including, among others, Safar, Elam, Gordon, Ruben, and Frey. Lind presented an evaluation of teaching mouth-to-mouth ventilation in schools, with and without manikin practice. Using manikins proved to be significantly more efficient. The proceedings of this symposium were widely distributed and recommended the teaching of mouth-to-mouth ventilation to the public at large, while restricting external cardiac compression to recognized lifesavers, nurses and medical personnel [2]. The crucial issue of the acceptability of mouth-to-mouth ventilation was answered 2 years later. In 1963 Lind and Stovner published their study which comprised interviews with 40 successful and 40 unsuccessful rescuers. Their conclusions were:

1. Lay people do not hesitate to start mouth-to-mouth ventilation.
2. The method is easily acquired [3].

The incidence of drowning accidents in Norway is high. A number of successful resuscitations from submersion have been reported, where the submersion time has been astonishly high. The diving reflex, originally described in mammals and man by the Norwegian physiologist, Scholander, and his co-workers, may explain the apparent increased tolerance to anoxia in drowning victims. Scholander made his first experiments as a medical student at the University of Oslo in the 1930s. He worked with seals, and "the sea" in which they dived was a bathtub. His first publication appeared in the Proceedings of the Norwegian Academy of Sciences in 1940 [4]. Better known is his publication from 1968 [5].

Since then the diving reflex has been studied by several authors. In 1980, Bjertnæs et al. in Oslo made an investigation on each other [6]. A Swan–Ganz catheter was inserted into the pulmonary artery for central hemodynamic pressure monitoring and assessment of cardiac output. The radial artery was cannulated for systemic blood pressure monitoring. During steady exercise on an ergometer bicycle, they held their breath and put their faces in icewater for 30 s. The experiments revealed that man has the rudiments for the same cardiovascular adjustments to asphyxia as the diving vertebrates, although much less effective.

This diving reflex plus hypothermia may share the credit for the survival of the case described by Siebke et al. in 1975. A 4-year-old boy who was playing on an icebound river fell through the ice and disappeared. The fire brigade was called, and a frogman arrived from a station 15 km away. Altogether 40 min elapsed before the boy was found and brought ashore. Cardiopulmonary resuscitation was immediately started, but another 5 min passed before he arrived at the hospital. The boy survived; he is by now 11 years old, and his intelligence is above average [7].

A doctor-manned ambulance has been operating in Oslo since 1967. In 1976, Lund and Skulberg reviewed 631 resuscitations outside hospital. In 75 cases in which resuscitation was started by lay people, the survival rate was 36%. Only 8% survived when an attempt to resuscitate was delayed until arrival of the ambulance team [8]. The same year the Norwegian Association of Anesthesiologists recommended the introduction of external cardiac compression in addition to mouth-to-mouth ventilation in the school curriculum. A pilot teaching program has been started; the results will, it is hoped, be reviewed this year (1982), and, if encouraging, compulsory training of school children in cardiopulmonary resuscitation (CPR) will commence as soon as feasible.

After 1970 the interest in brain resuscitation has been increasing in Norway as elsewhere, speeded up by the multi-institutional barbiturate protection study initiated and organized by Peter Safar in Pittsburgh, Pennsylvania. The study is based upon results from monkey experiments by Bleyart et al., who, in 1978, found that thiobarbital given 5 min after a standardized ischemic insult, reduced the central nervous system sequelae [9]. These results could not be confirmed by the Norwegian Dr. Gisvold et al., who worked in Peter Safar's research laboratory in 1980–1981 [10].

Peter Andreas Steen, another Norwegian, who worked with John D. Michenfelder in Rochester, Minnesota, explored the mechanism of barbiturate protection. He found the survival time of mice in 5% oxygen atmosphere to be related to the depth of anesthesia and not to the barbiturate concentration per se, which would be expected if the effect resulted from free radical scavenging [11]. In experiments on dogs Steen was unable to find any protecting effect on cerebral blood flow or cerebral metabolism beyond the reduction in cerebral metabolic rate [12]. He was also unable to confirm the postischemic brain protecting effect on dogs found by Goldstein [13].

Promising studies of cerebrospinal fluid creatinin phosphokinase (CSF-CPK) by Vaagenes and Kjekshus at Ullevål Hospital, may prove to be of prognostic value. They found that the increase in CSF-CPK was related to the brain insult, and that CK levels above 10–20 units per liter seem to be incompatible with survival [14].

Norway pioneered the teaching of mouth-to-mouth ventilation to a whole population. The teaching of external cardiac compression has been rather more hesitant. We are probably approaching the time of the turning tide. However, only the participants of the next congress on the history of anesthesia and resuscitation will see how many of Claude Beck's "hearts too good to die" can be restored to life.

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4.14 The Development of Modern Anaesthesia in Italy

M. Pantaleoni

Anaesthesia was officially born in Italy in 1934–1935, with the establishment of the Italian Society of Anaesthesia and Analgesia (Rome, 24 September 1934) thanks to some famous surgeons [1]. Among them was Turinese Achille Mario Dogliotti (1897–1966), who, 1 year later, in April 1935, founded the first Italian *Journal of Anaesthesia and Analgesia* [2] and wrote the first *Treatise of Anaesthesia* [3], an important stage for Italian culture.

Nevertheless, until the end of World War II, anaesthesia was still practically unknown and was empirically performed only by nurses and junior surgeons. It began to evolve as a scientific discipline in the years 1947–1950, when eminent and open-minded surgeons, eager to improve their surgical techniques, encouraged junior assistants to learn about respiratory function, endotracheal intubation and the use of curare. Professor Fasiani, a leading Milanese neurosurgeon, was one of the first to operate in team with a specialist in anaesthesiology. This was Dr. G. Curà, who gave a lecture on "Anaesthesia for endotracheal intubation" at a surgical Congress in Bologna on 21 October 1948, with Dr. Manzocchi as coauthor [4].

At the same time, some aspiring anaesthetists went to the United States and the United Kingdom to acquire knowledge directly from where this new discipline had been developed. Other self-taught anaesthetists reached a similar level through their ardour, enthusiasm and organization. In this way, Italian anaesthesia changed in a few years, from an empirical non-scientific approach to a highly technical scientific discipline. For this reason the schools of specialization (1948–1949) and official undergraduate courses (1958–1960) were formulated in the medical schools. New laws were necessary in order to give the same dignity to this new branch of medicine as to all the other specializations in the public health service. Bill no. 653, passed on 9 August 1954, established the service of anaesthesia in the hospitals.

In the following sections of the paper I shall illustrate the main contributions which have been made by Italian anaesthesia in its 30 years' history, with regard to its teaching programme, organization and scientific research.

Teaching Programme and Organization of Italian Anaesthesia

The teaching programme has consisted of the foundation of schools of specialization; the introduction of official courses of undergraduates in the medical schools and the "Libera Docenza", equivalent to the British PhD; the establishment of full professor-

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ships of anaesthesia; the organization of congresses and meetings; and the publication of journals. The first schools of specialization, which initially offered 2-year courses, were founded in Milan [5, 6]; Turin [7] and Naples in 1949–1950; Padua, Rome and Palermo in 1950–1951; Florence in 1951–1952; and Bologna in 1952–1953 [8]. The university courses began in Turin (1958); Florence, Milan and Siena (1960); and Rome and Naples (1961). The first permanent appointments for full professors were made in Turin (1962), and Rome and Naples in 1964. Table 1 summarizes the establishment of the schools of specialization and the university courses in Italy.

The first "Libera Docenza" were awarded on 21 February 1955 [9, 10], while the First Congress of the Anaesthesia and Analgesia Italian Society was held in Bologna as early as 26 October 1935 [11]. The congresses held after World War II included: the Second Congress of the refounded Society (SIA), which was held in Naples on the 28 May 1949 [12]; the Third (or First Independent Congress) of the SIA, held in Bologna from 25 to 26 May 1950 [13]; and the Fourth (Third National Congress), which was held in Turin on 2 June 1951 [14]. Since then, a new congress has been organized every year, and the Thirty-third Congress was held in Bologna from 25 to 27 September 1981.

There are four main Italian journals for anaesthetists:

1. *Minerva Anestesiologica,* formerly called before 1953 the *Giornale Italiano di Anestesia e Analgesia,* which was founded by A.M. Dogliotti in 1935 and is Minerva Medica Publishing Company, Turin. This is now the official journal of the Society.
2. *Acta Anaesthesiologica,* founded by G. Ceccarelli in 1950 and edited from 1964 by Mazzoni and from 1973 by Gasparetto. It is published by "La Garangola", Padua.
3. *Anestesia e Rianimazione,* which was founded by G. Calligaris in 1960 and is the official journal of the Associazione Anestesisti Ospedalieri Lombardi. It is published by Idos, Milan.
4. *Incontri di anestesia, rianimazione e scienze affini,* which was founded in 1966 and edited by Cocchia and Cuocolo. It is printed by "Il Cerchio", Naples.

From 1947 to 1948 the first anaesthetists began to appear in some hospitals: Ospedale Maggiore of Milan, S. Anna of Ferrara, Mauriziano and Regina Vittoria of Turin [15], Clinica Chirurgica of Naples and Ospedale di Circolo of Legnano [16]. However, the anasthetist was not always taken seriously as an independent specialist. Concurrently, eminent and perseverant men such as the surgeons Dogliotti and Valdoni and the anaesthetists Ciocatto, Mazzoni, Damia, Tonso, Callegaris and Arosio were working on the Bill to make the service of anaesthesia in the hospitals independent from the other branches of medicine. In Italy, with the help of Parliament Raimondo Borsellino, the Bill was passed, one of the first in the world, on 9 August 1954 [17], which recognized the compulsory institution of the independent service of anaesthesia. From this starting point it was possible to develop the career of anaesthesia [18–20]. This law was further ameliorated with the Bill no. 128 (art. 18) of 27 March 1969, in which the rules of the hospital service were laid out [21].

After the Bill of 1954, there was a drastic change in the world of Italian anaesthesia: the first consultant jobs were advertised in Savona (Ebbli), Cesena (Righini) [22] and Treviso (Massera). In 1952, the first form of members association of the specialty was established. The foundation of the Association "Anestesisti Ospedalieri Italiani" was due mainly to the efforts of Consuelo Tonso from Bergamo (1914–1966) [23]. He was the founder and the first President. The first meeting of the Association was held in Bologna on 5 December 1954 [24]. In 1976–1978, the first anaesthesia outpatient departments were introduced [25, 26].

Table 1. Establishment of Chairs of Anaesthesia in Italy

University	Specializaton school	Chair of Assignment	Permanent university chair holder	Date of institution
Ancona	1980–81	1974–75	Gritti 1980	
Aquila		1972–73 Pastore (A) Leonardis (R)	Leonardis 1980	
Bari	1960–61	1967–68 (A) 1972–73 (IC)	De Blasi 1970 Brienza 1980	1971
Bologna	1952–53	1966–67 1972 Suriani (PTP)	Cetrullo 1971	1972
Cagliari	1960–61	1967–68	Saba 1967	1967
Catania	1957–58	1964–65	Foti 1965	1966
Chieti	1978–79	1979–80	Martinelli 1980	
Ferrara	1958–59	1970–71	Guerrieri 1975 († 1980) Gritti 1981	1970
Florence	1951–52	1960–61	Novelli 1975	1976
Genoa	1955–56	1962–63	Cattaneo 1968	1969
Messina	1968–69	1969–70	Montanini 1971	1982
Milan I	1949–50	1960–61	Damia 1971	1973
Milan II	1981	1971–72	Tiengo 1969	
Milan III		1982 Tiengo (PTP)	Trazzi 1975	
Modena	1960–61	1972–73 Barbieri (AP)		
Naples I Fac.	1949–50	1961–62	Cocchia 1964 (A) Viglietto 1980 (R) Mostarda 1980 (IC)	1976
Naples II Fac.	1973–74	1972–73	Cuocolo 1973 Mazzarella 1980	
Padua	1950–51	1965–66	Gasparetto 1970 Giron 1975	1970
Palermo	1950–51	1964–65	Sparacia 1975	1975
Parma	1958–59	1962–63 Uleri (AP)		
Pavia	1956–57	1968–69 Carbonera (AP)		
Perugia	1956–57	1967–68 Calderazzo (AP)		
Pisa	1954–55			
Rome State Univ.	1950–51	1961–62	Mazzoni 1964 († 1972) Gasparetto 1974	1964
Rome Catholic Univ.	1968–69	1967–68	Manni 1970	1967
Sassari	1978–79	1969–70	Ruju 1975	1981
Siena	1962–63	1960–61	Bellucci 1971	1972
Turin I Turin II	1949–50	1958–59	Ciocatto 1962 Pattono 1973	1969
Trieste	1971–72	1968–69	Mocavero 1975	1972
Verona	1970–71	1969–70	Ischia 1975	1970

A, anaesthesia; R, reanimation; IC, intensive care; AP, associate professor; PTP, physiopathology and therapy of pain

Italian Scientific Contribution to Anaesthesia

In order to understand the level of organization after the war we can take into consideration the official data from 1950 of the Department of Surgery of Turin [27]. Local anaesthesia represented about 79% and was subdivided into: local, 47%; segmental peridural spinal anaesthesia, 18.5%; peridural lumbar, 13.18% and sacral epidural, 1.35%; whereas general anaesthesia (ether, barbiturates, curare) was only 21%.

Segmental peridural spinal anaesthesia was introduced and diffused throughout Italy by A. M. Dogliotti, who had worked on it from 1931 [28, 29]. This technique was also widely applied for the treatment of pain by his great pupil Enrico Ciocatto, who became himself a nestor of Italian anaesthesia – President of the SIA, first Italian full professor of anaesthesiology (1962), one of the founder members of the International Association of the Study of Pain (1973) and of the World Federation of Societies of Anaesthetists (WFSA), Fellow of the Faculty of Anaesthetists of the Royal College of Surgeons of England, and recipient on an honoray doctorate from the Miami University (1980) [30, 31].

Anaesthesia by inhalation of ether or trichloroethylene using the mask of Ombrédanne, Dogliotti–Giordanengo [27] or Brancadoro (Analgon) [32] was still widely used [33]. At the same time new drugs and techniques were being introduced: pentobarbital sodium (the so-called American injection of the postwar period) [34] and curare; endotracheal intubation [35–46]; and the use of automatic respirators. It is worthwhile recalling that one of the first automatic respirators for controlled artificial respiration was made by Daniele Petrucci (1921–1973) of the surgical department of the University of Bologna, while in London [47]. Among the first people to use thiobarbiturate were: Prof. G. Bracala [48], Prof. G. D. Errico [49], and Prof. A. Ruggiero [50], in Naples; Prof. E. Ciocatto [51] in Turin; Prof. C. A. Carlon and Prof. P. G. Mondini [52, 53] in Padua; Prof. P. Mazzoni [54, 57] in Rome; and Prof. F. Bianchi [55, 56] in Modena.

Piero Mazzoni (1921–1972) was a pioneer in the research and organization of anaesthesia in Italy [58, 59]. He had the Chair of Anaesthesia in Rome and was President of the SIA several times. He studied, in particular, the interaction of general anaesthesia with metabolism; he also studied the distribution of sodium thiopental and hyperbaric oxygenation. He was one of the first people [60–62], together with Manni and Ottolenghi, who were pupils of Professor Valdoni [63], to use curare either in its natural or synthetic form.

E. Bovet and his colleagues from the Istituto Superiore di Sanità of Rome, showed the curare-like properties of succinylcholine [64]. Further important studies on the action of curare were those of D. Petrucci, who was the first to use decamethonium on man in 1947 [65, 66], and those of Ruggero Rizzi from Vicenza, a Member of the Royal Society of Medicine of England (1968) and author of the monograph of 1957 entitled *Curare and Curare-like Drugs* [67]. This was one of 28 publications on the subject published between 1951 and 1966 and one of most exhaustive sets of data obtained from the use of 19 different curare-like drugs. The studies which began in Rome [60–62], Naples [68–70], Padua [71], Florence [72, 73], Pavia [74], Turin, Bologna and Milan reached the international scene in Venice in 1958 during the

Eleventh Congress of the SIA on relaxants [75], which were further improved with the introduction of new types of curare [76].

Utilizing curarization and controlled respiration, the problems connected with open heart operations and brain surgery were now confronted. Similarly, the problems arising from the use of this new anaesthetic technique on various systems and apparatus were studied, and numerous papers were published on controlled hypotension and hypothermia [77–84]. A major contribution was given by the groups from Turin, led by Ciocatto, Cattaneo and Bianchetti [85–92], and Milan, whose main investigator was Maria Luisa Bozza-Marrubini, a pupil of the eminent neurosurgeon Fasiani and herself world famous in the field of neuroanaesthesia and neuroresuscitation [93–95]. Another investigator was V. Borroni, founder member of a Group of Experts on Anaesthesia and Resuscitation [96–101].

The problem of extrapulmonary oxygenation of the blood has been tackled in Italy since 1947, when heart-lung machines were invented contemporaneously but separately by P. Mondini, pupil of Ceccarelli of Padua, and E. Tosatti, assistant of Paolucci from Rome [102, 103]. In 1953, Dogliotti and Ciocatto cooled human blood, in an extrapulmonary circuit. This method was initially popular [89].

We must recall from among the others L. Cabitto, who gave a lecture on electroanaesthesia in Vercelli (1950) [104], M. Bonino from Novara [105], who first applied the technique on humans, S. Brena [106], A. Trojanello [107, 108] and especially Mario Cattaneo, director of the Department of Gynaecology of Turin, who in 1935 was the first in Europe to use electroanaesthesia experimentally on dogs [109, 110]. Finally, P. Ruju was particularly interested in the subject from 1964 to 1965 [111, 112].

The toxicology of anaesthetics, until then unknown, has been studied, together with their tolerance level, and new drugs and techniques have been experimented with and applied in clinical practice. In a lecture given at the Sixteenth Congress of the SIA in 1963, C. Cetrullo, Professor in Bologna and member of the WFSA, demonstrated a physiological approach, which had been applied since 1954 [113–116] and consisted of a narcotic-analgesic association mainly orientated towards analgesia. This is a balanced anaesthesia in which the analgesic component is preponderant, while the narcosis is kept within specific limits. It can be summarized in this way: In order to be closer to a physiological status use, "little anaesthetic, little curare and a great deal of oxygen". This anaesthetic strategy was applied even before the publication of the technique of neuroleptanalgesia (NLA); it had numerous followers in several Italian schools of specialisation [117–120]. It was brought to extreme limits with the introduction of the algosynaptolisis, which was a technique applied in Padua by A. Gasparetto in 1964 [121–123].

Volatile anaesthetics have been used by Italian anaesthetists since they were first introduced (e.g. fluothane, by Raventos, 1956, penthrane; by Van Poznak and Artusio, 1960; ethrane, by Dobkin, 1968) [124–128]. Several national symposia were held on this subject: on fluothane at Verona in 1957 [129], at Milan in 1962]130] and at Udine in 1963 [131]; on the use of methoxyflurane at Siena in 1966 [132], at Vicenza in 1965 [133] and in S. Vittoria d'Alba in 1970 [134] and on ethrane in Alghero in 1973 [135].

Twenty years have now passed, in which time the modern and dynamic Milanese team, through perseverance and skilful scientific application, has brought Italy to a leading position in the field by its knowledge on the mechanism of inhalation-type anaesthetics (physical-chemical characteristics, absorption and distribution in the body, grade of solubility in the blood etc.) [136–142], in the study of pulmonary ventilators [143–146] and evaporators [147], with the introduction of new concepts such as that of equipotent doses of the level or dose required to produce loss of consciousness (LPC and DPC respectively), the minimum alveolar concentration (MAC), and the MAC for sympathetic inhibition (MACSI) etc. [148–151] and of electrical analogue. The same concepts were also extended to the intravenous anaesthetics [152–155].

The School of Milan is involved, at the moment, in research sponsored by the European Economic Community (EEC) on the pathogenesis of the complications of artificial mechanical ventilation (VAM) and the capacity of preventing them. This research has produced the new technique of low-frequency positive-pressure ventilation with extracorporeal carbon dioxide removal, which is commonly defined as the "artificial lung" [156–159].

Interesting studies on the action of the technique of ventilation and volatile anaesthetics on the surfactant system were performed in Rome [160, 161] and in Padua [162, 163]. This research was aimed at reducing the negative effects of volatile anaesthetics on the alveolar surface tension and is at present being directed towards the study of "jet ventilation" [164, 165].

Respiratory alkalosis caused by hyperventilation was first applied in closed circuits to eliminate carbon dioxide. The results were published by Damia et al. in a paper entitled "CO_2 in general anaesthesia" in 1964 [166]. This standard work expressed the advantages of a slight degree of respiratory alkalosis to prevent an acid – base equilibrium imbalance to determine the "narco-hypnotic" state and the optimal muscle relaxation with the minimum use of drugs [167–173].

Major Contributions

A. Gasparetto, Professor in Padua and Rome, wrote a paper in 1968 on the "Biochemical basis of anaesthesia" [174] and another in 1979 entitled "Biochemical aspects of shock" [175], together with G. P. Novelli, Professor in Florence and an expert on the problems arising from anaesthesia in the large and small circulation [176, 177]. C. Manni, Professor of Anaesthesia at the Catholic University of Rome, and his colleagues wrote in 1978 an important paper on the "Immunological aspects in anaesthesia and resuscitation" [178].

Finally, here are details of the programme of the Siena School, directed by one of Italy's most eminent anaesthetists, G. Bellucci: "homogeneity of the national teaching programme, principles of minimum posology, professional code, study and prevention of professional pathological hazards" [179–181].

I should like to close with this wish of Montaigne: "I would that every man write what he knows and no more", and ask to be excused by all whom I have inadvertently left out.

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4.15 On the Development of Modern Anesthesia in Yugoslavia

D. Soban, V. Andonov, P. Lalević, L. Ribarić and A. Stajić

The first inhalation anesthesia on Yugoslav territory was performed in 1847 [1] and the first spinal anesthesia in 1900 [2]. Regional anesthesia was practiced by surgeons, while general anesthesia remained in a primitive form for the next 100 years. It is the privilege of our generation to live to see the period of a widespread progress of anesthesiology – the history of modern anesthesia.

Soon after the end of World War I, when F. Pagés in Madrid published his first results with epidural anesthesia [3], in Great Britain H. Boyle was presenting anesthesia machines and I. Magill was introducing endotracheal intubation into the practice of anesthesia. This he did not only to facilitate H. Gillies' face-and-jaw reparative surgery on disabled soldiers [4, pp. 57–70], but also to create suitable conditions for the development of all surgical branches, and certainly a sine qua non for thoracic operations. F. Sauerbruch, the dominant surgeon on the European continent, was at the time experimenting with another approach to thoracic surgery. For about 20 years he tried to treat open pneumothorax by operating in a low-pressure chamber. Though aware of Magill's endotracheal tube and the possibility of positive-pressure ventilation, he obstinately refused the cooperation of anesthesia as an independent medical specialty. For more than 20 years, Sauerbruch's influence in all the surgical centers of continental Europe was an embargo on advanced British anesthesia crossing the Channel.

In 1942, when in Canada H. Griffith and E. Johnson were introducing the clinical use of curare – the green light for many new anesthesia methods – and in Sweden the first modern amide-linked local anesthetic agents were being synthesized, Yugoslavia was at war. In that same year, 1942, I was a medical student volunteering at the surgical department of the University Hospital in Ljubljana. As the youngest and hardly trained member of the staff I had to give general anesthesia – under the supervision of an aged nurse. I first practiced open drop ether on Schimmelbush's mask; later on I progressed to the more sophisticated Ombrédanne inhaler, "the outrageous crib of Clover inhaler" according to R. Macintosh [5]. It was a relief for me that the majority of surgical work was done as a routine under local anesthesia, which was performed by the surgeons (Schleich's infiltration technique, spinal anesthesia).

After the fascist invasion in Yugoslavia in 1941, all civil and military hospitals were occupied by the enemies. Until late in 1944, all the medical work in the Yugoslav Army had to follow a guerilla pattern. To provide care to the wounded, improvized hospitals were built deep in the woods. In the northern Yugoslav Republic of Slovenia, one of them is still preserved as a unique war museum. The choice of

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anesthesia, poor even in peace, was during the war still more dependent on the scarce availability of anesthetic drugs as well as of trained personnel. In these conditions, up to 1944, local infiltration with procaine was the most common method. In many hospitals in the woods open drop ether was used even in the presence of acetylene lamps! Ethylchloride was used for inhalation and for topical refrigeration during short procedures. However, one of the oldest known narcotics – scopolamine – was then available in abundance, though not ready for use. In the large northern woods of Slovenia, which provided security for the care of wounded partisans, *Scopolia carniolica,* the rich source of scopolamine, was blooming in its thousands every spring. More than 200 years ago, this plant was found in the same woods of the ancient province of Carniola and described by J. Scopoli, the miners' physician at the nearby large mercury mine, Idrija. This was how, according to Scopoli's great Swedish contemporary C. Linné, both Scopoli and Carniola gained "immortal glory" [6].

During the first period of our guerilla fighting many a surgical procedure was performed even without anesthesia – in endorphin analgesia. According to a report from Foča in Bosnia, there were performed in 1942 60 foot amputations, mostly resulting from frost injuries, without anesthesia and without shock, with one exception [7, pp. 192–198]. If available, morphine and homemade brandy were also used as analgesics.

In 1944, as the result of the aknowledgment of Tito's Yugoslav Army by the Allies, a number of Allies' Missions joined the Headquarters, among them some doctors [8]. Our military doctors met then for the first time with the very advanced methods of treating war injuries. Among the anesthetic drugs that we obtained from this relief by the Allied Forces, thiopentone was for us the most interesting one. Intravenous anesthesia was hardly used in Yugoslavia, except for the sporadic use of Evipan since 1934 [9]. The lack of experience with thiopentone, together with the easy technique of its administration, accounted for a rise of more than 100% in anesthetic mortality as compared with inhalational anesthesia.

Anesthesia for the surgical treatment of war injuries in the Yugoslav Army in 1944–1945 was divided into: operations without anesthesia (6.7%), operations with anesthesia (93.3%), general anesthesia (56%; of these 70% open drop method and 30% intravenous), regional anesthesia (42.5%), and combined anesthesia (1.5%). These figures reflect the general status of anesthesia in Yugoslavia, in the military [7, pp. 148–158, 201–213] as well as in the civil medical services up to the end of World War II.

After 1944 a number of severely wounded partisans, evacuated to Bari, Italy, were treated by the British Plastic Unit I, one of the six military surgical units organized by H. Gillies. Owing to the endeavors of this team many of our soldiers returned home with reconstructed bodily appearance and function.

In 1945, when the war was over, as a result of an agreement between H. Gillies and our government, Plastic Unit I came to Belgrade in order to organize a similar Yugoslav unit. The British anesthetist Patrick Shackleton was the leader of the Unit [4, pp. 440–441]. During 1 year's work at the Military Medical Academy, he introduced endotracheal anesthesia and educated the first Yugoslav physician-anesthetists. He changed the course of Yugoslav anesthesia from pure layman empiricism to a professional art and science, becoming the founder of modern anesthesia in Yugoslavia. During the following years our first teacher, P. Shackleton, visited our country on several occasions to see our work and to give lectures at our meetings. Until his death in 1977 he remained in warm contact with his "Yugoslav grandchildren" [10].

In 1946, P. Shackleton was followed in Belgrade by the British anesthetist, Russell Davies. It is to Davies' credit that the interest for the new anesthetic approach has spread to all other surgical branches. In 1946 and 1947, the United Nations Relief and Rehabilitation Administration (UNRRA) provided anesthetic machines (Forregger) for many Yugoslav hospitals. R. Davies postulated two more conditions for the development of modern anesthesia: the institution of blood banks and the production of nitrous oxide. As in 1946 there was to Davies' knowledge no nitrous oxide plant in Europe to the south of London, it was his opinion that a Yugoslav factory could provide gas for all southern Europe. He even discovered a nitrogen plant in Slovenia, where presumably the production of laughing gas could be organized. It was only in 1962, however, that a new nitrous oxide plant was built at the foot of the northern mountains. The factory is only a few miles distant from the village of Podkoren. The house no. 63 at Podkoren was visited several times during the years 1819–1828 by the discoverer of the anesthetic properties of the laughing gas, H. Davy, as mentioned on the memorial plate on the house: "Sir Humphry Davy (born 1778 – died 1828), the famous natural scientist and admirer of the local natural beauties, often lived in this house. May his memory be held in honour" [13].

Owing to the successful work of P. Shackleton and R. Davies, Yugoslavia was – like Sweden in the north – the first country in southern Europe to start modern anesthesia. In 1947 anesthesiology was legalized in Yugoslavia as an independent specialty. The first of Shackleton's pupils, Sever Kovaćev, obtained a specialist degree in 1948. In 1949 he organized the first anesthesia department, in Belgrade. P. Shackleton and R. Davies were awarded the Honorary Fellowship and Bettini's Medal of the Yugoslav Anesthesia Society. In 1957, H. Gillies was promoted Honorary Doctor of the University of Ljubljana, where – to his great satisfaction – he found not only a rather developed plastic surgery but also an anesthesia department. During an earlier visit to Belgrade, in 1948, H. Gillies was given a lemon from the tree in Tito's private garden and asked Tito to sign it; he published the photograph of the occasion in his textbook [4, p. 441] as "Order of the Lemon, First Class."

The increase in the number of anesthesiologists in Yugoslavia from 1945 to 1982 was from 1 to 724. Their education followed two paths. First, Shackleton's and Davies' pupils became our teachers in Belgrade. S. Kovaćev became Professor of Anesthesia in 1954. Teaching centers also developed in Skopje, Zagreb, Ljubljana, and Rijeka.

Second, the World Health Organization (WHO) anesthesia courses in Copenhagen, of 1 year's intensive practical training and theoretical teaching, were attended by 30 Yugoslav trainees from 1950 to 1971. Six of them were surgeons; in spite of WHO anesthesia diplomas, none of them proved a happy convert. Thus, whether by intention or not, they later represented anesthesia as being a minor part of surgery, which could be done with the surgeon's left hand. During a long period the surgeons in my country retained a rather unlimited influence upon the development of anesthesia – in both positive and destructive directions.

The first surgeon of the Yugoslav Army, and my late Professor of Surgery in Ljubljana, Božidar Lavrič, firmly supported the new specialty. In 1961, when this noble teacher died, the number of anesthesiologists in the small Republic of Slovenia was 35, as compared with 18 in Serbia, 12 in Croatia, 3 in Bosnia, and a few in Macedonia. Professor Lavrič started pulmonary resections in 1949 and open heart surgery in 1958. Nowadays, anesthesia departments are part of every Slovenian hospital, and all anesthesias are given by anesthesiologists. In another republic, however, because of the unfavorable and hostile approach of the surgeon, the then well-organized and modernly equipped anesthesia and intensive therapy department completely collapsed as late as the 1960s and it took years to be reconstructed by a new staff.

Because of the shortage of physician-anesthetists during the first decades of modern anesthesia in Yugoslavia, some surgical teams started to train technicians in the technique of endotracheal intubation and in the managing of anesthetic machines. First under the pretence of temporarily filling of the gaps, this new tissue in the anesthesia body proceeded to show the characteristics of cancer growth. Professor of Anesthesiology in Belgrade, P. Lalević, endured a long and difficult fight against this anachronistic trend in order to assure a future in which every anesthesia should be administered by anesthesiologists. The conflict has had great publicity in Serbia, both within the profession and outside it. The case was finally settled in the courts in favour of the anesthesiologists.

Regional anesthesia is the only part of our specialty which has never been taken out of doctors' hands. After the explosive development of modern general anesthesia, regional anesthesia was considerably neglected by the surgeons. The renaissance of regional anesthesia, performed by the anesthesiologists, started in Yugoslavia about 1958 as a result of the availability of the new Swedish local anesthetic drugs with reduced toxicity and duration. Modern regional anesthesia is still the Cinderella in my Country; however, once introduced into the routine of a department, it keeps a firm and steady position.

The Yugoslav Society of Anesthesiologists (YUARIL) was founded in 1962. It includes the anesthesia sections of six national medical societies (Table 1).

A congress is held every 4 years, and intersectional meetings yearly, all of them well attended. In 1969 the journal of the Society, *Anaesthesiologia Yugoslavica,* was founded.

There are, at present, no functioning independent chairs of anesthesiology in the Yugoslav medical faculties. In the program undergraduate study anesthesiology and reanimatology is lectured upon in six medical faculties by the university teacher-anesthesiologists attached to the chairs of surgery. Undergraduate teaching is limited to 15 lectures and 15 h of practical training. The program of postgraduate study is not uniform for the whole country. It lasts for 4 years in Slovenia and Croatia and 3 years

Table 1. Members of the Yugoslav Society of Anesthesiologists in 1982

National section	Founded	Number of members
Bosnia and Herzegovina	1975	75
Croatia	1962	225
Macedonia	1962	68
Montenegro	1981	11
Serbia	1958	187
Slovenia	1957	158

in other republics. The Institutes of anesthesiology, reanimatology, and intensive therapy of 12 medical centers (Beograd, Ljubljana, Niš, Novi Sad, Osijek, Priština, Rijeka, Sarajevo, Skopje, Split, Titograd, and Zagreb) are the nuclei of postgraduate education. The work in these institutes follows the international standard, in spite of economic limitations, especially with regard to equipment.

Systematic experimental work is still not organized on a large scale. The move toward a uniform program and duration of postgraduate education which would integrate clinical training in anesthesia with specialized instruction in basic sciences is now being discussed in some universities as well as in our Society. In 1979, the first Yugoslav textbook of anesthesiology and cardiopulmonary resuscitation was published by Prof. P. Lalević [12].

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4.16 The Development of Anesthesiology in Czechoslovakia

B. Dworacek and H. Keszler

B. Dworacek

In the nineteenth century, the part of Europe which is today known as Czechoslovakia was part of the Austro-Hungarian Empire. Prague not only boasted one of the oldest universities in Europe, but also took an active part in establishing the fame of the surgical school of Vienna. Therefore, perhaps not surprisingly, the first ether anesthesia in Prague was given (by C. Opitz in February 1847) less than 4 months after its efficacy had been shown in Boston, Massachusetts. Other advances soon followed. Among them were the early acceptance of chloroform, the introduction of premedication, and the use of the O'Dwyer metal endotracheal tube for maxillofacial surgery (K. Maydl).

In spite of this promising early start, modern anesthesiology in Czechoslovakia really began only after World War II. Medical assistance by the United Nations supplied a considerable amount of thiopental, tubocurarine, as well as modern anesthesia machines to the country. After specializing in anesthesiology in the United Kingdom during the war, L. Spinadel, upon returning to Prague, in 1948 founded the first independent anesthesia department in Czechoslovakia. Two years later he published the first Czech textbook on anesthesia. In 1952, the first ten specialists in anesthesiology became certified (based mainly on experience and full-time devotion to the specialty). Their efforts, and those of others who joined the specialty, soon led to a more systematic and organized training program in anesthesiology. The specialty became firmly established as a permanent department of the Institute for Postgraduate Medical Education in 1962 (with a Czech branch in Prague and a Slovak counterpart in Bratislava).

The development and growth of modern anesthesiology in Czechoslovakia was from the very beginning based on the principle that safe anesthesia requires medical knowledge far beyond that of anesthetic techniques and drugs. Basic sciences and a broad foundation in internal medicine and surgery were considered necessary. For this reason, clinical anesthesia was considered a medical specialty, but the need for specially trained nurse anesthetists to help the physician specialists was also recognized. The basic concept of anesthesiology was from the outset linked to profound interest and involvement in resuscitation and intensive care. The Institute for Clinical

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and Experimental Surgery in Prague has considered resuscitation to be one of the main components of its research program since its foundation in 1951. Ten years later, H. Keszler published the first Czech textbook on resuscitation [1]. Dworacek was instrumental in introducing the teaching of basic life support at all levels in the entire school system. Anesthesiology was soon officially recognized as the specialty responsible for intensive care, as documented in various rulings of the Czechoslovak Department of Health in 1962, 1971, and 1974. The rapid development of anesthesiology led to the publication of a number of textbooks [1–8].

Before starting specialization in anesthesiology, it was initially necessary to acquire a basic specialist certification in internal medicine or surgery. Since 1971, this system has been replaced by specialization in two stages, each taking about 3 years. The first stage includes a thorough study of basic sciences, and both stages are concluded by an examination. The rapid development of anesthesiology in Czechoslovakia was welcomed and supported by most surgeons. It was considerably aided by a high level of industrialization so that anesthetic drugs and anesthesia equipment could promptly be produced in the country. The production of a pneumatic nonrebreathing valve was started in 1951 (based on patents granted to H. Keszler) [5]. The valve later became part of a simple portable anesthesia vaporizer built to the specifications of L. Démant (Fig. 1). This vaporizer had two vaporizing chambers – one for ether and the other for trichloroethylene. It also had a bellows which could be used for assisted or controlled

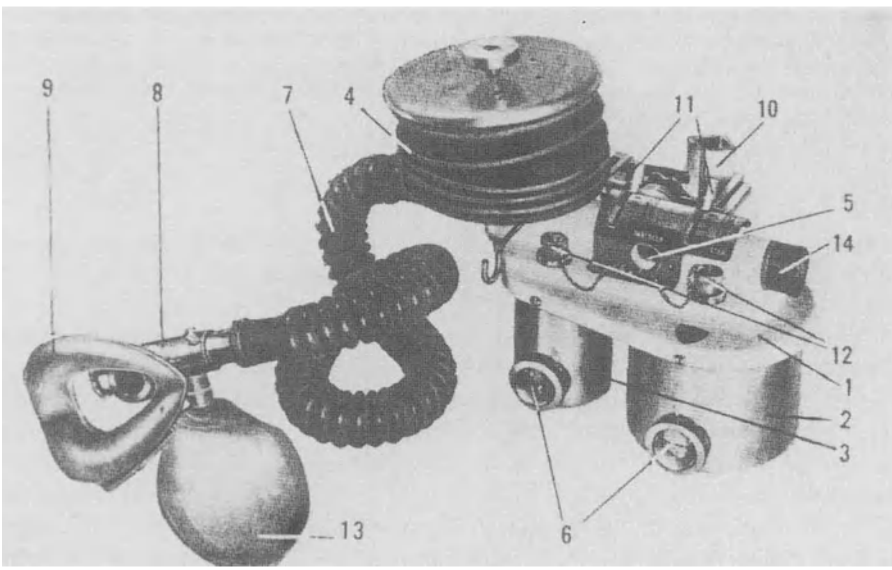

Fig. 1. The Démant-Keszler (DK) transportable anesthetic apparatus (1951). Dome of the apparatus (1), diethyl ether draw-over vaporizer (2), trichlorolethylene draw-over vaporizer (3), inflating bellow (4), air or gas-mixture inlet (5), fluid level control window (6), tubing (7), one way DK inflating valve (8), face mask (9), holder (stands, etc.; 10), levers for turning on one of the two vaporizers; when one was on the other was automatically turned off (11), stopers for filling vaporizers (12), bag for use when fresh gas flow was available (13), room for supplementary valve discs and rubber capsules for the inflating valve (14)

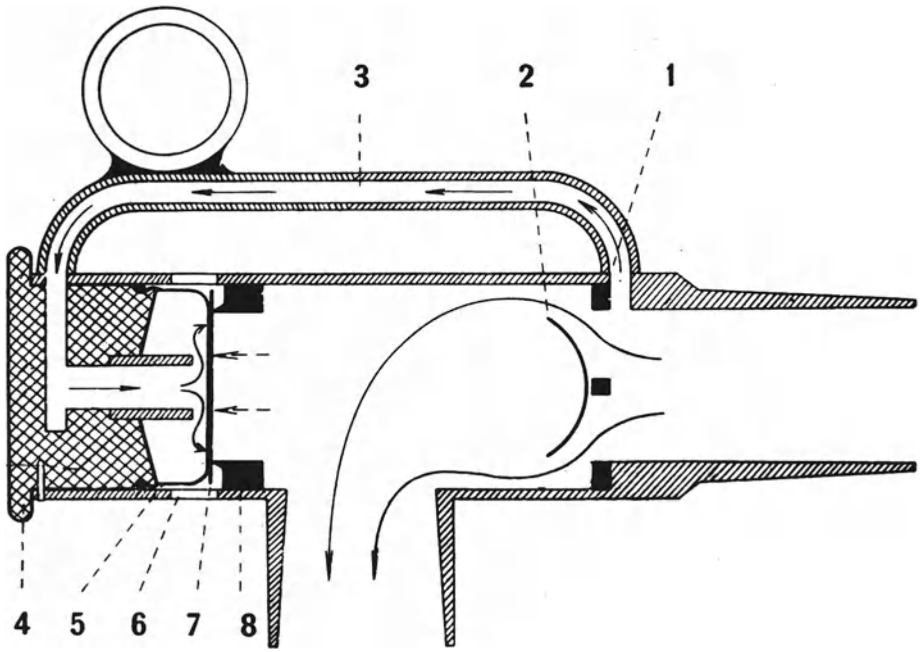

Fig. 2. Démant-Keszler (DK) inflating valve (1951). Inspiratory valve seat (1), one way inspiratory valve made of flexible rubber (2), connecting narrow tube from the inspiratory port to the capsule behind the expiratory valve disc (3), stopper with the seat for the rubber capsule (4), thin-walled rubber capsule closing the expiratory valve disc (5), outlet ports (6), one way expiratory valve disc (7), and expiratory valve seat (8). The pressure which is generated during the inspiration phase of the controlled ventilation is transmitted through the connecting tube to the small rubber capsule and pushes the valve disc onto the expiratory valve seat

ventilation with the nonrebreathing pneumatic valve [1] (Fig. 2). Modern closed-circuit anesthesia machines were soon also produced locally with the close cooperation of qualified anesthesiologists.

The involvement and enthusiasm of many physician specialists led to the formation of the Czechoslovak Society for Anesthesiology and Resuscitation in 1952. Although originally part of the Surgical Society, it became independent in 1961. This Society not only held frequent national meetings, but also organized the first regional Eastern European Symposium in 1965 and the European Congress of the World Federation of Societies of Anaesthesiologists (WFSA) in 1970 – both held in Prague. This degree of involvement and the fact that the Czechoslovak Society belonged to the WFSA from the very beginning also led to the nomination of a Czechoslovak anesthesiologist (B. Dworacek) as Deputy Chairman of its European Committee. The enthusiasm and cooperation of many individuals were instrumental in the rapid and successful postwar development of our specialty in Czechoslovakia. The merit of individuals seems to be less important in this context. All the same, we would like to mention a few who, we believe, deserve to be called pioneers of Czechoslovak anesthesiology. In addition to those already mentioned they include: J. Hoder, T. Kadlic, J. Minář, and J. Pokorny, who were followed later by A. Balla, M. Buroš, E. Racenberg, P. Scheck, and Z. Kalenda. The last five, as well as the authors of this report and L. Démant, left Czechoslovakia after the occupation by the Soviet Union in 1968. For this reason, their names have been purged from Czechoslovak textbooks on anesthesia and resuscitation. In spite of this, we are gratified that in the face of considerable difficulties modern anesthesia, resuscitation, and intensive care have attained a high level in the country of our origin. We are proud that until our departure we contributed to this development to the best of our ability.

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4.17 The First Interdisciplinary Centre for Intensive Care Therapy in Prague

E. Racenberg

The development of modern and autonomous anesthesiology in Czechoslovakia during the 1940s and the early 1950s was moulded by two personalities to such a degree that in retrospect one can state that all the distinguished anaesthetists of the Republic of Czechoslovakia are directly or indirectly disciples of one or both of them. They are the late Dr. Leo Spinadel, who received his professional training with Sir Robert Macintosh in Oxford during World War II, and Dr. Hugo Keszler, who acquired his specialization as anaesthetist at the Karolinska Hospital in Stockholm and who was the tutor of the author of this lecture.

These preliminary remarks in my lecture on the first interdisciplinary intensive therapy unit in Czechoslovakia were necessary, as it was Dr. Keszler who, by his active cooperation and support, had founded that unit, of which I was in charge, in Prague in 1965. I certainly do not have to emphasize the amount of problems and obstacles that had to be overcome in order to found an intensive therapy unit, managed by anaesthetists only, because I believe nearly everyone present is well acquainted with those problems. Furthermore, it is obvious that the specific problems of a socialist country did not exactly facilitate the organization. As compensation, however, a beautiful early baroque building in the centre of the old city of Prague was made available for our purposes, and the cooperation of an enthusiastic architect was ensured. At last, on 15 February 1965 this central intensive care unit was opened. Up until that time, the beginning of 1965, Prague, the capital of Czechoslovakia, with over 1 million inhabitants, did not have a central institution for the treatment of critically ill patients. Before that all those patients had to be treated in various hospitals which were rather poorly equipped as regards medical staff and technical appliances.

From as early as 1959 a group of staff members at the Institute for Clinical and Experimental Surgery – then led by Dr. Keszler – had been thinking about setting up a resuscitation centre following the Scandinavian model, in which all patients who require continuous ventilation and intensive therapy could be treated centrally. After the thorough conversion of one part of an eighteenth-century monastry, the Department of Resuscitation of the Prague Institute was established in the hospital of Na František. The maximal capacity of the department was considered to be a 14 beds. The admission of patients was arranged in close cooperation with the ambulance service of the capital, thus enabling the doctor on call to be informed in advance by radio about the patients being sent for treatment. The department dealt with acute intoxications, comatose conditions, neuroinfections such as, for example, tetanus,

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polyradiculoneuritis or mayasthenia gravis, and life-threatening conditions in general. Patients were not only admitted from the town area of Prague, but also from other hospitals in Bohemia and Moravia.

The resuscitation ward was designed on the principle of one large unit, that is to say a hall with simple, easily removable screens, about 1.5 m high. According to the plan of organization this central intensive care unit represented an autonomous department of the Institute of Clinical and Experimental Surgery, managed by an anaesthetist. Although all members of the department were fully trained anaesthetists, the department did not carry out any anaesthetic services as such, but only met the tasks of intensive care therapy. In addition to that, the department took part in research work in the field of pathophysiology of terminal conditions, as well as investigating the problems of controlling continuous ventilation and making a technical examination of respirators. Furthermore, they investigated the problems arising from the treatment of intoxications.

The central intensive care unit additionally served as a training centre of the Institute for Postgraduate Studies, concerned with the special training of doctors and nurses in the field of intensive care medicine. The staff consisted of four specialized anaesthetists, one assistant (registrar), 16 nurses with one matron, three male nurses, four ward aids, two laboratory assistants, one mechanic and one secretary. The department was equipped with a central plant for oxygen, compressed air and vacuum supply, as well as with specially developed intensive care beds. In addition, there was some further technical equipment for the diagnosis and therapy of critically ill patients. Of the larger pieces of equipment the department owned a moveable X-ray unit, a six-channel ECG, two simple ECG monitors, one blood gas analyser and one capnograph. The therapeutic equipment consisted of three Engström ventilators, two Lundia ventilators, five Bird ventilators, three volume-cycled ventilators produced in Czechoslovakia and two French-made volume-cycled ventilators. The department was able to make use of the services of the central biochemical laboratory and of the Neurological Department of the Na František Hospital. The ward closely cooperated with the Institute for Toxicology and Forensic Chemistry, with the Isolation Clinic and the Institute for Forensic Medicine and the Institute for Aviation Medicine.

I shall now give a short survey of the patients who were treated in that department in the course of the first 2 years. All in all, 794 patients were admitted during that time, among which were 393 (50%) with drug intoxication, 179 (22%) with town gas poisoning, 47 (6%) with neuroinfections, and 175 (22%) with various comatose conditions and respiratory disturbances. Of those patients 93 (11.5%) died, but among them there were 35 (4%) with acute intracerebral haemorrhage who had been admitted to the department with comatose conditions of unknown aetiology. The cases of neuroinfections were subdivided into 23 patients with tetanus, 14 with polyradiculoneuritis and 20 with encephalitis. The techniques performed included prolonged intubation, forced diuresis, alkalinization in cases of intoxication, and, in cooperation with the Prague Military Hospital, hyperbaric oxygenation – techniques of intensive care therapy which then were quite modern.

Research work concentrated upon the problems of the technique of long-term ventilation and humidification of the airways, as well as on problems arising from prolonged intubation. The initial experiences of the department have shown that centralization of critically ill patients and their treatment by methods that are based on modern therapeutic measures as applied in daily anaesthetic practice can save up to 30% of the lives of those patients who, until then, were irretrievably lost.

Finally, I must emphasize that at the time, when we were about to take up our work at the central intensive therapy unit in Prague we had good friends in other European countries who supported us by work and deed. Now, 20 years later we should like to express our thanks to them. These friends were Rudolf Frey, Martin Holmdahl, Karl Steinbereithner and Ulrich Strahl.

4.18 From Open Ether to Open Hearts

D. M. E. Vermeulen-Cranch

D. M. E. Vermeulen-Cranch

Anaesthesia today is the product of the achievements and failures of yesterday. Success requires not only insight, enthusiasm, knowledge and skill but also considerable powers of perseverance in the face of obstacles. This has been so in the progress in anaesthesia achieved in the Netherlands.

As a student at the Welsh National School of Medicine, Cardiff, I found "Anaesthetics" fascinating but rather frightening. It was a visit to the Radcliffe Infirmary, Oxford, in 1941 that really sparked my enthusiasm to become an anaesthetist. Obtaining a post as resident at University College Hospital (U.C.H.), London during World War II opened up great possibilities. To see such renowned anaesthetists as, among others, I. Magill, M. Nosworthy, R. Mansfield, Machray, G. Organe and Massey Dawkins on the job, and to attend the Royal Society of Medicine and Association of Anaesthetists Meetings, was stimulating. Many a free afternoon I spent at the Brompton Hospital. Mostly, these visits extended well into the evenings. How could it be otherwise with such active thoracic surgeons as Tudor Edwards, Price Thomas and Brock. Thoracoplasties were carried out under local analgesia and sedation. Lobectomies for bronchiectasis – preceded by bronchoscopy to remove that sputum which had eluded the fantastically competent physiotherapists – and operations for lung abscess, destroyed lung and tumours – necessitating Magill or Thompson blockers or endobronchial tubes – were the order of the day. The concerted skills of surgeons and anaesthetists resulted in reasonable success, although eyes, fingers and ears were the only monitors apart from blood pressure, pulse and capillary refill. Infusions and blood were given to patients. For abdominal surgery, intercostal nerve blocks combined with coeliac plexus block or spinal analgesia, supplemented with sedation and oxygen, were an improvement on deep anaesthesia. With the introduction of curare, local analgesia was largely displaced by light anaesthesia combined with the muscle relaxant. At University College Hospital, however, Massey Dawkins was enthusiastically using epidural analgesia. Some of this enthusiasm rubbed off on me and I did a series of epidurals for caesarean section [1]. Prof. R. Macintosh came to see how it worked and was surprised at the well-maintained blood pressures. Good fortune must have been on my side, because we knew nothing about inferior vena cava compression syndrome then.

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On 17 June 1946, armed with this experience and a British training, I took up the challenge to improve anaesthesia at Amsterdam University Hospital, at the invitation of Prof. W. Noordenbos Sr., who held the Chair of Surgery. Noordenbos was the first Dutch surgeon to realize that without the help of modern anaesthesia, surgical progress in the Netherlands would be impossible. As in other continental countries "narcosis" (anaesthesia) was the responsibility of the surgeon, who delegated it to the youngest surgeon in training or to a nurse. Since the youngest trainee was keen, above all, to become a surgeon, he had little interest in anaesthesia or in the equipment for giving the occasional nitrous oxide with oxygen and ether. Mostly, local, spinal and regional analgesia and open ether were used.

It amazed me that "Killian" and "Hewer" were the only books available. The only anaesthetic apparatus I found in the academic Hospital was a McKesson circle machine, modified to give a continuous flow, and a very simple Boyle's machine, modified so that expired gases could escape only at the machine end under water at about 10 cm or more of positive pressure. The bubbling sound on expiration and the deep spontaneous respiration were evidently reassuring to the surgeons. Fortunately, since most operations were short, carbon dioxide accumulation was not fatal. However, this idea of expiration against a positive pressure was conceived, as I discovered much later from Dr. W. Hekman, one of my trainees in Amsterdam, by a surgeon, Meisz, who wrote in his thesis (Leiden, 1925) that it could prevent the lung collapsing if the thorax was opened, provided the face mask was held tightly on the face throughout. His promotor, Prof. T. Zaaijer, had introduced this gas, oxygen and ether machine, but in spite of the fact that it could be cheaply made it roused no general interest. It was used successfully for orthopaedic operations in Leiden. I was shown one of these machines in Burger Hospital in Amsterdam, unused. Having seen the glass tubes, corks and leaking tubing, I was relieved when the patient decided not to have his operation.

It was an exhilarating experience to improvize with so few facilities. Oxygen was available, but nitrous oxide was scarce. Endotracheal anaesthesia was unknown and its use caused quite a stir, as did the use of tubocurarine and controlled respiration. Burroughs Wellcome had supplied me with their first batch of curare in solution as I left London in June 1946. Obviously, thoracic surgery had not been able to develop, but the demand came on the day that Professor Boerema succeeded Professor Noordenbos in September 1946. Waters' canisters, my portable machine and endotracheal equipment saved the day. On Boerema's initiative and with my enthusiasm the first School of Anaesthesia in the Netherlands started in January 1947 with two trainee's, Dr. Boere and Dr. Mauve, both unsalaried but sincerely motivated for the future.

Professor Nuboer of Utrecht, who, in May 1946, had told me that there were no anaesthetists in the Netherlands and that they were not needed because the surgeons were responsible for the anaesthesia, came to me in Amsterdam one Sunday in August because his last three patients had died during operation, as the result of the anaesthetic, so that he did not dare to continue operating. On my arrival in his operating theatre, as I had suspected from his description, I was able to show him why they had died of carbon dioxide poisoning. The unidirectional valves in his McKesson circle machine had disappeared, probably as the result of too rigorous cleaning procedures. Afterwards, I managed to help Professor Nuboer with difficult and thoracic patients for two or three afternoons and evenings a week, from August 1946 for about a year. To my relief, Dr. Bobby Roberts of the Middlesex Hospital, London, took over from me in the autumn of 1947. Later, after a period of training with Roberts, Dr. C. R. Ritsema van Eck went to Groningen to train other doctors in anaesthesia.

In November 1947, a congress on thoracic surgery was held in Amsterdam to demonstrate the surgical procedures carried out with the aid of modern anaesthesia. The surgeons were elated. At last the key to the closed thoracic cage was available. In exchange, I acquired the assistance of a head male nurse solely for the anaesthetist, a set of Negus bronchoscopes, bronchial blockers, and the ward nearest the theatre as a postoperative ward, fitted with oxygen tents and suction, where, if physiotherapy failed, I could also bronchoscope the patient. It must have been the first recovery room and intensive care unit on the Continent. By this time, other departments, such as Neurosurgery, Gynaecology, Ophthalmology, ENT, Plastic Surgery, Psychiatry, Pediatrics and Internal Medicine were seeking the help of our little Department of Anaesthesia. It was not long before operations for patent ductus arteriosus (1947) and coarctations of the aorta (1947) were being carried out in Amsterdam, to be followed by closed intracardiac surgery for valvular stenosis (1948). In the meantime, the Dutch Association of Anaesthetists was founded in January 1948. Regulations for a training period of at least 2½ years were made based on the English Diploma course.

For a few patients in extremely poor condition I had been using refrigeration analgesia for amputations. "Could we use it for a radical mastectomy," Boerema asked. "No", I replied, "without a tourniquet there would be generalized body cooling." Boerema's alert mind applied this information, and he started his experimental work, with our help, on hypothermia in dogs as an aid to closed cardiac surgery. The results were published in 1950 [2], the same year as Bigelow, but quite independently.

The University of Amsterdam was the first to give recognition to anaesthesiology by appointing me as *Privaat Docent* (Lecturer) in Anaesthesia, in 1951. I had been lecturing in English to medical students for 3 years, but now the official first public lecture and my lectures thereafter had to be in the Dutch language [3].

Experimental work was done and theses and papers were written and presented on temperature measurement, expired carbon dioxide monitoring, continuous blood oxygen saturation measurement during anaesthesia, postoperative blood oxygen saturation measurements, hypothermia for closed cardiac surgery, controlled hypothermia with air cooling, controlled hypotension, resuscitation of the newborn, resuscitation, nerve blocks for pain relief, and therapeutic and prognostic nerve blocks [4–9]. Trainees came and went. Boeré became Lecturer in Leiden in 1955, and Mauve was similarly appointed later by the University of Utrecht. Forming a permanent or semi-permanent staff was extremely difficult, when anaesthetists were in great demand all over the Netherlands.

Clinical demands increased, particularly during the poliomyelitis epidemic in 1953 in Holland, when the benefits of our assistance outside operating theatres became obvious. Again, the University of Amsterdam rose to the occasion, and I was appointed with Royal consent Professor of Anaesthesiology in May 1958 [10]. This was the first chair in anaesthesiology on the Continent and the first ever to be held by a woman in anaesthesiology. Since I then had two children, and being honest, I requested one afternoon a week for my children. Officially my appointment was 9/10 full time. This however did not limit my position or voting power in the University. A recovery room, induction rooms, a workshop, a conference room and offices were built for our Department. I was able to appoint an instrument maker and electronics engineer, so that, apart from routine care of apparatus, a new infant ventilator and apparatus for controlled hypothermia using air cooling could be built [11]. A budget for books and apparatus, and even a secretary, were made available. Further research resulted from the hyperbaric chamber built for Boerema, namely anaesthesia in a hyperbaric operating theatre, hyperbaric oxygen in surgery of cyanotic cardiac disease, and a thesis on hyperbaric oxygen in the treatment of carbon monoxide poisoning. The first heart operation in the hyperbaric chamber was carried out in 1960 [12–17].

The employment of full-time staff became possible when I agitated for improved salaries. The attraction to work part time elsewhere on completion of training decreased. This resulted in improved teaching programmes and a higher standard achieved by trainees [18, 21]. Two trainees, J. Spierdijk and D.H.G. Keuskamp, now occupy or have occupied Chairs in Anaesthesia in Leiden and Rotterdam. Sluyter and Deen became lecturers in my Department. The period of training required by the Dutch Committee for Registration of Specialists was prolonged recently to 4½ years to include 6 months' internal medicine and 6 months' intensive care. Central theoretical courses on a national scale have become popular, and examinations – at present on a voluntary basis – are being carried out. In the future it will be an asset to have partaken in and passed such courses and examinations.

Nowadays, a certain minimum of equipment and assistance is required to be available wherever anaesthesia is given (Netherlands Ministry of Health Advice 1972 and 1978). The standard set is high and, since annual budgets have been reduced, there are problems. Fortunately, however, priorities are frequently being given to anaesthesia departments.

The Amsterdam Academic Hospital is built in the pavilion style. This is a disaster for the supervision of trainees, if staff is inadequate, and also for postoperative care in the diverse recovery rooms. Fortunately, in 1981 the new Academic Medical Centre, Amsterdam opened. Part of the hospital has already moved there. As I planned many years ago, there is a centralized preoperative holding area, operating theatres with induction and extubating rooms and a central recovery room, adjoining the holding area. Trained technicians care for the modern anaesthetic, monitoring and ventilating equipment. Specially trained nurses assist the anaesthetist in theatre and recovery. A centralized intensive care unit and special facilities for paediatric patients and for day surgery are available. Automation and computers will play an important role in this new centre. In the centralized outpatient department the anaesthesiology department will hold regular pain clinics with multidisciplinary consultation facilities. Patients for clinical admission and for day surgery will be seen at a preassessment outpatient clinic held by anaesthetists to improve the preoperative psychological and physical condition with respect to anaesthesia. This will offer new facilities for research and teaching to trainees and students.

Our present research programmes are concerned largely with chronic pain relief, pharmacological research in the cardiopulmonary department, clinical research on conscious sedation methods in dentistry for handicapped patients, high-frequency ventilation and complications associated with high-risk patients [22–27]. Our teaching programmes and clerkships for medical and dental students and postgraduate teaching are being intensified and are well evaluated.

In the Netherlands, the progression from pure patient care and the provision of a service towards professionalism in anaesthesiology has taken place in the comparatively short number of years following World War II. With specialists in short supply, patient care and service has had to take priority, but teaching and research are making steady headway.

The standards of patient care, anaesthesia, personnel facilities and equipment are high. There are increasing opportunities for improvement in teaching and research, enough to fill the tomorrows of our young anaesthetists, who will function, with full recognition, alongside their professional colleagues in other specialties.

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4.19 Cyclopropane Anesthesia: Its Introduction at Wisconsin

Betty J. Bamforth

B.J. Bamforth

Shortly after Ralph Milton Waters was appointed as Head of Anesthesia at the State of Wisconsin General Hospital in Madison, in 1927, he embarked on several laboratory investigations with members of the basic science faculty. These included evaluations of new drugs, mechanisms of anesthetic action, and methods of administration. Many efforts were made during the 1930s to find an anesthetic agent which would be more acceptable than the commonly used ethyl ether or the less potent gases, nitrous oxide and ethylene. Thus it was especially interesting to Waters, when in June 1929, at the meeting of the Canadian Medical Association in Montreal, he heard Prof. Velyien E. Henderson report the anesthetic properties of cyclopropane.

Professor Henderson, the Head of Pharmacology at the University of Toronto, and an anesthetist from Toronto General Hospital, Dr. W. Easson Brown, had been experimenting with propylene, but problems with toxic impurities led this investigation to be discontinued for a time. The chemist, George H. W. Lucas, who had joined Dr. Henderson's department, suggested that cyclopropane, an isomer of propylene, might be the responsible contaminant. On 22 November 1928 he prepared enough of the gas to administer it to two small kittens in a bell jar. Lucas and Henderson were impressed with the resulting anesthesia and, realizing that cyclopropane was not the toxic impurity in the tanked propylene, conducted further investigations of the gas. They determined the concentrations needed for surgical anesthesia, the solubilities, and the explosive range. Dr. Brown anesthetized several of the staff, including both Lucas and Henderson. It seemed time to submit the agent to clinical trial.

However, as Lucas was later to report:

At this juncture our luck changed. Three anesthetic deaths occurred in Toronto in a relatively short period; there was much newspaper publicity about them. Dr. Brown, who had anaesthetized several of us successfully in the laboratory, requested the privilege of administering cyclopropane, even for a short surgical procedure. A demonstration was arranged in our laboratory one evening, when Dr. Brown anaesthetized Dr. Frederick Banting before a group of Toronto anesthesiologists. Among the guests was the Head of the Department of Anaesthesia of the Toronto General Hospital. But because of the ethyl chloride deaths and the fear of any consequences should a fatality follow the administra-

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tion of cyclopropane, Dr. Brown was forbidden to use this gas in the Hospital. We continued some experiments with commercial cyclopropane supplied in small tanks by E. R. Squibb & Sons Inc. Professor Henderson realized our position and encouraged his close friend, Dr. Ralph Waters, to use cyclopropane clinically" [1].

In the spring of 1930 Waters wrote to Henderson requesting reprints of papers on anesthesia and also said,

I should be greatly interested also in knowing what the latest developments are with the cyclopropane matter. If you feel that this gas deserves further clinical trial than you are able to give it, we should be very glad, of course, to run a small series; and as you know, our technique here lends itself readily to small quantities of gas, two or three gallons or four or five at the most, being sufficient for the conduct of an anesthesia".

He was referring to his closed system of anesthesia with carbon dioxide absorption. (This and other letters quoted are in the Archives of the University of Wisconsin, Madison.)

Henderson responded,

We have recently tested on man, samples of cyclopropane furnished us by the Ohio Chemical Company, but see no possibility of really satisfactory clinical trials here. I have no doubt the Ohio people could furnish you with a good quality of cyclo and we would be glad to see you try it, if you would care to do so, for anaesthesia.

Waters admitted that he felt "some hesitancy" in asking the Ohio Chemical Company to supply samples of the gas because the hospital in Madison did not "habitually deal with the company." However, on the same day he requested that they quote a price for a very small quantity of the gas. Records indicate that a cylinder containing 10 gallons of cyclopropane, at the cost of U.S. $ 5.00 for the tank and U.S. $ 16.00 for the contents, was shipped to Wisconsin General Hospital on 1 August 1930. Waters' laboratory records note that on 17 August 1930.

A large shepherd dog (wild) was given (with no premedication and with the carbon dioxide absorber method) one part of cyclopropane and three parts of oxygen, beginning at 9:31½. Respiratory rate increased from 30 to 65; pupils dilated markedly and did not react to room light. Expiration was an extremely unusual jerky type during the induction. Complete loss of sensation and brain reflexes, together with conjunctival and corneal reflexes occurred in 1½ minutes. An unknown, but slight addition of oxygen then resulted in rather smooth, with apparent complete relaxation, respiration deep and slower and pupils contracted.

Waters stated:

From the above experiment, we will conclude that in this particular dog, surgical anesthesia could be maintained with responsible safety, with mixtures of cyclopropane and oxygen varying from fifteen percent up to fifty percent. We would also conclude that there is a reasonable margin of safety, at least on the table, in the use of this gas as an anesthetic agent, the circulatory system maintained long after respiratory depression and even arrest had occurred.

On the basis of the careful laboratory work of Lucas and Henderson and because of the small amount of cyclopropane available to him, Dr. Waters proceeded to anesthetize clinical subjects. On 20 August 1930, he wrote to Professor Henderson:

Being satisfied that I need not harm the patients, I have used the remainder of the tank for three complete clinical anesthesias. One simple appendectomy – thirty-five minutes, one inguinal hernia – forty minutes, and one fat lady (her tenth operation) for the removal of a gall bladder, previously drained, and the repair of an inguinal hernia, the latter operation lasting one hour and twenty-eight minutes. An attempt to use the tank again this morning gave me an induction, but during the insertion of the pharyngeal airway, the small amount of cyclopropane was lost so that the one dog anesthesia and three clinical were all I could secure from the ten gallons. He then described the relaxation achieved as "better than could have been secured in any other way than spinal. Whether it was as good as we would have secured with spinal, I doubt."

He also noted that the blood pressure was "surprisingly stable" and that there was "a surprising lack of respiratory stimulation even during induction in the first case and we therefore didn't insert the soda lime during induction in the other two." In conclusion he stated,

I believe that further investigations in this gas are distinctly indicated because the thing which anesthesia needs more than anything else at the present time, it seems to me, is a quick acting gaseous agent which will produce reasonably extreme relaxation of abdominal muscles with reasonably rapid recovery therefrom. This, it seems to me, cyclopropane shows some possible evidence of doing.

Waters wrote in a similar vein to Mr. J. G. Sholes, President of the Ohio Chemical and Manufacturing Co. and added,

I do not mean by this that it should receive any hit or miss trial by the general run of anesthetists throughout the country, but I do believe that by carefully controlled administration and observation, we can come to some definite conclusions. Three cases are not sufficient for making such conclusions.

The empty cylinder was returned so that it might be available for refill whenever a further supply of the gas became available.

Cyclopropane was produced on a small laboratory scale by the manufacturer, making the high cost an embarrassment to the company, which found it necessary to charge U.S. $ 50.00 per cylinder or U.S. $ 2.50 per gallon. However, Mr. Sholes added

... of course, as soon as we are assured of any steady demand, we will manufacture the gas on a commercial scale which would undoubtedly reduce the cost at least 50%. If you write a paper, we hope that you will mention that the present high cost is entirely due to manufacturing two or three cylinders at a time by laboratory methods with improvised equipment which is far from economical.

The Great Depression was to play a role in further research. It was nearly a year later that Waters inquired about an additional supply of the gas, saying, "I desire very much to continue some experimental work with the gas, but I find the University in a very hampered financial status which seems so far to have precluded the further purchase of this gas," and asked whether it could be purchased in larger containers at a more reasonable price. Later he wrote,

I am extremely anxious to continue some work this fall with cyclopropane. I have, however, to be frank with you, not the nerve to ask either the Hospital or the Dean to pay for cyclopropane at the rate of two dollars a gallon. This amount of nerve, however, may come to me, and when it does, I certainly want some cyclopropane. I do not need an excessive amount, since by use of the closed system, as you know, I waste none of the gas at all. I still believe that it has possibilities of being a distinct addition to our present group of gases. I must, however, do more clinical work with it in order to be positive enough to say this on paper.

As I said before, I hope that my courage may become bolstered up to such a point that I will insist that either the Hospital or the medical school furnish me with a supply at two dollars a gallon.

The manufacturer did find it possible to supply the gas at a lower price in order that the research work be continued. They also noted that if they were to invest a few thousand dollars in equipment, they would be able to produce the gas at a price which would "put it within the reach of all who wish to use it," and estimated that since it was mixed with a large amount of oxygen, the actual cost of anesthesia would be far less than one might think when compared with nitrous oxide.

Reasons other than funding may also have contributed to the delay in studying cyclopropane. Several years later, when Waters commended Professor Henderson for his interest in searching for better anesthetic agents, he added:

> I do not know whether I ever told you or not but when I heard your first report on cyclopropane in Montreal, I came home quite enthusiastic. I tried the drug in a few clinical cases as soon as possible thereafter and did some sporadic work with animals in the laboratory. It then became necessary to decide whether we would go into a thorough investigation with cyclopropane, and after careful thought at this time, I came to this conclusion. Organic chemistry had progressed a great deal in recent years. My attitude was that it would probably progress still further. One of the main disadvantages of the drugs which we were then using in the operating room was the fact that they did constitute a fire hazard. What we needed was a drug like nitrous oxide with simply a reasonable amount of added potency. My thought was that maybe some bright organic chemist would produce such a drug. I held off therefore with cyclopropane for a period of two years. Since my dream did not seem to come true, what work has been done on cyclopropane resulted. My impression now is, and I think that you would like to have it, that cyclopropane has been a very, very great contribution to clinical anesthesia. My impression also is that until a drug of the kind suggested above appears on the horizon, cyclopropane will stay.

This prophecy was indeed correct.

But we should return to the work already mentioned. Having ensured that a continued adequate supply of the gas would be available, work in the laboratory continued with renewed intensity, and plans were drawn for a rather intensive clinical trial. It was decided to replace ether and ethylene with cyclopropane on five anesthesia machines for a period of 3 months. Several hundred patients were anesthetized in this period.

At the Meeting in October 1933 of the Annual Congress of Anesthetists in Chicago, Stiles, Neff, Rovenstine, and Waters presented the results of the administration of cyclopropane in 447 cases. Animal studies which had been conducted in the medical school laboratories were reported a short time later. These included the important collaborative efforts with the physiologists and pharmacologists, a pattern of interdisciplinary investigation which was the hallmark of the Waters' era in Wisconsin. By 1934 Waters and Schmidt, the Chairman of the Department of Surgery, who had persuaded the University to appoint Waters to his academic position, presented the new anesthetic agent to the medical community in a paper published in the *Journal of the American Medical Association.* Interest in the agent had spread rapidly; after a 1933 presentation to the Anesthesia Travel Club, it was made available to a few selected anesthetists. Public interest in the new drug was certain to be high and it was necessary for the manufacturer to decide when and how it should be made available to others. The members of the Travel Club had suggested that there had not been sufficient work on the new gas and that it should not be placed in the hands of those not capable of using it safely. Several of the Travel Club members began to use it immediately, including Dr. Harold Griffith, who later wrote [2]:

> Early in October, 1933, our Travel Club again visited Madison, and this time we saw what cyclopropane really could do. No new drug has ever been given a more comprehensive, intelligent, and conclusive study by any one group of investigators. A few months later the work was reported by Waters and his associates, and even today this report remains the definitive paper on cyclopropane. Very little has been added to our knowledge of the gas after millions of cases which was not already observed by these wise investigators.
>
> Personally I was so favorably impressed by what I saw of cyclopropane that I arranged for a supply, and on October 30, 1933, in Montreal, I gave what I believe to be the first clinical cyclopropane

anesthetic anywhere outside of Madison. Very rapidly at my hospital cyclopropane became the most routine of all agents and has so remained to this day.

The Ohio Chemical and Manufacturing Co. continued to cooperate in withholding the gas from general sale until greater experience was obtained. Although they were anxious to begin selling cyclopropane so that there might be some return for the sums of money and years of time invested in its production, they continued to caution that it was extremely potent and to warn that it should be supplied only to those who understood this and its proper administration.

On 15 October 1934, at a meeting in Boston, Massachusetts, there was a report of a larger number of cases from Wisconsin and from other workers as well. The use of cyclopropane was introduced in many hospitals in the United States and abroad. However, in 1936, in a letter to James T. Gwathmey, Waters mentioned the enthusiasm which chloroform enjoyed in the 1840s and 1850s, and warned that

cyclopropane has some of the qualities of chloroform in that it is technically wieldy and "looks nice" to observers in the operating room. Until we are dead sure that it has not some of the pitfalls that chloroform had, I think we should call it an experiment.

At the old Wisconsin General Hospital it continued in favor for the next 25 years. It had the ability to provide a smooth induction and a speedy recovery from anesthesia, adequate relaxation of muscles for most operations, and was fairly economical when administered by the closed absorption technique. It was not until halothane became popular in the 1960s that Waters' prophecy of the 1930s came to pass. Cyclopropane did in fact stay until it was displaced by a potent, nonflammable agent capable of producing muscular relaxation.

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4.20 The Introduction of Neuromuscular Blocking Drugs into Anaesthetic Practice in a Large "Poor-Law" Hospital

F. R. Ellis and W. P. J. Bickford Smith

The introduction of any drug into clinical practice is always interesting, especially when it is the first of a new group. The introduction of curare is particularly important as it marked the beginning of the modern concept of balanced anaesthesia. Yet in 1942 curare was not a new drug.

Waterton obtained wourali in 1812 during his first "wandering" in British Guiana and brought it back to Great Britain in 1814. Some of Waterton's original wourali, which was donated by the Waterton Collection in Wakefield Museum, Yorkshire, has been investigated in St. James's University Hospital, Leeds. It was found to contain a *d*-tubocurare-like substance and other alkaloids which produce reversible muscle relaxation of a rat phrenic nerve diaphragm preparations [10]. South American arrow poison was known to others before Waterton, but it was he who, with Sewell and Brodie, performed the crucial experiment to show the poison was reversible if artifical respiration was maintained [1]. Claude Bernard demonstrated in 1850 that curare acted on the motor end plates [2], and King isolated the pure substance [3]. Although Waterton was prepared to try wourali in rabies he never had the opportunity. Hunter, and much later West, Cole and Mitchell all tried curare in a variety of spastic conditions, including tetany and tetanus [4–6]. In 1938, Richard Gill took South American arrow poison to the United States, where McIntyre stimulated E.R. Squibb & Sons to produce a water-soluble extract called Intocostrin [7].

With hindsight, the beautifully straighforward paper by Griffith and Johnson describing their use of curare in 25 anaesthetics was a classic [8]. The conclusion at the end of Gray and Halton's paper [9] delivered at the Royal Society of Medicine on 1 March 1946 was as follows:

> The road lies open before us, and with a grave and insistant warning to the inexperienced that we are dealing with one of the most potent poisons known, we venture to say that we have passed yet another milestone and the distance to our goal is considerably shortened".

In the remainder of this paper the intention is to try and assess how rapidly the "rank-and-file" anaesthetist appreciated that the introduction of curare was indeed the milestone claimed for it by Gray and Halton.

In St. James's Hospital in Leeds, as in other British hospitals, there is a legal requirement to record in an operating theatre book details of all surgical procedures. In the 1940s it was customary to record not only the patients' details and type of operation but also the anaesthetic drugs used. As curare was a new agent for anaesthetists, it may be assumed that its use would have been faithfully reported. Indeed,

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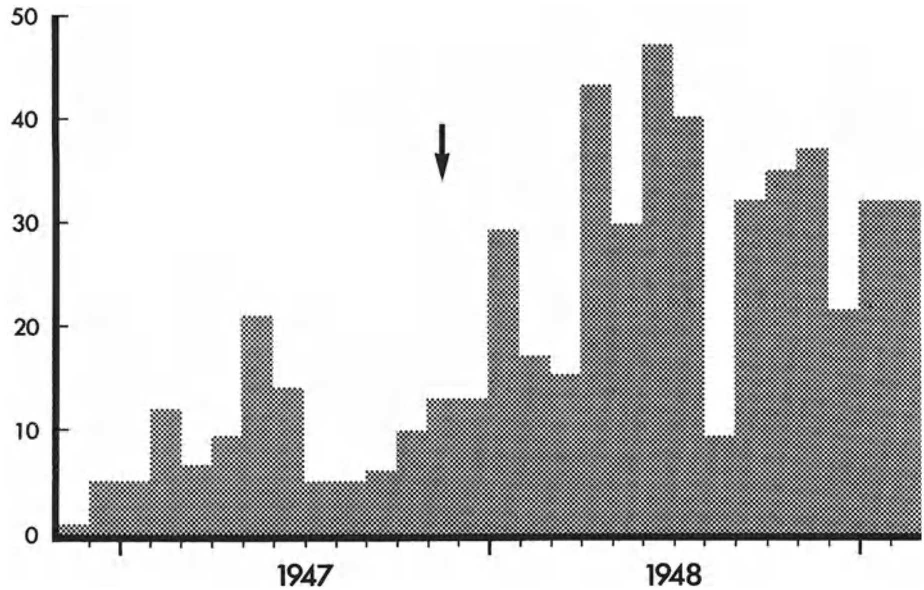

Fig. 1. Incidence of curare anaesthesia

an entry made on 13 November 1946 indicates that Miss Mertle Hicks (who has only recently retired from consultant anaesthetic practice) was the first anaesthetist to give "curarine" to a 24-year-old man who was to have a partial gastrectomy performed by Mr. Pyrah. During the following month curare was used on three occasions by two other anaesthetists. On 26 November 1947, Dr. Jean Hall addressed the Inaugural Meeting of the Yorkshire Society of Anaesthetists on the use of curare. This followed her visit to Liverpool, where Professor Gray had demonstrated its use. Following this there was a rapid acceptance of curare by most of the senior anaesthetists attending St. James's Hospital, judging from the increase in the number of cases for which it was used (Fig. 1).

The influence of curare can be seen when the various type of anaesthetic used in the 1940s is assessed (Table 1). This decade was a period of rapid change. The sudden drop in the number of ether-air anaesthetics is dramatic and is mirrored by the rise in the ether-nitrous oxide anaesthetics between 1942 and 1945. By 1948 the use of

Table 1. Percentage incidence of types of anaesthesia

	1942	1945	1948
Ether	77.4	15.4	0.7
GOE	8.0	72.2	49.6
Local	8.0	3.7	8.8
Spinal	2.6	3.2	5.7
Barb. ind.	3.1	3.3	53.3
Cyclopropane	0	0	3.4
GO	0.4	0.9	24.7
Curare	0	0	8.5

GOE, gas, oxygen and ether; Barb. ind., barbiturate induction; GO, gas and oxygen

Table 2. Percentage incidence of type of surgery for which curare was used. Number of cases is shown in parentheses

	1946	1947 (1)[a]	1947 (2)	1948 (1)[a]	1948 (2)
gastric	80 (4)	28 (19)	29 (15)	8 (13)	5 (7)
acute peptic		7 (5)	2 (1)	6 (10)	5 (8)
gall bladder		3 (2)	15 (8)	8 (13)	2 (3)
appendix	20 (1)	16 (11)	8 (4)	13 (21)	14 (21)
laparotomy		15 (10)	2 (1)	6 (10)	1 (2)
lower abdomen		7 (5)	10 (5)	8 (12)	3 (5)
plastic		12 (8)	25 (13)	39 (62)	49 (73)
other		10 (7)	10 (5)	11 (17)	21 (31)

[a] 1947 and 1948 cases are presented as first and second 6-month periods

barbiturates can be seen to have greatly increased, and at the same time curare was making a distinct impression on anaesthetic techniques. The use of curare and of barbiturates probably accounts for the great increase in the number of nitrous oxide/oxygen anaesthetics recorded. The rapid changes in anaesthetic techniques may relate largely to the effects of World War II on the training and experience of anaesthetists. In 1942 most of the trained anaesthetists were in army service. 1948 is the year of the birth of the National Health Service in the United Kingdom, and with it the establishment of anaesthetists with full specialist status.

The case selection is surprising (Table 2). Early papers often stressed the preservation of normal respiratory muscle activity even though abdominal muscles were well relaxed. It is presumed that most of the patients during this period were spontaneously breathing. The use of prostigmine is mentioned only twice in this period, once in late 1947 and once in 1948. The rapid growth in the number of plastic surgical patients whom were given curare is inexplicable.

The latency period between the first description by Griffith and Johnson of the use of curare in anaesthesia and 1946, when it was first used in a typical "poor-law" hospital, can be ascribed to a variety of factors, including poor transatlantic communication and the other effects of World War II. Professor Gray may have been correct to refer to the use of curare as a milestone in anaesthesia. Although it was reached in the 1940s, it was not passed until the early 1950s.

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4.21 Reminiscences of the First German Anesthesia Congress in Hamburg (1927) and Rolf Frey's Departure to Mainz

H. Killian †

H. Killian

On the occasion of this meeting at the Erasmus University on the history of modern anesthesiology it seems to me to be correct to remember the first anesthesia congress at Hamburg in 1927, which had been organized by a few men who were interested in anesthesia – men such as the gynecologist Professor Gauss and the pharmacologist Wieland (both of them from Freiburg im Breisgau), who had developed and propagated narceine anesthesia; the surgeon Helmuth Schmidt, the assistant of Perthes in Hamburg-Eppendorf, who had reintroduced anesthesia with nitrous oxide *(Lachgas);* the general practitioner Von der Porten; the pharmacologist Behrends; the gynecologist Franken; and myself. Dr. McMechan, the Editor of *Current Researches of Analgesia and Anesthesia* and President of the Anesthesia Research Society of the United States, with whom we were in close contact, was also present at that time.

The problem then was the elimination of chloroform and other halogenous anesthetic compounds because of their extreme depressive effect on the heart and circulation and because of negative statistics in favour of other less dangerous methods such as ether-oxygen anesthesia *(Äther-Sauerstoff-Narkose)* and gas anesthesia with nitrous oxide *(Stickoxydul),* ethylene *(Äthylen),* and narceine in the mixture with oxygen. At that time the death rates for chloroform anesthesia were 1:2670–2700; for chlorine-ethyl anesthesia *(Chloräthylrausch),* 1:3000 with wide deviation; for ether/oxygen anesthesia *(Äther-Sauerstoff-Narkose),* 1:15000–20000; for gas anesthesia with nitrous oxide/oxygen anesthesia *(Stickoxydul-Sauerstoff),* 1:13000–1:100000; for ethylene *(Äthylen),* more than 1:100000; and for narceine, about 1:1000000. In the struggle against the unpleasant effects of ether anesthesia, first of all the uncontrollable Avertin rectal anesthesia was developed, but it could not be continued on account of extreme respiratory depression. Then came intravenous anesthesia with the Evipan-Natrium of Helmuth Weese, which meant a tremendous improvement and which helped us greatly in the front lines during World War II.

Already in 1927/1928 we had considered whether the time had come to create a special study group or a professional society for anesthesia, bringing our two anesthesia journals to concentrate on the pertinent studies. This first large anesthesia

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Fig. 1. "With what shall we anaesthetize after this congress?" This humoristic drawing demonstrates well professor Killian's artistic gift. The drawing shows doctors attending the first German Congress of Anaesthetists in Hamburg and bears several signatures. Dr. McMechan attented the meeting as well *(upper left)* and his wife Laurette McMechan is remembered here by one of her very rare written statements. It appears, however, that the drawing was composed in two different years: there is a date 21 Oct. 1928 as well as the 1927 *(lower right)*

congress was very well attended. It developed in an interesting way with great vitality but ended rather unsatisfactorily because no far-reaching resolutions were taken and nobody really knew what he should do. In memory of this congress in Hamburg I have supplied a small sketch. On it one can read the signatures of some of the pioneers of anesthesia, such as that of Dr. McMechan and his efficient wife Laurette (Fig. 1).

The fate of gas anesthesia with ethylene and narceine was very soon decided because of the great explosive danger of the oxygen mixture. Very many, unfortunately lethal, accidents caused by explosions had occurred in the United States. Also cyclopropane, which was introduced later by Hendersen and Lucas and by Ralph

Waters and Schmidt (in 1929/1930) had to be dropped as an anesthetic because in higher concentrations it caused disturbances in the conduction system of the heart. According to my own studies this is a characteristic effect which is specific for all gases of the hydrocarbon type with three C-atoms in the molecule.

The demand for specialization in anesthesiology became most urgent and it was categorically denied by competent German surgical circles. In the minutes of the committee of the *Deutsche Gesellschaft für Chirurgie* (German Society of Surgery) of 30 May 1950 under the responsible guidance of K.H. Bauer, Rolf Frey's Chief, one can read (in translation): "For the training of anesthesia physicians there is no urgent need; on the contrary, a better training of the anesthesia nurses is more urgent." Consequently, the whole affair was dropped. It was said, that according to the then valid jurisdiction, the operating surgeon was responsible for the whole operative procedure; consequently, the anesthetist only took the part of an assistant and actually was permitted only to take this part. A specialization or an independent position of this branch had therefore on all accounts to be declined. At the most an older assistant or a university physician could be made responsible for the whole sphere of anesthesia in a hospital. This person, however, would have to remain the subordinate of the head of the hospital.

Under these conditions it was impossible to obtain a solution by negotiation. Everyone who was engaged in the further development of anesthesiology soon realized that. Action became imperative.

The unbearable situation in Germany was very apparent, especially as other civilized countries in Europe had followed the good example of the British and Americans in acknowledging fully the special branch of anesthesia and had created professional societies. As a result of this pertinacious opposition by prominent surgeons our nation was thrown back in the development by more than 10 years. Nevertheless, as everyone knows, in the end we have succeeded in regaining lost time. Many experienced the decisive meeting in Salzburg in 1950 and the creation of a study group for anesthesiology followed by the creation of the *Deutsche Gesellschaft für Anästhesiologie und Wiederbelebung* (German Society of Anesthesiology and Resuscitation) in 1951, during the great convention of surgeons in Munich. But only a few know that the actual stimulus for the creation of the first professorship in anesthesiology did not derive from our numerous articles and textbooks, our proposals, or from my memorandums, but from one of the expert opinions I was asked to give on the anesthetic deaths at the university surgical hospital in Mainz, where Prof. Georg Brandt was Herbert Peiper's succesor.

This is what happened during Peiper's time:

A young, inexperienced assistant was allowed to operate independently for the first time on a 17-year-old boy with an acute appendicitis. A trainee was ordered to give the anesthetic. No protocol existed, but it was possible to conclude from the report of the operation that the boy had been prepared in the usual way with morphine-atropine, and then, shortly before the operation, with two 50 mg doses of Dolanthin. The anesthetic was Evipan-Sodium IV. The operating surgeon had great difficulty in finding the extremely inflamed concealed appendix. The operation lasted for more than an hour; finally the young man had to admit his incapability and had to seek help from the head physician. He found the appendix within a few minutes and removed it. During the anesthetic the patient had repeatedly suffered muscular spasms and cyanotic phases. The trainee, considering the restlessness caused by the muscular spasms to be a sign of the patient's awakening, took a second ampoule of Evipan-Natrium and injected about 7 ml of the 10% solution IV. The muscular spasms and the breathing disturbances with cyanotic phases increased, and only in the postoperative phase did they cease.

At 5 h postoperatively the boy had not gained consciousness; he lay in bed pale, unconscious, his skin greyish-blue. His circulation collapsed during the night, his breaths came by fits and starts, and slight muscular spasms could be registered. In the treatment record there is no information concerning an infusion, nor of a blood transfusion, but strophanthin and Coramine were given in small quantities. After a slight improvement the patient showed no reflexes. He was put under an oxygen tent. An intubation was tried but owing to lack of experience it failed. The possibility of tetanus was discussed in differential diagnosis. However, the consultant neurologist diagnosed damage of the cerebral truncus caused lack of oxygen. The worse was feared, and death followed the next night. The patient's elderly father, a widower, was left in despair, his life destroyed by the loss of his only son. He could not comprehend this outcome, and a lawsuit followed.

In my evidence I stated that many of the mistakes that had occurred were due to lack of a thorough training and to lack of experience in the persons involved. Although the anesthetist had noticed during the operation the repeated phases of muscular contraction with disturbance of the breathing and also cyanosis, he had not started with an ether-oxygen anesthesia as was the rule. Because he did not recognize the problem and believed the patient was waking up, he injected a second ampoule of Evipan-Natrium IV. After that, the spasms and breathing disturbances with cyanotic phases increased, and a cerebral defect due to lack of oxygen was the result. Furthermore, as a consequence of the spasms, hemorrhages occurred in the brain, in the heart, in the stomach, and in the bowels, as was discovered later by the autopsy. Neither the surgeon nor the anesthetist had recognized the extreme danger of the situation in time to act properly.

I wrote: "A beginner cannot be burdened with a case of malpractice, as he is not yet in command of this mode of medical treatment." It was not correct to transfer the burden of responsibility for the operation on two young physicians in training without supervising their work. Undoubtedly there existed a lack of supervision. It was not so much the two physicians involved who were responsible for the unfortunate result of the operation, but the head surgeon, and indirectly the medical faculty, the university, and the ministry for culture and education, because not enough had been done to change the impossible conditions for anesthesia in Germany. Of course, the court requested an additional expert opinion. The law suit lasted for years; in the end, the accused persons were condemned because the judges had to accept my arguments. As was to be expected, there was an appeal against the verdict as the prestige of the university and the hospital had to be considered. We do not know how the case was solved; that is not important at the moment. What are important, however, are the consequences of my complete revelation of the situation. Professor Brandt, a most warm-hearted and intelligent surgeon, declared afterwards: "Things cannot continue in this way, something must happen to improve the training in anesthesia and its control."

At that time, the technique for intubation was beginning to gain ground and was an additional technique to be learned. Therefore, Professor Brandt turned to Dr. Rolf Frey because he knew that Frey, then assistant at the surgical hospital in Heidelberg, had a special interest in anesthesia. Frey had habilitated in 1952 with a thesis on the subject: "Relaxants for surgery," and had also worked with Hügin in Basel and with J. Lundy at the Mayo Clinic. In 1960, he was offered an independent position as the head of a department for anesthesiology at the surgical hospital at the University of Mainz – in effect a position as the first professional anesthetist to be given the title

Fig. 2. Prof. Dr. med. Rudolf Frey †

Professor. Rolf Frey came to consult me. Knowing well that he (disabled during the war) was suffering extremely under the eccentricities of his chief K.H. Bauer in Heidelberg and that his health was in bad state, I advised him most seriously to accept the call at once, so as to ensure all his rights for the further steps of becoming appointed as university professor and member of the medical faculty in Mainz. Only after getting all contracts signed should he inform his chief of the accomplished facts, otherwise great difficulties were to be expected. That is exactly what happened. R. Frey (Fig. 2) became the first officially appointed professor of anesthesiology in Germany and soon afterwards also the first university head professor (Ordinarius) for anesthesiology and reanimation, that is *Intensivmedizin*. This arrangement was copied by others.

In the meantime, the development of anesthesiology as an independent branch of medicine could no longer be stopped. It had become an interdisplininary branch. This development has logically increased and expanded tremendously. Our resuscitation technique for all kinds of cases has led to intensive nursing and intensive medical treatment. This technique has become part of the first-aid organization, thus improving it, and has become part of emergency medicine and recently also part of disaster medicine.

You will understand that the sad events of Frey's death in Mainz during Christmas 1981 have affected and shocked me greatly, as it was I who pointed out to Rolf Frey the way he should go. You all know better than I how he made use of his possibilities. Who could foresee that his rise to be a man so greatly estimated in international circles would end so tragically? Nobody doubts the fact that it was he who, with his extraordinary activity, succeeded in gaining worldwide acknowledgement for German anesthesiology and who helped decisively to promote this branch. There is now nothing more for us to do but to try to forget this tragic end to his life and to remember with thankfulness his great merits.

4.22 A Tale of Two Cities

T. C. Gray

T. C. Gray

The word symbiosis is defined as the association of dissimilar organisms to their mutual advantage. This definition summarizes admirably the historical relationship between the two great cities of Northwest England, 30 miles (48 km) apart, during their phenomenal growth to prosperity in the eighteenth and nineteenth centuries; but it also relates to their contribution to anaesthesia in the second half of the twentieth century. As this is a meeting concerned with history, perhaps it is appropriate to review briefly their history and so put into context their anaesthetic contribution.

Manchester is the older of the two cities. Whilst that part of the country which is now the city of Liverpool remained nothing but forest and marshland, the Roman fortress, Mancunium, was established by the time of the second Roman invasion under the Emperor Agricola in 79 A.D. It was an important fort, a staging post on the way to the wild north and a junction between the Roman roads traversing the country from north to south and from east to west. For another thousand years Liverpool was to remain a small fishing hamlet, until King John, on a journey through his realm, suddenly saw the potential of the River Mersey as a harbour and the hamlet as a centre convenient for keeping in subjugation the troublesome areas of Wales, for colonizing the unruly and savage kingdoms of Ireland and for controlling the barbarous tribes from Scotland in the north.

Thus Liverpool was actually the first of the two towns to be established by a Royal Charter, which was bestowed by King John in 1207. Despite many evidences of Royal favour enjoyed by the burgesses of Liverpool, the town remained as just a useful port and changed little over the next 500 years. In the fourteenth century there was a change in the situation of Manchester – a change in which the Netherlands played no little part. King Edward III of England, having married the daughter of the Earl of Hainault, sent emmissaries in 1350 to tempt the workers of Flanders to come to England in order to exploit their skill in wool and cotton manufacture. The nineteenth-century historian, Fuller, describing the lot of these workers in Flanders writes: "Early up and late in bed and all day hard work and harder fare – a few herrings and mouldie cheese, they were happy to come to England to bring with their mystery" [1].

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However, it was the Industrial Revolution and the introduction of steam that resulted in the great transformation of the towns into two of the most prosperous cities in the world. The symbiosis then became very apparent. Baubles and textiles manufactured in and around Manchester were carried in Liverpool ships to the west coast of Africa and traded for men und women – slaves. These were then transported in the same Liverpool ships to America, where the slaves were in turn traded for cotton, which was brought back again in the same ships to the mills of Manchester and the surrounding towns. The merchants of the two towns required faster transport than that provided by the roads and canals linking the cities, and together they built the first passenger railroad in the world. This ran between the two cities and was opened in 1830. Manchester, however, was not content to be just a centre of industry. It saw Liverpool as a glamorous port with prosperity not founded on the grime of industry but on shipowning and the receipt of customs duties. Manchester decided to turn itself into a port also, and thus the great Manchester Ship Canal was constructed and opened in 1879. This could allow large vessels to sail from the waters of the Mersey right into the very heart of Manchester.

As in trade, so in medicine: Whilst Liverpool had the earliest medical school (in fact, the first medical teaching in Liverpool arose from the necessity of keeping the slave ships supplied with surgeons), it was Manchester that gave the Liverpool Medical School its first university status. The Liverpool Medical School was at first a constituent body of Victoria University Manchester, which already had university status, and only in 1903 did Liverpool University receive its own charter.

A spirit of collaboration with friendly competition has characterized the anaesthetic societies of the two cities. Both have had their distinguished pioneers. In Manchester, Pinson, hoping to achieve a more efficient dosimetric method of giving ether, developed his "Ether bomb" (Fig. 1). This was a tough, thick metal container for the ether, which was immersed in hot water; when the outlet tap from it was opened, there emerged a jet of pure ether vapour. Also in Manchester the *British Journal of Anaesthesia* was founded in 1923. Many here will remember Dr. Falconer Hill, who represented Manchester on its first editorial board. He died as recently as 1974, at the age of 97 years (Fig. 2), and maintained his interest in anaesthesia up to the end of his life. He did original work in the early 1930s to elucidate the mechanism of changes in respiration and circulation during spinal anaesthesia and for this was awarded a Doctorate in Medicine and a Gold Medal [3]. It was, I think, at about the same time that he developed an experimental temperature-controlled vapourizer for chloroform. He thought deeply about "automatic anaesthesia", and I quote from Professor Hunter's obituary: "In an era before computers, he pioneered 'automatic anaesthesia' using the respiratory displacement as the servo-mechanism to push the requisite amount of anaesthetic into the patient and the respiratory centre as the sensor."

Whilst all that was going on in Manchester, Liverpool also had its pioneers. The first wire frame mask for the vapourization of volatile anaesthetics was developed not by Schimmelbusch but by Thomas Skinner (Fig. 3), an obstetrician of Liverpool, in 1862. Undoubtedly, however, the man who contributed most to the specialty in Liverpool in the years between the two world wars was Robert J. Minnitt (Fig. 4). Of Irish descent and from a line of churchmen he was one of the outstanding British anaesthetists of a generation which included Rowbotham, Shipway, Magill and Dudley Buxton. Min-

Fig. 1. Pinsons Bomb

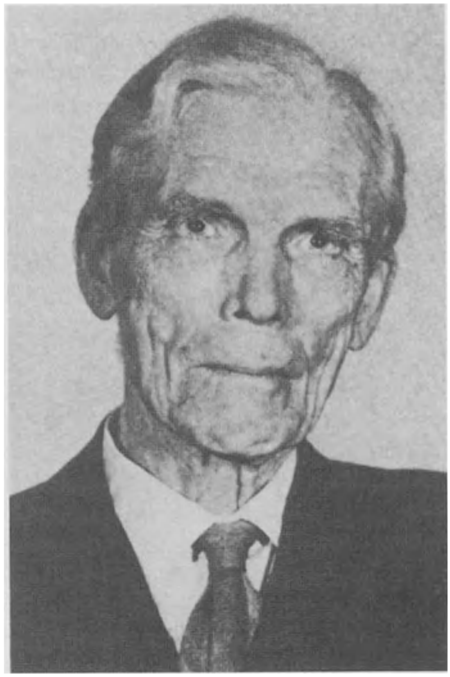

Fig. 2. Dr. E. Faulconer Hill

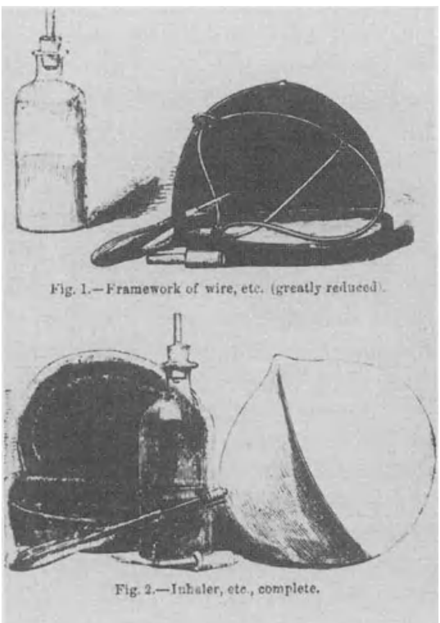

Fig. 3. Skinners Mask

Fig. 4. Dr. R. J. Minnitt

nitt's fame rests on his lifelong dedication to the relief of pain during obstetrics. Like most anaesthetists of his day he was in general practice. He had quite a large obstetrical practice and this directed his attention to the relief of pain during labour. He sought a method which could be used with safety by midwives, for they carried out the majority of deliveries in England in the patients' homes. In 1933 Minnitt attended a meeting to discuss the use of nitrous oxide and oxygen for obstetric pain relief held at the Royal Society of Medicine [2]. The disadvantages of this combination were clear, and Howard Jones suggested that air might be considered as a substitute for oxygen. Minnitt considered this suggestion as he made his way back to Liverpool on the midnight train. He was soon in touch with his friend Charles King (Fig. 5), a designer and manufacturer of anaesthetic equipment in Devonshire Street, London, and it was he who suggested that the McKesson oxygen administration apparatus, using nitrous oxide cylinders instead of oxygen, might be modified so as to entrain air during inspiration. Minnitt initially suggested 60% nitrous oxide and 40% air and carried out the original clinical investigations and trials. A 50:50 mixture was eventually accepted and became the basis of the Minnitt gas and air machine (Fig. 6) for administration by patients, which was eventually accepted for use by specially trained midwives. But perhaps more important was Minnitt's influence as a teacher of safe and scientifically based anaesthesia, for this gained him the respect of his colleagues in the hospital service. He became the first lecturer in the subject in the University of Liverpool, the first anaesthetist member of the Faculty of Medicine, and, what was even more remarkable in those early days, he was admitted as a full member of the medical board of his hospital – the first anaesthetist in Liverpool to be thus appointed. He was

Fig. 5. Mr. Charles King

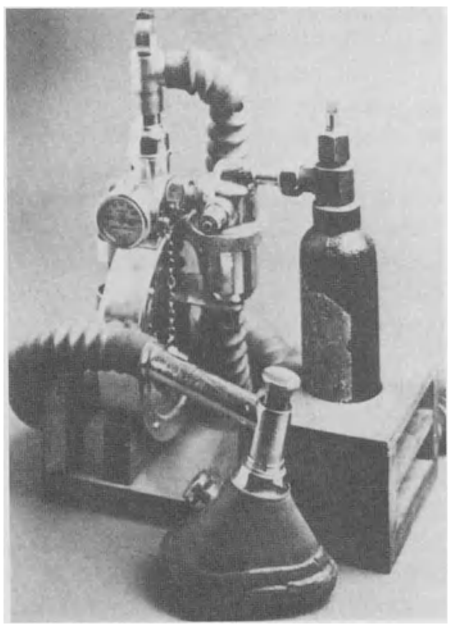

Fig. 6. Minnitts Machine for self administration of nitrous oxide and air

honoured nationally by being elected as a founder member of the Association of Anaesthetists and as President of the Anaesthetic Section of the Royal Society of Medicine, and he was given an Honorary Fellowship of the Royal College of Obstetrics and Gynaecology for his work on obstetric anaesthesia. Despite all this acclaim for gas and air anaesthesia, his most interesting contribution, in my opinion, was to be his research into the use of insulin and glucose in the shocked state – an idea recently resurrected. His thesis on this led to his Doctorate in Medicine.

In these early days of modern anaesthesia Manchester and Liverpool evolved together to some extent. Both Falkner Hill and Minnitt were associated with the *British Journal of Anaesthesia* as consultant editors from its beginnings. The Liverpool Society of Anaesthesia, the first in the United Kingdom outside London, was formed in 1937. When the Manchester Society, of which Falkner Hill became the first President, was formed in 1945, the two Societies started an Annual Joint Meeting and Dinner which still continues.

During World War II the Americans had a bomber base at Burtonwood, situated about half-way between the two cities. Merseyside was protected from German air attack by a barrage of balloons and a Royal Air Force (R.A.F.) squadron. The Medical Officer for the Merseyside Squadron was Dr. John Halton, a very remarkable man. Before the war he had established himself as a full-time anaesthetist of unusual ability, with skill amounting to virtuosity; so much so that when the thoracic unit in Liverpool was formed he was chosen by Morriston Davies, a distinguished pioneer in thoracic surgery, to be its anaesthetist. Halton was a man of ingenuity; he developed, among other things, a method of bronchial intubation and blockage, which could be performed blind without bronchoscopy. As he was in the R.A.F. he had entry to the Officers Mess at the American Base at Burtonwood near Liverpool, and there, in 1943, he heard of the work with Intocostrin being carried out in Montreal by Harold Griffith. He persuaded his American friends to provide him with samples of the precious material. This he used on his thoracic patients and he gave me some for my cases in general surgery. Rather quickly it became apparent that it was not a very satisfactory product. It seemed that a large amount was required to produce a really helpful effect. This may have been because both of us wanted to use minimal doses of volatile agents.

However, we were able to treat a very few patients with the small quantity made available to us by the Americans and, excited by these early results, we sought more material. Recalling the curare which we had used in physiological experiments as students, we approached Dr. Rod Gregory, then a Lecturer in the Department of Physiology at Liverpool. He gave us all of the "curarine" in the Department – small glass phials of a white powder, which was, of course, the pure alkaloid tubocurarine which had been isolated in the Wellcome Laboratories in 1934 by Harold King. After autoclaving the vials we dissolved the powder in bottles of saline for infusion and dripped it into the patients. The result was miraculous and we were clearly on to something far better than Intocostrin, for we were administering quantitatively the pure alkaloid. This was late in 1943. With Gregory, I carried out a number of Starling heart-lung preparations in cats to determine the effects on the myocardium and reported jointly with Halton the results of our first thousand cases at a meeting of the Anaesthetic Section of the Royal Society of Medicine on 1 March 1946 [4].

We were convinced that the way to use curare intelligently was to use it in doses greater than advocated in the United States and with very light anaesthesia, and not just as a tool to achieve better relaxation during anaesthesia with potent and consequently therefore toxic anaesthetic agents such as ether or cyclopropane. So we advocated that the lightest narcosis, produced for the most part with nitrous oxide, should be used with curare.

Now Halton at that time had a liaison with the I.C.I. Pharmaceutical Laboratories at Alderley Edge outside Manchester and was friendly with their superb pharmacologist James Raventos, who had been doing work on new intravenous barbiturates [5]. One of these, "kemithal", he was using in thoracic work. But the interest of I.C.I. in anaesthesia extended further. In the 1930s, at their laboratories near Liverpool, a research chemist, J. Ferguson, was investigating fluorinated hydrocarbons and had become particularly interest in their biological effects. As Johnstone has pointed out, Ferguson "formulated the thermodynamic approach to the chemical constitution of narcotics" [6]. His work was interrupted in 1939 by World War II, but after the war he went back to I.C.I. and was joined by another Liverpool graduate, Charles Suckling. Between them they synthesized hundreds of fluorocarbons and examined their biological effects on lower forms of animals [7]. Ten of these fluorocarbons, Suckling decided, might be useful. Their biological screening was carried out by James Raventos [5]. One of them – "fluothane" – was considered the most promising [5]. So the discovery of fluothane originated in a laboratory near Liverpool and was fostered by a Liverpool graduate, Suckling. But Dr. Ben Wevill, the Medical Director of the Pharmaceutical Division of I.C.I., who was responsible for organizing the clinical trials of the new compound, turned to Manchester for help and not to Liverpool. Liverpool at that time had an active University Department of Anaesthesia, it had collaborated with Raventos through John Halton in the clinical trials of kemithal. There is little doubt in my mind that Ben Wevill's decision to turn to Manchester was at least in part determined by Liverpool's strong advocacy of relaxant techniques based on the lightest anaesthesia and on the whole the discouragement of what I used to call the "smelly agents". (In the discussion following this paper Prof. A. R. Hunter pointed out that the reason for the choice of Michael Johnstone for the clinical trials was his work on the interpretation of the ECG changes during anaesthesia.) In fact, I.C.I. were absolutely right in their decision, for at that time neither Halton nor I, nor indeed any of our colleagues in the Liverpool University Department, would have had much enthusiasm for a halogenated hydrocarbon as a volatile anaesthetic. I.C.I. were doubly lucky in enlisting for the clinical trial Michael Johnstone [8]. The first patients received fluothane in the Manchester Royal Infirmary on the 20 January 1956, and Johnstone's most careful work and intelligent approach to the clinical trials led to the agreement by the Medical Research Council that the trial should be extended further. John Dundee was the one in my Department who took part in this extended trial, and I well remember the satisfaction with which I received a preliminary report on his personal headaches when he was using the new anaesthetic! The story from then on is well known, for within 2 years fluothane was in worldwide use and has, of course, been truly a milestone in anaesthesia!

Thus it was that Liverpool for a short time pushed back the volatile agents from the frontiers of advancing anaesthesia, and it was Manchester which within 10 years brought them forward again. Dr. John Nunn put this very well at the ceremony at which he, as Dean, presented James Raventos with the Honorary Fellowship of the Faculty of Anaesthetists:

> It seemed that in the late 40's we were set on a course in which the inhalational anaesthetics were destined to disappear. It appeared that the future was to be i.v. agents supplementing nitrous oxide. Quite suddenly as a surprise to nearly all of us, you [Raventos] revolutionized the trend in anaesthesia completely by introducing a brand new inhalational agent which turned out to be a major advance in pharmacology. Halothane had come to stay.

Acknowledgments. I wish to express my thanks to Prof. J. E. Utting for suggesting a comparison of the contributions of the two cities and to Dr. Michael Johnstone and Prof. Andrew Hunter for help with the story of Manchester's contribution.

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4.23 Reminiscences of the Development of Modern Anaesthesia in Norway

I. Lund

In Norway, as in most other countries, anaesthesia used to be the surgeons' province; nurses gave the general anaesthetic. Student nurses were taught to give "drip anaesthetics" during their training in the operating theatre, but medical students received no such instruction. Surgeons, who were legally responsible for the anaesthetic, were considerably handicapped when things did not go as planned. Anaesthesia as a discipline did not exist.

The need to develop the discipline of anaesthesia was eventually recognized in our country, partially as a result of surgical advances. Before and during World War II, the pioneers of thoracic surgery, Johan Holst and Carl Semb, had advanced beyond thoracoplasties to operations on organs within the thorax – which were considered complicated and dangerous. So it was our thoracic surgeons who saw that further advancement in surgery was dependent of what was then called "modern anaesthesia" and who encouraged the first Norwegian doctors who choose this specialty.

It is interesting to look back on the amount of interest which was placed in the techniques of intubation. One was rightly aware of the necessity for tracheal intubation during intrathoracic operations. It was not always easy, today's anaesthetists will certainly understand. Especially when we remember that curare was not available and that nurse-anaesthetists were terrified of giving the patient too deep an anaesthetic. A successful intubation was, in other words, not unreasonably regarded as a sort of "open sesame" and an omen of success. The intubator was an important person. In Norway of that time, a few ENT surgeons had taught themselves the art of bronchoscopy, and were used to intubating the patients who were to undergo intrathoracic surgery. This arangement, where the responsibility for intubation was separated from the many other anaesthestic responsibilities and problems, was, of course, unsatisfactory.

During World War II, Otto Mollestad was appointed to take charge of some anaesthetics at Ullevål Hospital, Oslo. Otto Mollestad had performed research at Oslo University's Pharmacological Institute on narcotic solubility and distribution within the organism. He had had no formal training in anaesthesia, but he acquired a didactic practical experience. His skill and technical ability, and not least his enthusiasm, advanced the development of anaesthesia at a time when the country was isolated from the rest of the world by the war and occupation. Otto Mollestad worked at Ullevål Hospital without pay. Ivar Lund had also become interested in anaesthesia, and had administered many anaesthetics during his surgical training. These two doctors were the first to specialize in anaesthesia after the war: Otto Mollestad with

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Robert Macintosh at the newly established Nuffield Department of Anaesthetics in Oxford and Ivar Lund at Henry K. Beecher's Department at Massachusetts General Hospital in Boston. They were then appointed to the first anaesthetic posts to be created in Norway, at Rikshospital in 1946 (Otto Mollestad) and Ullevål Hospital in 1947 (Ivar Lund).

Anaesthetic departments were later established at the two teaching hospitals, with training posts for doctors and nurse-anaesthetists. The doctors who were later appointed in Norwegian hospitals started their training at these two anaesthetic departments. Many supplemented their training abroad, for example at the Anaesthesiology Centre in Copenhagen. The demand for anaesthesia in Norwegian hospitals soon became significant, and for many years it was impossible to meet this demand. Not only was the capacity for training anaesthetists too small, but recruitment to the few training posts which existed was also unsatisfactory. The development of anaesthesia seems to have been slower in Norway, as compared with its neighbours, but the development of the specialty has otherwise followed the same pattern as in the rest of Scandinavia.

As in other countries, the responsibilities of the Norwegian anaesthetist have widened to include a number of activities outside the operating theatre and outside the hospital. Thus it was anaesthetists who took the initiative in Norway to start postoperative and intensive care departments, and who took the clinical responsibility for these departments. Norwegian anaesthetists took an early interest in the problems of resuscitation outside the hospital, including first-aid training and the development of an efficient ambulance first-aid service. Posts of lecturer in anaesthesia were created in 1965 at Rikshospital and Ullevål, the two largest teaching hospitals in Oslo, but it was not until 1972 and 1973 that the first academic posts were created. Jacob Stovner became the first Professor of Anaesthetics at Rikshospital, and Ivar Lund became Reader in Anaesthesia at Ullevål Hospital. Academic posts were also established at other universities in the country: Bergen in 1973 (Lorents Gran); Tromsø in 1975 (Hans Renck, followed by Lars Bjertnaes in 1980); and Trondheim in 1977 (Harald Breivik).

The Norwegian Association of Anaesthesiologists was founded in 1949 with ten members. The Society has, throughout the years, looked after the professional and financial interests of its members. The Association has helped the anaesthetic situation in Norway to change in many ways in the 35 years since the first two anaesthetists were appointed. Norwegian anaesthetists have not only increased in number but have achieved a professional recognition which members of a new specialty often have to fight for. The present generation of anaesthetists promises well for the future.

4.24 Combat Casualty Anesthesia in Viet Nam*

Th. P. Mathews

Of the 2.8 million American military who served in Southeast Asia during the 10 years of the progressively escalating struggle known as the Viet Nam War, 57000 died and 300000 were wounded. Of those, there were 10000 amputees, 2000 spinal cord injuries and 800 blind. Today, almost 10 years after the cessation of hostilities, if one were to take a census of US Veteran's hospitals, one might still find 6000 Viet Nam-related psychiatric inpatients.

If we take a look at just one of those years, 1969, we find 19 US military hospitals throughout the country of the Republic of Viet Nam handling a total of 55000 surgical admissions, of whom 1162 were surgical deaths, thus giving a ratio of about 20 surgical deaths for every 1000 surgical admissions. Of these deaths, 43% were head injuries, 24% hemorrhagic shock, 12% septic shock, 6% respiratory and 3% burns. Sixty-one per cent of these deaths occurred in the first 24 h of admission and 14% more within the first 5 days. Dead-on-arrival statistics are not included in these numbers. During this same year of 1969, while these statistics were being generated, there were as many as 134 anesthetists staffing these 19 hospitals, of which 35 were physicians.

The US Army staffed 15 of these hospitals, designated "Surgical", "Evacuation", or "Field." Within certain limits imposed by the availability or nonavailability of the various medical and surgical specialties, all functioned as "front-line" hospitals when the fighting was within close helicopter transport time. The US Navy staffed the other four hospitals, two of them 500-bed hospital ships which were virtual floating modern medical centers. A neat system of patient referral was worked out where by a wounded man would be flown to the closest place, or else to one further away but better suited for his care in terms of type of wound, waiting time for surgery, and other logistic factors. Besides these 19 installations "in-country," there was of course the ne plus ultra, the US Air Force Medical Center at Clark Field in the Philippine Islands, only 3 or 4 h away by air. So, all three major Services were involved in what could be truly called a joint military medical effort to save as many lives as possible.

Some of today's civilian critical care techniques and procedures, such as helicopter aeromedical transportation, cardiocerebral, hemodynamic and respiratory resuscitation, burn therapy, and the increased use of specially trained paramedics, were then in the process of being discovered, improved, or proven there in Southeast Asia. But, it

* The views expressed herein are those of the author and do not necessarily reflect the views of the United States Air Force or the Department of Defense.

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didn't start that way. Rather, it began as an extension of the field anesthesia practices developed during the wars of the 1940s and 1950s. When the first field medical units went to Southeast Asia in 1962, ether anesthesia was the mainstay. Simple portable GOE machines were provided: GOE standing for *G*as (meaning nitrous oxide), *O*xygen, and *E*ther. These were the Ohio Chemical Company's Field Model Heidbrink, designed in 1938 and affectionately called "Pigs" by those who had to use them.

The anesthetist of 1962 had a rather limited drug store, which included sodium pentothal for intravenous induction, succinylcholine for intubation and *D*-tubocurarine for more prolonged muscle relaxation. Nitrous oxide was not always available. When it was scarce, it was simply left out of the GOE technique and ether/oxygen used instead. The anesthetist had lidocaine for regional blocks and procaine and tetracaine for subarachnoid blocks. He had all the blood he needed, plus some of the earlier blood substitutes and lactated Ringer's solution. He had no electronic monitors but could make his own central venous pressure monitor out of some polyethylene tubing, a three-way stopcock, and a spinal manometer. He had no arterial blood gas measuring capability. He took his patient's blood pressure indirectly by hand-operated cuff and used an esophageal stethoscope regularly.

Fortunately, these were not the busiest of times. Because of the very gradual increase in combat casualties, there was time to bring the anesthesia armamentarium up to date. It was fortuitous that this time was available before the larger set-piece battles took place. Somewhat unusual in the history of medical support for warfare, the necessary medical facilities were actually in place and staffed by the time they were needed. But the increase in the tempo of the struggle did take place, concomitant with the arrival of more and better and newer equipment, and more recently trained medical personnel.

It was recognized during the 1940s that large doses of morphine given by the field medics were not always in the best interests of the patients when time for anesthesia and surgery rolled around. During the Korean conflict it was shown that rapid transportation by helicopter brought the patient to definitive medical care faster than even an accident victim on the streets of a city back home. These two practices were further developed in Southeast Asia: little or no battlefield narcotic administration and movement by air as soon as possible to the medical unit.

Once at the field medical installation, triage and ABC (Airway, Breathing, Circulation) treatments would begin simultaneously and without delay. Large-bore (14 gauge and larger) intravenous catheters would be put in place. Crystalloid solutions would be started. Blood cross matching would begin and/or uncross-matched low titre type O blood would be started. (One rather impressive statistic is the transfusion of 40000 units of blood during a period of just 1 month in 1968). Airways were established. Endotracheal intubation was performed without hesitation, many times without the use of any anesthesia. Hand-operated portable ventilators were used where indicated.

With all segments of the resuscitation in progress but by no means completed, the patient would be anesthetized, usually with some form of general anesthesia, and the surgery would be begun. It became the rule rather than the exception to give the patient less than the standard amounts of medication initially and add to it only as needed. One common way to assess the state of hemodynamic resuscitation was to watch for the patient to show some sign of needing additional anesthesia. As mentioned, some patients were already intubated. Others would receive small amounts of sodium pentothal and succinylcholine by vein and then be intubated. Many moribund patients would require only oxygen or up to 50% nitrous oxide initially and until their resuscitation was well on its way. Then, small amounts of some other agent would be added, such as ether in the early years and halothane or methoxyflurane later on. It would be still later that neuroleptanalgesia, balanced narcotic/relaxant anesthesia, and ketamine would be added to the list of available agents and techniques. All would have their place and their problems. For here was a big clinical testing ground on the one hand, the place where anything which could happen would happen. On the other hand, here also was the place where, before very long, the medical personnel had more experience with massive trauma and resuscitation than even the biggest city hospital back home.

Regional anesthetics had their test as well. Many techniques were tried, but axillary blocks and low dose and "one-leg" subarachnoid blocks were used more than others. With appropriate fluid replacement and efforts to limit subarachnoid block to the lower lumbar and sacral dermatomes, spinal anesthesia was used more effectively and with fewer complications than in previous combat situations. Still, the overall use of regional anesthesia did not exceed 10% of the total.

A steady stream of new equipment, ideas, and personnel flowed across the Pacific Ocean as the years of the conflict continued. At the same time, there began a reverse flow of information and ideas learned at the field hospital which would benefit the inner city civilian disaster hospitals. Personnel returned home after a year of extensive experience in intensive care to put these practices to work in a different setting. Civilian air rescue and air transportation services were initiated. Paramedical and professional medical providers experienced in triage, resuscitation and life support began to staff hometown ambulances, emergency rooms and intensive care units. Full-time staffing of special care units by returning anesthesiologists proved the value of this kind of physician where ongoing life support was needed. More than any other medical discipline, he or she became the new breed of intensivist, particularly when it came to patients with varying degrees of respiratory failure.

Back in the field, advances in blood, blood fractions, blood substitutes, and fluid therapy took place. Intensive respiratory care became refined as blood gas analyzers and volume ventilators entered the scene, spurred by the recognition of the shock or wet lung syndrome in the seriously wounded whose pressure of oxygen reached very low and sometimes unheard-of levels. Medical electronics came to the field in the form of cardiac monitors, defibrillators, and pressure transducers, powered in some cases by the auxiliary generator whining away outside the tent.

What was it like to be one of these anesthetists, transplanted from a medical center half a world away to live in a tent in the sand and administer to the victims – friend and foe – of this armed conflict? Many who read or hear this, particularly the middle-or older-aged physician, remember all too well. It was a rare experience for this author to sit in the comfort of Rudolf Frey's parlor and listen to some of his memories of the Eastern Front as a *Sanitätsoffizier* during the 1940s. The treatments and procedures were different. Yet, it was easy to identify with the look of pain and frustration in the eyes of someone like Professor Frey, who had lived through such an experience. It was one of the things which made him such an international humanitarian, and probably had much to do with his efforts to bring critical care physicians from all parts of the world together, to sit and talk, to share knowledge and become friends.

Improvements and refinements in wartime anesthesia have occurred in the 10 years since the end of hostilities in Southeast Asia which make us even better prepared to administer to those who will fall in battle in the future. Prepare as we will, we who have lived through this kind of past history should do no less in Rudolf Frey's memory than continue to tell the story of combat medicine as it was, in the hope that those who have never seen battle casualties will not only be better prepared to care for the trauma victim, but also suitably impressed with the horror and waste associated with the loss of men, women, and children who fall victim to modern warfare.

Acknowledgments. The author wishes to thank Dr. M. W. Lichtmann, Dr. A. B. Tarrow, Dr. W. McDermott, and Dr. J. A. Jenicek for their efforts in helping gather much of the material used in this presentation.

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4.25 Early History of the *British Journal of Anaesthesia*

T. C. Gray

In my earlier paper I related a "tale of two cities", which illustrated not only the friendly relationship but also the rivalry that has existed historically between Manchester and Liverpool. This symbiotic relationship has also played a part in the history of the *British Journal of Anaesthesia,* which was started in Manchester, grew up and then nearly died in London, only to be resuscitated in Liverpool. I am grateful to Dr. Edmund Riding, my successor as Editor of the *British Journal of Anaesthesia,* for collecting a great deal of information on its early history.

It was an American-born doctor, Hyman Morris Cohen (Fig. 1), who was its founder. Cohen was born in New York in 1875. He was originally destined for a military career and went to the Military Academy. He then qualified in medicine at Harvard and Baltimore. After qualification he met and married a lady from Manchester. She must have been homesick, for soon after his marriage he came to England and, as his American qualification was not recognized in the United Kingdom, he took a British qualification at St. Bartholomew's Hospital Medical School. He ended

Fig. 1. Dr. Hyman Morris Cohen (died 1928)

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up living and practising in Withington near Manchester. He was appointed an Honorary Anaesthetist at St. Mary's Hospital, one of the Manchester teaching hospitals. When he was at Barts he would have come under the influence of Dr. Edmund G. Boyle – of Boyle's machine fame – and it is probable that it was Boyle's enthusiasm that turned Cohen's attention towards anaesthesia. He was certainly friendly with Boyle, because the idea of launching a journal exclusively devoted to anaesthesia was conceived by him and Boyle and another Manchester anaesthetist, Dr. S. R. Wilson. Cohen arranged for guarantors and for a Manchester firm of printers and publishers, Messrs. Sherratt and Hughes, to publish the journal; thus the first of the quarterly issues appeared in July 1923. However, the *British Journal of Anaesthesia* failed by 12 months to be the first journal in the world devoted to our specialty, for *Current Researches* had been launched in the United States in 1922.

Dr. Cohen in the first editorial admirably summarized what is still the aim of the *Journal* in these words: "It is hoped to be able to keep abreast of the time in all that appertains to anaesthesia, and to reflect the progress our Specialty is making everywhere." A Liverpool anaesthetist, Dr. James O'Leary, was on the original Editorial Board, and Liverpool has maintained the connection ever since. The first issues contain contributions from Langton Hewer, Sir Francis Shipway, Dudley Buxton, J. T. Clover and J. Blomfield, as well as from Gwathmey in the United States and Wesley Bourne in Canada. These are all names to conjure with in the history of the specialty. The scientific side was represented by a pioneer article on cardiac massage by a physician, Dr. Goodman Levy – the Levy who had drawn attention to the true nature of the cardiac arrest that sometimes occurred during chloroform anaesthesia. In 1928, Cohen died prematurely at the age of 53, as did also S. R. Wilson, who was Secretary and Treasurer of the Editorial Board. Dr. Joseph Blomfield (Fig. 2) of St. George's Hospital, London, became the Editor and remained so until his death 20 years later.

Fig. 2. Dr. Joseph Blomfield (died 1948)

Between 1938 and 1946 there was no meeting of the Editorial Board, and by 1946 things were becoming very serious. The *Journal* was appearing only sporadically, twice a year; both the paper used and the print were extremely poor; the pages often appeared smudged; and the proof reading was execrable. An Editorial Board meeting was called in 1946, after World War II had ended. It was attended by Dr. Magill, Dr. John Gillies and Dr. R. J. Minnitt, as well as by the Editor. Its minutes showed no sign of urgency; however, there must have been anxiety about the situation, for, at the subsequent meeting, two new members appeared on the board. They came from Liverpool – Minnitt's influence here is obvious. They were Dr. Jock Harbord, then recently appointed as head of the new university department in Leeds and myself, recently appointed at that time to the corresponding post in Liverpool.

Dr. Alastair Spence, the immediate past Editor, will give some indications of the subsequent development of the *Journal* and of its editorial policy. However, I would like to put on record a part of the story in which I was involved. Blomfield was the President of the Association of Anaesthetists of Great Britain and Ireland from 1935–1938, but it does not seem that he ever suggested that the *British Journal of Anaesthesia* might become the journal of the Association. When he died in 1948, it was not clear who owned the *Journal.* Indeed, claims of ownership might have been made by Mrs. Blomfield or even by the publishers. The first action of the Editorial Board after Dr. Blomfield's death was, therefore, to establish itself as a Board of Proprietors with a constitution.

In 1946, the Faculty of Anaesthetists had been formed within the Royal College of Surgeons of England. Its first Dean, Dr. Marston, was just completing his period as President of the Association, and Dr. Bernard Johnson, the first Vice Dean of the Faculty was the Association's Honorary Treasurer. I was a member of the Board of Faculty and joint Editor, with Dr. Falkner Hill, of the *British Journal of Anaesthesia.* I suggested that there could be advantages both for the Faculty and for the *Journal* if it were to become the official journal of the Faculty of Anaesthetists. Bernard Johnson agreed, but, not surprisingly, the suggestion did not receive support from the new President of the Association, Dr. John Gillies, nor from the Editor of the journal *Anaesthesia*, of which Dr. Langton Hewer was the editor, nor from the others on the Council of the Association who saw in the suggestion a threat to the future of *Anaesthesia.* John Gillies, Langton Hewer and others closely associated with the Association were foundation members of the Board of Faculty and their opposition was final.

In 1952 Bernard Johnson became the second Dean of the Faculty and I, the Honorary Treasurer of the Association. It seemed then that there could be real advantages if we had one journal, representative of both the Faculty and the Association. One must remember that good material for publication at that time was limited. The Board of Proprietors of the *British Journal of Anaesthesia* agreed to an amalgamation provided that the title of the journal would remain *The British Journal of Anaesthesia.* There was agreement from the Faculty that the idea was a good one, if the Association could agree. I remember well the debate in the Council of the Association to decide the issue. All seemed to be going our way, until the late Prof. Edgar Pask, of illustrious memory and an admired friend, suddenly announced with great seriousness, "Well, if this motion is passed, I shall tomorrow start a rival journal of anaesthesia." He saw competition as being essential and had faith that even at the time all the work coming from newly founded university departments could support two good journals. The cause of amalgamation was lost from that moment. I believe the subsequent history of the two journals has proved that Pask was right, but there are still those who wonder. Unfortunately, my friends – for so we always remained despite such political differences – Gillies, Johnstone and Pask are no longer with us and able to comment, but I believe they would not quarrel with the record as I have presented it.

Acknowledgment. I am grateful indeed to Dr. J. E. Riding for allowing me to use material which he researched from the archives of the *British Journal of Anaesthesia* and for the photograph of Dr. Cohen.

4.26 The *British Journal of Anaesthesia*: Its Evolution to the Present Position

A. A. Spence

The *British Journal of Anaesthesia* was launched in 1923, and it is certainly worthy of record that its instigator and first editor, H. N. Cohen, was an American. He had married an Englishwoman and had settled in Manchester, where he practised anaesthesia. There is every sign that his predominant interest was the promotion of the specialty in his new country; the introductory editorial (July 1923) called for a greater organization of the specialty in the United Kingdom, a corporate association of anaesthetists and a diploma examination, although it was some years before these wishes were to be fulfilled.

The contents of the *Journal* were lively from the outset. There was little which, these days, could be held to reflect the "scientific method" in clinical investigation, but there is little doubt that the *Journal* was a useful vehicle of communication in a specialty that was still in embryo form. From the outset there was strong transatlantic involvement with the *Journal*. This may have been a reflection of Cohen's origins, but there is a clear sense of a coterie of leading figures in anaesthesia, from both sides of the Atlantic, who had the opportunity to meet and who used the *Journal* for continuing exchange. Gwathmey and McKesson stand out from the others in their frequency of contribution, the latter being particularly diligent in his contributions to the Correspondence Section of the *Journal*. Sometimes the material which was carried in correspondence (and in editorials) was of a highly personal nature and occasionally of a type that would be regarded nowadays as indelicate. For example, on two occasions there is quite frank mention of the recent deaths of two doctors, which had not been a result of natural causes. In one instance, a suicide, there was quite open discussion of the intolerable circumstance under which the gentleman had lived; as an anaesthetist he had been inadequately paid for what were considered to be outstanding services, as a result of which he had suffered considerable financial embarrassment. In the other case, the death had resulted from self-administration of general anaesthetic drugs, and this led to a concerned letter about the high risk of this problem.

In the early years, there were within the United Kingdom only two established societies of anaesthetists: the Section of Anaesthetics of the Royal Society of Medicine and the Scottish Society of Anaesthetists. The proceedings of their meetings were given full coverage and appeared to constitute a continuing dialogue between the north and south of the country on the relative merits of ether and chloroform.

Cohen died within 5 years of founding the *Journal* and was succeeded by Dr. Joseph Blomfield, who continued as editor until after the end of World War II. Perusal of volumes for the 1930s shows that he served the *Journal* well in that the quality and

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quantity of published material and the amount of gathered news flourished. In the war years, however, there was a serious decline in the *Journal's* activities, which did not really pick up after the war until after Blomfield's death. The style of the present-day *Journal* owes its origins to the leadership of Dr. E. Falkner Hill and Prof. T. Cecil Gray who, as joint editors, gathered about them an impressive team of consultant editors representing the leading departments of anaesthesia in the United Kingdom. Thus they were able to command the support of those who were responsible for fostering the important research and development in the specialty in the United Kingdom, while at the same time being able to offer a high quality in what is now called peer review of manuscripts.

It would be fair to say that the philosophy of the Falkner Hill and Gray editorship has been continued by their successors, Dr. J. E. Riding (1963–1973) and myself, although over the years there has been a substantial change both in the desire of anaesthetists to publish in the learned journals and in the type of material offered. There is clear evidence that in the late 1950s and early 1960s the ranks of anaesthetists included many skilled clinical scientists, but the broad range of material at that time reflected the immediate and practical problems of clinical practice. As the major and fundamental problems were solved and the methods of anaesthesia became safer and more predictable in their effect, so the researcher in the specialty turned his attention more towards basic scientific research applied to anaesthesia; inevitably, the *British Journal of Anaesthesia*, in common with its contemporaries, became less able to provide issues in which all of the papers were of immediate relevance to all of the readers.

At the present time the objective of the Editorial Board is to reflect the best of research and development in the specialty while remembering that the great majority of the readers will be interested primarily in material that they can apply in their day-to-day practice. As an editor one is often asked why the learned journals do not publish more "good clinical papers". The answer is that we publish all that we receive and that these have a priority over most other types of editorial copy. The fact is that the logistical and ethical constraints on clinical research limit what is available, while the development of outstanding research departments of anaesthesia in many countries of the world has led to a very high quality in laboratory research reports for which journals such as the *British Journal of Anaesthesia* must provide an outlet. Thus the *Journal* of today has a traditional role as a vehicle of communication for clinicians while providing a necessary archival role for research reports. The latter activity presents certain potential traps of which the modern editor must be fully aware.

It is a matter of statisfaction that the standing of the *British Journal of Anaesthesia* today is such that unsolicited contributions may come from basic scientists who have no training in anaesthesia but who wish to bring their work to the attention of clinicians. For obvious reasons we are anxious to encourage that. At the same time, however, it is especially important that material which might (if less appropriately) be presented to the basic science journals should be submitted to a process of review no less exacting that the good basic science journals have been able to provide over many years. Thus, today, the Editorial Board is supported by a large number of regular assessors from a variety of disciplines, without whose services quality could not be maintained. Nevertheless, the Editor must try to reflect the interests of the clinical reader by ensuring that what it published, no matter how erudite or specialized in origin, is intelligible to readers who have the same background and training as his own.

The extent to which we achieve these objectives is for others to decide, but it is gratifying to note that the number of subscribers to the *Journal* is greater than ever before and that the *Journal* makes its way to almost every country of the world. In particular, there is a very high level of subscription from North America and from Europe. It is for this reason that news items, which made such fascinating reading in the earliest issues of the *Journal,* are no longer carried, because it would be quite impossible to perform a comprehensive service in this respect. Certainly, to restrict ourselves to news of affairs within the United Kingdom would be a serious mistake since we would be catering for the interests of only a minority of our readers.

Communication technology is undergoing radical change. The arrival of electronic devices which threaten the traditional role of the printed page, added to the increasingly high cost of producing the latter, make it impossible to predict the long-term future of the learned journals in medicine, or, for that matter, any other professional activity. In the short term, at least, the health of journals in anaesthesia seems assured. The blossoming of the specialty in so many countries of the world, coupled with a desire to promote research and development, has led to a flow of manuscripts of an order that has never been seen before. In this I know I reflect the position of my contemporary editorial colleagues as much as my own. This is not to say that all manuscripts are of outstanding quality. The rejection rate of the *British Journal of Anaesthesia,* as with other journals, is very much higher than before. We continue to follow the example set by our predecessors of trying to ensure that no manuscript is rejected without clear and constructive reasons for the decision being given to the author. While it would be an exaggeration to say that we have never had a dissatisfied author, it is very rare for us to close the dealing on a manuscript without an amicable and appreciative exchange of correspondence.

This leads inevitably to the question of what should be done with the rejected material and whether there is a need for an expansion in the number of learned journals related to our specialty. My own view is that we are not at that stage. Having regard to production and distrubution costs, I believe that the amount of material published in the learned journals in anaesthesia is about right, and I am certain that there are no scientific or clinical reports which are of fundamental importance to the practice of anaesthesia which, because of editorial decisions, do not see the light of day. It is increasingly the case, however, that young doctors in training look to publication of reports in learned journals as objective evidence of peer approval, and it may be that reports which, while not being sufficiently newsworthy, reflect investigation conducted in a diligent and disciplined manner pass unseen. It is for this reason that I believe that the authorities, in various countries, who are responsible for peer review should give further thought to the potential value of limited publication of minor scientific reports, perhaps in the form of a mini-thesis. That approach could fulfil a valuable service in relieving the pressure of manuscripts on the editorial boards of learned journals; they might then restrict themselves to composite accounts of the work of a research group, perhaps embracing several studies, or individual reports of which widespread and rapid publication is obviously essential.

4.27 The *Acta Anaesthesiologica Belgica*

G. Rolly and H. Reinhold

Belgium is a small country of ten million inhabitants, with over 600 anaesthetists (1982). Over 30 years ago Belgian anaesthetists felt that a national periodical of anaesthesia would be favourable for the promotion of their specialty in the country and for maintaining a good standard in postgraduate education. That is why the journal *Acta Anaesthesiologica Belgica* was founded in 1950. Before that, Belgian anaesthetists published mainly in the national surgical journal, the *Acta Chirurgica Belgica*. Their meetings, too, were held as sessions of the Belgian Society of Surgeons.

Acta Anaesthesiologica Belgica was first published in 1950, a journal of the Section of Anaesthesiology of the Belgian Society of Surgery. It was a biannual publication, containing papers presented at meetings of Belgian anaesthesiologists, Dutch colleagues and invited guests. Papers were published either in French, Flemish or English.

In 1964, an independent Society of Anaesthetists, the Société Belge d'Anesthésie et de Réanimation, was created and in 1965 the *Acta Anaesthesiologica Belgica* became its journal. Owing to the limited of members and submitted papers in the beginning, only two issues per year were edited at that time. The issues gradually increased in volume, and occasionally special supplements were published.

In order to obtain a more widespread diffusion of the journal, it was decided in 1973 to publish entirely in English, with summaries in the two national languages. This decision and the growth of the society led to a complementary increase in volume, to three issues per year in 1974 and to four issues from 1975 on. Regular issues count now about 300 pages, supplements about 250.

Professor H. Reinhold of Brussels had been the editor until 1973 and was succeeded by Professor G. Rolly. In 1977, an editorial board was nominated. Although initially founded for national use, the *Acta Anaesthesiologica Belgica* now has a fair number of subscribers from abroad.

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5 The World Organization

5.1 Foreword

M. J. van Lieburg

This short section about the international organization in anaesthesiology may be considered as an addition to the sections about pioneers and about regional developments. The central question in them concerns the rise of anaesthesia as a special branch of medicine, especially in regard to the development of the profession. The pioneers described in this book not only were concerned with the improvement of anaesthetic techniques, the expansion of knowledge on pain and the possibilities of fight against it, but also have struggled for the recognition of their specialty and for the

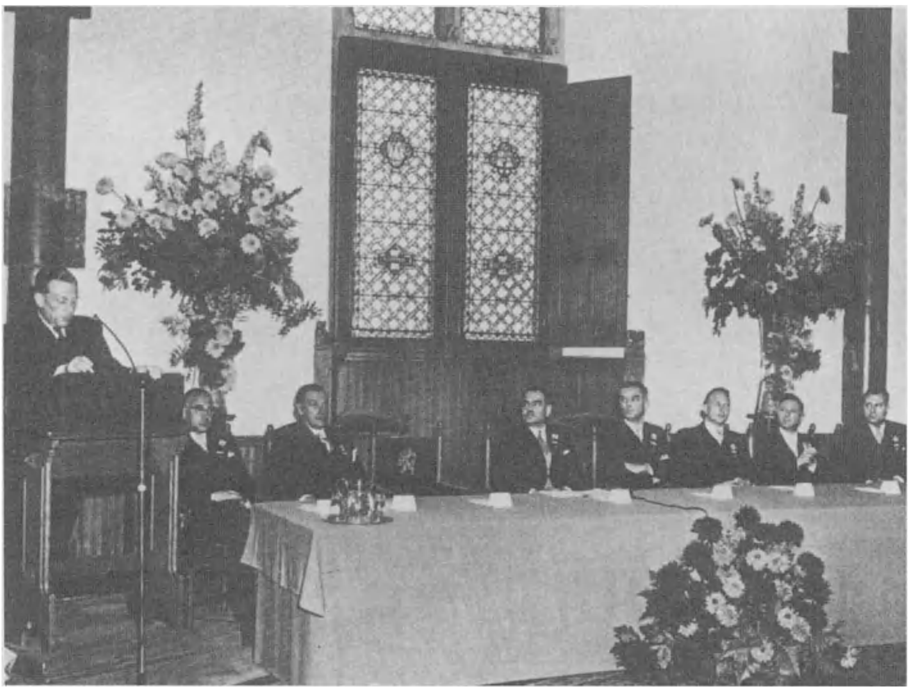

Fig. 1. Opening of the First World Congress of Anaesthesiologists (from left to right): Mr. J. G. Suurhoff, Minister of Social Affairs und Public Health, (addressing the 1st World Congress of Anaesthesiologists); Dr. Laterveer, M.D.; Dr. H. Boeré, M.D.; Dr. C. R. Ritsema van Eck, M.D.; Mr. M. Mauve; Dr. Zwijgman, M.D.; Dr. De Vries Robles, M.D.; Dr. J. Van 't Oever, M.D. (courtesy Mrs. Van 't Oever)

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establishment of professional standards. From the contributions in the section about regional developments one can learn about the great differences in the development of anaesthesia in various countries, which are mostly determined by the structure of the medical, surgical and nursing professions and by the health system in which the anaesthesiologists are involved.

The foundation of professional organizations, the regulation of educational affairs and the promotion of scientific communication by organizing national and international congresses and by editing scientific journals are all appropriate indicators for studying the development of a profession. For the specialty under consideration most such indicators are dated after World War II. Obviously, anaesthesia, after a century of scientific and technical progress, then reached the stage in which professional affairs came into discussion and anaesthesiologists started the shaping of their discipline in the complex world of medical occupations. In the early fifties the discussion emerged at an international level. Sir Geoffrey Organe describes in his contribution how at that time a committee was appointed to realise an international organization in anaesthesia. The activities of its members resulted in the foundation of the World Federation of Societies of Anaesthesiologists in 1955, during the first World Congress of Anaesthesiologists in The Hague (Holland). The account of the early years of the Federation is continued by D.D.C. Howart, who gives information about its activities during the period 1968–1984. Besides the impressive growth of the Federation from 28 national organizations in 1955 to 75 in 1982, the most striking point in their

Fig. 2. Official banquet of the 1st World Congress of Anaesthesiologists, September 1955, at the Palace Hotel, The Hague, The Netherlands

Fig. 3. The Inauguration of the World Federation of the Society of Anaesthesiologists; Meeting of National delegates during the 1st World Congress of Anaesthesiologists, 1955; The Hague, The Netherlands (courtesy Mrs. Van 't Oever)

Fig. 4. A group photograph of some participants at the 1st World Congress of Anaesthesiologists, The Hague, September 1955. From left to right, front: Mr. Günzberg, Mr. Hobbel, Mr. & Mrs. Roberts, Mr. Bosman. Behind: Mr. & Mrs. Raven, Mr. Van 't Oever, Mrs. Bosman, Mrs. Tiggelovend-Gibbs and Mrs. Bosman (courtesy Mrs. Van 't Oever)

description is the way in which the Federation has stimulated the training, including postgraduate training, of anaesthesiologists by forming Visiting Educational Teams and by editing training manuals. The concern for educational and training facilities on an international level is also the theme of the contribution by Ole Secher, who gives a very detailed description of the Anaesthesiology Centre in Copenhagen. This institution served as a centre for training in anaesthesiology. Within a quarter of a century this Centre had had 673 trainees from 73 countries, including 220 trainees from Denmark.

A short notice about the history of the Section of Anaesthesia and Intensive Care of the European Union of Medical Specialists, written by D.D.C. Howart and H.E. Reinhold, completes the survey of world organizations in anaesthesia. This Section, to which the branch of Intensive Care was added in 1966, is also strongly preoccupied with educational affairs.

5.2 An Account of the Development of the World Federation of Societies of Anaesthesiologists

G. Organe

The centenary of the introduction of ether anaesthesia was celebrated in 1946. During this long period, advances in general anaesthesia were almost wholly confined to the English-speaking world: to the United States and Great Britain with its dominions and colonies. The system prevailing in continental Europe, whereby a professor of surgery was responsible for all activities in this department, actively discouraged any specialization; anaesthetics were administered by junior doctors, nurses and even porters, under the direct control of the surgeon. In the previous 15 years there had been dramatic advances in the agents and techniques available, including endobronchial anaesthesia for thoracic surgery, Evipan and Pentothal, cyclopropane in closed breathing systems, which allowed artificial ventilation of the lungs, and curare. Techniques of such complexity clearly could be used safely only by medically qualified specialist anaesthesiologists.

During the next 5 years, there was a tremendous upsurge of interest in anaesthesia among doctors, many of whom had trained abroad, and there was a general desire for an international organization which would help in the spread of knowledge and in the development of the specialty in countries which were emerging from the dark ages of surgical control. This desire crystallized in 1951, when the International Anesthesia Research Society (IARS) was to hold one of its annual congresses in London. The IARS was not itself acceptable, because its membership was very largely in North America and because its Board of Directors would not have wished to lose control of what was a very successful organization. In fact, they were very sympathetic to the idea of a World Federation and gave much encouragement and financial assistance.

In the same year, the Société Française d'Anesthésie et d'Analgésie proposed the setting up of an International Organization based in Paris. This did not find favour because both the President and the Treasurer were surgeons. After discussion among representatives of a number of countries who had been invited to the International Congress in Paris, an Interim Committee was appointed to explore the matter further. The original members of the Committee were: Dr. Harold Griffith (Canada), Dr. Alexandre Goldblat (Belgium), Dr. John Gillies (United Kingdom and Ireland), Dr. Torsten Gordh (Sweden) and Dr. Jacques Boureau (France).

This attitude of suspicion towards surgeons was widespread and strongly felt. Indeed, a few years later, the re-election of the surgeon as Treasurer of their Société led to a serious split among French anaesthetists and to the formation of a rival association. It was only recently, in 1982, that these two bodies finally joined together. On the other hand, it must be remembered that without the active encouragement of

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influential surgeons, the establishment of anaesthesiology as a major specialty would have been more difficult in some countries. In 1953, Ciocatto reported that, during a visit to the Ministry of Health in Moscow, he was told that the specialty of anaesthesia was not considered to be necessary. Yet, 2 years later, a deputation from Moscow and Leningrad attended the First World Congress as observers; as a result of their pressure on the authorities, within a few years there were hundreds of anaesthetists in the Soviet Union, including professors in the major hospitals in Moscow.

The Interim Committee set to work, expanding their membership to include representatives of the IARS (who were also members of the American Society), of the Association of Anaesthetists of Great Britain and Ireland and of the Australian, Italian and Netherlands Societies, with Dr. Delafresnaye, the Secretary of the Council for International Organizations of Medical Sciences (CIOMS), whose legal experts helped in drawing up draft Statutes and Bylaws. At all stages, there was consultation with all the existing national societies. It was agreed that our new organization would take the form of a World Federation of Societies of Anaesthesiologists, with individual members only in those countries where there was no national society. To avoid the ridiculous position of the United Nations, it was agreed that the number of voting delegates from a member society would be related to the number of its individual members, with restrictions on the larger societies to prevent them from dominating the Federation.

In 1953, the Committee felt able to recommend that the First World Congress should be held in the Netherlands in 1955, under the Presidency of Dr. Ritsema van Eck. This meeting, held in Scheveningen, was an outstanding success, and, on Friday 9 September, the World Federation of Societies of Anaesthesiologists was duly formed by the delegates of 28 founder member societies.

The object of the Federation is to make available the highest standard of anaesthesia to all peoples of the World.

In pursuit of this aim, the functions of the Federation shall include, in particular, the following:

a) to assist and encourage the formation of national Societies of Anaesthesiologists;
b) to promote education and the dissemination of scientific information;
c) to arrange at regular intervals a World Congress of Anaesthesiologists and sponsor Regional Congresses; to encourage meetings of special interest groups within the specialty and make provision for them to meet at the above Congresses (1980);
d) to recommend desirable standards for the training of anaesthesiologists;
e) to provide information regarding opportunities for postgraduate training and research;
f) to encourage research into all aspects of anaesthesiology;
g) to encourage the establishment of safety measures including the standardisation of equipment;
h) to advise, upon request, national and international organisations;
i) to apply all other lawful means which may be conducive to the object of the Federation.

From 28 member societies in 1955, the number rose to 36 in 1960 and to 46 in 1964. Many of these societies were established largely in order to qualify the anaesthesiologists of those countries for membership of the World Federation. On the other hand, although some international standards have been agreed, they have been largely ineffective, owing to lack of cooperation by some of the larger manufacturers in Germany and the United States.

With the example of the very successful Anaesthesiology Training Centre in Copenhagen, set up by the World Health Organization (WHO) in 1950, we hoped to start similar centres in other parts of the world, only to discover that the WHO will pay only for foreign students and lecturers and that the basic cost of the centre must be covered by the government of the country in which it is situated. After disappointments and delays, centres were established in Caracas, Venezuela in 1966 and in Manila, the Philippines, which, I understand, have been successful. More are needed.

The Second World Congress took place in Toronto after a gap of 5 years, during which little appeared to have happened, owing to a lack of finance. In 1956, only half the expected subscriptions were received and things would have been very difficult had it not been for generous gifts of U.S. $ 500 from the IARS and of U.S. $ 1000, repeated in 1957, from Dr. Oscar Schwidesky, not himself an anaesthetist. The Executive Committee had not been able to meet during this time and its decisions were reached by correspondence. It was decided to offer U.S. $ 500 towards the expense of travel to Toronto to Dr. Gonzales Varela from Buenos Aires and U.S. $ 400 to Dr. Zairo Vieira from Rio de Janeiro. For the remaining members of the Committee who were not already in the United States or Canada, I was able to offer one-way travel from London in a chartered aeroplane. The aeroplane caught fire and had to return to London, but eventually reached its destination!

In Toronto, Dr. Ritsema van Eck was elected President in place of Dr. Griffith, and half the members of the Executive Committee retired and were replaced. There was a general feeling that the world congresses were too infrequent and too remote for many of the member societies. It was decided to encourage the holding of regional congresses between world congresses, in Europe, North America, Asia and Australasia, and in Latin America. The first series of these was held in 1962 in Vienna, Manila and Peru. (This last was one of a number of Latin American congresses, the first of which I attended in Buenos Aires in 1949.). The second series was held in 1966 in Copenhagen, Caracas and Tokyo. These regional congresses, at which attendance is as large as at the world congresses, have given an opportunity to many more member societies to act as hosts.

After the Tokyo meeting, the Japanese took members of the Executive Committee to see their new conference centre in the beautiful city of Kyoto, to persuade us, successfully, that this would be a suitable venue for a world congress in 1972.

At the Third World Congress in São Paulo, Brazil in 1964, I was elected President, Prof. Otto Mayrhofer, Secretary, and Dr. Henning Poulsen, Treasurer. At the Fourth World Congress in London in 1968, Dr. Francis Foldes succeeded me as President and Prof. I. S. Zhorov, a Moscow surgeon, was admitted as a Fellow of the Faculty of Anaesthetists for his services to anaesthesia.

It is with greath pride and pleasure that I have watched the development of the World Federation since I ceased to hold office. I have a copy of a photograph of all the participants and their wives, taken at the First World Congress in Scheveningen. This will never be possible again!

5.3 The World Federation of Societies of Anaesthesiologists, 1968–1984

D. D. C. Howat

D. D. C. Howat

Sir Geoffrey Organe has already covered the period from the inception of the World Federation of Societies of Anaesthesiologists (WFSA) until the time of the Fourth World Congress in London, when he handed over the Presidency to Prof. Francis Foldes. I shall tell you something of its history from that time until the time of writing (1982); indeed, until the present constitution comes to an end in 1984.

The aims of the WFSA were stated in the original constitution drawn up at the time of the First World Congress in Scheveningen in the Netherlands in 1955. The first aim is to assist and encourage the formation of national societies of anaesthesiologists (Table 1). In 1968 there were 59 member societies, with a total membership of over 20000. By 1972, this figure had risen to 65 societies, with a total membership of about 27000. After that, the increase appears to have been more in the number of members in each society rather than in the number of societies. However, the directory for April 1982 gives the names of 75 societies, with a total of nearly 45000 members, but this does not include the figures for 11 societies which have not yet supplied the information. It seems likely that there are at least 50000 anaesthesiologists in the world, but there are no accurate statistics. Indeed, the numbers vary from year to year, for the following reasons:

1. Some societies do not communicate with the Secretary at all, so that the figures are either not known or out-of-date, and the current number of members has to be guessed at.

Table 1. World Federation of Societies of Anaesthesiologists

Year	Number of member societies	Number of anaesthesiologists
1968	59	20000
1972	65	27000
1974	68	34000
1976	69	42656
1978	69	44000
1980	69	44000 (43172)
1982	75	44921
1983	77	45423

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2. Many countries are too small and have too few anaesthesiologists to form a society. There must be at least ten members to be accepted as a national society, although a number of specialists from different nations may join to form a regional society.
3. Some societies pay dues for all their members – specialists, trainees, honorary members, even nurses – while others pay only for their full specialists. Recent figures show that some societies have reduced their numbers over recent years, although it is difficult to believe that they have fewer anaesthesiologists.

The second aim of the WFSA is to promote education and to disseminate scientific education. This has been done by the establishment of training centres and by the formation of Visiting Educational Teams. In 1964, at the World Congress in São Paulo, Brazil the General Assembly agreed that the establishment of regional training centres would be one of the main aims of the WFSA in the following 4 years, and a Board of Trustees was set up to use the donations which had already been made for this purpose. Two years later, the World Health Organization (WHO)'s Regional Office for the Americas expressed its willingness to support a WFSA Training Centre in Caracas, Venezuela, under the directorship of Dr. Carlos Rivas, whose Department of Anaesthesiology had already organized nine annual postgraduate courses. The WHO granted four fellowships for students from Latin America and the WFSA funded two more.

Until 1976, the WFSA helped to pay the costs of visiting professors and some trainees, but since then the Centre has been wholly funded by the Venezuelan government. The course now lasts for 2 years, with an extra elective year for training in the subspecialties of cardiovascular, paediatric and neurosurgical anaesthesia, and intensive care. Since the Centre was opened, over 120 Venezuelan doctors have graduated in anaesthesiology there, but relatively few have come from other countries. Altogether, 17 non-Venezuelan doctors have taken the course. Unfortunately, although they were obliged to return to their own countries for at least 2 years, many went back later to practise in Venezuela.

In 1970, a second training course was started in Manila, in the Philippines, under the directorship of Prof. Quintin Gomez, who at that time was Treasurer of the WFSA and, of course, later its President. This course lasts for 1 year and is designed for doctors working in the Asian-Australasian Region, particularly the Western Pacific area. In the first 10 years, 216 doctors graduated as anaesthesiologists. During the first 5 years, the Centre received support from the Rockefeller Foundation and from the various hospitals in Manila, but the University of the Philippines now meets all expenses. The WHO Regional Office for the Western Pacific has given fellowships for trainees and the Scandinavian Society of Anaesthetists has given travel grants for visiting professors. The WFSA has also provided some financial help.

Many efforts have been made to establish training centres in other parts of the developing world, particularly in Africa. The difficulties have been considerable, largely because of lack of facilities and shortage of money. The WFSA's Executive Committee gave considerable thought to what was required; in the light of the experience of the centres in Caracas and Manila, it decided that the following criteria must be applied to new centres:

1. There must be a strong and willing local teaching faculty, not only in anaesthesiology, but also in surgery, internal medicine and the other medical specialties. The *total* medical teaching atmosphere and hospital facilities must be attractive.
2. Approval and support by the WHO and the government of the country concerned are essential and the Society of Anaesthesiologists of the best of the host country must be a member of the WFSA in good standing.
3. It must be feasible for the training centre to adopt an official language which is acceptable to both local faculty and visiting professors and one that can be used and understood by large numbers of trainees from a wide geographical area.
4. Political considerations must not influence the choice of a site for a training centre or the selection of faculty members or trainees from a wide geographical area.
5. General conditions, including climate and cost of living, must be attractive both to trainees from different countries and to visiting teachers.
6. The training centre must be designed to produce teachers and leaders in anaesthesiology. To this end, all trainees must be physicians who, upon returning to their own countries, will be capable of developing training programmes in anaesthesia, airway management, resuscitation, and so on, for doctors, nurses or paramedical personnel, according to the specific needs of each country.
7. The training centre must be so planned and developed that, after a period of not more than five years, financial support will no longer be needed from the WFSA.
8. The Director of the centre must submit an annual report of its activities to the Executive Committee of the WFSA, which will arrange for regular inspections of the centre to be carried out.

The Executive Committee wished to establish two training centres in Africa, one English-speaking and one French-speaking. In 1973, Dr. Henning Poulsen, who was then Chairman of the Executive Committee, paid a visit to West Africa and investigated some of the possibilities there. He had intended to make a further visit in 1975, but was unable to do so, owing to political difficulties there and elsewhere. Prof. Jean Lassner undertook to investigate the opportunities in French-speaking Africa. Unfortunately for our plans, the policy of the WHO changed in the mid-1970s under a new Director-General, and it gave priority to the provision of primary health care for the poorer countries. Therefore, the wealthier African countries, such as Nigeria, Kenya and the Côte d'Ivoire, were no longer likely to be favourably considered by the WHO, as I learnt from its Regional Director for Africa when I visited him in Geneva in 1978, although they were the very ones which were most capable of fulfilling the criteria laid down by the Executive Committee.

In spite of this, after I succeeded Dr. Poulsen as Chairman in 1976, I visited Nairobi in Kenya and Khartoum in the Sudan, because I had good reason to believe that the departments of anaesthesiology there might be suitable. Unfortunately, although there was no lack of enthusiasm for the idea, neither country was able to take on the additional burden of a WFSA training centre at that time, owing to lack of sufficient teaching staff. Meanwhile, Professor Lassner pursued his efforts in West Africa, and the possibility of establishing a centre in Togo is still being explored. Also, in the Middle East, investigations have been made in Egypt and Kuwait.

Being unable to find any place in Africa which fulfilled all the Executive Committee's requirements for a training centre and which was, at the same time, acceptable to the WHO, we began to consider other ways of training doctors in anaesthesiology in their own countries or region. Accordingly, the idea of Visiting Educational Teams (VETs) of one or two teachers visiting a country for a short period of time was pursued. In 1978, the Executive Committee laid down the following rules for VETs:

- Visits are to be made only on the invitation of a member society of the WFSA.
- An educational team will be sent to the country or region concerned and will consist of at least one senior leader and one or two junior instructors who have a variety of expertise, for example paediatric anaesthesia, regional anaesthesia, and so on.
- A local representative or contact anaesthesiologist must be appointed by the host society, who will decide the time and arrangements for the team's visit.
- The VET must spend at least one week, preferably two, in each place they visit.
- In planning for a VET, the host society and the Committee on Education and Scientific Education of the WFSA must ensure that the visitors have an adequate knowledge of the language of the country or that good interpreters are available, as well as secretarial help and facilities for copying and distributing teaching material.
- Financial support by the WFSA will include provision of funds for transport. All other expenses must be paid by the host society, university, or hospital. The teacher's stipend must be covered by his own institution or member society.

The WFSA is prepared to spend U.S. $ 5000 on each team, and a total budget of U.S. $ 40000 a year has been approved by the Executive Committee. In 1980, the first VET, consisting of a husband and wife from the United States, Drs. Ty and Penelope Smith of San Diego, California, visited Boliva, Brazil and Ecuador. In September 1981, Dr. Micheal Rosen of Cardiff, Wales, headed a team of obstetric anaesthetists in Malaysia. Recently, another team has visited Honduras, Guatemala and Panama. Further visits are planned to Eastern Europe, Tanzania and Kenya.

The WFSA has been very successful in another method of disseminating education – the publication and distribution of its two training manuals, one on cardiopulmonary resuscitation and the other on obstetric analgesia and anaesthesia. In 1955, the Committee on Cardiopulmonary Resuscitation and Critical Care Medicine (CPR-CCM) asked Dr. Peter Safar to write a manual on the subject; the Åsmund Laerdal Company made a generous grant, which permitted its distribution gratis or at cost price throughout the world. Between 1968, when it was first available at the Fourth World Congress of Anaesthesiologists in London, and 1978, some 250000 copies were distributed, printed in 15 languages. Dr. Safar has re-written the manual and it has recently become available in its second edition, still supported by the Åsmund Laerdal Foundation. In 1971, a Committee on Obstetric Analgesia and Anaesthesia was set up under the chairmanship of Prof. John Bonica and, with Dr. Shnider and Dr. Gertie Marx, he produced the well-known manual on this subject. It was published for the WFSA by Springer-Verlag of Heidelberg and first released at the Fifth World Congress in Kyoto, Japan, in 1972. Over 26000 copies were distributed in the English version and it was also translated into French, Spanish and Turkish. The second edition of this highly successful booklet was first on sale at the Seventh World Congress in Hamburg in 1980 and is already being translated into other languages.

The Executive Committee has recently approved the establishment of a special Committee on Safety in Anaesthesia under the chairmanship of Dr. Manfred Lüder of Berlin in the German Democratic Republic. More will be heard about this in Manila in 1984.

With regard to its relations with other bodies, I have described the WFSA's association with the WHO. It has also maintained relations with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and with the Council for the International Organization of Medical Sciences (CIOMS). However, difficulties of communication and, particularly, restricted funds have prevented us from pursuing some of the other aims of the WFSA. For example, it has not been possible

Table 2. Composition of the Executive Committee of the WFSA (1980)

President (ex-officio, non-voting)
Secretary (ex-officio)
Treasurer (ex-officio)
Deputy Secretary (ex-officio, non-voting)
Deputy Treasurer (ex-officio, non-voting)
13 delegates, including at least one from each of the regions: Europe; North America; Latin America; Asia; Australia, New Zealand and Pacific Islands; Africa

to do much to encourage research, the costs of which are steadily mounting. The total assets of the WFSA amount to less than U.S. $ 230000 and it has only about U.S. $ 15–20000 of income to dispose of annually.

This is not the place to go into the details of WFSA administration, but one should bear in mind that the General Assembly meets only once in 4 years, on the occasion of the world congresses. The Executive Committee meets only once in 2 years, at world and regional congresses. Table 2 shows its composition and the fact that it has representatives from all over the world. Its most recent meeting was in Auckland in 1982 at the Asian-Australian Congress. The Officers, that is, the President, Secretary, Treasurer and Chairman of the Executive Committee, would like to meet more often, but they can very rarely do so, and most of their work must be done by letter of by telephone. Table 3 shows the names of those who have served as Officers since the WFSA was founded.

The original WFSA Newsletter, published by Springer-Verlag, was established to try to solve the problem of communication between officers and members, but it had to be discontinued because of the heavy costs of printing. When the President, Professor Bonica, was Secretary, he distributed a very full report to all the member societies once a year. Dr. John Zorab has continued the tradition with a much smaller bulletin, which he sends out two or three times a year and which he has been able to persuade firms such as Medishield and Portex to sponsor. Unfortunately, it has proved easier to get the newsletter to the societies than to ensure its distribution by them to the individual members.

There are three types of committees in the WFSA (Table 4). *The Standing Committees* deal with the regular business of the Federation. *Ad hoc Committees* are set up at each world congress to verify the credentials of the delegates to the General Assem-

Table 3. Officers of the WFSA (1955–1984)

Year	President	Secretary	Treasurer	Chairman Exec. Committee
1955	H. R. Griffith	G. S. W. Organe		A. Goldblat
1960	C. R. Ritsema van Eck	G. S. W. Organe		R. Sappenfield
1964	G. S. W. Organe	O. Mayerhofer	H. Poulsen	R. Sappenfield
1968	F. F. Foldes	O. Mayerhofer	Q. J. Gomez	H. Poulsen
1972	O. Mayerhofer	J. J. Bonica	Q. J. Gomez	H. Poulsen
1976	Q. J. Gomez	J. J. Bonica	C. Rivas	D. D. C. Howat
1980	J. J. Bonica	J. S. M. Zorab	C. Rivas	E. S. Siker
1984	C. Parsloe	J. S. M. Zorab	R. Ament	Say Wan Lim

Table 4. World Federation of Societies of Anaesthesiologists

Standing Committees:	Membership Finance Statutes and Bylaws Education and Scientific Affairs
Ad hoc Committees:	Credentials Nominations World Congress Venue
Special Committees:	Cardiopulmonary Resuscitation and Critical Care Medicine (CR-CCM) Obstetric Anaesthesia and Analgesia World Congresses

bly, to make nominations for election to office and to consider the offers from societies prepared to organize the next world congress. A decision on this last point has to be made at least 8 years ahead. In addition to the Standing and Ad hoc Committees, *Special Committees* are set up as required. Unlike the others, they do not have a fixed team or membership. I have already referred to the committees for CPR-CCM and obstetric anaesthesia.

In 1980, the General Assembly agreed a new aim for the WFSA, to arrange congresses and sponsor regional congresses; this was considered sufficiently important to place third in the list of aims in the amended Bylaws. The *World Congress Committee* was set up at the same time to maintain contact with the organizers of the next world congress, since these meetings are becoming bigger and more difficult to arrange (Table 5).

Finally, the Constitution of the WFSA states in its third Article: "The Association [This is the title required in Dutch law for bodies such as the WFSA and is used because the headquarters was established in Amsterdam at the time of the First World Congress in Scheveningen] has been established as from the 9th of September 1955, for a period of about 29 years and this until the ult. [that is, the end] of December 1984." It will therefore be necessary to draft a new or revised constitution for ratification by the General Assembly in Manila.

As I have already shown, the number of anaesthesiologists has greatly increased since 1955. Communications, although in many ways easier, are also more expensive to maintain and are further hampered by upheavals in various parts of the world. International congresses, which are one of the main concerns of the WFSA, are getting bigger. They are onerous for the organizers and expensive for the participants.

Table 5. Attendance at World Congresses 1968–1980. Number of participants

Year	Active	Associate	Total
1968 (London)	2846	923	3769
1972 (Kyoto)	2087	775	2862
1976 (Mexico City)	2909	1011	3920
1980 (Hamburg)	4628	970	5598
1984 (Manila)	–	–	>3000

Some people doubt if they have any scientific value. I have been involved in organizing one world congress, I have attended many national and international meetings and I have worked on the Executive Committee. I have no doubt that world congresses, whatever their deficiencies, offer unrivalled opportunities for anaesthesiologists to meet and to make lasting friendships. Those from isolated or poorer parts of the world gain far more from them than does the scientist working in a country rich in resources. For this reason alone, I feel that congresses justify their existence.

Can the World Federation of Societies of Anaesthesiologists be made more effective in its aim to raise the standards of anaesthesiology throughout the world – or is it too unwieldy? 1984 offers a challenge.

5.4 Anaesthesiology Centre Copenhagen

O. Secher

O. Secher

The Anaesthesiology Centre Copenhagen has a rather unique position in the history of modern anaesthesia and the establishment of the specialty in a number of countries all over the world. Throughout its 23 years – a record with the World Health Organization (WHO) – 453 trainees from 71 countries and 220 Danish trainees, 673 in all, participated in the 1-year course of theoretical and practical training.

At the First Congress of the World Federation of Societies of Anaesthesiologists in Scheveningen, the Netherlands, in September 1955, I had the pleasure of presenting the results of the first 5 years [1]. In the late 1940s, the WHO in Geneva received a number of requests from countries in Europe for help in the field of anaesthesia. Among these countries was Denmark, where, at that time, only a group of 16 doctors was occupied in anaesthesia. The request from Denmark was initiated by Prof. Erik Husfeldt (1901–1984), through the Medical Faculty of the University of Copenhagen, and the Director of the National Health Services in Denmark, Dr. Johannes Frandsen (1891–1968). Husfeldt, being a thoracic surgeon, was able to convince the Faculty that Denmark had to be considered "undeveloped" in the field of anaesthesia.

After these requests to the WHO, the question of anaesthesia was discussed as part of a public health problem. The man who convinced the WHO was Dr. Erwin Kohn (1901–1962), Chief of Exchange of Scientific Information Section, WHO, and he presented his arguments in this way:

> If modern anaesthesiology can reduce morbidity and mortality in connection with surgical operations, it stands to reason that all the tens of thousands of people on whom surgical operations are performed every day are being given increased protection from complications and death, and anaesthesiology thus becomes an effective means in the prevention of disease and death in situations that are often as inevitable as disease itself, namely surgical operations.

It was also his idea to establish a course in the English language in Copenhagen, not only for the benefit of Denmark, but for the whole European Region of WHO. He was a great man for the specialty of anaesthesiology.

Following a number of negotiations by the WHO; Dr. Kohn; the University of Copenhagen, in the person of its Rector, Prof. H. M. Hansen (1886–1956); the

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Edited by Joseph Rupreht, Marius Jan van Lieburg
John Alfred Lee, Wilhelm Erdmann

Table 1. Copenhagen hospitals affiliated with the course

University Hospital (Rigshospitalet; RH)	1950–1973 (1953)
Bispebjerg Hospital (BBH)	1950–1973 (1954)
Municipal Hospital (Kommunehospitalet; KH)	1950–1973 (1954)
Finsen Institute (Cancer Hospital; FI)	1950–1973 (1953)
County Hospital, Gentofte (CH)	1950–1973 (1954)
Øresund Hospital (Chest Hospital; ØH)	1950–1953
Orthopaedic Hospital (OH)	1952–1973 (1955)
County Hospital, Glostrup (CHGl)	1966–1973 (1958)
Sundby Hospital (SH)	1966–1973 (1963)

The years in parentheses refer to the establishment of an anaesthesia department

Medical Faculty, in the person of Prof. E. Husfeldt; and the Danish National Health Services, in the person of Dr. Frandsen, it was decided to start a course in anaesthesiology in Copenhagen on 1 May 1950. As far as I know, it was the first time the University and its Medical Faculty was involved in a postgraduate course lasting for 1 year in the English language.

In order to train Danish doctors, it was necessary to obtain positions for them in the different hospitals. Through the influence of Dr. Frandsen this was made possible, and 12 positions were created in the hospitals (Table 1): University Hospital (Rigshospitalet), Bispebjerg Hospital, Municipal Hospital (Kommunehospitalet), County Hospital, Finsen Institute (Cancer Hospital) and Øresundshospitalet (Chest Hospital). Later, two to three more hospitals were involved.

The course was established with Professor Husfeldt as Director, and he served in this position through all the years. The Medical Secretary was E. Wainö Andersen (1919), who kept this position for 23 years with some interruptions. The Ministry of Interior supplied a treasurer. The first was Bent Sörensön (1919–1984) from 1950–1956, followed by Folmer Nielsen (1922–1973) from 1956–1973. For the remaining 3 years of refresher courses it was J. H. Koch (1926). Tables 2 and 3 give further details of the staffing of the course.

Table 2. Staff of the course

Director:	Professor of Surgery, Erik Husfeldt (1901–1984)	1950–1973
Secretary:	E. Wainö Andersen (1919)	1950–1973
	S. H. Johansen (1921)	1968
	Henning Ruben (1914)	1955–1956
Treasurer:	Baent Sörensen (1919)	1950–1956
	Folmer Nielsen (1922–1973)	1956–1973
The founding group of instructors:	E. Husfeldt (1901–1984)	1950–1973 (RH)
	E. Wainö Andersen (1919)	1950–1973 (CH)
	Willy Dam (1914)	1950–1973 (BBH)
	Björn Ibsen (1915)	1950–1973 – Prof. 1971 (KH)
	Henning Rueben (1914)	1950–1973 – Prof. 1975 (FI)
	Ole Secher (1918)	1950–1973 – Prof. 1964 (RH)

The abbreviations refer to the different hospitals (see Table 1)

Table 3. Other instructors

V. F. Askrog (1929)	1966–1973 (BBH)
G. Buchmann (1923)	1973 (OH)
V. Dyrberg (1923)	1952–1954, 1961–1973 (CH)
N. Guldmann (1923)	1961–1973 (SH)
J. Hagelsten (1928)	1964–1973 (BBH)
E. Hansen (1927)	1966–1973 (KH)
B. F. Haxholdt (1919)	1954–1955, 1966–1973 (CHGl)
H. Henriksen (1933)	1973 (CH)
O. Jacoby (1917–1978)	1950–1953 (ØH)
S. H. Johansen (1921)	1957, 1961–1973 - Prof. 1971 (CH)
S. Jörgensen (1920)	1958, Prof. 1970 (RH)
E. Keutmann (1919–1961)	1951–1953 (KH)
J. Kirchhoff (1919)	1952–1973 (OH)
K. Kjaer (1921–1961)	1954 (OH)
H. Poulsen (1918)	1950–1953 (KH)
H. Rask (1920)	1963–1965 (BBH)
J. Rosen (1919)	1961–1973 (RH)
C. Thorshauge (1919)	1961–1973 (RH)

The abbreviations refer to the different hospitals (see Table 1)

The Faculty established a governing board consisting of the Director, E. Husfeldt; the Professor of Physiology, Einar Lundsgaard (1899–1968); the Professor of Pharmacology, K. O. Möller (1896–1973); and the Professor of Surgery, E. Dahl Iversen (1892–1978), the last one acting as Director at the times when Husfeldt was absent. As far as I remember, this board had very few meetings, but was important for maining the status of the course in the different hospitals. The course started as an experiment in a field where nearly none of the Danes had any experience. It took time and discussions to prepare the surgeons and the personnel in the different hospitals for an "invasion" in the operating rooms of not only Danish anaesthetists, whom they had only started to get used to, but also a number of people from other countries and instructors speaking English.

From the outset the course was meant as a basic training course of 1 year. It was to give the participants a fundamental knowledge and background, both theoretical and practical. By further studies, they could become specialists and train other people in their home country. A considerable number of suggestions were made all the time for improving the course, but the basic idea never changed throughout the 23 years.

The WHO representatives were well aware of the difficulties in starting such a course because of the interference with the daily routine in hospitals. For this reason they made it possible right from the beginning to engage highly qualified instructors, mainly from the United Kingdom, the United States and Scandinavia. For this reason also a great number of well-known anaesthetists visited Copenhagen, some several times, and at the same time they had a tremendous influence on the Centre. In this way it developed as a mixture of opinions, and it is to be hoped that the participants extracted the best from all of them. I am so happy to see a number of these instructors at this meeting, and it gives me the opportunity to present to them the results to which they have contributed so much.

Fig. 1. Dr. Stuart C. Cullen giving anaesthesia to a patient. Behind him, from the left are B. Ibsen, Dr. Ralph M. Waters, H. Ruben, E. Wainö Andersen and O. Secher. The photograph was taken in May 1950

The first course started on 1 May 1950. For the inauguration on 3 May 1950, a great celebration, the WHO had sent its Assistant Director-General (from 1949 to 1951), Martha Eliot (1891–?). The Rector of the University and the Director of the National Health Services were both present, together with the Dean and Professors of the Medical Faculty (Fig. 1). The first instructors were from the United States: Prof. Ralph M. Waters (1883–1979) from Madison, Wisconsin, and Prof. Stuart C. Cullen (1907–1979) from Iowa City, who stayed for 1 and 3 months, respectively.

The invitation and selection of the trainees were done through the WHO, and the WHO also supplied scholarships and books for them. Some equipment and books for a central library were also supplied by the WHO. After 3 years the invitations were not only sent out to the European Region, but to all regions within the WHO; an increasing number of trainees from regions outside Europe came (Tables 4–10). The

Table 4. Trainees from the regions of the WHO

	Countries	Trainees
Africa	7	9
The Americas	13	21
Southeast Asia	6	27
Western Pacific	7	59
Eastern Mediterranean	12	102
Europe	26	205
Total	71	423

Table 5. Trainees from the African Region

Angola	2
Biafra	1
Cape Verde	1
Ghana	1
Mozambique	2
Tanganyika	1
Tanzania	1
7 countries	9 trainees

Table 6. Trainees from the Region of the Americas

Argentina	2	El Salvador	1
Bahamas	1	Guatemala	1
Brazil	2	Martinique	1
Chile	1	Mexico	3
Colombia	1	Peru	3
Costa Rica	3	Venezuela	1
Dominican Rep.	1		
13 countries		21 trainees	

Table 7. Trainees from the Southeast Asia Region

Bangladesh	1
Burma	1
India	4
Indonesia	5
Nepal	2
Thailand	14
6 countries	27 trainees

Table 8. Trainees from the Western Pacific Region

Hong Kong	6
Japan	11
Korea	10
Philippines	15
Ryukyu Islands	4
Rep. of China (Taiwan)	11
Vietnam	2
7 countries	59 trainees

Table 9. Trainees from the Eastern Mediterranean Region

Afghanistan	3	Jordan	6
Cyprus	3	Lebanon	3
Egypt	17	Pakistan	16
Iran	15	Saudi Arabia	1
Iraq	19	Sudan	7
Israel	4	Syria	8
12 countries		102 trainees	

Table 10. Trainees from the European Region

Albania	1	Italy	4
Austria	10	Malta	2
Belgium	1	Norway	10
Bulgaria	11	Poland	16
Czechoslovakia	4	Portugal	9
England	1	Rumania	4
Finland	22	Russia	3
France	1	Scotland	1
Germany	9	Spain	16
Greece	15	Sweden	4
Hungary	6	Switzerland	7
Iceland	2	Turkey	15
Ireland (Eire)	1	Yugoslavia	30
26 countries		205 trainees	

requirements for selection were primarily 2 years' experience in anaesthesia in the home country and enough knowledge of English to be able to speak, read and understand it. The next requirement was that trainees had to sign that afterwards they would serve their country for a minimum of 3 years. Generally speaking this worked out well, although it gave some problems. I only remember one trainee who was sent home because of lack of knowledge. Those who had insufficient English were sent for language courses, quite often with amazingly good results.

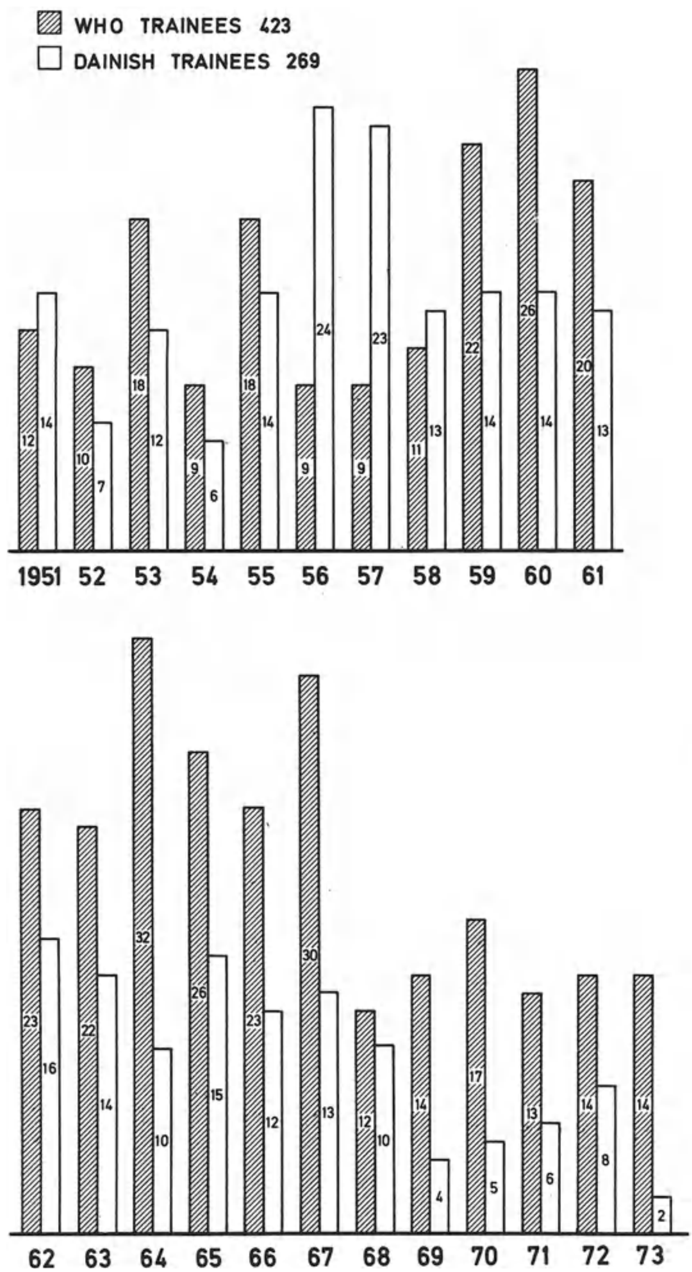

Fig. 2. The number of trainees is shown in columns for the different years. The total number of Danish trainees here is 269, and in Table 11, 275. The difference is due to those who repeated the course more than once

For the first 5 years the scholarships continued to be supplied by the WHO. In 1956 they were transferred as a part of the expanded programme for Technical Cooperation with Developing Countries, later called the Danish International Development Agency (DANIDA). The invitation and selection of trainees were still administered by the WHO Regional Office for Europe. It is worth mentioning that the interest of these organizations was unfailing throughout the 23 years. When, in 1951, the WHO Regional Office for Europe was established in Geneva (in 1957 it moved to Copenhagen), the first Director, Dr. Norman D. Begg (1905–1956) showed a special interest in this course and visited it several times. The later directors were Dr. Paul J. J. van de Calseyde (1903–1971), from 1956 to 1967, and Dr. Leo A. Kaprio (1918), from 1967 to 1984. Among the staff of the WHO Europe Office, Prof. William Hobson (1911), Chief of Education and Training from 1958–1968, paid a special interest in the course.

Throughout the years the number of scholarships has varied a great deal, owing to variations in response to invitations and the financial situation (Fig. 2). On average there have been 19–20 participants in a course, with a maximum of 30 and a minimum of 9. The number of Danish trainees per year has also varied, but it has always been dependent on the number of positions available in the hospitals. In later years new requirements for specialist training were laid down, and a regular course became a part of them. This explains the decreasing interest in the course in the later years.

In Table 11, which shows the number of Danish trainees, there is a group of 30 named "Non-Danes." These are foreign doctors who filled positions in the different hospitals at times when it was difficult to obtain Danish doctors. I do not have details of the nationality of them all, but nearly all of them went back to their home country, as did the WHO-trainees.

The professional standard of the trainees varied a great deal for the different courses. Some came with only little or no education in anaesthesia, and some came with many years' education. This, of course, created difficulties; however, for the last-mentioned group it was usually possible to let them study special fields of anaesthesia. There may have been trainees who went home disappointed, although I know of none. If so, the truth is probably that they did not realize how much they had learned before they came home.

The theoretical teaching was given through lectures, mainly by the instructors, supplemented by specialists in all sorts of fields. The lectures were given at the University Hospital in the lecture room in department H (Dermatology). Many of you will remember the place. Each week there were two to three lectures. The most

Table 11. Danish trainees

Total number (approx.)	**275**
Took the course 2 × (approx.)	46
Took the course 3 × (approx.)	6
Revised total number (approx.)	**220**
Still in anaesthesia	120
Left anaesthesia	52
Retired	9
Dead	8
Non-Danes in hospital position	30
Expatriated Danes	5

important part of the teaching programme was probably the "Morbidity and Mortality Meetings" once a week, where all sorts of complications and deaths were presented and discussed in an informal and straightforward way. Criticism and suggestions were given. I think that many of us in Copenhagen today are missing these meetings, now that the course has finished. During the period when the course ran, the number of anaesthetics in the hospitals increased yearly, starting with 40000 and ending with 80000 per year – a vast material to draw cases from. The morbidity meeting was introduced by Dr. Cullen in the first course and continued unchanged in style for 23 years.

The practical training took place in the different hospitals, and the trainees rotated through most of the hospitals during the year. In this way they had an opportunity to become acquainted with all sorts of techniques and with the different opinions of the best choice of anaesthetic for all kinds of operations. The different instructors, local as well as visiting, varied a great deal in this respect. This was undoubtedly to the benefit of the trainees, who could then extrapolate what they thought was best. Every third month the trainees were tested, usually by multiple-choice questions, and at the end they had a written and oral examination. For the first 10 years trainees were awarded a certificate of participation at the end of the course, but this was then changed to a diploma after the examination. Certificates and diplomas were handed over by the Dean of the Medical Faculty at the Closing Ceremony. If a trainee failed the examination, and a number did, they were usually allowed an extension for 2 months and a re-examination. Trainees with long experience had the chance of obtaining a scholarship from the WHO for special studies in other countries, usually in the United Kingdom.

Probably the most important event during the course was the "bus-trip". Usually after 3–4 months it became important to "shake" the trainees together. They probably only saw each other at the lectures or at social events, but otherwise stuck together in different language groups. The Danish instructors took the trainees in their private cars and drove them round the country to see it and its hospitals. Two hospitals were seen per day, where lunch and dinner were served, and in between we saw the natural scenery and the historical sites of the country. One lunch was arranged as a picnic. The tour took place at the beginning of June and lasted 5–6 days. We went out with an inhomogenous group and always came home with a totally different and very happy group. Common daily experience does shake people together. To me it has always been one of the great events of the years.

The same year as the first course was inaugurated, the First Congress of the Scandanivan Society of Anaesthesiologists was held in Oslo in August 1950. The trainees of the course participated in the congress, and it was at this congress that Dr. Erwin Kohn gave his paper, "Public health aspects of anaesthesiology and the World Health Organization programme in promoting modern anaesthesia" [2]. The Scandinavian congresses are held every second year, and trainees of the respective courses participated each time. When the Second European Congress of Anaesthesiology took place in Copenhagen in 1966, the trainees also participated.

The visiting instructors were all eminent people within the speciality of anaesthesiology (Tables 12–13). I have a list of their names, but it is too long to give here. Some stayed for a long time: Prof. Ronald F. Woolmer (1908–1962), from the United Kingdom, stayed for 1 year (1951–1952) and came back twice. Jack Moyers (1921), from Iowa City, came as a junior instructor for 9 months (1950–1951) and came to visit

Table 12. Visiting instructors and lectures during the years

1.	1950–1951	9	13.	1963	2
2.	1951–1952	7	14.	1964	6
3.	1952–1953	12	15.	1965	7
4.	1953–1954	9	16.	1966	1
5.	1954–1955	6	17.	1967	6
6.	1955–1956	6	18.	1968	7
7.	1957	2	19.	1969	5
8.	1958	3	20.	1970	10
9.	1959	5	21.	1971	9
10.	1960	4	22.	1972	7
11.	1961	4	23.	1973	7
12.	1962	2			
Total					136

Table 13. Visiting instructors and lecturers at the course

United States	63
England	39
Sweden	12
Norway	4
Bulgaria	3
Scotland	3
Australia	2
Germany	2
Belgium	1
Canada	1
Holland	1
Lebanon	1
Poland	1
Russia	1
South Africa	1
Switzerland	1
Total	136

the course twice after that. Dr. Phyllis Edwards, London, stayed for 5 months in 1950. Some stayed for 1–3 months and some came for a week or two. Some came several times. I like to think that Stuart C. Cullen, who visited six times, felt that this course played some importance in his life.

Let me mention some of the names of those who came here. Among all the visiting instructors and lecturers, Prof. Eric Nilsson (1915), from Lund, set the record as he came 16 times, mainly for lectures, but of course he lives very near. Prof. John Severinghaus (1922) and Dr. Harry Churchill-Davidson (1922) visited seven and six times. Professor William W. Mushin (1910), Prof. James O. Elam (1918) and Prof. Myron Laver (1926–1982) came four times. Those who came three times were the Professors Sir Robert R. Macintosh (1897), Sir Geoffrey Organe (1908), Henrik Bendixen (1923), C. Prys-Roberts (1935), T. Wainö Andersen (1920) and Stoyan

Saev. I ought to mention that Saev is among the former trainees, so we were proud to have him among the teachers. The "two-timers" were the Professors Henry K. Beecher (1904–1976), James Eckenhoff (1915), Leroy Vandam (1914), Francis Foldes (1910), Dr. Bernard B. Lucas (1916), Dr. H. W. Griffiths, Cecil Gray (1913), J. S. Gravenstein (1925) and B. Raymond Fink (1914). I would like to mention a few "one-timers": Dr. Derec Wylie (1918), Dr. G. Jackson Rees (1918), Prof. Patric Schackleton (1905–1977), Robert D. Dripps (1911–1973), E. M. Papper (1915), Dr. John Beard and C. Ronald Stephen (1916). From Sweden and Norway I can mention Prof. Torsten Gordh (1907), Otto Mollestad (1908–1973), Ivar Lund (1911), Martin Holmdahl (1923), Bertil Löfström (1922) and Olle Friberg (1912–1979). Among former trainees we also had the Professors Elena Darmir (1928), Jacob Stovner (1916–1980), A. Hollmén (1930) and K. Nolte (1929).

While the course was running, it was decided to make "follow-up tours" in order to see the conditions under which the former trainees were working in their home country and what had become of them, and to help them in promoting anaesthesia in their country. There were six such tours:

1. In 1964 Prof. Husfeldt and Dr. E. Wainö Andersen were joined in Greece by Prof. R. R. Macintosh.
2. In 1964, Prof. H. Ruben did a tour in connection with the Third World Congress of Anaesthesiologists in São Paulo, Brazil, to Portugal, Brazil, Argentina, Peru, Costa Rica, Mexico and the Bahamas.
3. In 1966 J. Kirchhoff went to Lebanon, together with the surgeon Dr. H. C. Engell, and was joined by Prof. Bernard Brandstater from Beirut to Jordan, Iraq and Iran.
4. In 1966 Dr. E. Wainö Andersen and O. Secher went to Bulgaria, together with Dr. Harry Churchill-Davidson.
5. In 1968 V. Dyrberg and O. Secher, together with Prof. William Hobson from the WHO, went to the Philippines, Japan, Korea, Taiwan, Hong Kong, Malaysia and Singapore.
6. In 1969 Dr. E. Wainö Andersen went to India, Burma, Thailand, Indonesia and Ceylon.

Table 14. Refresher courses

	Year of course	Trainees	Visiting lecturers
1. 1961	1951–55	21	3
2. 1963	1956–58	22	4
3. 1965	1959	14	2
4. 1967	1960	19	6
5. 1968	1961	14	4
6. 1969	1962	19	4
7. 1970	1963	19	5
8. 1971	1964	21	5
9. 1972	1965	15	5
10. 1973	1966	21	7
11. 1974	1967	23	8
12. 1975	1968	16	8
13. 1976	1969–71	25	4
Total		249	65

In 1960 it was decided to establish refresher courses so that former trainees could be invited to come once more to Copenhagen for a 2-week course in anaesthesia. The purpose of these courses was to give the participants a "brush up" and to find out what had become of them, and where and how they could be helped. To keep contact was also a part of it. Not all former trainees came because only trainees from countries eligible for technical assistance were invited (Table 14). In all, there were 13 refresher courses from 1961 to 1976. Unfortunately, the trainees from the last main course were never invited back because the financial support was stopped in 1976. The staff for the refresher courses was basically the same as for the main course, supplemented with people from other disciplines and visiting lecturers. These courses became a great success, and no doubt the trainees enjoyed them. As social events, a 1-day "bus-trip" and different parties were organized. I think most of them went home "refreshed".

It is natural to ask what became of the trainees and whether the course fulfilled its purpose. In later years I have tried to find out about all these people whenever I met them at meetings, during travelling and through correspondence. Today I have information about 271 (see Table 15), or more than half of the total number of participants, but it should be possible to make contact with more. Perhaps this meeting will stimulate some to deliver information.

Table 15. Positions of 271 WHO-Trainees in 1982

Within the speciality	
Chiefs of anaesthesia departments	120
Professors and assoc. professors	38
Hospital positions	31
	189
Private practice	13
Expatriated to other countries to anaesthesia positions:	
Denmark	12
Sweden	5
Germany	5
United States	8
United Kingdom	1
Other countries	14
Unknown	3
	48
Outside the speciality	
Surgery	14
Other specialities and hosp. administration	3
Non-medical professions	4
	21
Total	271
Extra details on 189 in hospital positions	
Retired	22
Dead	20
Private practice	6
	48

From the information I received, I can tell you that 120 have obtained a hospital position as chief anaesthesiologist, and 38 have positions as professors, most of them in their home country. A fairly large number have moved to other countries, and addresses and information are hard to obtain. Comparatively few have left the speciality, which is very satisfactory. The number of trainees who have retired is small, owing to the fact that most of them were young when they took the course. I have information of 20 who have died since the course started, but this figure is probably more accurate than the others, because of continuous information through the years.

All in all I have no doubts that the Anaesthesiology Centre Copenhagen has fulfilled its purpose and through this the importance of good anaesthesia has been brought to many countries. The work and results of the Anaesthesiology Centre Copenhagen are described by Andersen [3], Andersen et al. [4] and Husfeldt et al. [5]. Among these countries there are some where the course has been of greater importance than others; some have even been very dependent on it and have used the Centre as a means of establishing the discipline of anaesthesiology. In Europe I will mention the countries Bulgaria, Finland, Greece, Norway, Poland and Yugoslavia; in the Eastern Mediterranean, Iraq and Jordan; in the Western Pacific, the Philippines and Taiwan; and in Southeast Asia, Thailand. Of course, the country which benefited most was Denmark. The development of anaesthesiology in Denmark is described by Haxholdt and Secher [6], Ibsen [7] and Secher [8].

Other courses, either national or international, have been started for shorter or longer periods of time throughout the years by the help of the WHO. In Paris, for instance, a French-speaking course was started in 1952 and lasted for 2 years (?). Several have been suggested, but none has survived except one, the Anaesthesiology Centre, Manila, which has now been running for 15 years, with support from the WHO, and is still functioning as an international course mainly for the Western Pacific region. I had great pleasure in helping the WHO and Prof. Quintin Gomez (1919) in starting this course.

Whenever I go abroad and meet former trainees, I am always asked, "Why did you stop the course? We want to send people to Copenhagen", and "When will you start the course again?" The course was stopped because DANIDA allocated money for other purposes. They considered the course had fulfilled its purpose and other places could take over. The Anaesthesiology Centre Copenhagen will never appear again; it is only a part of the history of modern anaesthesia.

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5.5 The Section of Anaesthesia and Intensive Care of the European Union of Medical Specialists and Its Contribution to the Professional Status of Anaesthesiology in the European Economic Community

D. D. C. Howat and H. Reinhold

The European Union of Medical Specialists was created in 1962. For those of you who are unfamiliar with the development of the European Economic Community, it may be helpful to remind you of a few historical facts. The treaty which created the Community was signed in Rome in 1957. The political leaders who took this initiative were inspired by idealism. At the time, their aims certainly appeared romantic and unreal to most people. Now, more than 25 years later, the functioning of the institutions of the EEC are in many ways still far from perfect, and conflicts of interest between its members are all too evident. In spite of this, there have been many positive achievements. There has been constructive work in the organization of medical practice, as the following account will show.

The programme of the Treaty of Rome included the suppression of national borders for professional activities within the European Community. It was therefore necessary to guarantee satisfactory professional standards for individuals moving from one country to another. Members of the medical specialties of all our countries were seriously concerned about this problem. They were anxious to avoid rules and regulations being made solely by political authorities, without the approval of our profession. A group of medical specialists therefore founded an organization to look into the matter. Since the problems of each specialty are different and require examination by suitably qualified people, they wisely decided to set up a subcommittee for each specialty. This led to the birth of the Section of Anaesthesiology of the European Union of Medical Specialists. It held its first meeting in September 1962. The six countries which were then members of the EEC – Belgium, France, Germany, Italy, Luxemburg and the Netherlands – were all represented. In 1972, Denmark, Ireland and the United Kingdom joined the EEC, raising the number to nine. In 1980, Greece was added. Future members are Spain and Portugal.

The representatives appointed by the national societies of anaesthesiology have naturally changed during the 20 years of the Committee's existence. Altogether, a total of 45 leading anaesthesiologists of the EEC countries have taken part in the Committee's activities:

Belgium: C. Chevalier-Thewissen, H. Reinhold, J. van de Walle
Denmark: H. J. Clementsen, N. Fjeldborg

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France: J. Boureau, J. Chopin, R. Deleuze, L. Lareng, M. Maroger, J. Montagne, Y. Noviant, J. M. Picard, J. Verhaege
Germany: H. Burchardi, W.F. Henschel, K. Horatz, C. Lehman, K. Peter, M. Zindler
Ireland: T. J. Gilmartin, W. S. Wren
Italy: L. Bianchetti, E. Ciocatto, G. Damia, S. Magalini, P. Manzoni, R. Rizzi
Luxemburg: A. Felten, P. Kayzer, M. Knaff, G. Knaff-Quast, G. Welter
Netherlands: J. Crul, B. de Vries-Robbeles, J. P. M. Lelkens, C. R. Ritsema van Eck
Spain: M. A. Nalda Felipe
United Kingdom: P.J.F. Baskett, A.J.W. Beard, D.D.C. Howat, G.S.W. Organe, R. P. W. Shackleton, J. S. M. Zorab.

The function of this committee is to offer expert advice to the Commission of the EEC, the highest administrative authority. Initially, when the Committee obtained official recognition, it was given the task of harmonizing the practice of anaesthesiology, in order to remove all obstacles or difficulties in the application of the Treaty of Rome. However, the Committee has always taken a broad view of its terms of reference, which, it believes, include the promotion of anaesthesiology in the countries of the EEC. The following are some of the main topics which it has studied:

1. Definition of the Specialty of Anaesthesiology

A definition of anaesthetic practice was drafted, not as a linguistic or academic exercise, but for reasons of precision. Naturally, most of the administrative staff of the EEC knew the meaning of the word "anaesthesia", but they were poorly informed about the other activities of anaesthesiologists. The Committee also felt it was important that it should be consulted whenever there was to be discussion of any matters with which it was concerned, particularly if any other specialties were also involved. The definition was presented in a concise text of ten points:

a) Application of the various methods of anaesthesia
b) Pre-, per- and postoperative care, including the various methods of monitoring and therapy
c) Treatment of respiratory insufficiency
d) Oxygen therapy and other inhalation treatments
e) Transfusion, intravenous infusions and parenteral alimentation
f) Intensive care
g) Treatment of pain syndrome
h) Extracorporeal circulation
i) Extrarenal dialysis
j) Emergency care and the transportation of critically ill patients

To stress the importance of the related activities of our specialty, it was decided in 1966 to change the name of the Committee to the "Section of Anaesthesia and Intensive Care".

2. Requirement of Specialist Recognition as a Condition for Exchanges of Anaesthesiologists Between EEC Countries

The adoption of this rule has had a beneficial effect, particularly for France. Up to 1965, anaesthesia was not recognized there as a full medical specialty, but only as a skill in a particular branch of medicine. Since our Committee ruled that this state of affairs would not allow French doctors to practise anaesthesiology in the other countries of the EEC, the *Conseil de l'Ordre des Médecins de France* decided on 4 July 1965 to grant the status of full specialist to French anaesthesiologists who were registered on an official list.

3. Minimum Training

In 1962, the duration of training in anesthesiology in the six countries which at that time formed the EEC varied from 2 to 7 years. In 1963, a proposal was adopted, stipulating 3 years as the minimum training period. The conditions required for a European qualification in anaesthesiology were laid down as follows:

a) Qualification in medicine for at least 5 years
b) Practice of anaesthesiology for at least 3 years
c) Specialist recognition by the national authority of the applicant
d) Professional activity exclusively in anaesthesiology

Another proposal which was considered was an EEC multinational examination, but difficulties were encountered in realizing this project. The number of candidates from the whole EEC would represent a heavy burden for an examining board and would impose a heavy load on the organizers. So far, this problem has not been solved.

In 1969, the subject of training was re-examined. The duration of training in the countries of the EEC and in those about to join was as follows: Belgium, 3 years; Denmark, 7 years; France, 3 years; Germany, 4 years; Ireland, 6 years; Italy, 3 years; Luxemburg, 4 years; Netherlands, 3 years; and United Kingdom, 6 years. In November 1969, it was agreed that, starting in 1972, a minimum period of training of 4 years should be required. It was also specified that only training in a regular department of anaesthesiology, headed by a specialist in that subject, would be approved. More recently, in April 1980, a proposal has been made to prolong the minimum training period to 5 years.

4. Practice of Anaesthesia by Nursing Staff

In Belgium, Ireland, Italy and the United Kingdom, the administration of anaesthetics is restricted to the medical profession, whereas in Denmark, France, Germany, Luxemburg and the Netherlands the status of nurse-anaesthetists is recognized. This has created a problem. The nurse-anaesthetists in these countries practise in two different ways. In Denmark, Germany and the Netherlands they work only under the control of an anaesthesiologist; in France and Luxemburg they are allowed to practise under the supervision of any doctor, even one with no training in anaesthesia. Until recently, in several countries, the use of nurse-anaesthetists was due partly to a shortage of specialists in anaesthesiology, but this situation is rapidly changing. Indeed, a plethora of doctors is now appearing. For these reasons, and to ensure the safety of patients, it is no longer justifiable for anaesthetics to be given by anyone who has not had a full education in medicine and a training in anaesthesiology. As it is difficult to correct the situation in countries where nurse-anaesthetists are still used, it has been decided to proceed gradually. It is proposed that the administration of anaesthetics by persons not qualified in medicine should cease by the end of the year 1984. To solve the problem this policy will create for the nursing staff concerned, it has been recommended that, after additional training, they should become technical assistants in anaesthesia, who will assist anaesthesiologists and look after the preparation, setting up and maintenance of anaesthetic, monitoring and intensive care equipment.

5. Teaching of Cardiopulmonary Resuscitation to Undergraduate Students

In the last 20 years, the correct application of methods of resuscitation has proved its value in saving lives. Knowledge of this subject is often satisfactory in those newly graduated from the medical schools. To fill this gap in medical education, it has been recommended that a period of 1 month's training in a department of anaesthesiology should be made compulsory in all medical schools. The unconscious, curarized patient in the operating room offers an excellent opportunity for an understanding of the principles of emergency resuscitation.

6. Theoretical Education in Anaesthesiology

The experience acquired in the teaching of anaesthesiology of each of the countries of the EEC has been studied and, as a result, a document has been drawn up, listing the various subjects of basic and clinical science to be included in the teaching programme. This document has been prepared as a guide to the scope of knowledge required in anaesthesiology for the use of those in charge of teaching, and to provide information for administrative authorities, who may be unacquainted with the exact meaning of anaesthesiology.

The questions, "What is the minimum practical experience required in the whole field of anaesthesiology?" and "What are the minimum requirements in each subspecialty?" are still under consideration. The answer to the first question is "a minimum of 1250 anaesthetic administrations". So far, a definitive answer to the second question has not been given, because it has not yet been decided how much time should be allocated to activities like intensive care, treatment of chronic pain, transportation of the critically ill, and so on. However, the following proposal (in weeks) has been adopted: obstetric cases 25, thoracic surgery 25, neurosurgery 25, paediatric surgery (under 1 year of age) 10, paediatric surgery (under 12 years of age) 30, dental and stomatological surgery 50, eye surgery 20, spinal anaesthesia 25, peridural anaesthesia 50, other regional methods 20 and intensive care 6 months.

7. Training Record Book

Once the principle of free exchange of anaesthesiologists between countries had been established, our Committee thought that there was a pressing need for a training record book. Such a book would provide a clear picture of how a trainee specialist stands at any particular stage of his career and would supply clear evidence of completion of training. It was also felt that the keeping of a record book, in which the trainee regularly entered the theoretical and practical work he had done and the duties he had assumed during his tuition would be a helpful guide to the trainee himself. For these reasons, a Training Record Book was devised. It is printed in the two languages most widely understood in the EEC countries (English and French). An accompanying, but separate, document supplies a translation in the other languages used in the EEC.

The booklet is divided into 8 sections:

I. Identification (trainee's personal particulars) – 1 page
II. Hospital training – 16 pages
III. Related experience (emergency care, pain clinic etc.) – 12 pages
IV. Courses attended – 6 pages
V. Seminars attended – 4 pages
VI. Papers read or published – 2 pages
VII. Record of cases – 1500 boxes
VIII. Days of duty – 420 boxes

The Training Record Book has recently begun to be distributed throughout the EEC countries.

Summary

This report summarizes some of the main tasks so far undertaken by the Monospecialist Section of Anaesthesia and Intensive Care of the European Union of Medical Specialists. Our Committee started work as a result of personal initiative. It later became an official counselling body to the EEC. It has acted in close collaboration with the boards and councils of the various national societies of anaesthesiologists. The Committee commonly meets at the time of a national or international gathering of anaesthesiologists, but its activities seem to be little known to the majority of the members of our specialty. This meeting on the history of modern anaesthesia has offered an opportunity of presenting an account of our Committee's work. This study was performed on behalf of all the present members of the Committee.

6 Humanism in Anaesthesia

6.1 Foreword

J. Rupreht

On might rightly wonder whether it is honest to give the Nobel, and other such prizes for exceptional achievements, to only one or two individuals. An achievement as such, on the other hand, may well merit the highest prize. This reasoning may be applicable to achievements in the field of anaesthesiology and especially to one of its supreme qualities, humanism. It has been stressed frequently in this book that, in contrast to other medical specialities, development of anaesthesia abated not because of the lack of technical means but simply because of the views opposed to it.

This section gives us an opportunity to become acquainted with the ways in which the idea of caring for the suffering patient has been translated into the everyday practice of anaesthesiology. One of the papers explains how, in order to become an appreciated medical speciality, anaesthesia had to firmly anchor itself in the humanistic ideals of the Western world. The author also stresses the universal importance of a harmonious interplay between research and clinical activities in the speciality, through which a prosperous future can be ensured. There is a great danger that "super-specialisation" of anaesthetists working in research may alienate them from the origins of their speciality – clinical work with patients. In order to prevent this, one should focus on the individuals who are selected for training in anaesthesia and give them a sound knowledge of the techniques, attitudes and vocational aspects of this speciality.

Through his great insight and wisdom, one of the most illustrious academic personalities of our time presents his analysis of the problems related to the past, present and future of anaesthesia.

Humanistic attitudes and goals have been a major force in the development of anaesthesia. As long ago as 1944, at the centennary of nitrous oxide anaesthesia, this fact was accentuated when C. M. Durán stated "Anaesthesia was undoubtedly a moral victory" [1]. This section describes how concern for the patient has been reflected in the visionary action of Lord Nuffield, who recognized the need for the "right man in the right place" when considering the development of anaesthesia. This great man gave a lasting impetus to the academic development of a then new medical speciality – anaesthesia. Indeed, though a lay person himself, but saddened by memories of suffering caused by surgery, he was largely responsible for the creation of the first Chair of Anaesthetics at Oxford. A paper of great significance and beauty illustrates how this was achieved. We are indebted to the author for having put the story on record, being the last one from behind the scenes at that time.

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Concern for the patient under anaesthesia is reflected in a remarkable study of awareness during surgery. This emphasises that anaesthesia is not solely a utilitarian endeavour; it stresses the value and importance of comfort and care for the patient. This attitude was so aptly termed "your life in our hands" by Professor W. W. Mushin in his well-documented BBC production.

Nurses have become essential to the execution of modern anaesthesia; in many parts of the world the development has been reversed: one starts with trained anaesthesia nurses in the hope of replacing them with qualified doctors in due time. With higher medical standards, however, a moment arises when the patient's "life in our hands" has to be trusted to the most skilled hands. This development is well described in a chapter by a nurse who followed the course of anaesthesia as a pioneer, veteran and adventurer in several countries.

We live in a very challenging world – established ways and attitudes are subject to swift changes. A must of yesterday is becoming a taboo of tomorrow. The great harvest of humanistic achievements in anaesthesia will only be preserved by perpetual dedication to humanistic aims of the speciality. Cheap suggestions have been made to consider our medical task from the "push-button mentality" point of view. Such proposals have over simplified the complexity of the human body and the wealth of associated knowledge. To advocate "automatization" of anaesthesia in a period when we do not understand how it works at all does seem rather premature. Several papers in this chapter warn us of such dangers. But there are others amongst us practicing and perpetuating the noble interests and activities in our speciality. A paper has been written on the importance of studying the historical aspects of anaesthesia, papers about collecting and preserving anaesthetic equipment and about first catalogues which will help interested people to locate collections.

Very few medical centres advertise an ability to produce good medical books. From a "worm's eye view", the making of an anaesthesia textbook and the daily life of the department was recorded by a secretary who served the department for over 30 years. She emphasised that without sympathetic assistance from many non-medical individuals, anaesthesia would not be what it is today. Irrespective of whether it is an understanding surgeon, a sponsor or a dedicated secretary, we must not forget our indebtedness to them all. They too are a part of the humanistic endeavour in our speciality that strives to preserve, enhance and perpetuate the good of the past for the benefit of mankind. The aims and endeavours in anaesthesia so aptly described in this chapter are a remembrance of things past, knowledge and wisdom fortunately preserved for the future in the distance.

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6.2 Reflections After a 40 year Interest in the History of Modern Anaesthesia

Th. E. Keys

Th. E. Keys

At least 150 years have passed since the modern introduction of an anaesthetic to combat the horrors faced by the patients, the patients' relatives and friends, and the surgeons in operations undertaken prior to surgical anaesthesia, and it is only now that this historic occasion, the first international symposium on the history of anaesthesia is taking place. We all owe a debt of gratitude to the Department of Anaesthesiology of Erasmus University in recognizing the need and sponsoring a historical meeting on man's achievements in the conquest of pain.

In the early days of modern anaesthesia, beginning in the 1840s, there were frightening obstacles to overcome. There remained the problem of eliminating the septic conditions under which surgery was practised and which brought with it a high mortality. Even with the miracles of modern anaesthesia few surgeons dared to operate, for in spite of their surgical skill, death from sepsis following surgery was just as frequent as before the days of modern anaesthesia. Great credit is due to Lord Lister and others for the introduction of antiseptic techniques in surgery [1]. Lister, grasping the importance of Pasteur's work on sterilization to destroy microorganisms in liquids (wine and beer), set out to eliminate and to prevent the development of toxic organisms in surgical wounds. His success was achieved by simple measures. He washed his hands with a solution of carbolic acid, which destroyed the offending germs. To ensure success he also had an assistant spray the operating room prior to surgery. With the miracle of anaesthesia and with "Listerism", patients could now be operated upon with comparative safety. It took many years before the importance of the combination of anaesthesia with simple antisepsis was practised on a large scale. However, reports in the medical literature on a large number of cases of surgery with low mortality began to appear in the 1880s. Many of these publications were not believed, but continued successes were reported. This brought about the realization that modern surgery was now successful, and it was dubbed the "Queen of the Medical Arts". One must not forget either that surgical shock, which contributed to many postoperative deaths, was largely overcome and became a contributing factor to these successes. We are especially indebted to the efforts of the late George W. Crile of Cleveland, Ohio, for pre- and postoperative care in this regard.

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Antisepsis led to asepsis. This achievement, combined with the development of antibiotics in later years, and with the support of anaesthesia, facilitated the miracle of modern surgery. Even such procedures as operations on the heart and the lung by bypassing the circulation could now be accomplished. Here the anaesthesiologist plays a most important role.

As mentioned in my book *The History of Surgical Anaesthesia,* "It does seem reasonable to believe that more facts have been and will be uncovered concerning the history of anaesthesia as the older books and manuscripts are read and re-read by the scholars interested in the subject" [2]. The contributions of the famous Japanese surgeon, Dr. Seishu Hanaoka (1760–1835), for instance, although casually mentioned in the 1940s, have now received proper emphasis [3]. Since the Dutch were among the first Europeans to visit Japan and later to enter into trade with the Japanese, they brought their "modern" medical knowledge with them. Dr. Gempaku Sugita studied Dutch anatomy books, especially the anatomical tables of Kulman, and the Dutch translation of Vesalius. Dr. Sugita found out by post-mortem study that the Dutch were correct in their anatomical observations and that the Japanese were incorrect. It is possible, also, that Remberto Dodoens' *Cruydt-Boeck* (1644) which was translated into Japanese, influenced Hanaoka. Since Dr. Hanaoka's anaesthetic, which was given as a potion, contained scopolamine as its chief ingredient, it is possible that Hanaoka received his ideas of anaesthesia from Dodoens. His book discusses mandragora, of which the chief ingredient is scopolamine. Later, around 1897, this was used with morphine as an analgesic in the practice of obstetrics, as mentioned by Claye [4].

I wish also at this time to thank the German anaesthesiologists who were responsible for the translation of my book into German (1968). These were Dr. Friederike Lehner of Munich, Dr. Sigrid Schramm of Würzburg and Dr. Heinrich Teuteberg of Mainz. All of the translation was done under the supervision of Prof. Rudolf Frey, Director of the Department of Anaesthesiology at the University of Mainz. His recent death still leaves all of us in a state of shock, but his contributions as a leader in the field of anaesthesiology will always be remembered. I think that the German edition of my book reached a larger European audience than the American editions, since it was reviewed in many medical and surgical journals throughout Western and Eastern Europe. I should like to quote in translation from a few of these reviews. Dr. Püschel of Bochum wrote:

> The American text has been translated from the original into such good German by Friederike Lehner, Heinrich Teuteberg and Sigrid Schramm, that one gets the feeling that one is reading the original version. I was so fascinated by the content, the presentation and the composition of the book that I read it again and again. There is no doubt that the book ... helps to gain the place in medicine which this specialty should have [5].

These are gracious and sympathetic words from a distinguished professor.

Of course, there are omissions in my book. And reviewers have pointed out some of them. Dr. Birger Strandell, at that time (1965) the Editor of *Acta Medico Scandinavica,* stated, "In future editions the Swedish Xyclocain, which was synthesized by Erdtman and Löfran in 1943, and is used throughout the world, should have its given place, as should too its successor, Citanest" [6]. Professor Valentin of Hannover, in his review, brought the reader's attention to the omission of the early use of ether anaesthesia by Heyfelder (Erlangen) on 24 January 1847 and by Eduard von Siebold

(Göttingen) on 8 May, 1847 [7]. He also thought that the important book by Dieffenbach, *Ether Against Pain*, published in 1847, should have been mentioned. I believe these and other omissions were rectified by the late Prof. Hans Killian, whose book on historical anaesthesia is well known. We corresponded about mutual problems.

The Editor of the *New Zealand Journal of Surgery* mentions in his review the speed with which the news of surgical anaesthesia travelled around the world after Morton's successful demonstration of 16 October 1846 [8]. It was soon to reach Paris (15 December 1846) and London (19 December 1846). Attention is called by the Editor to the fact that ether reached Her Majesty's Penal Colony of Van Diemen's Land (Tasmania) by June 1847. It may be assumed that ether anaesthesia was carried from there to the mainland of Australia, and was carried by way of the Cape to South Africa and other regions of that continent.

Early Anaesthesia in South Africa

A personal communication from Prof. C. H. Van Hasselt, Chief Anaesthetist, University of the Witwatersrand Medical School, Johannesburg, tells the little publicized story:

An editorial of the *Cape Town Medical Gazette* published in July, 1847, stated that the news of an amputation using ether carried out at the University College Hospital, London (by Mr. Robert Liston on 19 December, 1846) had reached Cape Town in April of that year (1847) [see ref. 9]. Subsequent to this, trials were carried out with a bullock's bladder distended with air and containing one fluid ounce of ether and fitted with a sponge mouthpiece. This apparatus was used "within 6 months" of its introduction in London, and an editorial of the *Cape Town Medical Journal* (October 1847) stated that there was a report of 2 below-knee amputations of patients under general anaesthesia. It was assumed that H.A. Ebden and F. le Seur Fleck were involved in these trials and it was possible that the amputations were performed by Henry Bickerseth, surgeon of the Somerset Hospital.

In Grahamstown, however, Dr. William Guyborn Atherstone had in his own words "received the news direct from the U.S.A." Dr. Atherstone was regarded as South Africa's most famous pioneer physician. He completed his medical studies in Ireland and received his M. D. degree from the University of Heidelberg. Atherstone, as mentioned by Benson became famous for being the first to use ether as a general anaesthetic outside of America and Europe [see ref. 9]. His patient was Frederick Carlisle, Deputy Sheriff of Albany, who had an ulcerous and useless leg. Dr. Atherstone rigged up an inhaling apparatus resembling a Turkish hubble-bubble into which the patient breathed and when ether anaesthesia was complete, Atherstone amputated the lower one-third of the thigh. The operation took place previous to 26 June, 1847, as reported in the *Grahamstown Journal* of that date.

The Emergence of Anaesthesia as a Medical Specialty

Other contributors have described in fuller detail the emergence of anaesthesia as a medical specialty. However, let us return to early times. Mayo Foundation House, Rochester, Minnesota, contains on its East Wall a magnificant stained-glass window depicting 2500 years of medical progress [1]. The emergence of anaesthesia as a specialty is suggested by representations of plants used as soporifics and prepared in draughts for drinking prior to surgery. Also represented is an illustration of the ether dome in the Massachusetts General Hospital in Boston, Massachusetts. It was in the room beneath the dome that Dr. William T.G. Morton on 16 October 1846 successfully demonstrated before Harvard Medical School students and faculty that inhalation of sulphuric ether would produce insensibility to pain during a surgical operation. The actual operation, the removal of a tumour of the jaw from the patient, Gilbert Abbot, was accomplished without incident. The surgeon was Dr. John C. Warren, who was skilled and highly competent and of outstanding character [2].

Some reviewers of my book believe that I should have given more credit for the discovery to Dr. Horace Wells, who had introduced the use of nitrous oxide previously, or to Dr. Crawford Long, who used ether in 1842. But, as Sir William Osler wrote about the controversy, credit belonged properly to Morton because it was Dr. Morton who successfully brought anaesthesia to the medical world [10]. This view was also expressed by Dr. Oliver Wendell Holmes: "This priceless gift to humanity went forth from the operating theater of the Massachusetts General Hospital, and the man to whom the world owes it is to Dr. William Thomas Green Morton" [2].

It is futile to think that one is first in any great discovery. In scrutinizing the literature on historical anaesthesia I found out that Dr. W.E. Clarke of Rochester, New York administered ether to a young woman prior to the extraction of a diseased tooth by a dentist in January 1842. This anaesthesia preceded Dr. Crawford Long's use of ether by a couple of months [2]. This information has been acknowledged by others and is the subject of a recent cartoon in the *Bulletin of the Medical Library Association* [11]. I am sure there are prior claimants, not only these I have suggested, but ones that others have found or will discover. Recently, for instance, my attention has been brought to the accomplishment in anaesthesia of the famous Herman Boerhaave of Leiden (1668–1738). As Baur [12], in recalling the early history of anaesthesia, pointed out, Boerhaave used opium as a narcosis by inhalation, in powder form and in combination with other ingredients, probably about 1710. Van Swieten, in reproducing Boerhaave's Aphorism 469, suggested that the patient be given opium as a draught (with other substances), 1 h before the operation and another 15 min prior to surgery if the patient was still awake. However, as Joseph Priestly, the pioneer in the discovery of carbolic acid, gas, oxygen and nitrous oxide said:

> When for the sake of a little more reputation, men keep brooding over a new fact, in the discovery of which they might possibly have very little merit, till they think they can astonish the world ... they are justly punished for their ingratitude to the fountain of knowledge, and for their want of a genuine love of science and of mankind, in finding their boasted discoveries anticipated and the field of honest fame preoccupied, by men ... [who] with an ingenious simplicity immediately communicate to others whatever occurs to them in their inquiries ... [2].

After all these intervening years, despite modern advances, the next publication in this direction has been made by Frederick W.L. Kerr, MD, Professor of Neurosurgery and Neuroanatomy, Mayo Foundation and Medical School. In his recent book Dr. Kerr considers all kinds of pain, surgical and non-surgical [13]. He writes:

> To sum up, there are some 100 billion neurons capable of making synaptic contacts between one another by means of ten or even hundreds of thousands of terminals. Next to this, the most complex computer yet developed appears to be a child's toy. Need one be reminded that the computer was conceived by the human brain? ... Somehow, 100 billion neurons "know" how to get together and organize themselves into that most perfect of organs, the human brain ...

So, as indicated by the late Dr. Kerr and by colleagues both in this Symposium and elsewhere, great strides have been made in our understanding of pain, and consequently we are on the path to a better understanding of the cause of anaesthesia.

In *Foundations of Anesthesiology* several papers are reprinted on the theories of narcosis, including those of Marie-Jean Flourence, Isidor Traube, Hans Meyer, Ralph Lillie, Hans Winterstein, Linus Pauling and others [14]. They merit study. Today's anaesthesiologist now possesses advanced training in physiology, pharmacology and medical electronics, and also deals with resuscitation, pre- and postoperative care, electrolyte imbalance and hyperbaric oxygen therapy. A critical analysis of important developments in anaesthesiology since the end of World War II has been made by E.M. Papper et al. [15]. Among the problems discussed is the possible harmful effects of air pollution in the operating room. The problems of anaesthesiology continue to challenge the skill of not only the anaesthetist physician but also the nurses and the paramedical personnel involved.

Specialisation in medicine is not a new development. In the earliest known records – those of the Egyptians as recounted by Herodotus – we read:

> Medicine is distributed in the following way: every physician is for one disease and not for several, and the whole country is full of physicians, for there are physicians of the eyes, other parts of the head, others of the belly, others of obscure diseases, and even a guardian of the anus (cited in [16]).

Perhaps the last-named specialist was the forefather of the anaesthetist, for it is reported by Dioscorides that in the first century A.D., anaesthesia was achieved by the use of mandragora, either in the form of a suppository or by rectal injection (cited in [17]). We must not lose sight of the advancement of medicine during the Renaissance as contributing to the development of anaesthesia. One thinks of Vesalius, the founder of the new anatomy, of Robert Boyle in physiology, and especially of William Harvey, whose discovery of the circulation of the blood led the way to many other important advances.

Why did it take so long to achieve modern surgical anaesthesia? There are many early examples of the use of ether inhalations as well as that of nitrous oxide. Sir Humphry Davy suggested nitrous oxide about 1800 and wrote, "It probably may be used with advantage in surgical operations [18]. Dr. John C. Warren of Boston, according to Lyman, made use of ether inhalations in the treatment of the later stages of consumption, about 1805 [19]. There are many other examples from both the ancient and modern literature. As with other medical discoveries, the time had to be ripe before surgical anaesthesia was generally accepted. No historical account of this subject can ignore the contributions of Dr. Ralph Waters, formerly of the University of Wisconsin, and those of the late Dr. John S. Lundy, formerly of the Mayo Clinic. Not long ago Dr. Emmanuel Papper wrote.

> The development of anaesthesiology as we see it now began in the 1920's, and I think it is fair to state that the first interest in this field as a specialty, organized apart and separate from other fields of medicine, began at about the same time at the schools of Waters in Wisconsin and Lundy at the Mayo Clinic [20].

Early physicians and others who gave anaesthesia prior to surgery were often careless and some gave ether or nitrous oxide until the patient fell into a deep sleep. John Snow and others appreciated the need for measuring the amount of the agent administered, the significance of oxygen lack and the problem of carbon dioxide [21].

Deaths attributable to anaesthesia began to diminish following Dr. Snow's observations. Dr. Harold Griffith pioneered the use of curare as a muscle relaxant, helped to establish the World Federation of Societies of Anaesthesiologists and planned the First World Congress in the Netherlands in 1955. Pioneering with him in establishing the organized existence of anaesthesiology was the many-sided Dutch anaesthetist Dr. C.R. Ritsema van Eck. There are many problems in anaesthesia that are still in need of solution. Some of them have been pointed out by Beecher and Ford [22]. The high death rate in infants and small children and the problems caused by cardiac arrest and ventricular fibrillation still remain.

I conclude with Dr. Campbell Gardner's statement regarding the essential qualifications of an anaesthesiologist:

Show me a man with sympathy, honesty, strength and a moderate amount of skill who is interested (1) in the welfare of the patient, (2) in the team of which he is a part, and (3) in the profession of medicine as a whole and in the institution to which he belongs, and I am quite certain, not only that he will have the essential qualities of a wonderful anaesthetist, but that his own success and that of anaesthesiology in his community will be assured [23].

How close have anaesthesiologists come with this description to the elevated Erasmus' description of a good doctor?:

I wish you the greatest luck, you worthy men, privileged to excell in the fairest of professions. This is my advice: dedicate all your gifts to the science which will foster your honour, glory, respect and fortune; and from which in turn, your friends, your country, all the mankind will benefit in an exceptional way [24].

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6.3 Modern Anaesthesia, with Special Reference to the Chair of Anaesthetics in Oxford

R. Macintosh

R. Macintosh

The description "modern anaesthesia" is somewhat vague, but we have all got a good general idea of what is meant. To me, the adjective "modern" implies change, and when I received an invitation to contribute to this Symposium, my mind ran back to my early days in our specialty and to a number of the changes which have since taken place. My most vivid memory of those early days was of the virtual impossibility of relaxing the rigid abdominal wall of the man with a perforated gastric ulcer, particularly if his respiratory centre had been depressed by morphine. And then I remembered there wasn't a single anaesthetist of my generation who had not suffered his moments of embarrassment through holding up the start of an operation – when everyone else was ready – because of difficulties associated with passing an endotracheal tube. With these two pictures of the old days still clearly in mind, it is not surprising that my outstanding impression of modern anaesthesia is the dramatic ease with which fundamental protective reflexes are now abolished – or, in other words, the transformation which has been effected by the relaxants. For this, all of us, patients, surgeons and anaesthetists alike, are indebted to Harold Griffith. One of our senior colleagues put it neatly when he remarked that anaesthesia could be divided into two separate eras, pre- and post-Harold Griffith.

I subscribe to this view, but I remain conscious of another watershed between the old and the new. I refer to methods of induction. In my early days, it never entered the minds of any of us that there was any practical alternative to the mask and inhalation – a procedure disliked by all and dreaded by quite a few, including, I know, men who had distinguished themselves for bravery on the battlefield. Anxiety on this score was eliminated by German chemists. I remember the introduction of Pernocton, the first of the intravenous barbiturates to be made up conveniently in ampoules. Then there was that excellent drug, Avertin. Either of these put the patient pleasantly to sleep in his bed, and when he woke up it was to become blissfully aware that what he had been dreading was already a thing of the past. A blessing of this sort, now taken for granted, was, at that time, regarded as a near miracle.

I have been asked to devote the major part of this talk to giving an account of the background of the establishment of the Chair of Anaesthetics in Oxford, the first chair

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in our specialty in Europe, and, indeed, the first fully endowed chair of anaesthetics in the world. I do this, though, with two slight misgivings. The narrative may be on the long side for this occasion, but an account has never been given before by anyone who was behind the scenes at the time, and if I do not record it now, there will be no one left to do so. My second misgiving is that I have introduced myself into the subject more than I like, but I have done this solely to make the sequence of events more easy to understand.

The Benefactor was, of course, that striking personality, Lord Nuffield, born William Morris in October, 1877 – a date which is easy for me to remember as he was exactly 20 years my senior. His family background was modest, and so, too, was his formal education, which was restricted to the village school at Cowley, on the outskirts of Oxford. He left at the age of 15 to work in a shop repairing bicycles at a salary of 5 shillings a week, or £13 a year – admittedly before present-day inflation. After a year, his request for an increase was refused, so he left and set up in business on his own.

A few years later, this young working man was the victim of two terrifying anaesthetics of which he retained vivid memories throughout the rest of his life. There is no doubt that these two experiences, which he described as nightmares of prolonged suffocaction, formed the cornerstone of the Chair at Oxford, in the negative sense that if they had not occurred, then a Chair would not have been thought of. His teeth had been neglected, and toothache forced him to the dentist, who administered nitrous oxide and then proceeded to multiple extractions. It is well known that a dream involving prolongation of time can be triggered off by a stimulus which lasts only a couple of seconds, and that the content of the dream, pleasant or otherwise, is related to the nature of the stimulus. So that, when a single-handed dentist of almost 100 years ago administered nitrous oxide and then went on to remove as many teeth as he could in the short time afforded, the stage was well set for a nightmare.

From repairing bicycles, young Morris went on to making them, then to repairing and making motorcycles – learning as he went along – and then on to small cars. Four biographies about Lord Nuffield make it clear that he was a pragmatist. As a young man, he was an extremely hardworking, naturally gifted mechanical engineer, and his progress to becoming a multimillionaire was characterized by imaginative, bold and completely unexpected decisions which clearly turned out to be right in a high percentage of cases. These decisions were his alone, and perhaps it was on this account that they often gave the impression of being made rapidly, but they were always based on careful thought.

He played a competent game of golf – handicap of 8 – at Huntercombe, 17 miles (27 km) from Oxford, on the way to London. When the Club encountered financial difficulties, he bought it and made his home in the residential quarters. There he came into close contact with members of the staff of Guy's Hospital who, in those more spacious days, frequently spent their weekends at the Club. This led to lasting congenial friendships, and also to the great benefit of Guy's Hospital, to which he later contributed so very generously. I make the point that over the years a special relationship was built up between Nuffield and Guy's Hospital.

When I joined Huntercombe, in 1927, the small coterie of Guy's doctors were in the habit of having their evening meal together in the Club's dining room. Almost invariably we were joined by Mr. and Mrs. Morris, who had no children, and, unusual in those days, didn't keep a cook. Mr. Morris was not widely read, but he was a man of lively intelligence, who quite naturally became involved in the wide variety of problems commonly discussed by doctors when they get together.

During his lifetime, Lord Nuffield gave away 30 million pounds, or, say, 150 million at presentday values. At the time I am talking about, his spectacular gifts – *many associated with Medicine* – were given prominence in the daily press, and this in turn led to further appeals for his help. During these Huntercombe weekends, he often asked for our opinion on the potential for good of the applications which related to medicine, some of these quite bizarre. In a way, he was curiously reticent, because only later did we find out how he had reacted to our views.

Here I interpose two personal stories because they bear on what I have to say later. In the early 1930s, Lord Nuffield had to have a small operation in London, and I gave the anaesthetic. When I tell you the circumstances, you will realize I am not being immodest when I say that this had an inordinate affect on the patient. I gave him Evipan (the precursor of Penthothal), which had just been introduced – and what an immense step foreward that was. When the operation was over, the patient slept on for a while, then looked at his watch and enquired why the operation had been postponed. The contrast between this and the nightmares of prolonged suffocation could not have been more complete. Later, at Huntercombe, he frequently referred to what he described as the magic of this experience.

Now the second personal story. In the late 1920s, I formed a very happy and successful partnership in London. My first partner was W. S. McConnell, who subsequently was elected to the staff at Guy's Hospital and later became senior anaesthetist there. The other, Bernard Johnson, became senior anaesthetist at the Middlesex Hospital and also the second Dean of our Faculty. Anaesthetists, like other mortals, had to live, and, before the British National Health Service was founded in 1948, the only activity that made this possible was private practice. Success in those days was equated with size of private practice, and this did not depend on possessing an Honours Degree in Physiology or a Doctorate of Philosophy. What did help and, when it came to reputation, what separated the men from the boys, was the ability to pass an endotracheal tube – no easy matter 50 years ago. With a tube in place, the surgeon could rely on tranquil, safe anaesthesia – something which then was not just taken for granted – and the services of the technically competent anaesthetist were much in demand. Ivan Magill was the first in the field and the most skilful exponent, and he was sought after more than anyone else; however, my partners and I were kept comfortably busy.

In the summer of 1936, the Annual Meeting of the British Medical Association was held in Oxford, and the Presidential Address was given by the University Regius Professor of Medicine, Sir Farquhar Buzzard, who stressed how fitting it would be for Oxford to become a postgraduate medical centre of repute. He followed this up by appealing to Nuffield for a million pounds to turn this dream into reality by establishing three clinical chairs – of Medicine, Surgery and Obstetrics. I happened to be sitting next to Lord Nuffield on the following Saturday, evening, at Huntercombe, when he told the table of this proposition. Without the slightest ulterior motive, but merely as a social gesture to keep the conversation moving, I remarked, "I see they have forgotten anaesthetics again." This comment was ignored, and the conversation turned to wider issues. But this chance remark set his imagination going in a new direction. He recalled the horror of his early experiences, and he saw an opportunity of sparing others what he had been through. Within a matter of days, Nuffield told the University he was favourably disposed to their scheme for a postgraduate medical school, so much so that he would increase the sum requested because he wanted a chair of anaesthetics to be included. Doubts had been expressed as to whether anaesthetics was a suitable subject to be studied at university level, and I know that I pointed out to him that, though there were quite a number of well-known, experienced anaesthetists, none had the academic background to justify professorial status in an ancient university. He accepted this, adding that he realized the first incumbent would be at a disadvantage, and the same would probably apply to his successor, but he was confident that the next in line would be able to hold his own. I well remember his rhetorial question, "If I don't establish a chair now, who is going to do so in the future?"

Nuffield expected that his offer would be accepted enthusiastically, and he was much surprised when Buzzard called on him at Huntercombe, on a Sunday afternoon, to tell him that deeply grateful as the University was for the offer of the additional chair, they thought it wrong to accept, as the creation of a chair in a subject such as anaesthetics would expose both the University and Nuffield to ridicule. Nuffield's reaction was entirely typical. In a friendly way, he thanked Buzzard for taking the trouble to point this out, otherwise he might have pressed for something obviously undesirable – and Buzzard left fully satisfied with his mission.

Some 2 weeks went by, after which a slightly worried Regius Professor telephoned to enquire when the University could announce its Medical Benefaction – to be told by Nuffield that he understood at their last interview that the University had declined his offer. And then it became crystal clear that his offer was for four chairs or none.

Our small group of Guy's doctors at Huntercombe knew that negotiations were going on between the University and Nuffield, but not of any details beyond the fact that he had rejected the University's suggestion that any person appointed should be given the status, not of professor, but of reader (higher grade of lecturer). It was only when he told us, later, with a gleam in his eye, that he had won his battle to establish a chair, that we realized he had taken it for granted that I would be delighted to play my part in his crusade to raise the standing of our specialty – and it then transpired that he had already told the University that I would take the chair on. For a brief period, the situation could have become embarrassing. Neither my wife nor I had any desire to leave London, where life was running very smoothly. I saw no advantage in translating myself to an academic life in Oxford where there was always the possibility that I might find myself a fish out of water. On the other hand, if I didn't accept the post, I disliked the idea of the absolute certainty that Nuffield would think I had let him down. My wife and Lady Nuffield had been close friends for a number of years. My colleagues from Guy's would have been disenchanted if any action of mine had lessened Nuffield's interest in medicine in general, and in their hospital in particular. I told my partners in London of the position in Oxford, and I said I would be prepared to take the job on for a year if they would keep my place in the partnership open. If during this period I found I didn't like Oxford, or Oxford didn't like me – which probably would amount to the same thing – I could resign with the assurance that I could resume my old place in the partnership in London. This they agreed to quite happily.

Envoi

After moving to Oxford, I do not think I ever seriously contemplated going back to London. There were difficulties, of course, but these were outweighed by the attractions and potentialities. At that time there was not a single specialist anaesthetist on the whole of the mainland of Europe, and I wanted to see how famous surgical centres overcame this handicap. I accepted an invitation to visit Spain during their lamentable civil war. I found it intensely interesting to work in a country where endotracheal anaesthesia was unknown. Fortunately, the American plastic surgeon[1] warned me to bring a laryngoscope and tubes so that he could carry out repairs of the head and neck. Nitrous oxide was not introduced into that country until 12 years later (Prof. Alfredo Arias, personal communication), and I did not see a cylinder of oxygen throughout. The only apparatus available was an Ombrédanne. There was plenty of room for improvization, and opportunities for teaching and research were all too obvious.

Even if I had entertained any doubts about remaining in Oxford, these would have been removed by a talk I had with Ralph Waters whom I have described elsewhere as the outstanding personality in our specialty over the past hundred years [1]. I know of no anaesthetist who set a better example, or who gave better advice to those who sought it.

1 Dr. J. Eastman Sheehan

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6.4 A Worm's Eye View of the Anaesthetic Department

Jean F. Davenport

J. Davenport

The Anaesthetic Department at St. Thomas's Hospital, London celebrated its Silver Jubilee in 1973 – a year too late! It was founded in 1947, the year before the National Health Service took over British hospitals, but it had no secretary until I came in September 1948.

It had never occurred to me that my own 33½ years began long enough ago to constitute history, although when I arrived at St. Thomas's the current edition of Lee's *Synopsis of Anaesthesia* had 254 pages and today's Lee & Atkinson has 986. An occasional patient still succombed to something mysterious called "status lymphaticus". Curare was the only muscle relaxant. There was cyclopropane (in silver and red cylinders), but no halothane. There was thiopentone, but before our trainees were allowed to use it they had to induce 100 patients with ether, so Guedel's famous "signs and stages" were constantly in everyone's mind. I was relieved to learn from these that a patient's breathing stopped before his heart ceased to beat. People whose hearts had stopped, I thought, were dead.

It must have been the very end of the "rag and bottle" era. I remember one of the anaesthetists going to an emergency with a Schimmelbusch mask and some lint in one pocket and a bottle – it may even have been of chloroform – in the other.

I had previously worked in a bank and knew nothing about medicine. When the eye surgeons had a patient on their list for "cosmetic squint" I believed this had been caused by carelessly applied make-up, and when one anaesthetist complained to another that he had "an awful patient with no veins", I sat marvelling to myself "How extraordinary, fancy having no veins!"

A different kind of ignorance obliged me to ask the name of somebody who came in looking for one of the anaesthetists. Need I say he was one of the senior surgeons? He was so outraged that when another impressive person came in I didn't dare ask who *he* was and had to spend the rest of the day describing him to try to find out.

I wasn't the only ignorant one. I used to get some funny messages from the porters. I was once asked to send someone to the General Lying-In Hospital for a "ten per cent". By the time this happened I was a bit more knowledgeable and could translate it into "retained placenta".

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Soon after I arrived, our Department created history by appointing Marjory Murray as the first woman resident at St. Thomas's. Despite the precedent of every hotel in the kingdom, this threw the authorities into consternation. They refused outright to allocate a room to her among the male doctors. Instead, she was given one in a bomb-damaged block at the end of a long corridor leading to the linenry, which was full of people during the day but totally deserted at night. Big cities were safer then than now, but even in 1948 it was a bit eerie! Luckily Marjory had a resilient temperament, and it was not long before she had taken over the empty room next to her own and organized a series of parties in it.

The Department in those days was at the end furthest from the window in a long, thin room belonging to the Chief Pharmacists's secretary. We owned a desk, a filing cabinet, two wooden chairs, an enormous red leather armchair – ideal for our Director, Dr. Low, who was 6 ft 3 in. (1.9 m) tall and weighed 112 kg – and a board with hooks under the names of the various operating theatres. On these hooks were hung circular pieces of plywood, each bearing the name of one of the ten anaesthetists, typed on white paper. I painted these in different colours and was surprised how much people minded what colour I gave them. For example, nobody wanted blue! I also compiled a frivolous magazine called *Cyanosia* which got no further than the first issue. It was all rather jolly, but nothing could hide the fact that I had not enough to do, and I threatened to leave, so it was agreed that I should work for the gynaecologists as well.

This brought to a head our desperate shortage of space. If more than two people wanted to talk to each other they usually sat outside on top of a radiator in a row like swallows on a telegraph wire. Dr. Low brought his considerable weight to bear, and we were given a new home, in another bomb-damaged block. It was a very large, green-walled, shadowy room, two of whose four windows had been bricked up to support a tottering ceiling. But this time it was I who had the place near the windows. I was coming up in the world. We bought a Visitors' Book. The first to sign it was John Gillies. Others on the first page are J. H. Blease, Frankis Evans, Cecil Gray, Sir Ivan Magill (he was "Pat Magill" in those days), Geoffrey Kaye and Zeb Mennell. Later visitors included Virginia Apgar, of "Apgar score" fame, and Ralph Waters. I enjoy telling the young that I met "Waters the Canister".

In this room the fateful decision was taken to write *A Practice of Anaesthesia.* Maybe it is as well I do not remember which recently published book had failed to meet with the approval of the members of the Department, but one of them said disgustedly, "We could write a better book ourselves", and another asked, "Why don't we?" The speakers were not Dr. Churchill-Davidson and Dr. Wylie, as you may have assumed, but Dr. Wylie and Dr. Andrew Doughty. It was only after these two had already signed the contract that Dr. Doughty asked to be released and Dr. Churchill-Davidson took his place.

It was a happy collaboration between two indefatigable but otherwise totally dissimilar people. Their writing differs, too. Dr. Churchill-Davidson's is big and clear, though his spelling is a bit peculiar. Dr. Wylie's is appallingly difficult to read, very small and mostly written with a blunt pencil. As the book finally ran to 1056 pages you can imagine the size of the task. I really would advise any secretary who overhears a conversation such as I have described to create an instant diversion, unless she is prepared for years of desperately hard work, evenings and weekends included.

Incidentally, the first edition contract allowed for 6 months' research and 6 months' actual writing. It was signed in March 1952 and the book was published at the end of 1959!

We jogged along with the gynaecologists surprisingly happily, considering that they were halfway to being surgeons. Mr. Wrigley, of the Wrigley forceps, was the senior one, and their bright young man was the famous Ian Donald, later Professor of Obstetrics in Glasgow, who used to plug in strange machines of his own invention and fuse the lights. But both Departments grew, and when they separated I had no hesitation in choosing to stay with the anaesthetists.

Our next home was across the road from the hospital in a terraced house which had been upgraded by the addition of toilets in the basement. The former occupants must somehow have managed without. One room contained a massive and hideous, mahogany, glass-fronted cupboard. Dr. Foster at last had somewhere to display the old anaesthetic apparatus he had been collecting since 1951. Remember, I was a houseproud young woman setting up the first home I did not have to share. I hated his unattractive hoard of tarnished metal, yellowed gauze, moth-eaten felt and perished rubber.

In 1963 the houses were demolished, and, in the coldest weather they could find, the authorities *first* took out the windows and *then* announced that we should pack our own books and apparatus while they dealt with the furniture. The museum people in Oxford are said to have thrown away the only known skin of a dodo "because it had got so dusty". I had already asked Dr. Foster, "Must we take all that old junk with us?", and I am afraid he still suspects that I had something to do with the loss of some irreplaceable items from his collection during the move. I did throw away the months-old remains of an uneatable pumpkin pie somebody had hidden on top of the cupboard to avoid hurting the feelings of the cook! We have moved twice again since then, and the museum is now fittingly housed and looks very attractive. We have an Academic Unit and run courses in our own big lecture theatre and are altogether very prosperous and grand, but I was fond of our little house.

What seems to me the biggest step forward since I came is not something you would find in any anaesthetic textbook, but the invention by Peter Styles, of the Electronic Workshop at St. Thomas's, of the bleep system. In 1948, if I wanted an anaesthetist, I would ring up the porters, who sent out a code call by means of bells. The bells did not ring all over the hospital but only in certain places. This raised the problem – should I use the internal phone to try the others? If I did, I blocked the line, If I did not, and the call remained unanswered, I had wasted valuable time. A life might be at risk. I used to worry a lot about this.

Later on we had a Tannoy system, operated by the telephone girls. Wooing voices from up in the ceiling used to call enticingly "Dr. So-and-so: Dr. So-and-so!" Dr. So-and-so would then ring the switchboard to find out who wanted him. But the Tannoy did not work everywhere, either. Peter Styles' invention revolutionized things. Individuals had their own bleeps which worked throughout the building; I just sat back and waited. It was marvellous, though one anaesthetist got so exasperated because I called him halfway through his lunch that he dunked his bleep in the water jug. It cost £ 20 to repair.

By July 1960 the bleeps had become sophisticated enough to transmit messages and we started the "Crash Call System" and could send an anaesthetist anywhere in the hospital within 4 min. Multiplied throughout the world, this must have saved many hundreds of lives. Doctors owe a great debt to Peter Styles.

So, looking back, there have been many changes. One thing, however, has remained constant. We have always been an immensely happy Department. I expect most anaesthetic secretaries could say the same, since anaesthetists are nearly all patient, peaceful, tolerant folk with an ironic sense of humour. This makes it not only possible but a positive joy to work – as I now do – with and for 37 of them. Picture the lot of a secretary working for 37 surgeons! The imagination boggles!

I am very proud of my association with anaesthetists in general and my Department in particular. Perhaps there are not many people who can honestly say they have been continuously and consciously happy in a job for over 33 years. Fewer still can have been lucky enough to be invited at the end of those years to a wonderful meeting in an exciting city and given the chance to say in public, "Thank you very much for having me."

6.5 The Value of the History of Anaesthesia for Anaesthetists and Anaesthetists in Training

Th. B. de Bruyn and J. L. Couper*

The main purpose of this talk is not so much a lecture on history itself as an effort to share our enthusiasm in the development of anaesthesia and interest in the misfortunes that have caused accidents in the past. All of us should learn from the mistakes of our predecessors and our colleagues and from our own mistakes. Is this not one of the best methods of learning? – learning from the errors of others and in so doing avoiding them in our own daily practice, thus becoming more efficient anaesthetists.

A knowledge of the history of anaesthesia has no commercial value for the practising physician but it does have an immense cultural value. History is the cement which binds together all the varied activities of man. Without history a man's soul is purblind, seeing only those things which almost touch his eyes. Experience is the best of schoolmasters, but the school fees are heavy. One must remember that experience itself is of no value unless it is combined with the ability to learn from experience. Errors in many forms have killed and will do so again unless one knows about them. Therein lies the value of history: that we learn from the mistakes of others. Learning from our own mistakes is a very slow process.

Are anaesthesia deaths mistakes? Properly administered anaesthesia should not cause death, and the corollary that deaths from anaesthesia are due to errors or mistakes except in the very poor-risk patient is probably also true, although at times it may be very difficult to pinpoint where one has erred. Hannah Greener died like a shot rabbit on 28 January 1848. Whole generations of patients given chloroform had died before Goodman Levy's classic experiment with adrenaline in light chloroform anaesthesia explained the mystery, no less than 63 years later, in 1911 [1, p. 82].

Confusions Relating to Prescriptions

The confusion of the similarity of drug names has led to many unfortunate accidents. The short name "Percaine", for example, could be and was easily confused either in speech or writing with procaine. The addition of the two letters "N" and "U" to Percain (making "Nupercaine") was bought at a cost of three lives [1, p. 14].

Recently an inquest was made into the death of a young married woman who one evening attended the casualty department of a hospital for a threatened abortion.

* Professor De Bruyn died and Professor Couper completed the unfinished manuscript

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Although the duty doctor had been in the country for over 3 years, he had a very poor command of English. He ordered what appeared to be pethidine 100 mg and Scoline 1 ampoule. The sister on duty, with another sister as witness, asked the doctor whether he really meant to prescribe 1 ampoule of Scoline, and his reply was in the affirmative. The sister, because Scoline was not in the casualty department drug stock, again contacted the doctor, who resented being queried regarding an order. The writing of the words "pethidine" and "Scoline" was clear and left no room for error – but the dosages were scribbled. Is it not often the practice when uncertain of a name or dosage to scribble the prescription, in the hope that the person carrying out the order will give the correct dose or correct drug? The defence council argued that the accused had prescribed 1 mg and not 1 ampoule of Scoline. Needless to say, the patient was given 1 ampoule of Scoline intramuscularly and when seen 20 min later was gasping. Resuscitation returned heart function and respiration, but did not restore consciousness, and the patient died of bronchopneumonia a month later without regaining consciousness. The doctor (who was a refugee from a totalitarian country and only had a temporary resident's permit that expired the day after the inquest) left the country that same afternoon. Had he confused Scoline with scopolamine, which is available in a premixed form with pethidine and which is used frequently in that particular hospital to produce sedation? The doctors and nurses frequently refer to "Peth Scop". Had the doctor just heard this spoken by his colleagues and thought "Scop" referred to Scoline? His defence council argued that the doctor had prescribed Scoline and that 1 mg was used to suppress uterine contractions in threatened abortion in the country from which the doctor came. Unfortunately, we will never know the truth, but we can learn to be more explicit and exact in talking with our colleagues and in writing orders, as well as being humble enough to acknowledge errors on our part.

A recent newspaper account of an inquest in Pretoria reported that a doctor and a nursing sister had been referred to the Attorney General for prosecution on a charge of negligence arising from a dose of a drug used for premedication for a 13-year old being given to a 13-month-old child. The correct dosage was calculated according to a schedule based on age. However, the details were not recorded on the hospital's prescription chart, and the doctor did not enquire further about the dose. The combination of the overdose of medicine and the anaesthetic used caused breathing problems and the child went into a coma. She died 10 days later. One solution to the problem would be to adopt the method used when writing out cheques, in which the amount of the transaction is written out in full in words as well as in figures.

Confusion Arising from Inadequate Supervision

"Just give her a whiff, old man!" With this sound advice from a senior consultant someone who has never seen a copper kettle or Oxford vaporizer number two is told to give a short anaesthetic for some minor procedure. Knowing nothing and fearing nothing he twiddles a knob, as he might twiddle the lever of the old bubble bottle, and sends a blast of undiluted vapour into the unfortunate patient with the inevitable result.

Anaesthetists' Reflex

How many people today know the "anaesthetists' reflex"? I have not seen this mentioned in any book, but am grateful that I was trained to believe that this was a reflex of vital concern to the patient and one that had to be learned to the point of it becoming a conditioned reflex: Certain events during an anaesthetic were reflexly monitored. There were four components of this reflex, and they are still as invaluable today, if not more so, in the care and wellbeing of the patient as in the days when anaesthetics were much simpler.

The first component is a constant check on the oxygen flowmeter. How easy it is for a cylinder to become empty, or for a workman to block the pipeline or for the sensitive needle valve to be accidently turned off. The next component is the respiration, not only as reflected in the reservoir bag if the patient is breathing spontaneously, but also in the movement of the chest. The latter is particularly important in a patient on a respirator. How often do we read of mishaps when the ventilator or connector has become disconnected from the patient? Yet the anaesthetist is blissfully happy hearing the hypnotic "woosh" of the mechanical ventilator that untiringly continues its useless function.

The third component is the pulse, with rhythm and volume as the important indicators of satisfactory heart function and hence reasonable tissue perfusion. Does the modern anaesthetist know where to feel the pulse? Should the cardiac monitor fail, what is his first reaction? Rarely, it appears, is it to check on the patient. The first reaction usually is to see whether an electrode has become loose or to send for a replacement monitor. At another recent inquest, evidence was given that when the patient was turned onto her face the electrode came loose. As she was only to be in the prone position for the short period of 10 min no attempt was made to rectify the fault. When the patient was turned onto her back it was discovered that there was no heart action. In resuscitating the patient she was given pure nitrous oxide (because the anaesthetic machine had been updated with the oxygen rotameter on the right and the anaesthetist from force of habit turned up the lefthand flowmeter). Had the anaesthetist put a finger on the pulse when the electrode became disconnected, another life might have been saved. Do we not rely too much on the fact that properly administered anaesthesia should not cause death? (After all, who are we that we do not administer proper anaesthetics?) Or do we judge that a properly administered anaesthetic is one with a plethora of monitoring equipment? We all know the cartoon of the anaesthetist gazing at his battery of equipment and the nurse telling a colleague that she has not the heart to inform the anaesthetist that the patient was wheeled out 20 min previously.

The fourth component of the reflex is the colour of the blood oozing from the wound, or lips or fingernails. Yet how often does one come across patients so covered with drapes that it is impossible to glimpse any part of them?

The Possibility of Crossed Pipelines

What about 100% oxygen? How often do we administer 100% oxygen, especially when in trouble of before intubation or at the end of a procedure? In most reports of accidents involving crossed oxygen and nitrous oxide pipelines the anaesthetist noticed the patient was cyanotic and turned off the nitrous oxide to administer 100% oxygen, but there was no improvement in the patient's condition. Only after three or four deaths or near fatalities from 100% oxygen does someone think of the possibility of crossed pipelines. Would these accidents not have been avoided if some nitrous oxide (even two or three litres) were given instead of pure oxygen?

Mistrust of Patients

Why are we as anaesthetists so mistrustful of our patients? At still another recent inquest it was revealed that the dead woman wore a medic-alert disc, but, it appeared, this had been ignored. The dead woman's husband told a reporter, "When my wife was admitted to hospital for the operation I especially asked them to contact Professor Z., but they didn't. Professor Z. was very surprised when I told her my wife had died." Professor Z. had extensively researched the family's background and published the results in 1973 – the family are prone to malignant hyperpyrexia.

Should we not be more explicit in giving instructions to our patients? Frequently patients tell me that they were told by a doctor that they did not react normally to anaesthetics. Often this may have been due to the inexperience of the person administering the anaesthetic. I have seen these patients successfully through subsequent anaesthetics without the slightest evidence of abnormality or untoward reaction. Should we not give a typewritten card in a clear plastic cover to any patient for future use? This could describe the problem experienced, whether a difficulty in intubation or bronchospasm with alphathesin etc.

Restlessness

Ask any final-year medical student, intern or most doctors what is the commonest cause of restlessness, particularly in a postoperative patient, and the instant reply is pain. If we really look at postoperative or most other patients in pain we see just the opposite: They unthinkingly rest any part that is painful, because experience has shown them that movement increases the pain.

A classic example of this confusion was given at another inquest. A woman who had recovered from anaesthesia for a hysterectomy was very restless when seen by the night sister on her rounds at 10 p.m. (22.00 hours) and given morphine as ordered for pain. At 2 a.m. (02.00 hours) next morning she was found dead in bed (probably the morphine helped her to die peacefully). The post-mortem revealed 2½–3 litres of blood in the abdomen from a slipped ligature. Restlessness rarely is the result of pain; rather, it is due to cerebral hypoxia.

Surgeons and Others

When will we convince surgeons and theatre personnel that the patient is the most important person in the operating theatre? Ambient temperatures are geared to suit the surgeon, who may only spend half the time that the patient (or anaesthetist) spends in theatre, with little or no regard for the dangers of heat loss in patients, particularly in infants and children. On many occasions when I have been present surgeons have asked for some electrical apparatus – an extra light or forgotten diathermy – and the nurse will obligingly remove a plug to satisfy the wish of the surgeon, with no thought that this might have been giving power to the ventilator or monitor.

History

Dr. Stanley Sykes in his second volume of *Essays on the First Hundred Years of Anaesthesia* devotes the first two chapters to "Thirty-seven little things which have all caused death" and "Anaesthetic deaths in the first hundred years" [1]. One has only to pick up the annual reports of the Medical Defence Union or Medical Protection Society to read that often the lessons of history are ignored and the same mistakes are repeated year after year.

I hope that have shown as have many others, that is is necessary to read widely and frequently to avoid the numerous pitfalls that befall anaesthetists. For those who do not read because they are practical anaesthetist, my advice is that a practical man is one who practises the errors of his forefathers. To the mechanical man the advice is that gadgetry does not seem to be a useful substitute for common sense and skilled patient management. Anaesthesia is usually terribly simple but sometimes simply terrible. The administration of anaesthesia is demanding, and the penalty of anything less than perfection is death.

The road to wisdom,
well it is plain and easy to express.
To err and err and err again.
But less and less ... and less.

Reference

1. Sykes WS (1961) Essays on the first hundred years of anaesthesia. Livingstone, Edinburgh, vol 2

6.6 The Nurse-Anaesthetist in Norway

J. Horner

J. Horner

The justification and need for nurse-anaesthetists in most countries where they are employed has been discussed endlessly without reaching any clear conclusion, ever since anaesthesiologists developed into a conscious and organized professional group. Without attending any more for the moment to that discussion, let us take a quick look at the situation for anaesthesia in Norway as it appears over a time perspective of about the last 50 years.

The need for nurse-anaesthetists in Norway arose partly as the result of advances made in surgical techniques prior to and during World War II, and partly because of the almost complete dearth of anaesthesiologists there at that time. Until nurses began to be used for this work, anaesthetics had been given by the surgeon – in the form, possibly, of a spinal, or perhaps an intravenous barbiturate followed by ether or maybe Trilene. If a surgeon was not available, a medical student could sometimes be ordered to do the job – or perhaps some lay person who was otherwise employed in the hospital – and this person would be responsible for dripping ether on to an open mask.

Eventually it became the custom to delegate the duty to one of the operating room nurses. No formal training was given. It was not considered necessary; perhaps it was not even thought of. In any case, nobody knew too much about anaesthesia to start with. Gradually the precedure developed into one where a nurse simply taught another what she herself had learnt. In those days surgeons were thankful for small mercies and patients were even more humble than they are today.

During World War II, the situation in Norway began to change. Two doctors developed an increasing interest in anaesthesiology. The one, Otto Mollestad, gave ether anaesthetics in his free time and without pay in order to learn more about it; the other, Ivar Lund, stole away in his sailing boat from Oslo, past the German coastguards along Oslo Fjord, to Sweden (and back the same way) to learn what he could there. As time passed, surgical techniques improved, and so, as we know, did the art of anaesthesia. However, the number of doctors qualified in anaesthesiology remained critically inadequate.

The right and the need of the patient to have safer anaesthesia, the conditions required by the surgeon, and the interest and the anxiety of the nurse-anaesthetists

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working on their own decided Otto Mollestad to start his pioneer work of training nurse-anaesthetists. His courses, held at the Rikshospital, were organized for nurses from all over Norway and lasted 14 days, after which the nurses returned to their own hospitals to work there, with responsibility delegated from the local surgeons. This was early in the 1950s. Over the following years, as the number of doctors specialized in anaesthesiology increased, similar courses we periodically organized by them. At hospitals which established separate departments of anaesthesia the training of nurse-anaesthetists was for many a constant part of their function. Nurses were now widely employed as anaesthetists all over the country, many working alone in smaller and peripheral places, others at larger central hospitals, alongside anaesthesiologists.

Some of us eventually went abroad to work, often to hospitals in the Third World. Those of us who did volunteer to work in the Third World with international peace organizations or church aid agencies or by similar arrangements (I with a peace organization to a brave but modest hospital in northern Thailand), discovered two important things: The first discovery was the discrepancy there between the need for medical services and the financial possibility of meeting those needs. In Thailand, at the time I was there (1964–1965), economic support from the government was very modest. The hospital depended on voluntary funding, and bazaars and fêtes were held to collect money. All who worked at the hospital contributed in some way: entertained with songs and dances, led competitions, made things for sale, begged gifts, stood at stalls or did one of the thousand jobs necessary to make the occasion a financial success. The economic squeeze at the Thai hospital had, of course, its repercussions on every aspect of work there. The patients paid for everything that was given them – either in money or in kind – or perhaps a relative paid by working for the hospital for a fortnight or so, as cleaner, gardener or perhaps carpenter. (I remember well one ex-patient who came trundling into the hospital garden on his elephant, carrying two huge sacks of rice as payment for his treatment.)

Ether was our basic anaesthetic. Trilene was used for emergency craniotomies. Nitrous oxide did not exist; it was too expensive, as was pethidine. Morphia was cheap and halothane was just a Western-World joke on account of the price. We had a few endotracheal tubes and even fewer connections, but the local carpenter made me some wooden connections which served their purpose well enough. Since the patient paid for everything, one thought twice about giving him IV glucose and the like, and one smartly tapped for blood all relatives who inadvertently came within range of the laboratory. One had occasionally to be very firm with relatives about giving blood, otherwise surgery would have been quite impossible.

One learnt to improvise too. For one intubated baby we made ether administration equipment with an oxygen flask, using the humidifying glass as ether bottle, and diverse pieces of rubber tubing and a glass Y-connection as a T-piece. The situation was critical; the system worked and our baby survived – despite both its volvulus and the anaesthetic. Perhaps Providence was with us – as well might be – for this was a mission hospital. The result of all these experiences was that one learned some very thorough economizing there. One simply did not waste. It also made one realize how terribly unfairly the wealth of our mutual world is distributed. However, the people there made the best out of the situation; they were ingenious and determined in a way which commanded genuine respect.

The other important discovery one made there was how inadequate one's training was – to the detriment of some patients – compared to the need that many had for anaesthetic service. This inadequacy was now also beginning to be felt by nurse-anaesthetists in the peripheral hospitals at home, where they were working alone. This feeling of inadequacy and the frustration it engendered led to the determination that we should do something effective about our training. In addition, because the patient has a justified right to expect his anaesthetist to give him the service he needs in safety, nurse-anaesthetists felt that, so long as they continued to be a necessary group, then their training should be reasonably in proportion to the demands made on them, and in proportion to the patient's need. This attitude was understood by most anaesthesiologists. But – and I would like to emphasize this – we were, and still are, nurses, and will always be. We have no wish to be more.

In 1971, as the result of the frustration many nurse-anaesthetists felt about their training, the Norwegian Association of Nurse-Anaesthetists reorganized and widened its teaching programme, after studying similar plans used in Finland, Denmark, Sweden, the United States and Germany. In 1974, the new plan was approved by the Norwegian Nursing Association, of which we are a branch, for a trial period of 2 years, after which it was to be evaluated and revised again. The latest revision is being undertaken now.

The Future

The health service maintains that all those engaged in this work are there for the patient – all of us, from the professor to the porter. The nurse-anaesthetist has really two roles: First, the primary role of nurse, the person whose duty it is to care for the patient, who is also a person; second, as anaesthetist – where there are not enough doctors to do the job, and only there. Care of the patient entails more than just giving a good anaesthetic, but for the nurse-anaesthetist it also includes the administration of a good anaesthetic. We are acutely aware of the rapid development of medical sciences during the last decade – and the prospects of more of it rushing headlong at us from the future – and it is perhaps at this point that the debate about the continued existence of the nurse-anaesthetist becomes important again.

With the advent of all the dramatic and heroic surgery we see today, nurse-anaesthetists are becoming engulfed in a dilemma. We know that we have not the background knowledge necessary for much of this advanced kind of work. Neither are we interested in becoming some kind of fancy technicians – or handmaidens for all and sundry. What is more, ethical aspects of health care vis à vis less priviliged patient groups and the Third World weigh heavily on many of us, and we ask ourselves if perhaps we have not reached the end of our career. We chose a field of work within the health service which, for many and varied reasons, gave us more satisfaction than we had experienced before. For the patient, however, we, as anaesthetists, have always been a make-shift solution. We see that in all probability we will continue to be employed as anaesthetist, for some years to come and will be able to manage the less complicated work. But we also wonder if it is not now time that the patient's expectations and needs within the province of anaesthesia should be fulfilled by those more competent to do so, and we hope that "care", in our meaning of the word, will not be forgotten in the prestige and drama of advancing medical sciences.

6.7 The Whys and Wherefores of Collecting

C. A. Foster

C. A. Foster

The first ingredient needed to make a useful collection of anaesthetic apparatus is an interested individual who has the squirrel mentality. It is to be hoped that this individual is adept at locating items in the hoard and is not too extreme, otherwise the second ingredient – space requirement – will become too vast, for if it is desired to include ventilators in the collection a large amount of floor space is soon used up. The third ingredient is that the individual must have an inbuilt appreciation of history and its importance and relevance to the present and future, or to be inspired in that direction. I was very fortunate to have received such inspiration from Professor Macintosh, when I attended a course for junior anaesthetists at Oxford in 1950. I have always been very grateful to him for the extra pleasure and interest I have had since then in following this aspect of anaesthesia. The last ingredient is luck – to be able to be ahead of those who wish to get rid of the old to make room for the new.

In my case, on my return from Oxford I found a room in St. Thomas's full of old anaesthetic equipment and apparatus which only needed moving, cleaning and displaying to form a good nucleus for a collection. Once a beginning is made, it is much easier to get additions. Amongst the discarded items were some which had only very recently ceased being used, such as Hewitt's three-way valved stopcock of 1893 and cylinder stand for the administration of nitrous oxide and air, taken from Casualty (where I had used it as a student), and his modified Clover ether inhaler of 1901 which was still being used weekly by Dr. Zebulon Mennell. When I bought a collection of books and medical instruments from the effects of an old general practitioner I found in what I had bought a Coxeter nitrous oxide apparatus of about 1868–1890. Later, an Ombrédanne's inhaler was given to us, having been found in use in Viet Nam.

The reasons for saving and collecting anaesthetic apparatus are (1) to illustrate the development of the art of anaesthesia and, the scientific principles on which the design is based, and (2) to be able to demonstrate to learners the hidden mysteries of modern apparatus so that they can be aware of potential faults and how they can be detected and dealt with. It is because of the second reason that it is necessary to beg, or as a last resort buy, modern pieces and section them to display their mechanisms. Many manufactures are very generous and will not only give pieces – particularly when they are

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assured that they will not be used to give anaesthetics – but will supply them already sectioned. It is also a form of advertising, for trainee anaesthetists are the purchasers of tomorrow's equipment.

It is not necessary to have an elaborate workshop in which to make sections. The tools required are spanners, Allen hexagonal keys, pliers and screwdrivers, for taking the apparatus to pieces so that the best places to make the cuts to show the various parts can be assessed. Then the cutting is done with hacksaws and finished off with files whilst the parts are held in a vice. Access to a milling machine will produce a truly professional result.

Sections are very effective teaching aids, but sometimes there is need of a diagram to complete the display. I am sure that the catalogue of the collection should be illustrated with diagrams, photocopies of old instrument catalogues and, where an anaesthetist's name is associated with the piece, a photograph and biographical details. A good anaesthetic library is a great help in providing the necessary documentary evidence as to the date of a piece and its connection with a particular anaesthetist or institution. Medical manufacturers' catalogues and advertisements are very useful in this context, and unbound copies of anaesthetic journals are a good source of advertisements, (which unfortunately are removed when they are bound). Patent and Registered Design numbers are another good source of information. Copies of patents are available which give the date of application for and grant of the patent, the name of individuals concerned and often scale drawings. Thus for an article marked "patent applied for", it must have been made between the date of the application and its granting.

We are now in the era of plastic and single-use disposables – the throw-away economy. It is thus important for some people to collect examples of these transitory objects. I like to put aside for the collection one of any samples I receive because when each item has been superseded it is impossible to find an old one – they have all been incinerated in the "sharps" boxes.

An aspect that adds a particular interest to an item is when it is known to have actually been used by its designer. In our collection we are fortunate to have one of the original brass blades tried out by Professor Macintosh in his search for the ideal configuration for his curved laryngoscope blades. Sir Ivan Magill gave us some of his original nasal endotracheal tubes, his portable nitrous oxide/oxygen apparatus for dental anaesthesia, his laryngoscope and laryngeal spray, and the piece of lead he used as a tooth protector, as well as other items. Dr. Michael Nosworthy gave us his modification of Sir Ivan Magill's small portable apparatus and intubating tracheoscope, and we have other smaller items used by their inventors, to all of whom we are very grateful.

When it is impossible to obtain a piece which it seems important to have in the collection to illustrate a particular point, it is nice to be able to have a replica made. This does require a very skilled engineer and a complete workshop, and either an example for him to copy or clear, accurate, full-scale drawings, or both. It has been our great good fortune to have such an engineer, Mr. Burns, in our Radiotherapy Department workshop. He first of all made a replica of Murphy's chloroform inhaler of 1847 and then went on to reproduce John Snow's ether inhaler of 1847. Since we have an example of Ellis' chloroform ether inhaler, 1866, which was given to us by the police, who found it in a back-street abortionist's room many years ago, I thought it would be nice to have a replica of the earlier version. Lastly, he has made a replica of Vernon Harcourt's chloroform inhaler of 1903.

One of the unsolved problems of collecting is the care and maintenance of rubber. Unless it is kept in the dark, powdered and cool, it is bound to become hard, brittle, and in the end powdery. If anyone can tell me how to preserve it and yet keep it displayed I would be delighted to know.

6.8 Historical Aspects of the Problem of Surgical Awareness

J. Mainzer

Anaesthesia's first century was characterized by success in controlling the fundamental problem of painful surgical awareness. Our second century, the modern period, which began in the 1940s with the introduction of muscle relaxants to anaesthetic practice, saw the frequent recurrence of painful and unplanned surgical awareness, a problem warranting a review of our ideas about both muscle relaxants and surgical consciousness.

The agony of surgical awareness, so frequently described in the preanaesthetic period pain literature [1, 2] is revisited exactly in the descriptions of painful paralysed awareness emerging from the current relaxant literature [3, 4]. This complication has been shown to be still a significant preoperative concern of a large number of patients [5, 6], just as it was before anaesthetics were available [7].

The nineteenth-century debate about curare's possible anaesthetic activity, or lack thereof, caused considerable controversy, especially agitating antivivisectionists in regard to animals who might be fully conscious during painful experiments [3]. Waterton's description of curare's causing a gentle death, or Magendie's claim that pain is always useful failed to dispel concern about the awake curarized experience, which Claude Bernard described as being entombed in one's own body [8, 9]. Though some researchers felt that curare had an anaesthetic action, experimental work by both Claude Bernard [8, 10] and John Snow [11, 12] showed that curare did not affect consciousness or sensation.

Bernard felt that which curare he could chemically dissect nerves from muscle, as well as physiologically dissect the motor system from the sensory one. He further noted that curare was a useful means of restraint during experiments, by which the animal could be pharmacologically "chained". Years later, in 1906, because of the standard use of this paralytic experimental technique, Hunt and Taveau in their research on the cardiovascular effects of succinyldicholine failed to appreciate that drug's profound relaxant effects [13].

In the 1940s, however, despite the fact that almost every clinical study of curare reported that it was not an anaesthetic, a belief that it was possibly a central nervous system depressant continued both clinically [3, 14] and experimentally [11, 12, 15]. Because of the persistence of this idea, some 4 years after Griffith and Johnson's article [16] launched the relaxants into anaesthetic practice, two anesthesiologists [17, 18] independently resorted to self-experimentation, in the tradition of Davy, Wells and Simpson, in order to finally resolve this question as to whether curare was or was not capable of an anaesthetic or analgesic action.

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Dr. Scott M. Smith of Salt Lake City, Utah received an intravenous infusion of 75 mg of *d*-tubocurarine over 33 min in his experiment,and despite total paralysis remained as "clear as a bell". He later stated, "I felt I would give anything to be able to take one deep breath." Pain perception and the awake EEG pattern persisted throughout his experience, and he felt that his hearing was more acute while he was paralysed, a finding still noted by paralysed awareness subjects [17].

Smith's results were published in the January 1947 issue of *Anesthesiology,* on page 1, number 1, volume 8. However in the abstract section of the very same number of *Anesthesiology,* on page 102, there appeared an abstract of the even earlier and epic personal experimental work of Dr. Frederick Prescott, originally published 6 months earlier in the *Lancet* of 20 July 1946. Here Prescott reported undergoing some five awake curarizations utilizing different relaxant dosage techniques and routes of administration. Here also no analgesic or anaesthetic action could be demonstrated for curare. He described the respiratory paralysis as particularly "terrifying" [18].

Despite these findings, however, curare has continued to be used in awake patients, though in much lower dosage [3] than Whitacre used [14]. Some 6 years after Prescott's and Smith's experiments, Dr. John Fuller recommended in *Anesthesiology* a concentrated curare in oil solution as a component of the premedication, especially in the operative reduction of fractures [19]. He stated that (1) "its use was without any respiratory diminution or untoward effects", (2) "it definitely improves the mental attitude of the patient", and (3) "postoperative pain and discomfort have been remarkably diminished". More recently, 3–9 mg of curare was recommended for premedication as a chemical restraint to limit movement during cataract surgery under local anaesthesia [20]. Although many reports suggest that the feeling of partial awake curarization is unpleasant [3, 6], in the absence of dyspnoea a modest generalized reduction of muscle tension in the anxious patient could well be associated with a feeling of comfort, and such an action may account for some of meprobamate's tranquilizing activity.

The controversy about a central nervous system action for relaxants thus continues, and especially in view of recent findings, such as (1) "cerebral curarization" is noted in the presence of an abnormal blood brain barrier, which has become a functionally ineffective filter [21]; (2) the fact that some relaxants such as mephenesin do act centrally; and (3) pancuronium was reported to decrease the minimal alveolar (anaesthetic) concentration (MAC) value of halothane [22], a finding which Fuller [19] likewise noted when using his curare premedication.

Robbins and Lundy [23] in reviewing the history of muscle relaxants pointed out that the acceptance of these agents into clinical anaesthesia was a direct result of Dr. Harold Griffith's cautious practices and conservative publications [16, 24, 25, 26, 27]. Initially Griffith experienced difficulty in making judgments about his studies with curare, because it represented a totally new and different type of agent, and therefore comparison was not possible. He finally settled on the simple criteria of: "Is this new drug reasonably safe and is it effective?" [24]. With thoughtful and typical caution, Dr. Griffith slowly increased his use of curare from 16% of abdominal operations to 38% [25, 26]. In two articles 10 and 15 years after his initial publication (1942), Dr. Griffith expressed his particular pleasure that he did not at these later times have to withdraw, deny, or apologize for anything he had said in his original succinct and carefully thought-out three-page communication [24, 27].

In 1963, at a celebration of the 21st anniversary of his first use of curare, Dr. Griffith kindly expressed the kind view that curare pioneer Dr. A. E. Bennett [28] should have received much of the fame and credit which he himself had enjoyed. Richard Gill went even further, and shortly after 1948 wrote that Dr. Bennett deserved a Nobel Prize for his curare work, which by 1941 had included the administration of curare for over 30000 shock treatments [28].

Concern about (1) old biases against curare as an historical poison, (2) the possible inherent cellular toxicity of curare, and (3) the problem of paralysed awareness runs through all of Dr. Griffith's writings [16, 24, 25, 26, 27]. His fears that curare would fall into the hands of the unskilled [25, 26] materialized in the frequent failure to support ventilation properly, and consequently critics and supporters of relexant usage began a battle, often a transatlantic one, about the fundamental safety of relaxants [8]. The awarding of the 1957 unshared Nobel Prize to Dr. Daniel Bovet for his work on muscle relaxants was, however, the final positive scientific statement needed to end this controversy, and was an unambiguous endorsement of relaxants and the "Liverpool technique". It represented as well an acceptance of the need to correct the occasional relaxant technical complications such as awareness episodes and improperly supported respiration during and after surgery.

Though relaxant-induced surgical awareness is usually regarded as a somewhat benign, incidental though regrettable happening, as a form of stress it may be implicated in the initiation of not only postoperative psychological problems [29, 30], but also, as Dr. Beverly Britt recently stated, in triggering the anaesthetic crisis of malignant hyperthermia [31].

A medicolegal suit was recently settled for U.S. $ 25000 for an episode of awareness, not of the surgical procedure, but for the experience of awake paralysis and pain during the intubation and postinduction/postintubation, presurgical period, during which the patient did finally become unconscious [32]. This negative experience is in contrast to Smith's [17] and Prescott's [18] judgement that intubation was not remarkably uncomfortable, an opinion with which Griffith also agreed [25].

A new and ominous chapter in the annals of potential relaxant awareness is currently being written in the United States, where four states (Oklahoma, Texas, Idaho and New Mexico) have recently enacted laws making "lethal injection" the humane means for criminal execution. The corrections policy and procedure manuals of these states usually specifcy that thiopentone with curare (or succinyldicholine or potassium chloride) be used to accomplish this. The current *New Mexico Statute,* 1979, #31–41–11, reads as follows: "The manner of inflicting punishment of death shall be by adminstration of a continous intravenous injection of a lethal quantity of an ultra-short-acting barbiturate in combination with a chemical paralytic agent." This non-medical execution use of anaesthetic drugs is being challenged in the courts at present.

In a somewhat similar situation, the not uncommon illicit use of relaxants [33, 34], is certainly associated with paralysed awareness, when relaxants are used in these sensational homicide attempts. Interestingly, the British Prime Minister, Lloyd George, in 1917, was the object of an assassination plot in which bullets soaked in curare were to be used. These non-anaesthetic legal and illegal uses of curare in our society suggest that there has been little change in the social evolution of this drug from the first observations of it as a poison in South America.

Recently, Dr. M. E. Tunstall described a test for paralysed awareness, the isolated forearm technique [35], which it is hoped will help to limit this complication clinically. No reference, however, has ever been made to the historical origins of his technique of vascular exclusion of limbs during curarization. Both Squire Charles Waterton and Dr. Benjamin C. Brodie are known to have practiced this in their work [36], but it is most clearly outlined in two experiments by Claude Bernard. Both of these were published with illustrations. In one a frog underwent vascular exclusion of the entire lower half of his body [37], and in the other the left lower extremity was excluded [10, 12], so as to observe the effects of curare in the non-perfused tissues. The vascualr exclusion techniques of Bernard continues to be used experimentally, and the frog in the 1959 experiment of Dr. Clement Estable is essentially identical to Bernard's [38].

Utilizing the same techique, Bernard further demonstrated, half a century before Pal discovered the anti cholinesterase antidote to curare [39], that a venous occluding ligature of an extremity, proximal to the site of a curare injection, was in fact an effective antidote to curare poisoning [9].

Since Dr. Tunstall and Dr. Bernard were both interested in the same goal – defining the amount of sensation and awareness during curarization – it is of historical interest that, separated by more than a century, they both came to use this same technique of vascular exclusion. The application of this early physiological work to clinical practice by Dr. Tunstall is in the best tradition of Claude Bernard's hope for a truly scientific medicine. It is also to be hoped that it will end this clinical relaxant complication, so that paralysed awareness may become an historical problem and not a continuing future one for anaesthesia.

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6.9 Clinician Versus Researcher in Anaesthesia

W. W. Mushin

W. W. Mushin

In this unique symposium on the history of anaesthesia, it is not enough just to rake over the ashes of the past, or to examine in ever-increasing detail the lives of our pioneers unless we can extract from the process a greater understanding of our present-day problems and so a greater likelihood of solving them.

I have become very much aware and alarmed at the gap which has developed between the researcher in anaesthetics and the clinician, and the pressing need to close it. Unfortunately, this gap has widened to such an extent that the effects on both researcher and clinician are now very damaging. To understand this problem, we must study its historical origins. Let us first be quite clear about the difference between research and practice. According to the dictionary, research is the endeavour to discover facts by scientific study and critical investigation. On the other hand, "to practise" is to perform something habitually. Thus research is characterized by critical activity and practice by repetitive activity. What has happened is that the researcher is not always aware of the ultimate objective and application of his research, nor is the practitioner aware of what the researchers are doing. These two activities have become separated and the links between them are not always close or strong.

After the initial impact of the discoveries of Crawford Long, and of Morton, there was a long period reaching to World War I, in which anaesthesia was digested and gradually accepted and incorporated into the practice of medicine. World War I, as all wars do , gave a spin-off of medical benefit to the public, which included anaesthesia. Some highly intelligent doctors were pressed into anaesthesia and as a result some progress in this specialty was made. Understandably, interest was focused on the clinical administration of anaesthesia – what I call the craft work of anaesthesia. Perhaps the two most important innovations from World War I were endotracheal anaesthesia and the widespread use of nitrous oxide.

Between the two world wars interest in anaesthesia was confined to a mere handful of men who had to stand up to what almost amounted to the contempt of their colleagues, because it was still widely held everywhere in Europe and the United States that anaesthesia was an occupation that hardly demanded a medical education. Men like Gwathmey, Guedel, Waters, Rovenstine, Lundy, Rowbotham, Magill and

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Macintosh kept the spark of interest alive. When I began to take a serious interest in anaesthesia in the middle of the 1930s, it was the publications bearing these names that encouraged me.

In general, the 20 years between the two world wars was one of marking time or even stagnation in anaesthesia. Then came World War II, but this time a huge leap forward occurred. Thousands of doctors were assigned to anaesthesia and they gave us what we call "modern anaesthesia" – curare, new inhalation and intravenous drugs, techniques of thoracic and neuroanaesthesia, and, most important of all, the institution of proper training schemes. After the war there was an explosion in anaesthetic medical manpower. There was no longer any doubt of the huge difference which modern anaesthesia made to the success of surgery. The leaders of surgery in the United States and the United Kingdom were nearly (not quite) unanimous in damanding high-quality anaesthesia. The continental European surgeons still hung back, and the resultant decay in their surgery gave British and American surgeons a lead which has taken 30 years to overcome.

Since World War II, the original interest in the practicalities of anaesthesia petered out. As a result, the technology directly concerned with the administration of anaesthesia has been virtually static for the last 20 years. On the other hand, interest in physiology, pharmacology and biochemistry now leapt forward as men of high intelligence were attracted into anaesthesia.

The characteristic of progress during and immediately after World War II was that those who contributed new knowledge to anaesthesia were all clinical anaesthetists. I had the privilege of watching men like Rovenstine, Waters, Macintosh and Magill actually at work in the operating room. They, and many others like them, not only produced a flood of new techniques and ideas, but they worked and taught daily in the operating rooms and they were all expert clinicians. They would have been surprised if they had been called researchers in the modern sense. From them – every one a clinician – came thoracic anaesthesia, and with it endobronchial intubation; neurosurgical anaesthesia; the intravenous barbiturates; and, of course, curare. These innovations were devastating in their impact and changed anaesthesia and, even more, surgery beyond recognition.

The very large number of doctors who became involved in the specialty of anaesthesia inevitably led to the appearance of professional organizations. Initially the criteria for membership were the very minimum for recognition by the public and by their medical peers. It was also essential that membership should be large enough to be effective in administrative matters. Later, as the numbers rose, market forces began to operate. Examinations were introduced which had the effect of restricting entry so that a hierarchy was established and there was always an apparent shortage at the higher levels. Then came the search for status; this has taken such forms as an impressive visible technology and the leaning towards a consultative and supervisory role rather than a craft one.

The professional body which represented the rank and file of practising clinical anaesthetists now took on the task of defining the minimum content of knowledge which had to be acquired by those aspiring to become specialist anaesthetists. This included not only the craft work of clinical anaesthesia, but also the theoretical and scientific basis on which the practice of anaesthesia rests. Practical training essential in anaesthesia is one thing, and can be carried out in most hospitals and by most hospitals and by most clinicians; theoretical and scientific education is another. It requires quite different thought processes and involves scepticism and a willingness to experiment. It is no wonder, therefore, that a division of the specialty began to occur, into the clinicians and the theoreticians or academics.

There are now three clearly defined groups within the field of anaesthesia. The largest group are the clinical practitioners. The clinician delivers anaesthetic care of an extremely high order. His instruments for the administration of anaesthesia are of great sophistication, bearing all the hallmarks of successful commercial interest and promotion. A huge range of drugs is at his command; the techniques are as varied and as complex as the surgical operations that they complement.

The second group is the innovator – the researcher. He generally finds his way into university institutions, where it is not only his wish but his duty to be involved in original research and thinking. Although, like his colleague, the clinician, he accepts the current standards of his profession, he is unhappy about the content of knowledge and skill required by these standards, and he seeks to change them by adopting a scientific attitude to anaesthesia. He is concerned that anaesthetists should know and understand more about the fundamental nature of their daily work, although he may be indifferent, and is indeed often ignorant, of the use made of his knowledge and whether or not it is relevant to the everyday practice of anaesthesia.

The researcher is necessarily laboratory and usually animal orientated, for the opportunities of human experimentation within an ethical framework are limited. For him the laboratory is home and the centre of his activities. Many of the discoveries of postwar anaesthesia have come from his laboratory. The pharmacokinetics of drugs, the design and function of lung ventilators, and other breathing equipment, the design and assessment of vaporizers, the elucidation of respiratory resuscitation of the newborn, the recognition and treatment of malignant hyperpyrexia – all these were in the first instance laboratory-based researches.

The comparative isolation of the anaesthetic researcher from the operating room is not difficult to understand. He is as much a prisoner of the enormous growth in knowledge of the physical and biological sciences as any other researcher in the medical field. He is simply not able to divide his attention and concentration between what have become two disciplines, each in their own right, each with their own language, each with their own objectives. The researcher needs to keep himself up-to-date with all that is going on in related and parallel fields, while the clinician has to do the same in terms of clinical anaesthesia and clinical medicine. Inevitably the anaesthestic journals have gradually sorted themselves out into two types, one catering for the researcher and the other for clinicians, unhappily developing in the process their own particular jargons and terminologies. A very serious gap has now developed between the researcher and the clinicians: The one travelling a path, exciting though it may be, which all too often is remote from and leads away from the operating room, and the other, with all his highly developed clinical skills in the operating room increasingly baffled by the work of his researcher colleagues. Instead of confidence and pride in his skills the clinician is vaguely unhappy and seeks to change his role.

Thus there has appeared an ill-defined third stratum which is now growing rapidly. These anaesthetists do not seek to increase the content of professional knowledge by research or an extension of skill by clinical practice, but seek to change the role of the anaesthetist. They want to turn him into an internist, an intensivist, an acupuncturist, a heart-lung machine operator, a pain reliever – in fact, anything but someone whose prime interest is the administration of safe anaesthesia in the operating room and the care of the patient afterwards.

Such is the sad situation existing today. The harm that results is not always immediately visible. However, I will give you a few examples of the ways in which clinicians have been misled or have failed to grasp the opportunities for investigation, and of researchers who, lacking clinical experience and skills, have failed to follow through their discoveries to the patient largely because of their inability to communicate their discoveries to their clinical colleagues in a way that makes assimilation and application possible.

The Vapour Concentration Inhaled from a Closed Breathing System

This is a story of ignorance, ineptitude or inertia by clinical anaesthetists, and a reluctance to apply the results of laboratory research. The invention and application of the carbon dioxide absorber and closed-circuit method by Waters and others showed how economies could be made in what has always been an expensive part of medicine. It also offered some advance in maintaining a reasonably level plane of anaesthesia. In 1956, over 20 years after the invention of the closed breathing circuit, it was clearly shown that the concentration of vapour inhaled from a closed circuit could be accurately assessed because it depended on only four main variables: the vapour concentration entering the closed system, the ventilation of the patient, the position of the vaporizer in relation to the breathing system, and the flow of fresh gases into the system. This relationship can be easily stated in mathematical terms and has been confirmed over and over again.

However, even after more than 25 years, the ideas, simple as they are and readily applicable in the operating room, have hardly seeped into anaesthetic practice. Anaesthetists are still uncertain where to place the vaporizer in the system and of the influence of ventilation and the fresh gas flow on the inhaled concentration. High gas flows of the order of 8–10 litres per minute or more are still common, with the attendant expense and pollution. The expense factor is substantial and the concern – one might say ballyhoo – about pollution, is familiar to you all. In the United Kingdom, anaesthesia accounts for over 12% of the hospital drug bill and of that, three-quarters is due to anaesthetic gases. The use of even partially closed systems would lead to a saving of several millions of pounds a year in anaesthesia alone.

Halothane and the Liver

This is a story of the baneful influence of researchers on clinical practice and of the sheer refusal by anaesthetists to accept that even anaesthetic drugs have adverse effects. The story begins in 1956 when halothane was introduced. Reports of liver damage soon began to appear and by 1963, only 7 years later, the manufacturers themselves considered the matter important enough to conduct a questionnaire among anaesthetists in the United Kingdom. As a result, 42 cases were revealed; the manufacturers said, and I quote, "the only really suspicious factor is the high proportion of cases who had had more than one administration".

It is extremely difficult to prove a cause and effect relationship between a drug and an adverse reaction. The only real evidence is the occurrence of inexplicable cases. Initially there is always reluctance to accept the connection by enthusiastic users. So it was in the case of thalidomide, the bronchodilator aerosols, the contraceptive pill and, more recently, practolol; and so it was with halothane. Personal experience is unlikely to help because of the rarity of the reaction, while detailed biochemical studies of individual cases are not very helpful in what is essentially an epidemiological problem. It was finally shown in 1971 that not only was repeated exposure important, but that an interval of less than 4 weeks between exposures was critical. Reports from the Safety of Medicines committee in the United Kingdom in 1974 and again in 1978 and from other European Drug Surveillance Authorities confirmed this.

While all the commotion was going on, the picture was kept muddied and the clinicians bemused by the researchers, who were not much concerned with whether halothane hepatitis (a highly dangerous complication with a mortality of over 50%) was a real threat to patients, or on practical advice as to how the risk could be avoided, but on determining possible mechanisms. Now, in the long term it may very well be important to know whether the liver failure is due to halothane metabolites, or concurrently latent virus infection, or to a disturbed immunological response. However, in the short-term, which may mean years, the only practical advice which can save lives is either to avoid halothane, or, if its desirable properties are to be utilized, to avoid repeated exposure within about 4 weeks.

The Intensive Care Unit

This is a story of the disinclination of anaesthetists to look at themselves in the mirror of their practice and to be clear about what they are actually doing and why. The longing for the status which goes with the managerial control of patients and hospital beds is shown in the eagerness by anaesthetists for participation in intensive care. I do not want you to misunderstand me. Let me state at once that I believe the concept of intensive care to be one of the great advances in the organization of medical work. However, the way in which anaesthetists are involved and the part they play gives me great concern. They can and do play an important role as points of excellence, disseminating interest and encouragement to improve the care of desperately ill patients, and by acting as consultants giving advice on diagnosis, treatment and prognosis, in circumstances in which anaesthetists are especially expert. Indeed, there have been a few notable instances of enthusiastic pioneers, one of whom (Prof. Bjørn Ibsen) is here with us in Rotterdam, who have achieved fame as experts in intensive care. In general, however, I cannot support those anaesthetists who want to claim sole territorial or managerial rights over this field of work. Already far too much expert anaesthetic potential is being dissipated in these units by anaesthetists who, far from acting as consultants secure and confident in their specialized knowledge, are more like superior interns deluding themselves that they are practising acute medicine but in reality carrying out comparatively simple supervisory technical tasks under the real direction and reponsibility of other specialists.

Intensive care is not a new medical treatment but an organizational and managerial advance. There is no logical basis for a medical specialty of "intensivism", and most anaesthetists entering this field discover that it is in effect a blind alley of medical work. Although their knowledge may become deep in a few areas, it is inevitably limited in breadth. What is even worse, by the very nature of the work, continuity of care and ready availability of the doctor are essential. No anaesthetist can provide this without virtually giving up clinical anaesthesia and all its demands on his availability and energies. When he deserts clinical anaesthesia he loses contact with the roots of his skill and knowledge that makes him so valuable a consultant in the intensive care unit. With few exceptions, any anaesthetist who becomes an intensivist sooner or later finds that to be effective in a field of work in which he is essentially a coordinator of other specialists to whom he is inevitably responsible does not require the highest levels of specialist attainment.

Pharmacokinetics

Here we have a story of a prodigious advance in knowledge which goes to the very roots of anaesthesia. Yet its lessons have either not been made clear or they have not been applied to everyday anaesthesia. We now have precise knowledge of the dynamic distribution of drugs, whether inhaled or injected, both in terms of time and of concentration in different body tissues. Investigations by men of the calibre of Eger in the United States and Mapleson in the United Kingdom have shown the interrelationship of the several factors involved, so that a fairly precise estimation can be made of the concentration of anaesthetic in the so-called compartments of the body, especially in the arterial blood and better still the brain, at any particular moment after induction of anaesthesia. This means that at last we can predetermine and bring about the precise desired state of anaesthesia deliberately. It is also now possible to predict how important parallel disturbances such as a change in cardiac output or of lung ventilation can affect the course of anaesthesia, so that measures can be taken to counteract any ill effects of these events.

Yet little effort is made to utilize this vital knowledge in practical anaesthesia by initiating programmed or automated anaesthesia, controlled by software based on a knowledge of the patient's characteristics and on the nearly continuous monitoring of various physiological functions during anaesthesia. In modern computer technology these would involve comparatively simple control systems. They could, for example, indicate almost continuously what changes need to be made in, say, the inhaled concentration of a vapour or in ventilation to maintain some predetermined blood or brain concentration of anaesthetic at any particular moment in the surgical procedure. A degree of flexibility of control and of knowledge hitherto unattainable would become available to the anaesthetist.

It seems that the clinician still distrusts exact physiological knowledge when it comes to practical anaesthesia. There is thus a paradox. On the one hand we have a widespread suspicion of the application of physiological measurement and a disinclination to apply much of the accumulated postwar research to clinical practice. On the other hand however, the anaesthetist of today surrounds himself with highly sophisticated technology in the form of monitors of blood pressure, blood gases, electrical activity of the heart, and so forth. Yet even when the information from them can be linked in some positive way to the conduct of the anaesthetic – and that is not very often – there is really little hard evidence of their relevance to safety and freedom from complications in anaesthesia for major surgery. I am a wholehearted supporter of the general principle of acquiring as much information about the status of the patient as possible during anaesthesia, but we must be sure that the information is of value and that expensive equipment is cost effective in terms of life and health in an increasingly difficult economic climate.

In the United Kingdom a national study of mortality associated with anaesthesia has just been completed. Although the data have not yet been published so far as mortality is concerned, as distinct from morbidity, it is clear that few lives are likely to be saved by sophisticated monitoring, while many are lost or put at risk by failing to recognize or incorrectly treat such well-known hazards – recognizable clinically – as a deteriorating circulation, poor pulmonary function, aspiration of vomit, poor post-operative care and injudicious choice of anaesthetic methods.

It is not my purpose either to denigrate or to praise the investigator or the clinician. It is to examine the historical origins of their present interrelationship because it is now evident to all, that since we need them both we must bring them together. The cult of scientific medicine has led to an explosion in both technology and in new knowledge, each leapfrogging over the other to an extent that has led to a loss of control over both. There is a widespread belief that an increase of knowledge is synonymous with progress – more by the public than by doctors, but we are caught up in this idea to the extent of being imprisoned within it and usually cannot see that progress may be more a matter of exploiting what we do know to the greater benefit of our patients.

Conclusions

My conclusions are as follows. First and foremost, researchers in anaesthesia must return in some way to the operating room, and every clinician must think of himself in some way as an investigator. This will once again lead to communication between the two and the re-establishment of a common language for each to understand. Each must respect the vital contribution of the other to the community. Neither can exist without the other – they are interdependent. The investigator might remember that the endotracheal tube and artificial ventilation of the lungs revolutionized anaesthesia and surgery. Neither came from the laboratory. The clinician should remember that without his colleagues in the laboratory he would have none of the wonderful new drugs or his vast knowledge of pulmonary function and pharmacokinetics.

6.10 Charles T. Jackson's Claim to the Discovery of Etherization

A. B. Gould

When the discovery of anesthesia is discussed, the names of W. T. G. Morton, Horace Wells, and Crawford Long are quickly mentioned; however, we must not forget the name of Charles T. Jackson, the physician, scientist, teacher, and author who was berated and publicly vilified for daring to claim what he thought was rightfully his. Of the three independent discoveries of anesthesia, only the Boston discovery resulted in the worldwide use of anesthetics for surgery. Crawford Long published nothing until the use of anesthetics was commonplace, and Horace Well's discovery resulted only in the use of nitrous oxide for dental anesthesia in the vicinity of Hartford, Connecticut.

As a young man, Jackson was involved in the struggle to receive recognition and the congressional reward for discovering the telegraph [1]. Although his 24-wire model was only one of 62 competing versions of the telegraph, he was the object of Samuel F. B. Morse's well-known wrath and was publicly accused of wholesale lying, which was a severe liability in the ether controversy that followed. Jackson practiced medicine only briefly and after 1832 devoted himself to chemistry and geology. On one occasion, in 1841, while he was in his chemistry laboratory, he accidentally inhaled some chlorine, a not uncommon event for chemists of that time [2]. His practice was to treat himself by inhaling sulfuric ether. This time he sat in a rocking chair and, to relieve his chest pain, inhaled the ether vapors until he became unconscious. On recovering, it occurred to him that painless surgery could be done under the influence of sulfuric ether. During the next few years he discussed this with many people. Affidavits from eight people support these claims by Jackson [2].

From 1844 to 1847 Jackson taught chemistry in Boston, and among his pupils was W. T. G. Morton. Morton and his bride lived at Jackson's house for a brief period. On 30 September 1846, Morton met with Jackson to borrow a gas bag. Morton said he wanted a very nervous dental patient to believe she was breathing something to relieve her pain while she was really breathing room air. Jackson warned Morton against this, and suggested he use sulfuric ether. Jackson loaned him a gas bag, but also gave Morton a flask with a glass tube inserted into it and instructions for using it as an ether vaporizer. The two witnesses to this meeting, George Barnes and James McIntyre, were students of Jackson's and testified that Jackson (1) told Morton about ether, (2) devised an experiment to verify his induction, (3) instructed Morton how to perform the experiment, and (4) assumed the responsibility for the result [3]. Later that same evening Morton administered his first documented ether anesthetic and the following day he announced the discovery in a newspaper and initiated patenting formalities. Morton wrote [4] that the notice "without my knowledge, got into the

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papers"; however, A. G. Tenney, who witnessed the Eben Frost anesthetic as Morton's assistant, also worked for the *Boston Daily Evening Journal* and swore that Morton called at the paper to insert a notice of the experiment. He was told that he would have to be an advertiser, so he took out an ad and got his notice published.

Following this initial experience, Morton returned to Jackson and asked for a certificate that "it was harmless in its effect." *Jackson refused to give him such a certificate.* Jackson was not invited to witness the first public demonstration of ether anesthesia; however, on several occasions after that he announced his role in the discovery and was soon invited by Morton to participate in the patent. On hearing of Jackson's role, John C. Warren, the surgeon who operated when Morton first publicly demonstrated ether, invited Jackson to administer the next anesthetic; however, Jackson was committed to a surveying trip and he explained that Morton had exclusive rights to use of the patent. Jackson was out of town when Henry Bigelow, another Massachusetts General Hospital surgeon, read a paper describing etherization to two societies that included Jackson among their members. Bigelow's paper was subsequently published [5], and Jackson accused him of releasing news of the discovery before Jackson had enough information to warrant publication [6]. It was not until 21 November that Jackson saw his first use of ether as a surgical anesthetic, and he was so impressed with the potential for hypoxia that he took along a bag of oxygen on his next trip to see anesthesia 2 January 1847 [4].

On 13 November 1846, Jackson sent a letter to Elie de Beaumont in which he announced his claim to the discovery of etherization. This letter was read to the French Academy of Arts and Sciences, at that time the highest authority in scientific disputes. After sending the letter, Jackson informed Morton of his actions, and Morton engaged Edward Warren to act as his agent in Europe. Edward Warren was a nephew of John Warren, the surgeon at the first public demonstration of anesthesia. The French Academy appointed a committee to determine the true discoverer of etherization, and the committee concluded that its Montyon Prize should be awarded jointly to Jackson as the discoverer and Morton as the implementer. Beaumont later described Jackson as ether's Columbus, and Morton as the lookout who shouted, "Land ho". Morton's claim to the discovery was also made to the Parisian Medical Society [7]. It was contested by Horace Wells, and Wells was recognized as the discoverer. Jackson was well known to the European scientific community, which was a great advantage in gaining recognition. For a brief time the administration of ether was known as "Jacksonizing" in Vienna. In recognition of his discovery of etherization Jackson received orders and decorations from the governments of Sardinia, Sweden, France, Turkey, and Prussia; however, the controversy between the discovery claimants interfered with the large monetary prizes that other discoverers had received. In 1848, the Trustees of the Massachusetts General Hospital, on their own authority, held hearings to determine the true discoverer and concluded that it was Morton. Nathaniel Bowditch was chairman of the committee, and Morton named his next son after him.

Within 6 months after the patent was issued it became worthless, and the only chance for financial gain rested with rewards from governments. Wells and Jackson were very popular in Europe, and Morton therefore directed his series of claims for recognition to the United States Congress. The controversy continued in Congress from 1849 until 1863. Six congressional hearings were held during this 14-year period.

Twice the sponsor of the appeal for an award to Morton was named chairman of the committee to investigate the recipient's worthiness. Although no committee made a recommendation unfavorable to Morton, some made no recommendation, and one didn't even make a report. Congressman Bissel introduced a resolution to reward Morton and was named chairman of the investigating committee in the first session of the Thirty-second Congress [6]. The committee never filed its majority report [7]; however, Morton had their unfinished report printed as the committee report, after he had made editorial changes. He added a complete "Appendix B", and later had it presented to the Senate.

Wells died in January 1847, and his discovery claim was advanced by his wife and friends, including Senator Truman Smith, who commented on Morton's claim by saying, "Mere experiments of verification, substitution, or improvement, cannot rise to the dignity of original discovery" [7]. He later said, "Dr. Jackson brings forward a large mass of testimony from witnesses of the first respectability, and of unquestionable rectitude, which proves conclusively that Dr. Morton is not entitled to the slightest credit for the discovery." In 1854, Crawford Long was proposed to be named the discoverer of etherization. It was suggested that this proposal was supported by Charles Jackson to end the dispute between himself and Morton. By this time supporters were firmly committed to Morton or Jackson, and as the Civil War approached, the addition to the controversy of the Georgian, Crawford Long, ensured that Morton's support would not increase enough to win congressional recognition as the discoverer. In 1861, Jackson threw his support against Morton by stating that if he had known of Crawford Long's use of ether in 1846, he would not have claimed the discovery [8].

In support of Jackson's claim, it is remarkable that Morton never succeeded in or even attempted tooth extraction in a patient anesthetized with ether until he talked to Jackson, and then this discovery was ripe and worthy of being heralded a triumph in the newspapers and of being patented, all within 24 h. There was no dispute that Jackson experimented with ether, was aware of the analgesic properties of ether, and advised Morton to try ether. Among Jackson's American supporters was Edward Everett, the President of Harvard, who 20 years later spoke at Gettysburg for 2 h before Lincoln's 2-min speech. Everett said that "numerous other gentlemen of eminent standing" around Boston had presented a statement of their belief "that Charles T. Jackson of the City of Boston by a legitimate induction from his experiments and observations discovered the power of sulfuric ether to destroy pain and first recommended its use in surgical operations for that purpose" [3].

Don Pedro Wilson, who was in charge of the surgical department in Morton's office until April 1847, said that nothing happened to modify his belief that Jackson was the sole discoverer of etherization. He relied solely on Jackson's advice for administration of ether relayed through Morton. Similar sworn depositions were recorded from L. E. Hemmenway, A. G. Tenney, and John Hunt, all of whom worked in Morton's office during this period [9]. Franklin Dexter, Professor of International Law at Harvard, wrote a letter stating that he had examined all of the evidence in the ether controversy and concluded that the whole merit of the scientific discovery belonged to Jackson [3]. The Editor of Littell's *Living Age*, a journal that reproduced many of the documents and details on both sides of the ether controversy, stated that "we have the opinions of persons on whom we rely, that Dr. Jackson was the exclusive discoverer; and we feel bound to add that we do not believe that Mr. Morton made any experiments with sulfuric ether until advised to do so, and how to do so, by Dr. Jackson" [10]. Walter Channing, Professor of Obstetrics at Harvard, stated that under Jackson's direction the belief that etherization would abolish pain was submitted to questionless experiment [3]. He posed this question: Since Jackson was no longer a practicing physician, why not expect that he would have someone else act as his agent? He further stated that they must consider the known character of the parties concerned and their witnesses.

Jackson continued to make contributions to anesthesia, including his *Manual of Etherization,* in which he carried on his support of using supplemental oxygen with ether and also recommended the use of a Davy safety lamp when using ether [11]. This book was written for the use of military surgeons during the Civil War. Jackson's claim to the discovery [13] was well summarized by Joseph Abbott, who concluded that Jackson conceived the idea of using sulfuric ether to relieve pain during surgical operations; that he personally instructed Morton about the anesthetic properties of ether; that he told Morton how to administer the ether; that he gave him an instrument to use as a vaporizer; and that, according to two witnesses, he expressly assumed the responsibility for the experiment [12]. It appears that if Jackson and Morton had not patented the discovery and had accepted the decision of the French Academy of Arts and Sciences, both would have become wealthy and famous as the men who gave pain-free surgery to mankind.

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6.11 Prof. William W. Mushin About Anaesthesiology. An Interview

J. Rupreht

Dr. Rupreht: Professor Mushin, I would like to thank you for the praise which you expressed for the organization of the meeting here in Rotterdam, the Symposium on the History of Modern Anaesthesia. I can assure you that many, many people came just because they knew that you would be here. You are very well known and, to my knowledge, one of the few anaesthetists whose integrity and dedication to the specialty has never been questioned by anyone. Therefore, I am especially happy to be able to put a few questions to you.

Question: Professor Mushin, during the Symposium on the History of Modern Anaesthesia, we have heard many, many times that long before anaesthesia started to develop into a science and practice as we know it nowadays, surgery was already highly developed. Is it not curious that interest in the "body in our hands" developed before the 'life in our hands'?

Mushin: Yes, what you say is perfectly true and well worthy of wonder. Of course, a development like anaesthesia could only occur in relation to the general social, intellectual and economic life of a country. All developments are related to the general life of a country and anaesthesia is no exception. Now, until the middle of the nineteenth century, and of course for centuries before that, life was much cruder and rougher than we know it today, and life was not so precious then as we consider it now. Surgery was extremely primitive and was only conducted in circumstances in which death was imminent, and even then was not very often successful. Anaesthesia would not have fitted into that context.

The discovery of anaesthesia was accidental, but by the middle of the nineteenth century life had already softened to the extent that relief of pain during surgery became important. As you know, even after the discovery of anaesthesia, it took another 40 or 50 years before it was generally accepted as an essential part of medicine. It was not until the beginning of the twentieth century that anaesthesia really entered into the general corpus of medicine. I am quite sure that the fear that many patients have, even now, on entering hospital is not just that they are fearful of anaesthesia, and that they might die from it. It is a folklore relic of the terrible dangers that were associated with surgery, and therefore with hospitals, in the preanaesthetic days. I know, for example, that in the preanaesthetic days, which means in the first half of the nineteenth century, when records were beginning to be kept in some of the biggest institutions in Britain, and in which only perhaps a hundred operations a year might be performed, the mortality after operations for amputation, for example after compound fracture, was as much as 70%. So you see, surivial in those early days was

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rather the exception than the rule. The general cultural atmosphere of a country has to be ready for the acceptance of relief of pain.

Question: Is it not then rather curious that anaesthetists themselves, after having been established and accepted as a medical specialty, are now trying to split it again into subspecialties – threatening to create superspecialists, such as cardiothoracic, paediatric and neurosurgical anaesthetists, to say nothing of intensivists. Is this trend dangerous?

Mushin: It is dangerous if the splinter groups either ignore or develop without relation to the main stem of their work. Anaesthesia, like so much of medicine, really consists of two parts. There is the practical "doing" part, performing things with your own hands, which I call the craft work of anaesthesia. Examples are passing an endotracheal tube, manipulating a piece of apparatus, and so forth. Then there is the intellectual part of anaesthesia, which means making decisions based on observed physiological changes in the patient. The splinter groups, such as the obstetric anaesthetists, dental anaesthetists, thoracic and neurosurgical anaesthetists, and so on, have a special craft work, which, I might say, is not particularly difficult to learn, and at which you become expert if you do it often enough. You really could teach the craft work of anaesthesia to almost anybody. In many countries it still is taught to non-medical people. But the intellectual side of anaesthesia, the ability to make decisions based on physiological observations, is something which is common to all these branches of anaesthesia. So long as the entry into these various splinter groups, however undesirable you might think them, comes from a single stem with the same intellectual background, then I think there is no danger. I know that the craft work, by developing special techniques and repeating them over and over again, is not particularly difficult, but anaesthetists in these specialist groups should never forget that the basic intellectual background which governs all these craft works is the same.

Question: Anaesthetists appear to have two main approaches to the study of anaesthesia during their training. There are practical people who "know" anaesthesia in their fingertips, and the people who "know" it by "milligram percents" "from books only. The group which intelligently combines both ways of acquiring knowledge and experience is sometimes in a minority. How can these two aspects be combined?

Mushin: I think the first thing is to select proper individuals for training in anaesthesia. We must select individuals who, firstly, are capable of developing the intellectual framework, based mainly on physiological knowledge, which covers the whole of anaesthesia. They therefore have to have a certain level of intelligence and the capability of understanding theoretical and scientific ideas. Then you also have to select individuals who not only have the intellectual capability but also the natural ability to use their hands. This is not given to everybody. But even those who are not gifted by nature to use their hands can be taught craftwork. I have come to see that the practical manœuvres of anaesthesia – the things that we do with our hands – are not very difficult to learn. And I am sure that the things which medically uneducated people do in factories with their hands are often much more complicated than those which we do in anaesthesia. So I think that the first thing is to choose people with a proper intellect and then to graft on to that by practical experience, knowledge of the craft work. If you choose individuals who are not particularly bright, as used to be done in the past, then you will never make good anaesthetists. However expert they are with their hands they will never have the full competence to make proper decisions about the physiological status of their patients.

Question: Why then do so many highly-qualified anaesthetists, when they become professors, so easily forget the patient, forget their obligation to train others and can so rarely be seen at work clinically in their own hospital or teaching in their own school? They seem to spend so much time in travel or sitting on committees or in being administrators.

Mushin: This is a very good question, but I can't or don't want to answer it directly. When a man achieves the seniority of being placed in a position as chief in a hospital or as a professor in a university, he must build his "power base" on clinical work. In other words, whatever his duties may be in the form of management, or teaching, or direction, he must never forget his own practical skills and his own theoretical knowledge about those skills. If he never neglects that in his own department, then he does have a duty to visit other departments and to attend congresses. All within reason. This means that perhaps for 25% of a year at most, he might be away from his own department. So far as management goes, well this is a matter of personal decision. Some are naturally good organizers, and others are not. If he feels organization or management is not the natural thing for him, then he can delegate that to others, retaining the final responsibility to see that his influence is as a doctor in a clinical direction based on good intellect and knowledge of physiological affairs. I think that this gives you my outlook. Never to be in the operating theatre, common enough for the chiefs and professors, in some countries is very, very bad. It creates a bad image of him and his post to his colleagues and students. It means the professor loses his clinical competence. It means that however expert in administration, even however expert in research, he is not a fully developed person who contributes to the welfare of the human race in the anaesthetic care of patients. He will never inspire others. I am afraid that where this has occurred it means that the individual has never been trained to have a proper, fully developed outlook on anaesthesia and his own position within it.

Question: Shall we now return to a very essential issue? We are sitting here in Rotterdam, the Netherlands, possibly the most Americanized country in Europe. We have been able to buy the most sophisticated equipment for monitoring. The idea of "total" monitoring has become familiar even to people who work in small peripheral hospitals. This idea has now been transferred to the public. Experts in other fields, for example lawyers, are inclined to think that anybody who neglects or who does not apply "total" monitoring during an operation is not doing his job well. How should we make it clear to people – patients and other experts – that the safety of the patient does not necessarily depend on complicated monitoring?

Mushin: Again, your question is very much to the point. This problem is not limited to the Netherlands but is really present in most developed countries. The short answer is that the anaesthetist must always behave like a doctor, a fully trained doctor, with considerable understanding of the working of the body, who then forms his decisions based on good physiological observation.

Monitoring instruments are quite clearly an extension of his own senses. Things which his own natural senses cannot determine can often be determined by some device which can pick up information from the patient's body, which he cannot. Viewed in that light, I think the position would be satisfactory. However, he must constantly emphasize to everybody in his teaching and his actual work that these instruments are simply an extension of his own five senses, and that they are not in any sense "administering" anaesthesia, and that whether he has few or many monitoring instruments they are all extensions of his own senses.

Where to draw the line is very difficult. Everybody will agree that monitoring the blood pressure is very important. It is very easy and very cheap. We use a sphygmomanometer because we cannot estimate the blood pressure accurately with our own senses. If you failed to measure the blood pressure regularly during a major operation I think people would say, fairly, that you had not done your job fully. If you went a little further and said that you wanted to observe the electrical activity of the heart with an electrocardiogram, I think it would be fair to say that that again is a very easily obtainable and fairly cheap instrument, and that the interpretation of the information from it is not very difficult. It gives you good information about the pulse and about irregularities of the heart, which may be very important in diagnosis and prognosis. You might say, with general agreement, that this is a very important monitoring instrument. I would go still further and say that every anaesthetist in almost every case should have some way of determining, fairly accurately, information about the ventilation of the patient, such as how big is each breath, and how many breaths there are a minute. You might agree that this would also be important. Only a very simple instrument is required, very cheap and easy to interpret. You could go on to the next stage and ask what about the composition of the gases in the inspired mixture, and what about the electrical activity of the brain? You can see that there is no end to monitoring. We would now be entering a grey area of discussion in which the information from the monitors (an electroencephalograph is an example) is of doubtful value. We have not yet reached the stage in which you can directly apply the information from such monitors to the care of the patient. We have not yet obtained the necessary knowledge. If an anaesthetist uses an instrument like the electroencephalograph (I do not want to be too specific here), for every single patient or even every major operation, and if he was not involved in some specific research activity but this was intended for ordinary routine work, then I would say that he was using a monitor to improve his status image rather than to help the patient!

We have not yet all agreed which monitors are essential and which are of doubtful value. I would say that blood pressure, electrocardiograph and ventilation measurements are all nearly essential. The instruments required are all cheap, they all give information which is very relevant to anaesthesia and which can affect diagnosis and treatment, and they are all easy to understand. I think they ought to be in every operating room. But beyond that we need discussion and more knowledge.

Question: I would like your opinion on a practice in this and other countries of anaesthetizing two or more patients simultaneously. Some visitors to the Netherlands have reported that the system works well. Others have been astonished and condemn it. Would such a practice be acceptable in Britain?

Mushin: No, not as a normal thing. It never has been, and there is no sign at all that it will be. I can imagine circumstances such as war time, grave national disasters, and serious economic problems in underdeveloped countries, i. e. circumstances in which it might be justifiable to have one anaesthetist supervising several patients each of whom was receiving anaesthesia from a non-medical, and to my sense, untrained person. But in a normal community in a highly developed country like Britain or any other European country, or in the United States, such a situation would be difficult to justify. I find that when I anaesthetize, and I have done this all my life, every day and every week, it needs all my energy and attention to be devoted to one patient. Things happen quickly, and disaster, as you know quite well, comes very quickly.

There is one aspect of this problem which I ought to touch on. The main function of an anaesthetist is to make decisions. His function is not really to turn knobs, and I see no harm in an anaesthetist having an assistant who, so to speak, turns the knobs at his command, so long as the anaesthetist makes the decisions. This is just to help him, in the same way as a surgeon has a helper to hold retractors and hand him instruments. So an anaesthetist should have a helper to do some of these things, but it doesn't mean that he can go away and leave the helper to carry on by himself. If he does that, then very quickly the helper, who is really quite untrained in the mysteries of the human body, will soon think that he knows enough to *administer* anaesthesia. The practical part of anaesthesia is very easy to learn; it is the intellectual part that is needed for decisions, and that is very difficult, and competence takes a long time to acquire. So if an anaesthetist has a helper he must be very careful never to let the helper make decisions. He must make the decisions himself. When an anaesthetist is supervising several patients at once, it may be almost impossible for him, simultaneously, to make a decision for more than one of these patients at the right moment. From what I have seen of this practice, in my opinion a very undesirable practice, the helpers soon begin to make decisions. Accidents must be inevitable in such an arrangement. In Britain, and I think in most developed countries, we would not tolerate it, except in such very special emergency circumstnaces that I have already mentioned.

Question: Would you agree that outside Britain anaesthetists often feel that they are not accepted as equals by other specialists?

Mushin: One must not forget that it is only since World War II war, and that means only a period of about 35–40 years, that specialist anaesthetists have developed the necessary confidence which comes with a sureness of their own intellectual knowledge and capability for them to be accepted within the corpus of medicine as experts like any other specialist. Anaesthesia is quite new – only 140 years old – and it takes a varying time to reach maturity in different countries according to differing social circumstances and differing social attitudes. I think that the time will come in every country, perhaps slower in some rather than quicker, when the anaesthetist will reach the same situation in relation to his fellow specialists as he has done in Britain.

Dr. Rupreht: Professor Mushin, I would like to thank you for your kindness in coming here and in answering my questions. I do hope that you will, for a long, long time to come, be with us and teach us and spread the glory of anaesthesia to those parts of the world and to those people who have not yet come in contact with it. Thank you very much.

6.12 The National Catalogue of Anaesthetic Books, Documents and Equipment

I. McLellan

The background of the National Catalogue of anaesthetic books and documents, as well as that of equipment, arose out of an interest in preserving the literature and equipment of latter days. Several years ago, David Wilkinson wrote a letter to *Anaesthesia* suggesting that any spare historic equipment or books be sent to him. A colllague and myself who had produced a small local collection were concerned that this might mean the loss of items with local connection. We therefore suggested in correspondence arising from this original letter that a National Catalogue be set up. During the next 2 years a catalogue of equipment was started and this turned into a partial success.

In the first instance, I felt we needed an overall list of books and equipment. Since then the Association of Anaesthetists of Great Britain and Ireland have formally decided that a National Catalogue should be organized. Dr. Wilkinson will be looking after the equipment catalogue, and I will be looking after the books and documents catalogue. As a sideline I think that we will be able to set up one of the most comprehensive slide collections of anaesthetic equipment and documentation. The Association of Anaesthetists has set up in its headquarters the Bryn Thomas collection of books, which it has purchased. Several regional groups and individuals have already contributed lists of books.

My original was to plan collect information through the journal *Anaesthesia,* through the Association of Anaesthetists Link-man Organization, so that every area would be aware and actively involved. However, in my limited experience of collecting, such formal organization does not catch the great prizes. We will also need local organization, where particular individuals with a great interest would have the background to deal with regional societies. As well as regional societies there are a number of small societies such as the Hickman Society with whom I will communicate. There are also an important group of institutions – The Wellcome Foundation Library, The British Dental Association Library, as well as major university libraries – with whom I will communicate. Finally, I will communicate with non-medical personnel, such as dentists, veterinarians, museum curators, librarians of smaller local libraries and antiquarian booksellers.

From these sources we hope to achieve a number of goals. The simple one will be to compile a complete National Catalogue of anaesthetic books and documents. Among documents I hope to include treasures of patent applications and pamphlets, all of which are so valuable in anaesthetic history. Also I wish to have as complete a list of published anaesthetic books and documents as possible, so that efforts can be made to

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find any missing items for the catalogue. A catalogue has already been started including cross references of collections of books. Although this is a field of history, modern as well as standard cataloguing techniques are being used, with a microcomputer for listing and cross reference. I hope that when the second International Symposium of the History of Modern Anaesthesia takes place, I shall be able to report that the catalogue is available. Naturally it will always need updating.

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