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THE HISTORY OF ANAESTHESIA SOCIETY PROCEEDINGS

Volume 36

Proceedings of the Summer Scientific Meeting

The Abbey Hotel, Great Malvern
7th and 8th September 2006

Contents of Volume 36

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We are saddened by the announcement of the deaths of the following members of the Society: Drs HT Davenport, R Jack, Eryl Rouse, BR Sugg, JSM Zorab and DDC Howat.

HISTORY OF ANAESTHESIA SOCIETY

2006 Summer Scientific Meeting, The Abbey Hotel, Great Malvern

7-8 September 2006

Organiser: Dr Henry Connor

The Organiser is very grateful to Mrs Pat Rossi and Mrs Sue Connor for their assistance.

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The Society acknowledges with thanks the photographs taken by Dr Geoff Hall-Davies.

HISTORY OF ANAESTHESIA SOCIETY

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EDITORIAL

Having taken over the editorship I wish to pay tribute to my predecessor, Peter Drury. I have a tough act to follow. For geographical and other reasons I have secured new printers. I hope you approve of the increase in print size.

Great Malvern was a delightful venue for the summer 2006 meeting of the HAS – held later than usual in deference to the Anesthesia History meeting at the Mayo Clinic in June. Our meeting was enjoyed by 61 delegates, who were indebted to Henry Connor for his excellent organization.

The programme was varied, starting with the problems of chloroform, equipment (props and tongue forceps) and postcards of anaesthetic interest. A refreshing innovation was the presentation of papers by four trainees, who had entered for the 2006 Abbott History Prize. Two of these papers were on pain management, tracing events from antiquity to modern. A complementary paper was delivered on the development of acute pain teams. Keith Sykes gave a taste of his forthcoming book on the influence of anaesthesia on the practice of medicine. After lunch there were presentations on intensive care medicine and resuscitation. Biographical papers included Giddy, Guedel and Barton. At the AGM the Presidential badge of office passed to David Wilkinson from the retiring President, Peter Morris.

On the second day the delegates were treated to part 2 of the equipment paper (gags), and to a review of the development of pain relief in dentistry. A double-act followed on the work of Brown and Fraser in preparing synthetic muscle relaxants, which preceded *Intocostrin*, but were never used clinically. The meeting concluded with an excellent guest lecture by Dr John Harcup on the Malvern Water Cure.

Alistair G McKenzie
Hon Editor

FUTURE EVENTS

2007 28-30 June. HAS Summer Meeting, Dundee
Contact: Prof JAW Wildsmith (jaww@doctors.org.uk)

2007 10 November. HAS Autumn Meeting, Newcastle
Contact: Dr Gary Enever (g.r.enever@ncl.ac.uk)

2008 27-28 June. HAS Summer Meeting, York

Speakers at Great Malvern

Dr Anne Florence

Dr D Zuck

Dr I McLellan

Dr AG McKenzie

Prof Sir MK Sykes

Dr R Seth

Dr G Enever

Dr PME Drury

Dr A Padfield

Speakers at Great Malvern

Prof JAW Wildsmith

Dr Ann Ferguson

Prof A Dronsfield

Dr JW Harcup

Members and guests attending Great Malvern meeting

Dr Aileen Adams	Cambridge	Dr Alistair McKenzie	Edinburgh
Dr Neil Adams	Bury St Edmunds	Dr Colin McLaren	Swindon
Dr Edward Armitage	Brighton	Dr Ian McLellan	Dorset
Dr Marshall Barr	Reading	Dr Kenneth Macleod	Huntingdon
Dr Moyna Barton	London	Dr Patrick Mahoney	NSW, Austral.
Dr Frank Bennetts	Wokingham	Mrs Iris Millis	London
Dr Rukinder Birk	Mansfield	Dr Peter Morris	Leicester
Dr Colin Birt	Southend	Dr James Mulvein	Bristol
Dr Thomas Boulton	Reading	Dr Angela Murray	Liverpool
Dr Geoffrey Burton	Bristol	Dr John Murray	Kidderminster
Dr Henry Connor	Hereford	Dr Bryan Ng	Reading
Dr Diana Coote	NSW, Australia	Dr DA Nightingale	Liverpool
Dr Juliet Drew	Hungerford	Dr Adrian Padfield	Sheffield
Prof Alan Dronsfield	Derby	Dr Eric Plumpton	Hastings
Dr Peter Drury	Liverpool	Dr Yash Pole	Manchester
Dr Gary Enever	Newcastle	Dr John Pring	Penzance
Dr Ann Ferguson	Broadstairs	Dr Nigel Rose	Ledbury
Dr Anne Florence	Liverpool	Dr Mohana Saigopal	Cardiff
Dr Anthony Gilbertson	Liverpool	Dr Rajan Seth	Manchester
Dr Veera Gopakumar	Walsall	Dr Janti Shah	Birmingham
Dr Clem Gordon	NSW, Australia	Dr Ian Smith	Aberdeen
Dr Michael Gough	Doncaster	Prof Sir Keith Sykes	Devon
Dr Paul Goulden	Dewsbury	Dr William Turner	Leicester
Dr Geoffrey Hall-Davies	Redditch	Dr Yoav Tzabar	Carlisle
Dr Helen Hannah	Chippenham	Dr David White	London
Dr Graham Housam	Powys	Dr Malcolm White	Cleveland
Dr Michael Inman	Plymouth	Dr Brian Whittard	Teignmouth
Dr Anthony Kitsberg	London	Prof JAW Wildsmith	Dundee
Dr Adrian Kuipers	Shrewsbury	Dr David Wilkinson	London
Dr Stuart McGowan	Dundee	Dr David Zuck	London

Guest Lecturer: Dr John W Harcup, Great Malvern

PROBLEM SOLVING IN THE 19TH CENTURY

Dr Anne M Florence, Liverpool

Following James Young Simpson's demonstration of the anaesthetic properties of chloroform in November 1847 this new agent rapidly became widely used in England with John Snow an early and avid proponent.

First death under chloroform

However, the death in Newcastle in January 1848 of a fit young girl, Hannah Greener, who was about to undergo trivial surgery alerted the profession to the potential dangers of this new agent. Initially, John Snow attributed the event to respiratory paralysis as the result of over-dosage.

In 1842 while experimenting with impure chloroform and other chlorine compounds in dogs and rabbits, Robert Glover had found intense engorgement of the pulmonary veins and capillaries with marked venous congestion of the mediastinal organs. While admitting that chloroform could paralyse the heart he remained convinced that a toxic action of the drug had had a specific effect on the pulmonary vessels.[1, 2] He was present at Hannah Greener's autopsy in 1848 when the presence of intense congestion of the lungs, brain and intestines was found indicative of cardiac failure rather contradicting his thesis. At the inquest, Sir John Fife who had performed the autopsy pronounced that the inhalation of chloroform associated with some peculiarity in her constitution was responsible for the fatal result.[3]

Further deaths

Over the next four months three further deaths occurred in identical circumstances. After careful perusal of the post-mortem reports on these cases Frank Sibson from the General Hospital in Nottingham concluded that the primary cause of death was the rapid onset of flaccid paralysis of the heart, not primarily respiratory failure. In collaboration with John Snow he immediately recommended a code of practice for the clinical use of chloroform in an attempt to reduce this risk.[4]

In three of these four early deaths chloroform had been administered in the sitting position, suggesting that fainting was a contributory factor. It was obvious to both Snow and Sibson that in all the cases death had occurred shortly after the start of the inhalation and was directly related to the strength of the vapour in the inhaled air. Snow refused to agree that fear played a significant

role but did admit the possibility of an idiosyncratic response to the drug. Despite the recommendation that patients should be carefully assessed, always placed horizontally before induction of anaesthesia with careful control of the administration of the drug, deaths from chloroform continued.

Committee appointed in London

In 1863 following the revelation that chloroform had directly contributed to 163 deaths and numerous near misses, the Royal Medical and Chirurgical Society of London appointed a Committee including Sibson to "give their anxious attention to devise a means for obviating such accidents". After numerous experiments observing the physiological effects of varying concentrations of chloroform on dogs, the Committee arrived at the conclusion previously reached by Snow and Sibson, that chloroform depresses cardiac action by poisoning the cardiac muscle thereby causing death by syncope.[5]

Chloroform related deaths in Liverpool

Liverpool was not immune. The first two deaths which occurred in the city in 1857 created considerable excitement. On both occasions, the 'chloroformist' postulated, perhaps erroneously, that the gradual inhalation of small quantities was more likely to have caused syncope than if the chloroform had been given more rapidly in greater quantities. For over 25 years chloroform deaths in the city remained infrequent but the proceedings from every Coroner's Inquest were reported verbatim in the daily papers with the exact timing of the event and the exact number of minims of chloroform given recorded. Despite this chloroform continued to be used as "a matter of course for every operation of importance" because associated fatality appeared to be "so rare".

The incidence of chloroform related deaths in Liverpool rose dramatically between January 1886 and October 1891. In just over five years the death rate had risen from the occasional one or, at the most, two per year to a total of seventeen, six of which had occurred in the first nine months of 1891. Concerned by these figures, Frederick Lowndes, a surgeon and experienced 'chloroformist' at the Royal Infirmary, arranged a forum for discussion of this development.

Liverpool forum, 1891

Frederick Lowndes
In his address to members of the Liverpool Medical Institution in November 1891 entitled "Deaths from chloroform: Can any measures be adopted to

prevent their frequency?" [6] Lowndes set out to establish a consensus among his peers on how to relieve the suffering of humanity and promote the preservation of life by the safe administration of chloroform.

He outlined his own experience of chloroform. He had encountered his first fatality after eight years of exclusive use of the drug in a large number of cases. A middle aged man with an intractable urethral stricture requiring 'forcible catheterisation' had died suddenly after inhaling a reasonable quantity of chloroform, well diluted by air and delivered by a Skinner's inhaler. At the time it was, perhaps correctly, concluded by consensus, that the combined poisons of uraemia and chloroform had proved fatal. A similar case soon afterwards in nearby Blackburn emphasised the importance of careful clinical assessment of all patients before chloroform anaesthesia. In the intervening twenty-three years and hundreds of chloroform administrations Lowndes had encountered "some very narrow escapes" but no fatality while undertaking surgery in a large number of patients anaesthetised with chloroform. In the majority of the cases the "chloroformist" had been diligent throughout the administration of the drug but in a small number of cases the reverse had been true. The administrator had either "forgotten or ignored his responsibility, performing his duty in a most slovenly and careless manner instead of being blind and deaf to everything saving his responsibilities". Lowndes felt that it was his professional duty to be truthful, loyalty must not blind one to the truth as indifference and carelessness had, undoubtedly, potentially disadvantaged patients.

He firmly believed that chloroform deaths could be reduced provided specific guidelines were followed. Patients should be properly assessed and reassured to ensure the smooth progression of induction of anaesthesia. Reassurance was of paramount importance to allay anxiety. It was widely known that the very first death from chloroform in January 1848 had occurred in a healthy young girl who "was terrified and fretted a good deal". He also felt that the frequent, gruesome press reports of the deaths related to chloroform examined in the Coroners' Courts of Liverpool had an adverse effect on patient confidence. A cause of significant distress was the publicised opinion of the profession that it was more difficult to kill a patient with ether than with chloroform.

Lowndes recommended that fully qualified medical practitioners specifically trained to administer chloroform carefully should always be present. The atmosphere should be calm and there must be no semblance of haste or impatience during induction. Only chloroform of absolutely good quality and proper preparation should be used to eliminate the risk of toxicity. It should be dispensed from a graduated bottle to enable measurement of the actual amount given. The method of administration should be standardised to produce a

continuous flow of the vapour well mixed with air in sufficient quantity to maintain a continuous "atmosphere of the vapour" until deep anaesthesia is achieved.

All users should be aware of the signs of impending death and must pay close attention to patient behaviour during induction, in particular, the colour of the face and the pattern of respiration. Idiosyncrasy to chloroform could have fatal consequences and, therefore deserved serious attention. His colleagues should beware the unexpected. Chloroform fatalities "are as likely as political crises". The very next death might end in censure, if not a verdict of manslaughter. Continued vigilance is essential as safe anaesthesia must be the responsibility of the administrator.

While deploring the right of the surgeon to control the anaesthetic, he concluded that the creation of specialists in anaesthesia with freedom of choice was of doubtful expediency and the appointment of specialist chloroformists to general hospitals unlikely to prove of real advantage. An opinion later endorsed by Dr Rawdon.

Declaring the meeting open, Dr Lowndes expressed his confidence that those present would find some measures by which deaths from chloroform could be reduced to a minimum and that all would agree to adopt them.

Dr Alexander

Supporting chloroform as the best and probably the safest anaesthetic known, Dr Alexander, the first to comment, confirmed that the recent increase in mortality allegedly associated with chloroform had had a most depressing effect on his patients. The operation itself was not "looked forward to with as much dread as the anaesthesia". It was impossible to evaluate the relative mortality of chloroform and ether as chloroform was administered every day in private practice while ether was the drug of choice in the public hospitals where anaesthesia was less frequent. Ether did have the propensity to activate serious, often fatal, respiratory problems but none of these cases were reported to the Coroner.

He admitted that it appeared to be more difficult to kill a patient with ether than with chloroform, probably related to the fact that the signs of danger with ether anaesthesia were more gross and, therefore, more easily detected at an early stage.

Dr Alexander was adamant that there should be more explicit awareness of the signs of danger during chloroform inhalation for optimum care of all patients. At present the directions given to simply "watch the respiration, watch the face and the pupil" were too indefinite. Many students of the art had no idea what they had to watch for except the signs of impending death!

Professor Carter

Dr Carter, Professor of Materia Medica and Therapeutics, felt that he must comment despite having been threatened with exclusion from the discussion by the President of the Institution because he was strongly opposed to the use of chloroform. It should be banned. He had found nothing but contradiction and controversy on every point raised by Dr Lowndes and was convinced that whenever death did occur some authority that considered chloroform to be the best anaesthetic available would be cited.

He felt that Dr Sayer's suggestion that chloroform should be given in small quantity in a concentrated form contrary to Clover's view that it should always be given slowly in dilute form was evidence that opposing opinions were being expressed with equal dogmatism leaving the young seeker after the truth hopelessly perplexed. Even the cause of death remained confused. Most Europeans and probably all Englishmen blamed cardiac failure despite the declaration by the Hyderabad Commission of 1890 that respiratory failure occurred in dogs exposed to chloroform. This same commission had, however, concluded that chloroform could be used with absolute safety in all humans requiring surgery.

Carter argued that amid all this controversy there were certain indisputable facts. Chloroform must be absolutely pure to reduce the risk of toxicity; there must be no free hydrochloric acid or free chlorine present. It ought not to be given immediately after a meal; where the clothing was tight or the patient was in the sitting position. As Professor MacWilliam of Aberdeen had suggested that even small quantities could cause appreciable dilatation of the heart of a healthy patient it should never be given to a patient with a weak or diseased heart. Dr Carter concluded by suggesting that all the evidence aired pointed to the obvious fact that chloroform must be totally abandoned in favour of ether.

Dr Rawdon

Dr Rawdon, who firmly believed that chloroform would long remain the first choice, considered that one of the great difficulties and, indeed, dangers of using either chloroform or ether was the very different ways in which patients

responded to these drugs. Individual peculiarities or idiosyncrasies were often totally unexpected, occurring particularly among the highly nervous, the robust and overindulgent. He also warned that even the purest and best quality chloroform could be potentially toxic.

R Parker

Rushton Parker, the first Professor of Surgery in Liverpool, declared that his confidence in chloroform as an anaesthetic agent remained unshaken by recent events but this confidence was not extended to "everybody's mode of administration". It was of the utmost importance to avoid and repress carelessness and negligence, particularly the pushing of the anaesthetic too lavishly and continuing it once breathing had deteriorated and pallor developed.

All clinical students should be made fully aware of the proper rules for its administration and should learn to use it with confidence and safety. At all times they must ensure that respiration is unimpeded and that body warmth is actively maintained throughout the procedure.

Frank Paul

Frank Paul, a man of integrity, a skilled surgical craftsman who had made substantial original and fundamental contributions to nineteenth century surgery, presented the most logical response to the rhetorical questions raised by Dr Lowndes by examining them separately.

He attributed the increase in the death rate associated with chloroform to

(i) asphyxia secondary to obstruction resulting from reflex paralysis of the tongue, the accumulation of mucous, blood or vomit or tonic spasm of the respiratory muscles during the period of excitement
(ii) overdosage and the poisonous action of the drug
(iii) the physiological action of chloroform on the cardiac and respiratory centres
(iv) the action of the drug accentuated by the depressing effects of fear, disease, response to surgical trauma and idiosyncratic response to the drug.

His solution to the problem rested in greater care and watchfulness by experienced administrators, while the inexperienced should place more reliance on ether or the combined use of ether and chloroform, which he considered to be safer and as convenient as chloroform alone.

Mr Larkin

Mr Larkin, the youngest surgeon present, expressed the opinion that all deaths from chloroform were avoidable accidents related entirely to careless administration. He did introduce a new dimension urging that all chloroform should be carefully tested before administration as it decomposed in storage. The colour, appearance and smell when a small amount evaporates on the hand and the reaction to litmus paper were important factors providing a reliable estimate of the purity and safety of the drug. While admitting that it was probably easier to kill a patient with chloroform than with ether, he argued that a careful approach to the administration of chloroform would reduce the risk. Ether was not entirely safe or free from unpleasant problems during administration. Deaths related to ether tended to occur in the post-operative period and thus escaped scrutiny in the Coroners' Courts. They were largely due to respiratory failure secondary to the irritating action of ether. He concluded that chloroform was a safe anaesthetic, requiring no more skill for its administration than the public had a right to demand of medical men.

Consensus

There was consensus that deaths during chloroform anaesthesia were largely, if not entirely, avoidable accidents. Discussion focused on the importance of constant vigilance as many of the fatalities could be attributed to the anaesthetist's mind being "up in the clouds whilst mechanically pouring on the chloroform". Even temporary distraction from close observation of the patient could have fatal consequences, therefore absolute care was essential throughout the surgical stimulation and the early recovery period.
It took two afternoons of intense debate for the medical men of Liverpool to arrive at the same conclusions reached by their peers in London many years earlier.

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PROPS, TONGUE FORCEPS AND MOUTH GAGS

Dr D Zuck
Past President HAS, London

My first acquaintance with tongue forceps and mouth gags coincided with my first observations of general anaesthesia as a surgical dresser, in 1942, an unbelievable sixty four years ago. In those days it was exceptional for the airway to be secured by an endotracheal tube, and never by a cuffed one. Very few anaesthetists were adept at laryngoscopy, and one, quoted by Gillespie in his classic monograph on endotracheal anaesthesia, described his attempts as being 'along a very blood-bespattered path, slippery with mucus. ... Ploughing up the larynx with a laryngoscope in an attempt to dig out an epiglottis from a pool of bloody mucus ...' [1] The main problem was securing adequate relaxation by deep inhalational anaesthesia, with the patient getting lighter with every breath during the attempted laryngoscopy. So whereas today no responsible anaesthetist would start to induce anaesthesia without at least one functioning laryngoscope, until the introduction of the neuromuscular blockers in 1946 the lifesaving instruments if there were problems during induction were the mouth gag and to a lesser extent the tongue forceps. These were to be found hanging on every anaesthetic machine; and every exam candidate tried to learn the difference between the Mason and the Fergusson, which was not straight forward, as we shall see.

Props

Props and gags were introduced for dental surgery, elaborated by oral surgeons, and only later modified by the practitioners of anaesthesia, as a means of keeping the mouth open. The first prop was improvised by John Snow when giving chloroform in two cases of cleft palate, and was described in his book, *On Chloroform.* 'A large cork with a string to it (sic) was kept between the molar teeth on one side during the operation' and in a footnote he said, 'I never allow a cork or any such substance being put into a patient's mouth when insensible unless it is well tied to a string, lest it should be swallowed.' [2] Strangely enough, he did not insert a prop before dental extractions, but used an instrument similar to Heister's gag to open the jaws if they remained clenched after induction.

The more conventional dental prop was invented by Joseph Clover, although he called it a gag. [3] In 1869 he described a telescopic spring prop secured in the compressed state by a bolt on a long handle (Figure 1). After induction the bolt was removed, and as the jaw muscles relaxed the spring caused the mouth to

open more widely. Some months later an improved model was introduced, which incorporated a ratchet, so that the prop, once extended, would remain so even if the jaws were clenched, until a release mechanism was activated. [4] What became the definitive spring swivel prop was invented by a dental student, S.J. Hutchinson, and described in 1871. But Hewitt complained that all props containing screws or springs were liable either to break, to cease to function properly, or become contaminated with blood or other unpleasant matter, so in 1891 he designed a much simpler prop, to be placed between the molar teeth, the dental surfaces being shaped to accommodate the angle made by the lower jaw when fully open. [5] It was produced in five sizes. He also designed a prop with a built-in chloroform tube, to be attached to a Junker's apparatus, to allow anaesthesia to be maintained with the mouth open. [6] The so-called London Hospital Prop wasn't a dental prop, but was used to keep the lips of an edentulous mouth apart. Prop design since Hewitt's has tended to emphasize simplicity, and ease of cleaning and sterilization.

Tongue Forceps

The practice, originally peculiar to Scotland from the very early days of chloroform anaesthesia,[7] of pulling on the tongue with forceps to relieve airway obstruction, owes its wider promulgation to Joseph Lister. As Professor of Surgery in the University of Glasgow and Surgeon to the Royal Infirmary, Lister was invited to contribute the section on general anaesthesia to a four-volume textbook, *A System of Surgery*, edited by Thomas Holmes, and published in 1862. [8] In Scotland the expert anaesthetists were surgeons, Lister's father-in-law, James Syme, being the prime example. Lister's chapter appeared in volume 3, and occupied 16 pages. It contained some statements that were remarkable even in his own times. For example he asserted that anyone could give chloroform safely as long as he followed a few simple rules; specialist anaesthetists were quite unnecessary, and had the disadvantage of investing the administration of chloroform with an air of needless mystery. Preliminary examination of the chest was, by alarming the patient, more likely to induce the dreaded syncope than to avert it. These opinions have been subject to much criticism, notably by Stanley Sykes,[9] but Lister's circumstances should be understood.

Lister's aphorisms

Lister was concerned that general anaesthesia, by which he meant chloroform, 'was scantily used in parts of Europe and even in the United Kingdom because of fear of fatalities.' He wanted to increase this use, because, and here he was ahead of the field, he thought it protected against surgical shock. His purpose

was to bolster the confidence of his medical students, so that when they entered practice they would not be afraid to administer a general anaesthetic. Hence his dismissal of Snow's 450 page textbook as unnecessary. 'The notion that extensive experience is required for the administration of chloroform is quite erroneous, and does harm by weakening the confidence of the profession in this invaluable agent.' Mr. Syme (his father-in-law) had administered 5000 chloroform anaesthetics without one fatality. All that was necessary was to follow some simple instructions.

However Lister was very concerned to avoid airway obstruction, and seems to have been the first to research and publish about it. He appears to have regarded strongly stertorous breathing as 'a sign of overdose in chloroform anaesthesia, which, if not recognised and dealt with, will become aggravated until it passes into complete obstruction to the entrance of air into the chest, though the respiratory movements of the thoracic walls still continue.' The whole condition is very dangerous, because 'it would seem that when chloroform is given in an overdose, the cardiac ganglia are apt to become enfeebled; and on this account asphyxia produces more rapidly fatal effects than under ordinary circumstances. But if the obstructed state of breathing is noticed as soon as it occurs, and the cloth is immediately removed from the face, and the tip of the tongue seized with a pair of artery forceps and drawn firmly forwards, the respiration at once proceeds with perfect freedom, the incipient lividity of the face is dispelled, and all is well.' In a footnote Lister added that 'The artery forceps are the most convenient means of drawing the tongue forwards. The puncture which they inflict is of no consequence; the patient, if he notices it at all, supposes that he has bitten his tongue under the chloroform.'

Lister continued to press the point. 'I am anxious to direct particular attention to the drawing out of the tongue, because I am satisfied that several lives have been sacrificed for want of it. In order that it may be effectual, firm traction is needed. I have, more than once, seen a person holding the end of the organ considerably beyond the lips without any good effect, and, placing my hand on his, have given an additional pull, that has re-established the respiration.' To emphasize the point he described a simple experiment 'which anyone may perform on himself.' It is easy to produce stertorous breathing at will but not if the tongue is gripped with a handkerchief and pulled out sufficiently to cause decided uneasiness. Lister continued to investigate stertorous breathing, and noted that it could be of two kinds, palatine, caused by vibration of the soft palate, and laryngeal. Just lifting the tongue off the back of the throat would not relieve the latter, nor would the increased second traction, so he concluded that a reflex must be involved. To elucidate this he examined his own larynx, by the indirect method, using Garcia's laryngoscopic mirror to reflect bright sunlight,

and concluded that true laryngeal stertor resulted from the vibrations of the mucous membrane at the apices of arytenoids cartilages. He observed that drawing the tongue forward forcibly caused the membranous folds to separate, so allowing free passage of air. Hence the forceful drawing forward of the tongue was of the highest practical importance. Gentleness would waste a golden opportunity of rescuing the patient from death.

Lister said in conclusion, that if the above is correct, and the first sign of too deep chloroform anaesthesia is respiratory obstruction, it follows that the attention of the administrator 'ought to be concentrated on the breathing, instead of being, as it too often is, diverted by the pulse, the pupil, or other matters still less relevant.' Hence the rationale for the Scottish technique.

Clover disagrees

Joseph Clover, during a discussion in the Odontological Society in 1868, said that he had never found it necessary to take hold of the tongue with artery forceps and draw it forward.[10] He merely raised the chin from the sternum to give effect to the muscles between the chin and the hyoid bone. The closure of the glottis from spasm ceases spontaneously with very few exceptions, but it is a grave complication if it occurs with the chest strongly supplied with chloroform. He did not advise tracheotomy in such cases, but artificial respiration by Sylvester's method. Although this would be useless with the glottis closed, it would begin to be effective as soon as it relaxed, which would be before the patient was quite dead. In cardiac syncope, if the heart was still acting slightly, artificial respiration was preferable to attempts to stimulate the beat by electricity.

Three years later Clover, in a paper on chloroform accidents in the *British Medical Journal*,[11] referred to Lister's revised chapter in the new edition of Holmes's *System of Surgery* as follows:
'If I understand Mr. Lister, he maintains:
That in deaths from chloroform breathing fails before the circulation.
That the chief danger arises from laryngeal obstruction.
That the chief duty of the administrator is to watch for laryngeal obstruction and draw the tongue forward with forceps when it occurs.
That it is useless to watch the pulse.
That chloroform may be given as safely by means of a towel as by any apparatus.'
Clover's experience obliged him to differ from Mr. Lister on these points. He had administered chloroform more than seven thousand times, and nitrous oxide on four thousand other occasions. He had never drawn out the tongue, and never

lost a patient from any anaesthetic.
'It appears that in Mr. Lister's practice the necessity of dragging forward the tongue is of frequent occurrence. Either his method of giving chloroform is not the best that may be devised for preventing the choking, or else the severe process of seizing the tongue with artery forceps when the choking occurs is not so imperative as he supposes. Probably some of his patients were so affected by the pungency of the vapour that the simpler expedient of raising the chin well away from the sternum, which I have never found to fail, might have been sufficient.'

The argument in fact centered around the differences of method between Clover and the Scots, the administration, with a finger on the pulse, of a known maximum percentage of chloroform prepared in the Clover bag, as against the towel and bottle and an eye on the chest. Clover attributed all Lister's problems to the inability to control the concentration and avoid overdose.

Lister strikes back

Three weeks later Lister's reply was published in the *British Medical Journal.*[12] It consisted of a long defence of the Scottish method, and an outspoken attack on Clover. Mr. Clover was esteemed by all who knew him, Lister began, and his large experience attached much weight to his observations. 'However, when he counselled medical men in general to disregard the drawing forward of the tongue, he makes, as I believe, a great mistake, and with the best intentions, promulgates most (sic) mischievous doctrine.'

There was a great difference between Mr. Clover's practice, where the undivided attention of the most experienced special chloroformist in the country was bestowed on the patient, and his own, where the chloroform was given by young men coming fresh every three months whose instruction was only to watch the breathing closely, and, in case of its obstruction, remove the cloth from the face and clear away the obstacle by the drawing forward of the tongue. Mr. Clover was wrong in thinking that this was a frequent occurrence; it was done once during the last two months, 'when we have had about as many operations as days.' With such beginners, and the large number of practitioners throughout the country who give chloroform without much experience, the necessity for traction upon the tongue would from time to time occur. 'When, therefore, Mr. Clover virtually recommends medical men generally to follow him in abstaining from this practice, he gives about as pernicious a piece of advice as can well be given with reference to the administration of chloroform.'

He had always regarded Mr. Clover's apparatus as a harmless luxury, but he had

heard lately of a case where the patient had shown no sign of being influenced by the anaesthetic. On investigation it was found that the introduction of chloroform into the balloon had been omitted. If that could happen, might not too great an amount be introduced also, through hurry or ignorance?
It appears that it is to Clover that medicine owes the basic manoeuvre of raising the jaw to maintain a clear airway, but his arguments did not prevail. G.H.B. McLeod, Professor of Surgery in the University of Glasgow, in a clinical lecture delivered to medical students on 23rd November 1875, said, 'Various things should be placed readily to hand before you begin to give chloroform to the patient. Here you always see an artery-forceps made fast to the corner of the pillow. I constantly have one in my waistcoat-pocket, and would never give chloroform without having this instrument at hand.' [13]

Innovation in design

Attempts to mitigate the crushing pressure of artery forceps led to the production of tongue forceps of various designs. The earliest was introduced by Woodhouse Brain, of Charing Cross Hospital, but being without a ratchet it tended to allow the tongue to slip out.[14] The next, by Probyn Williams, had an extended ratchet to allow pressure to be regulated, and a ring-type jaw to improve the grip while spreading the load. The one of this type in widest use was known as Guy's (Figure 2). Piercing types, claimed to be less traumatic, came a little later. Some of these were intended to grip the tongue during operations on the mouth, such as partial amputation for carcinoma, a not uncommon condition at the time. This type transfixed: an example is Bellamy Gardner's. Barton, following Hewitt, incorporated a chloroform tube.[15] But the sort more popular among anaesthetists, which doubled as a towel clip and ether bottle opener, was intended to grip the dorsum only, and went by various names according to size, Corbould, Backhaus, Mayo.[16] Langton Hewer, in his textbook on anaesthesia for children, illustrated and recommended this type as being the least traumatic[17] (Figure 3). But for Hewer, 'the only absolutely certain method of avoiding and curing laryngeal spasm is to pass a catheter through the larynx into the trachea.'

Mouth Gags

Coleman, Smith, Mason and Fergusson

The first mouth gag of the anaesthetic era was invented by the innovative dental surgeon Alfred Coleman. It was intended to open the mouth for the purposes of the operator after the induction of anaesthesia, and the idea was so new that

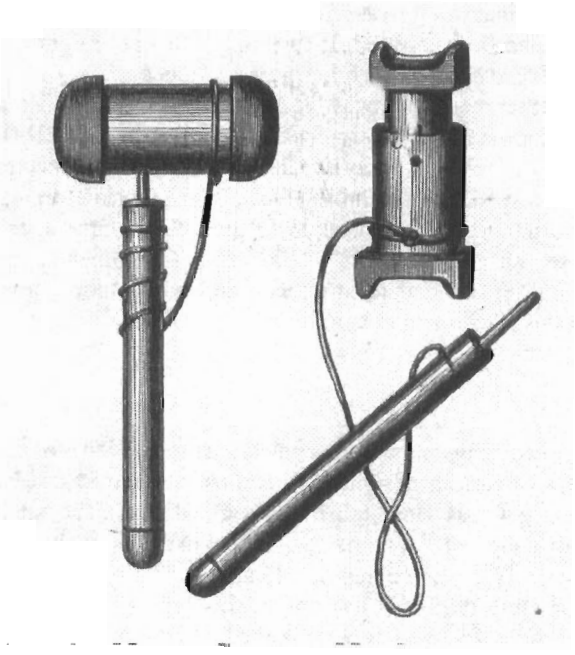

Figure 1 Clover's dental prop

Figure 2 Guy's tongue forceps

neither he nor the Editor knew what to call the instrument.[18] Coleman emphasised the principle of the design, that, unlike forceps and scissors, the handles do not cross over at the hinge, so that pressing them together separated the blades, rather than bringing them together. The extremities were broad, and covered with vulcanised rubber. A spring catch could keep the blades fixed apart at any distance (Figure 4). Coleman's gag appears to have been well known to dental practitioners, but it does not feature in any of the early instrument catalogues, and I have not been able to locate one in a museum, even that of the British Dental Association.

Further development of the gag was bound up with surgery for the repair of congenital cleft palate. The first successful repair of a cleft palate was accomplished by Dieffenbach, whose name is attached to one of the early ether inhalers, in 1834, but subsequent results were poor. In January 1868 Thomas Smith, Assistant Surgeon to St. Bartholomew's Hospital, in a very informative paper read to the Medico-Chirurgical Society, reported on two innovations that had greatly improved his success rate: the use of a gag, and of general anaesthesia.[19] The latter will come as a surprise to those who think that all operations were performed under general anaesthesia by then, more than twenty years since its introduction, but John Snow has an entry in his casebooks during 1853, saying that although he had anaesthetised for two such operations, most surgeons preferred the patient to be conscious.[20] Smith, later Sir Thomas, pointed out that general anaesthesia allowed lowering of the age of operation from the current earliest of fifteen, to childhood, 'before or while the power of speech is being acquired.' Chloroform and the gag allowed the operation to be performed with speed and accuracy.

But Smith's gag was complicated and difficult to insert and adjust; a much simpler model was introduced by Francis Mason, who had been Sir William Fergusson's personal assistant for some twelve years, specialising in the repair of cleft palate and hare lip. Mason was on the staff of King's College Hospital, where he had trained, and also of the Westminster and St. Thomas's. Fergusson, a colourful figure, who was the Professor of Surgery at King's, after careful dissection and study of the circum-palatal anatomy, introduced a number of improvements to the operation, notably tenotomy of the muscles that tended to pull the two sides of the palate apart, and became renowned for his success rate. Mason produced the definitive model of his gag in 1870, after several prototypes had been made for him during the preceding two years. He illustrated it in his monograph on the surgery of hare lip and cleft palate, published in 1877.[21] A particular feature was that the jaws swivelled, to allow secure positioning on the teeth (Figure 5).

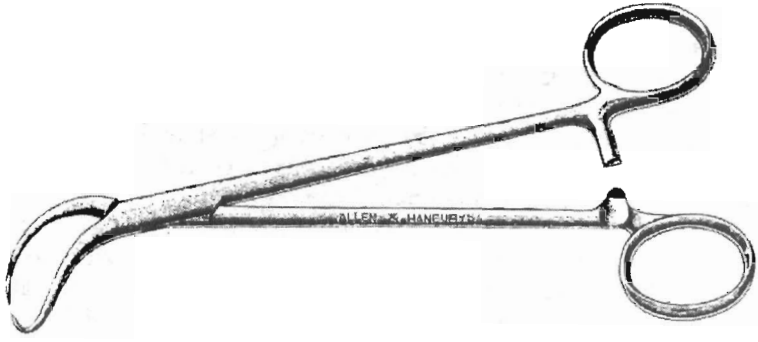

Figure 3 Mayo's tongue forceps

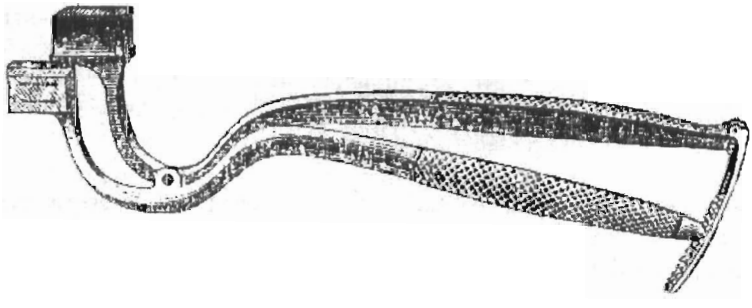

Figure 4 Coleman's gag

Fergusson, towards the end of a long review of his own experience of cleft palate surgery, which was published in the *British Medical Journal* in January 1876, said that he himself now used a modification of the instrument suggested by his friend Mr Mason of St Thomas's.[22] He pointed out, as his illustration showed, that the blades were narrow, and mentioned that it was useful to have two sizes, and that care must be taken when opening it not to dislocate the jaw (Figure 6).

Disputes about Priority

Fergusson's publication brought a letter from Coleman pointing out his priority, but generously suggesting that 'My friend Mr. F. Mason, was, I am convinced, unacquainted with my instrument when he devised his . . .' [23] Mason replied, agreeing that he had no prior knowledge of Coleman's gag.[24] Fergusson died the following year, 1877, and a published reference to the gag as Fergusson's shortly afterwards brought a letter from Mason asserting his priority, and claiming that comparison of the illustrations of his and Fergusson's versions would show 'a very slight difference between the one and the other.' [25] This was stretching it a bit, because the tooth plates, at least, were quite different. Mason dedicated his book to Fergusson, in acknowledgement of 'numerous acts of kindness.' Rather disconcertingly, during his description of operations for hare lip for infants of six to eight weeks, he said that 'chloroform or ether may or may not be administered.' For identification purposes, it should be remembered that both gags had a screw-type retainer. The main difference was in the shape of the tooth plates, and to a lesser extent of the design of the handles.

Smith published a revised version of his gag in the *Lancet* 1881.[26] He described it as 'essentially Mr Rose's double-ended modification of Mr Coleman's gag, to which Messrs. Meyer and Meltzer have adapted an ingenious sliding-ring-catch to keep it open.' To it he had added a tongue plate (Figure 7). He used it for tonsillectomy, and in some cases of staphyloraphy (repair of cleft soft palate or uvula). The following week brought a letter from Mr Rose, with an illustration of his gag (Figure 8), and the assertion, in fairness to the manufacturers, Messrs. Matthews, that they were the first, about three years earlier, to construct at his suggestion the double-ended gag 'with the sliding ring-catch that Mr Smith erroneously speaks of as an ingenious adaptation of Messrs. Meyer and Meltzer.[27] 'In fact, it was at the request of Mr Meyer that I lately sent him my gag to copy.' He concluded by saying that he did not think the tongue plate an improvement. It was liable to cause respiratory obstruction. The following week Meyer and Meltzer replied, saying that it was found that the smooth ring catch on Mr Rose's gag tended to slip, so they had added the serrations.[28]

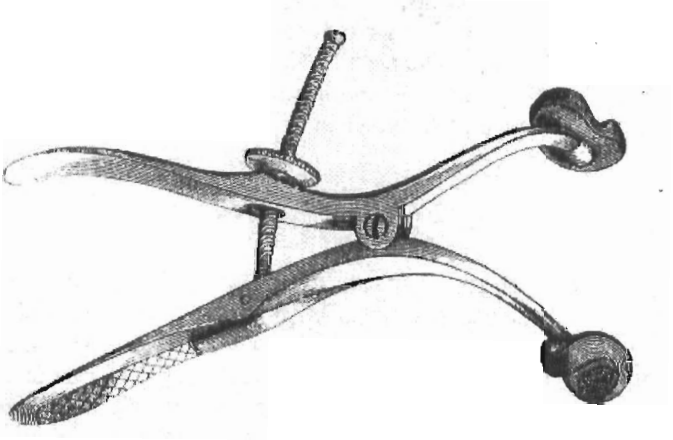

Figure 5 Mason's gag

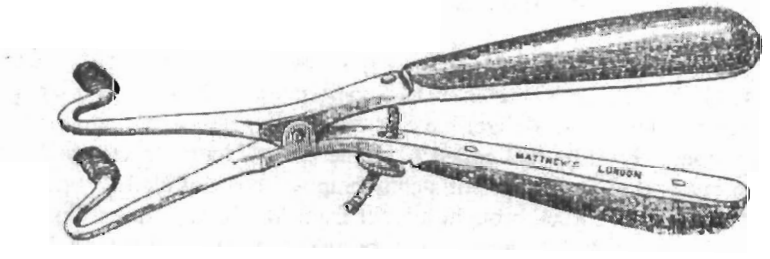

Figure 6 Fergusson's gag

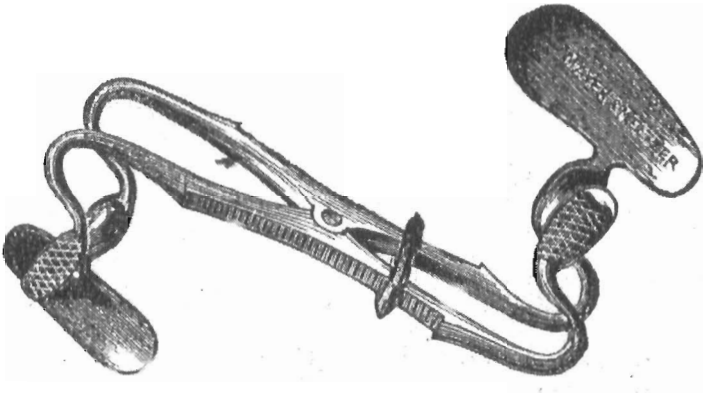

Figure 7 Smith's gag – second version

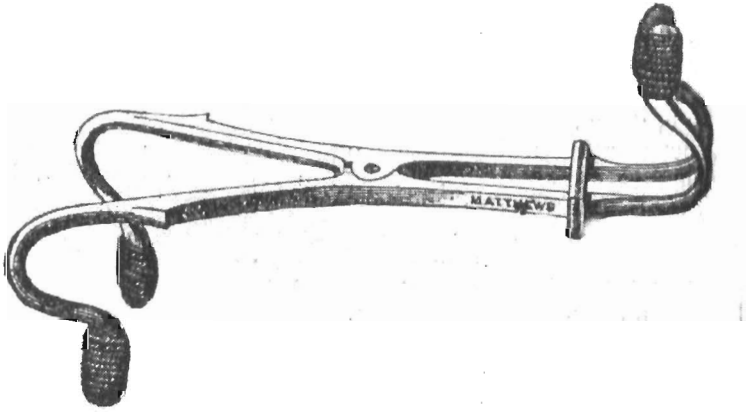

Figure 8 Rose's gag

A week later Rose's instrument maker, Messrs. Matthews, joined the fray.[29] 'Will you allow us to state that the "improved" ring-catch with notches, for which Messrs. Meyer and Meltzer claim credit, was the original form made by us for Mr Rose? The serrations, however, were found to do more harm than good, as they were found to jam the operator's fingers, and pinch the patient's face, as well as to prevent the ready adjustability of the instrument. They were therefore abolished, and the requisite fixation secured by "draw-filing" the opposing surfaces. We were under the impression that Messrs. Meyer and Meltzer were aware of this, as we find in their Catalogue, Fig. 431, a woodcut of a double-ended gag, with the serrations now claimed as original, described as "W. Rose's double-ended gag." It is not for us to go into the question of the advantages or disadvantages of tongue plates, but our experiences as instrument makers has been in conformity with our customers, to use them as little as possible. Indeed the gags constructed by us for the late Sir W. Fergusson, Mr. John Wood, Mr. Francis Mason, and Mr. W. Rose, have been especially designed with the view of getting rid of tongue-plates altogether.' This squelch brought the correspondence to a close.

Further Developments – Hewitt, Ackland, Buxton, Cock

A complicated spiral gag was described by Gowan in 1884, and endorsed by Buxton, but the most significant developments up to the end of the century were, firstly, the addition of two small tubes to Mason's, or Fergusson's, gag, as it should be called, by Hewitt, (Figure 9) to carry chloroform to the back of the mouth and allow anaesthesia to be sustained without impeding the surgeon's access; secondly, the modification of the jaws to make them narrower and easier to insert, described in 1898 by W.R. Ackland, a Bristol dentist practising in Clifton [30]; and thirdly, Buxton's addition to the screw and the ring slide of a third retaining mechanism, the ratchet.[31] Hewitt's chloroform tubes were soon modified by F.W. Cock, the historian of anaesthesia who preserved for posterity Liston's famous 'Yankee dodge' remark.[32] Cock replaced them by grooves covered by rubber tubing, the advantage being that they could be cleaned, and were not liable to damage, as he asserted that Hewitt's were.[33]

Review by Colt

In October 1907 a major paper on gags appeared in the *Lancet*.[34] It was written by G.H. Colt, Senior Resident Anaesthetist at St. Bartholomew's Hospital, and described a model designed by himself, for which he claimed a number of advantages. Colt started by pointing out that gags had to serve the differing

purposes of the general practitioner, the surgeon, the dentist, and the anaesthetist, and there were so many on the market that it may be doubted whether any single one supplied everyone's needs. 'Let him choose from a well stocked surgical instrument maker's shop a gag that will answer all the requirements of the surgeon and the anaesthetist ... and it is very probable that he will not use it 20 times without finding some material drawback which will oblige him to provide himself with a second or a third pattern. ... The instrument is in general use, and in some cases its inadequacy may prove fatal ...'

He continued with a survey of the development of gags as described in the main British medical journals between Coleman's in 1861 and 1906. He had collected descriptions of 21 gags, while there were others, he said, in the catalogues of surgical instrument makers. So when I came across this paper I found that I had been laboriously following in Colt's footsteps, and wished I had come across it much earlier.

After commenting on the features of a number of the better-known gags, Colt set out what he considered the main essential requirements. Firstly it should be capable of opening the mouth as widely as possible, and maintaining it in that position without the attention of the anaesthetist; and it should be equally applicable to the edentulous. Secondly it should be capable of introduction during spasm of the jaw muscles, in a patient with a perfect set of teeth, without causing any damage – so the ends of the tooth plates must be narrow. ' ... occasionally it is possible to save the life of a patient who would otherwise have died from faecal vomiting during the administration of the anaesthetic.' The inference was that Ackland's overlapping tooth-plates were likely to be best. Thirdly, the handles should be sufficiently long to give adequate mechanical advantage, but not so long as to cause displacement of the gag by touching the pillow when inserted into the mouth of a child with a small head. This was a very important point. Fourthly, the gag must not get in the operator's way.

Colt spent the next two pages on the trigonometry and mechanics of the design of the handles and jaws. This led him to the conclusion that the tendency to rotation and slipping could be abolished by altering the conventional set of the bearings of the tooth plates on the shanks. He also experimented with different metals and platings, and different retainers, rejecting the screw and the ratchet in favour of the sliding ring catch. The anaesthetic tubes should be removable.

He concluded with a description of his own gag, carefully designed and constructed on anthropometric principles. The measurements and fittings of the prototype had been made on 500 jaws, and it had actually been used in 220 cases, of which 160 were operations on the nose and throat. It featured a

removable chloroform tube. Colt claimed that the gag had probably saved the lives of three patients who had faecal vomiting during induction, a condition that was often rapidly fatal. Colt's gag appears to have had a number of advantages, but although Boyle gave it an honorable mention in his textbook it doesn't appear to have caught on, and it didn't feature in the majority of the instrument makers' catalogues.

Specific purpose gags

The aforementioned are, I think, the principle gags designed, in part at least, for use by anaesthetists. There were a number of others, the main additions to the genre being specialised gags designed for specific purposes, such as Doyen's, which required a relaxed jaw for introduction, Lane's cleft palate gag, which had spikes, because Lane pioneered very early operation, so all his patients were edentulous, and Denis Browne's atraumatic version, but none of these were of great interest to anaesthetists.

Confusion

Unfortunately the cavalier attitude to nomenclature and attributions of instrument manufacturers, and the textbook authors who used their illustrations, created great confusion among both examiners and candidates for the higher qualifications in anaesthesia. The tooth plates of Mason's original gag were so different from Fergusson's, that none used by anaesthetists and illustrated in the textbooks should have borne Mason's name.

Care of the airway

The research required for the preparation of this paper revealed that the early anaesthetists weren't too bothered about respiratory obstruction and the resulting cyanosis; that Lister and Clover seem to have been the first to take it seriously; and that Hewitt contributed several inventions towards overcoming it, including his boxwood wedge, and his airway. But in spite of Lister's, Clover's, and Hewitt's own teaching and efforts, and the addition of tongue forceps and mouth gags to the anaesthetist's armamentarium, it was uphill work, as Hewitt commented in the first edition of his textbook, in 1893.[35] He wrote, 'The importance of maintaining a free air-way during anaesthesia needs no comment. It is a curious fact, however, that very little attention has been bestowed upon this point. An anaesthetic is given, and the patient is said to "take it badly," or to "breathe badly," but the cause of the difficulty of breathing is rarely accurately defined. There is a tendency for all anaesthetics to indirectly or directly cause

obstructed respiration – a fact which should ever be borne in mind.'

I myself have been convinced for many years that Hannah Greener died not of ventricular fibrillation but of respiratory obstruction, the autopsy findings being pathognomonic; but that is another story.

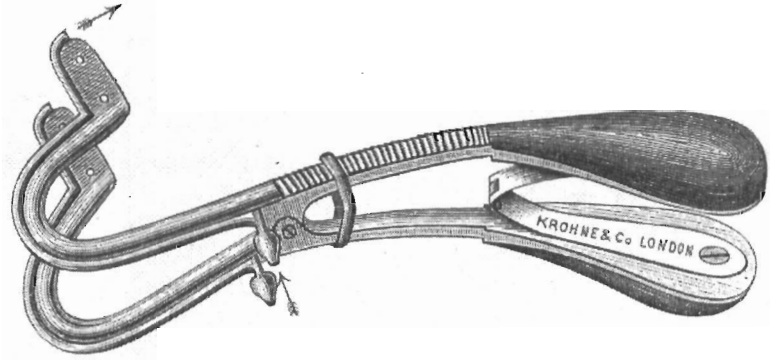

Figure 9 Hewitt's gag with chloroform tubes

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PENTOTHAL POSTCARDS AND BEYOND

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This is an introduction to my display of postcards concerning anaesthesia and related subjects which was on display at the meeting. I am a postcard geek, more properly described as a deltiologist, the term for a postcard collector. This is derived from the Greek word deltos, a writing tablet.

Dr David Lai presented Abbott's Pentothal Postcards to you in Sheffield[1] and also at the Sixth International Symposium at Cambridge last year[2]. He has also published a book on these cards[3] and is still collecting. His papers and the variety of these cards awoke my interest in advertising cards as part of anaesthetic history. Let us just consider the cards from the British Isles. These include three from the Irish Republic, four from England, two from Scotland and one each from Wales, the Isle of Man and Lundy Island. The latter is interesting as the text describes it as a place without Pentothal. The last card in this group is a super-sized card of the RMS Queen Elizabeth.

Postcards developed in the latter decades of the 19th century but their heyday was between 1900 and 1930. They were the equivalent of the text or e-mail at a time when in the UK there were several postal deliveries a day: so a postcard sent from a hospital by a patient would get a response the same day. I have been collecting postcards of anaesthetic interest for twenty five years and presented these as a historic resource to this Society at Epsom in 1990[4], the 11th World Congress of Anaesthesiology in Sydney in 1996[5] and as a poster at the Sixth International Symposium[6]. There is great interest in the history of anaesthesia amongst the public: I have recently spoken to the Dorset Postcard Club and, in the future, I am to address my local history society as well as hopefully to present a large display at one of the largest postcard fairs in Europe.

My collection contains at least two hundred cards mainly of operating theatres. Some depict operations either posed or real and have a variety of detail of anaesthetic apparatus. In the first group the cards show: operations using chloroform (presumably) as the Vernon Harcourt Apparatus is pictured (Figure 1), Clover's Ether Apparatus (Figure 2), an Ombredanne, a dental anaesthetic and Bob, the anaesthetist, with his machine. A dropper bottle is in the last of this

Figure 1 Vernon Harcourt chloroform inhaler

Figure 2 Clover's ether inhaler

group. Interestingly in today's climate, several cards have shown nurses administering the anaesthetics. In the next group a card shows a child in an 'Iron lung'. The final card has unclear anaesthetic apparatus. It is from a group at the Russian front in the First World War. What is clear and shows the reality of some cards, is that the operation is a leg amputation and the amputated limb is on the floor. As well as reality cards there are a number of comic cards. They make fun of anaesthesia as well as surgery.

Finally, let us revisit the Pentothal Cards. Why were none sent to the UK ? I believe it's because we used I think May and Baker's thiopentone, not Abbott's. These cards are part of a group known to collectors as Dear Doctor Postcards. A few were sent early in the 20th century, more by the 1930's, but most in the 50's and 60's. I think it's largely died out today, but looking at my own correspondence cards I found this one of Singapore's Changi Airport. It was sent to me in 1994 by a company making temperature and humidity control equipment as I had already expressed interest in attending the World Congress in Sydney two years later.

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THE HISTORY OF PAIN MANAGEMENT

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Introduction

Pain is the oldest medical problem known to mankind and the most complex enigma known to physicians. Throughout the ages religion, philosophy and science have shaped man's relationship to pain and its expression in trying to give pain a meaning, a reason for its very existence and, sometimes, a glimpse of hope to the sufferer.

Antiquity

We will begin in Ancient Greece, where many texts have been dedicated to the specific subject of pain, its value, aetiology, expression and treatment. In the Hippocratic Collection pain is valued as a means of predicting a diagnosis and prognosis, rather than considering it an isolated symptom. In particular, the characteristics of the pain served as a major clue to understanding diseases[1].

The concept of the Four Humours was developed by Greek thinkers around 400BC, and was applied to medicine by Hippocrates. It was part of the ancient belief that the world comprised four elements: earth, fire, water and air, each of which were represented by one of the four humours - yellow bile, black bile, phlegm and blood. The latter were fluids thought to permeate the body and were distinguished by their different combinations of hot, cold, wet and dry. Any imbalance in these humours, due to seasonal changes, for example, would influence the person's health and temperament (Table 1)[2].

Earth	Air	Water	Fire
Autumn	Spring	Winter	Summer
Black bile	Blood	Phlegm	Yellow bile
Dry, cold	Hot, wet	Cold, wet	Hot, dry

Table 1 Relationship between the elements, seasons, humours and constitutions

The aetiology of pain linked it to "cold and heat, excess and want". Pain was thought to be produced by heat in those with a cold constitution and by cold in those who were hot. Similarly, in the wet, pain was induced by dryness, in the dry by wetness. Hence, any disruption in the natural constitution, or physis, caused pain. The humoural theory had a great longevity which extended into the 19th century[3].

The treatment of pain was based on many medical attitudes since ancient medicine had no formal underpinning and competing schools and individuals formed the mainstay of practice[4]. A common framework for curing pain and the presumed cause was based on the humoural theory and made use of the principles of opposites. For example, cephalgia, a term used to describe a variety of headaches, was treated by hot affusions onto the head in an attempt to evoke a discharge of mucus, which would evacuate the excess cold humours there.

Others, like Aretaeus of Cappadonia, used a long and painful remedy which involved blood-letting, whereby the arm and forehead were incised and the head shaved and washed with hot water. Thereafter wet cupping was applied to deep scarifications and a branding iron used for cauterisation[1]. Cupping involved placing heated cups upside down onto the skin. As they cooled the partial vacuum inside raised large, red welts.

The curing of like with like was advocated in certain pains, a concept which is the very foundation of homeopathy today. In Hippocrates' *Aphorisms 46* it is stated that if two pains occur simultaneously but in different locations, the stronger cancels out the weaker. Applying this to practice would involve creating a worse pain to diminish the original one, a simple analogy which led Hippocrates to sometimes using painful remedies[1, 3].

When it came to ancient pharmacopoeas there was even greater diversity. Dioscorides compiled texts listing a rich pharmacopoea from the three natural kingdoms. His book, entitled *"De Materia Medica"* became the most successful pharmacological work in Europe and the Middle East for the next 16 centuries[5].

The opium poppy was used as an analgesic, for example, to painful joints where its juice was applied topically. Narcotic remedies were prescribed in a variety of forms: salves, fomentations, fumigations, decoctions, potions. Drugs were sold at markets and fairs with free access to all. With many drugs there was no specific dosage or mode of administration[3]. Ancient ideas on the mechanism of action of these drugs were probably based on their influence on hot and cold[3].

As well as drugs physicians were able to dabble in dietary regimens. Pleuritis, for example, was treated with vinegar and mustard applied topically to the chest[1]. With a whole array of remedies to choose from physicians were optimistic when it came to managing pain and the underlying disease.

Basic physiological concepts of pain were being developed by the Greek physician, Galen, towards the end of this period. He believed that perception of sensation required an organ to receive an external stimulus, a connector and an organisational centre to process the sensation. Sensory and motor nerves were distinct in terms of their location in the brain. Communication from the periphery to the encephalon was via the psychic pneuma, or "animal spirits", a material akin to "nervous liquor". A sudden change in pain's intensity stimulated this pneuma. Galen classified pain based on its qualitative characteristics and presumed cause. For example, throbbing pain became the specific sign of an inflammatory disorder, a dragging heavy pain indicative of tumours. Pain was caused by either an abnormal change in the communication of humours by internal influences or externally by contact of the affected part with a foreign body, causing compression, contusion or injury and a disruption in continuity[1]. This theory stood the test of time for centuries to come.

The Middle Ages

Pain in the Middle Ages had powerful spiritual and religious contexts. Medieval iconography of saints' tortures, with the sharp contrast between the painful nature of torture and ecstatic faces of sufferers was a powerful image which depicted the period. The Middle Ages was heterogeneous with a variety of cultural centres, but in broad terms saw the prevalence of Galen's teachings which constituted a natural and coherent medical system. In general the same treatment principles of treating disorders by their opposites still flourished, as did ancient pharmacopoeas.

The spread of Christianity throughout Western Europe in this period left a lasting influence on how pain was regarded. The Christian view of pain as a form of Divine retribution or a Divine blessing or gift centred around Christ's Incarnation and suffering on the Cross. Pain was supposed to bring believers closer to Christ. This may have encouraged a stoic indifference to pain. Those who followed the teachings of St Ignatius Loyola participated in "spiritual exercises" which forced subjects to suffer tangible pain using such methods as wearing ropes and chains which cut into the flesh, as a means of bringing them closer to God.

It is difficult to know how much these religious and medical influences affected suffering peoples' behaviour in terms of seeking medical help[6].

The Renaissance

The Renaissance saw the revival of anatomy and dissection of cadavers, inspired by Andreas Vesalius. Unfortunately no immediate strives were made in understanding the mechanisms and treatment of pain despite developments in anatomy. However, political events, such as the raging wars between France and Spain, indirectly contributed to this understanding. Wounds which had not received bodily oil or cauterisation healed better, leading to this treatment being abandoned. Bullets and musket-balls exerted their dangerous effects by laceration and tearing of the flesh rather than combustion or venom, as had been thought previously. Consequently, antidotes were replaced by surgical foreign body extraction and wound care as a form of treatment[7].

Some surgeons used ligatures before the amputation of limbs based on the logic that this would interrupt the circulation thereby preventing animal spirits from getting to the painful part and causing pain. Thus, the humoural aetiology of pain retained a firm foothold throughout the Renaissance.

The 17th Century

One of the milestones in the 17th century which helped physicians to break free from the teachings handed down from Antiquity and develop new and accurate investigative methods was revolutionary mathematical concepts in physics and astronomy which were being applied to medicine. The human body became envisaged as a complex machine, and only that which could be proven by natural laws was accepted. Descartes was the first to perceive the human body mechanistically. He dismissed the idea of there being separate sensory and motor nerves, and localisation of sensation in the skin or membranes. Instead, he viewed pain as a simple system where an input of one kind travelled along special nerves specific for that input and terminated in an area of the brain, again, specific for that stimulus. Immediate communication from the periphery to the brain was likened to the ringing of a church bell when the rope is pulled. This "Specificity theory" placed an emphasis on the physical basis of pain[8].

In the middle of the 17th century Sydenham prepared his famous laudanum, a concoction of sherry, wine, opium, saffron, cinnamon and clove, which had multiple uses, such as in the treatment of dysentery, hysteria, gout amongst many other pains[9]. In terms of analgesia for surgery, laudanum or opium were often used post-operatively as they were thought to cause vomiting if given before in sufficient dose to reduce pain[10]. Perhaps inaccuracies in dosage or preparation may have led to this conservative approach.

The 18th century

The management of pain was based on two principal philosophies of understanding pain at this time - mechanism and vitalism. Mechanism, which dominated the first half of the century, suggested that the human body functioned as a simple machine and that pain could be explained by distension or separation of fibres, or by "material obstructing vessels", or to an imbalance in humours. The supposed aetiology dictated the appropriate treatment. Obstruction, for example, would be cleared by forms of flux, such as blood-letting or purges. The nervous system was still perceived as a set of tubes filled with animal spirits rarefied by blood.

Vitalism dominated the latter half of the century. Vitalists believed that every part of a living thing was endowed with sensibility. Movement and feeling were evidence of life and pain contributed to the development of life by stimulating weak vital forces. Most medical doctrines agreed on the existence of a vital energy, or force, a spirit-like essence which animated a living organism and that was capable of being stimulated or consumed. Vitalists encouraged the observation of nature, which itself would endeavour to find a cure. In some situations, however, they assisted nature with therapies involving "medical electricity" or perturbation. The latter involved superimposing an acute pain onto another to produce a "crisis" which rid the patient definitively of the original pain by stimulating the diminishing energy. Methods used included cautery, flagellation, urtication, which was the deliberate application of stinging nettles to skin, vesicatories and moxibustion. Inspired by the Orient, moxibustion, comprised burning a stick of vegetables and fibres onto the skin[11].

Practically, for physicians, pain was valued as a warning and therefore had to be taken seriously. Pain's classification into four types; tensive, gravative, pulsating and pungitive were still being used by physicians for diagnosing and formulating a prognosis.

Despite attempts to rationalise treatment this era was dominated by polypharmacy with remedies handed down from centuries. If not based on humours and qualities then surgery was always an option, in such cases as abscesses and re-setting dislocated joints. Opium, usually in the form of laudanum, was used in high doses as this was the norm, unbeknown to physicians of its danger[11].

The 19th and 20th centuries

Electricity and hypnosis assumed greater importance in the 19th century as a means of fighting pain. Prior to Duchenne de Boulogne's major innovation of

"localised electrisation" in the 1850s, the use of electricity was unpopular, painful and generally ineffective. Boulogne made it possible to direct electricity to act at a specific location and spare other tissues. This new technology became a powerful means of diagnosing neurological conditions and for effectively treating a variety of pains from hysterical pains to trigeminal neuralgia, without the production of serious sores[12].

Hypnosis, or mesmerism, was pioneered by Anton Mesmer. He believed in a quasi-magnetic fluid present in air that could be absorbed by the body's nerves. Diseases were thought to be caused by a blockage or disruption in the circulation of this magnetic field in blood and the nervous system. To cure almost any disease this had to be corrected through "Mesmerism". An investigation by the French government proclaimed Mesmerism a fraud. In 1843 Braid, a British surgeon, adapted Mesmerism, coined the technique "hypnosis" and caused renewed interest in the subject, especially in France, where it was used frequently for treating pain[13].

One of the milestones of the 19th century was the birth of general anaesthesia. Humphrey Davy was the founder of one of the first anaesthetic agents which led to its introduction into clinical practice, through application of chemistry to medicine. Through auto-experimentation Davy fortuitously discovered the analgesic and sedative properties of nitrous oxide. There was a delay in its immediate application to surgery, but it was eventually put into clinical use in 1844 by Wells[14]. Ether, although known of centuries earlier in the form of "sweet vitriol" had a multitude of uses in the treatment of croup, topical applications for swellings, pain and rheumatism[15]. William Morton demonstrated general anaesthesia with ether in 1846 and James Simpson used it in obstetrics in 1847. Chloroform quickly followed suit. Several chemists contributed to the discovery and production of chloroform[16].

Topical ice and salt were used for local anaesthesia with short-lived results[17]. Modern local anaesthetics developed as a dual innovation of new techniques for drug penetration, namely the hypodermic needle, and the discovery of new substances. As a result of the Spanish conquest of the New World, Europe became aware of the medicinal benefits of coca leaves chewed by Indians. The alkaloid cocaine was isolated by Niemann in 1860 and its stimulant and euphoric properties were discovered through auto-experimentation. It was originally used for its stimulation properties in trials for detoxification from morphine and alcohol. Carl Koller, who was trying to find a way of immobilising the eye in ophthalmic surgery, noted cocaine's anaesthetic effects on reducing corneal movement[18].

The isolation of morphine, or, "the soporific principle", from opium in 1806 was a complex process pioneered by the pharmacist Sertürner. It became an important milestone because it allowed the application of morphine in exact doses and laid the foundation for a new class of pharmaceutical drugs, the alkaloids[19]. The "discovery" of morphine beautifully depicts the process of isolation of a substance, the elucidation of its properties through experimentation and verification as well as the necessary technical and commercial aspects in leading to its usage in clinical practice.

Work done on the discovery and use of anaesthesia annihilated the inevitability of pain during surgery and triggered research into comprehending transmission pathways for sensation.

Efforts were made in the 19th century to find a substitute for quinine, a popular remedy for fevers, as the cutting of the Peruvian cinchona trees had led to a decrease in its supply. The leaves and bark of the willow had been used since Antiquity by their application to painful joints[20]. The glycoside, Salicin, was extracted from willow bark in 1830 by H Leroux. It was prepared as salicylic acid and later synthesised in 1852. In 1853 von Gerhardt treated sodium salicylate with acetyl chloride to produce acetylsalicylic acid, or "Aspirin". Salicin was used clinically as an antipyretic in such illnesses as typhoid. In 1876, Thomas J MacLagan reported its benefits in acute rheumatism[21].

Inspired by Descartes' theory, pain surgery became widespread in the 20th century. It was originally limited to interventions which aimed to interrupt the sensory tracts at different levels, for example, a neurotomy to section a nerve branch or section of the antero-lateral bundle for spinothalamic sensations or psychosurgical lobotomies. The surgery required the resolution of major problems regarding sepsis, haemorrhage and maintenance of CSF levels. This occurred in the period between the two world wars when these techniques developed substantially and permitted radical solutions by attacking the source of the pain directly[22].

In 1965 Melzack and Wall revolutionised ways of thinking about the nervous system and pain physiology. They rejected Descartes' hard-wired system of a peripheral sensation linked to the brain via fixed connectors. They proposed that sensory information underwent dynamic integration and modulation at the level of the spinal cord and that the perception of pain could be modified by emotion and behaviour[23]. Neuroscientists now think of the nervous system as plastic. Methods for modulating inputs, such as hypnosis, acupunture and TENS machines are all based on this gate-control theory of pain.

Conclusion

The last 50 years has seen an increased communication between the disciplines of physiology, pharmacology and medicine to bring about cohesiveness in the understanding of pain and its different modes of treatment. Today medicine employs a more pragmatic approach to chronic pain which is specific to the individual and multidisciplinary in nature. As a result of changes in the conceptualisation of pain its treatment includes a combination of drugs, surgery, physical therapy and psychological approaches. Most methods for controlling pain, either pharmaceutical or physical, have been known of for a long time. It is the technical innovations, the determination and courage of researchers and physicians to adhere to their convictions, and the birth and progress of clinical disciplines such as pharmacology and neurophysiology, which have greatly contributed to the success and development in pain control today.

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THE HISTORY OF CHRONIC PAIN MANAGEMENT

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Introduction

This paper reviews the development of chronic pain management as a specialist field, highlighting the evolving concepts of pain, historical aspects of various treatment modalities, and proceeding to the development of Pain Clinics.

Evolving concepts of pain

Pain has always been a part of human experience. Yet, it has only become the focus of medical research in the past three centuries. In a pre-scientific society dominated by religious thought, pain was seen in spiritual terms, and was regarded as a punishment from God, best cured with prayer. The Babylonians of early Mesopotamia, who existed around 3000 B.C., would turn to the *asu* – a healer – who would employ a combination of surgery, potions, exorcism and prayer to treat their ailments. The ancient Greeks believed that the gods Apollo and Artemis shot arrows which resulted in disease and old age. Even up to the 1800s, physicians still over-valued pain as a symptom and a sign of the patient's vitality – the greater the pain, the greater must be our confidence in the power and energy of life[1].

The first major advancement in the understanding of pain came from Galen in the 2nd century. Galen, a Greek physician, suggested that the sensation of pain is recognised in the brain, and the brain was linked to other parts by nerves[2]. The writings of Galen were to influence European medicine for the next 1300 years. However, because Galen neglected to mention a spiritual aspect of pain, his teachings fell foul of the church and were discarded.

During the Renaissance, greater freedom of thought, the invention of the printing press and a more secular society, allowed rational scientific thought to flourish. It was during this wave of scientific revolution that 17th century French philosopher René Descartes lived. Descartes proposed that the body was nothing but a complex clockwork machine. Descartes explained pain and the subsequent withdrawal reflex using the model of a human machine coming into contact with fire. He proposed that fast moving corpuscles radiating from the fire would displace the area of skin it comes in contact with. This displacement pulls the end of a nerve filament, opening a pore in the brain. The animal spirits then rush through the open pore, into the thread to the muscles, which withdraw the foot and body, and turn the head and eyes to look at the fire[2].

Descartes is widely acknowledged for the specificity theory of pain. This theory proposes that a specific pain pathway carries messages from a peripheral nociceptor to an integrating centre in the brain, and suggests that interruption of this pathway, by cutting the nerve, would alleviate all pain. This simplistic model led to the unfortunate practice of indiscriminate division of nerves as a treatment of chronic pain, a practice that resulted in exacerbation of these painful states for the next three centuries.

The demonstration of surgical anaesthesia with ether by William Morton at the Massachusetts General Hospital in 1846 is often regarded as the birth of anaesthesia and the turning point of Medicine. Anaesthesia allowed surgeons to develop life-saving invasive procedures not possible before. In the shadow of this momentous occasion, it may be easily forgotten that ether and nitrous oxide had their humble beginnings as analgesic agents for dental and surgical procedures, with unconsciousness and anaesthesia as a side effect, rather than a primary effect.

Despite the excitement generated by anaesthesia, many physicians remained sceptical about its use. These physicians were wary of the ethics of operating on the insensate patient. Religious objections to the use of anaesthetic agents in obstetrics were publicized by James Young Simpson in 1847[3].
Melzack and Wall were distinctly opposed to Descartes' specificity theory. In 1965, they revealed the gate-control theory[4], in which they proposed the existence of a spinal gate which regulates the cephalad transmission of nociceptive stimuli. The activity of this gate could then be modified by diverse physiological stimuli like light touch and pressure. This theory also suggested a role for descending cortical and subcortical tracts in pain modulation. Their hypothesis not only explained the pathologic basis of chronic pain, but also proposed the mechanism of action of counterstimulatory mechanisms which had been used over the decades without any apparent scientific basis. While this hypothesis may be incomplete or indeed even inaccurate, it certainly sparked a wave of research that resulted in identification of the opiate receptor in 1973[5], isolation of enkephalin in 1975[6], and discovery of the role of N-methyl-D-aspartate (NMDA) in creating a state of central sensitization, producing chronic pain in 1991[7].

Development of analgesics

The discovery of drugs in days of yore was largely a "hit-and-miss" affair. Medical literature was still in its formative years, medical research was uncoordinated and significant discoveries were often lost, leaving the next

researcher to reinvent the wheel decades later. Self-experimentation on traditional and novel remedies was rife. Physicians would often try new remedies on themselves first, varying the dose to ascertain the drug's effects on themselves before administering it to the patient.

Most drugs during this period were used without knowledge of their exact mechanism of action. In fact, scientists would often study the interaction between a drug's actions and its effects on the body, as a means of gaining a better understanding of the body's function. Thus, understanding the mode of action of aspirin, contributed to the discovery of prostaglandins.

With modern understanding of physiology and function, the reverse now occurs, with drugs synthesized with a specific mode of action, based on physiological and pharmacological clues. These new drugs have a more targeted effect, and hence an improved side-effect profile. The development of the selective cyclooxygenase-2 inhibitors is such an example.

The "hit-and-miss" story of aspirin [8]

The healing power of the willow had been known to herbalists for a long time. However, the first scientific reference to the pain and fever-reducing properties of white willow bark was in a paper presented to the Royal Society of Medicine in London in 1763, by Rev Edmund Stone from Chipping Norton, Oxfordshire. Thereafter willow bark was frequently prescribed for fever. Chemists began to explore its structure and in 1829, Henri Leroux succeeded in extracting salicin from the bark. Raffaele Piria then isolated salicylic acid from salicin. Unfortunately, its bitter taste made it distinctly unpalatable. It was also irritant to the mucous membranes of the mouth, oesophagus and stomach, especially at higher doses. In 1853, Charles von Gerhardt modified salicylic acid by adding an acetyl group to the compound.
Approximately forty years later, Felix Hofmann, a chemist working for Bayer, reviewed the work of von Gerhardt, and simplified the acetylation process of salicylic acid. After successful trials Aspirin was born in 1899, more than a century after Stone's accidental discovery.

The story of morphine

The first reference to opium may be traced to the Sumerian tribes, dating back to 4000 B.C. Yet, for more than 5000 years, nobody understood how it worked! [8]
Morphine was isolated by Friedrich Sertürner[9] in 1805-6 and was named "morphium" after the Greek god of dreams. It was eventually renamed

morphine by Guy Lussac in an editorial that accompanied the French translation of Sertürner's work in 1817[10]. Sertürner's method produced morphine acetate which could be administered parenterally. However, it was not until the invention of the hypodermic syringe and needle in the 1850s that the use of morphine became widespread[11].

Most practitioners, like Alexander Wood, preferred the subcutaneous route, infiltrating the drug directly into the painful area, with the hope of producing local relief of symptoms. Charles Hunter disputed Wood's claims, and reported that injection of morphine at a site remote from the painful area produced equal pain relief[12]. This sparked a period of intense debate[13, 14]. To settle this stalemate, the Medical and Chirurgical Society of London appointed a special committee to investigate the relative clinical importance of local and systemic effects of morphine injection. After 2 years, the results were published, unanimously favouring Hunter[15]. More than one hundred years after the first subcutaneous administration of morphine, the discovery of peripheral opioid receptors[16, 17] has finally vindicated Wood, albeit only partially.

After spinal anaesthesia was reported in 1899, Rudolph Matas, a vascular surgeon from New Orleans, was the first to *publish* neuraxial morphine administration, intended to prolong the effect of intrathecal cocaine, as well as to provide sedation[18]. However, the idea of neuraxial administration of opioids did not take off until the identification of opioid receptors in the brain in 1973[19] and the spinal cord in 1977[16, 17]. Following these reports, there was renewed interest in intrathecal and epidural opioids, especially for the relief of cancer pain. Implantable devices for continuous intrathecal and epidural narcotic administration have been available since the early 1980s[20], and continue to be employed on selected patients today.

Neurolytic therapy

James Moore, a Glasgow-born London surgeon, inspired by the mechanistic concepts of Descartes, advocated neural compression as a means of provision of surgical anaesthesia[21] by demonstrating on himself in 1784. He designed clamps that could be applied to both the upper and lower limbs to induce a reversible neurapraxia, rendering a limb anaesthetic.
The French surgeon, Rene Leriche, who treated many patients with nerve injuries during World War I, observed that the vasomotor changes in the affected painful limb were consistent with an abnormality of vascular stimulation. He proposed careful resection of the arteries near the injury followed by a large injection of procaine. Only if the procaine failed to provide substantial relief, did he advocate the ligation of periarterial sympathetic nerve

fibres or the sympathetic ganglia supplying the limb[22]. Following the successful treatment of causalgia by Leriche in 1916, preganglionic sympathectomy soon became established as the standard treatment for painful nerve injuries[23], though such relief from pain was frequently only temporary.

When these techniques failed, physicians returned to the Descartes' model of pain transduction, and turned to neurosurgery in attempts to sever the connection. Early attempts were aimed at dividing the anterolateral column of the spinal cord. Other sites in the central nervous system that have been targeted include the thalamus, the mesencephalic spinothalamic tract, the dorsal root of spinal nerves and numerous sites within the brain. The effects of elective lesioning were variable, with most procedures offering only temporary relief of symptoms[23].

Counterstimulation

Acupuncture, transcutaneous electrical nerve stimulation (TENS), and other methods of counterstimulation have all been shown to have therapeutic effects in nociceptive and neuropathic pain[24]. These modalities had been used with anecdotal success, but experienced a revival generated by the gate control theory of pain in the late 1960s. In 1971, the discovery that stimulation of the periaqueductal grey (PAG) matter of the brain produced an intense analgesia in rats, which was reversible with naloxone, was published in Science[25]. This led to the elucidation of descending spinal pathways with powerful analgesic potential.

Cognitive behavioural therapy

From the battlefields of World War II, Henry Beecher observed that seriously wounded soldiers initially reported much lower levels of pain than civilian patients in the Massachusetts General Hospital recovery room[26]. He reckoned that there were less complaints of pain, as it was precisely the injury that meant that they would be repatriated home, and hence survive the war. However, once they were safely behind the frontline, these same soldiers would complain just as loudly when venipunctures were required, disproving the notion that these people were stoic in nature. Beecher concluded that clinical pain was derived from the complex interaction between physical sensation and a cognitive and emotional reaction component.

The learning theory of pain was conceived, whereby cognitive conditioning and relearning could be used as a therapeutic approach to pain. Operant conditioning was introduced as a treatment of chronic pain, using physician

attention as a positive reinforcement to help patients learn to self-manage their pain and to resume normal functioning through graded activity[27]. Ten years on, the cognitive-behavioural theory built further on the learning theory by adding a further assumption that "individuals are active information processors able to change the way they think, feel and believe"[28].

Pain medicine as a speciality

Pain Management Clinics

Chronic intractable pain continued to frustrate both patients and physicians alike in the romantic era of the late 18th and early 19th Century. Other than opiates, physicians had little else to offer their patients. As the field of neurology became more well-defined, the realm of chronic pain was eliminated from their professional purview.

By the 1920s, the care of those who suffered from unexplained chronic pain syndromes fell to the surgeons, who would routinely perform nerve ablation procedures. These techniques were the only hope of salvation for those who were generally condemned by the public as malingerers or drug abusers[29]. At about the same time, the rapid advancements in the field of surgery swayed the interest of the surgeons. Nerve blocks for pain syndromes gradually came under the purview of the anaesthetist, who was already regularly using local anaesthetic blocks to provide anaesthesia for surgery[30]. The first nerve block clinic for pain relief was started by Emery Rovenstine, an anaesthetist at Bellevue Hospital (New York City) in 1936[22].

Nerve block clinics in the UK only began in earnest after World War II[30]. In the beginning, anaesthetists performed nerve blocks in the anaesthetic room before, during or after an operating list. As the value of this service became recognised, so too, the number of patients referred for such treatment increased, such that half-day or full-day operating lists were dedicated for these procedures. With further increases in volume and demand, these nerve block sessions were eventually shifted to the outpatient setting. The first clinic in the UK was started at the University College Hospital in London in 1947. This was followed in the subsequent years by clinics in Plymouth, Liverpool and Southampton.

The focus of these clinics gradually shifted towards the management of chronic pain syndromes. Fuelled by advances in the understanding of the mechanisms of pain and treatment modalities, analgesics, adjuvant drugs, counterstimulatory methods and psychotherapy were introduced in these clinics with varying

degrees of success.

Formation of the International Association for the Study of Pain

The birth of Pain Medicine as a specialist field in its own right can be attributed to the effort of two different medical initiatives on either side of the Atlantic. The hospice movement in the United Kingdom was mooted by Dame Cicely Saunders, a physician who dedicated her life to the care of the dying. Saunders championed the idea of "total pain" – emphasizing the holistic concept of patient-centred management[31]. On the other side of the Atlantic, was John Bonica, who like Henry Beecher, had also treated veterans of World War II with complex painful symptomatology. In May 1973, Bonica chaired a multidisciplinary conference in Seattle attended by 300 clinicians and researchers with an interest in pain management. During this conference, the International Association for the Study of Pain was formed, with Bonica as its founding president[32].

Conclusion

Man and pain have coexisted since man's creation[33]. To understand the development of pain management strategies through the ages is to understand the very history of medicine and mankind. Today, illness and health have less of a religious and superstitious overlay. Modern culture is less accepting of a life plagued by pain. This will anchor the role of the pain clinic and pain physician in the practice of modern medicine, and inspire research into novel pain mitigation strategies for many more years. Perhaps the day will come when man and pain will be eternal partners no more.

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THE DEVELOPMENT OF ACUTE PAIN TEAMS

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Introduction

The demonstration of general anaesthesia by Morton in 1846 removed one of the two major obstacles to progress in surgery – intra-operative *pain*. The second major obstacle, *infection*, was overcome 20 years later when Lister described anti-sepsis. A century late huge advances had been made in the form of better anaesthetic agents, muscle relaxants, IV fluids and blood transfusion. However, the provision of postoperative analgesia remained parsimonious. From the 1950s attention was occasionally drawn to this shortcoming by medical staff, the lay public and nurses.

Thus an editorial in the *British Medical Journal* of 15 August 1953 drew attention to pain after laparotomy:

> "the surgeon seems ... to regard pain as the unfortunate but unavoidable sequel to any intraperitoneal manipulation. He is content for the most part to leave its relief to his houseman's cautiously administered opiate and to the balm that comes from time alone." [1]

A surgeon, Gilroy Bevan, who himself underwent cholecystectomy, felt compelled to publicise his painful experience in *The Lancet* (1964): "the bed of nails stage" (two days), "the stage of the rack" (next two days), followed by "the knife-in-the-side stage". He went home on the twelfth day and, on reflection, came to tardy agreement with his wife that "every abdominal surgeon should have an abdominal operation". He acknowledged that surgery is a team effort and that a shared experience with his patients should produce greater understanding.[2] The anaesthetists also testified, a good example being an editorial in the *British Journal of Anaesthesia*, August 1968:

> "At a time in the century when huge resources of brains, time and money are centred on projects such as organ transplant, is it too much to hope that a similar order of attention can be brought to bear on the perennial, but rather neglected, problem of postoperative pain?" [3]

The view of the lay public was exemplified by the novelist, Colin MacInnes, who after undergoing gastrectomy and oesophagectomy, castigated the British hospital system (1976) for "the nonchalant attitude of the medical profession towards quite unnecessary suffering".[4] The nurses joined in a little later – e.g. two nursing educationalists described in the *Nursing Times* (1980) how a nurse had withheld pain medication of a patient after gynaecological surgery because the systolic blood pressure had fallen by 10 mm Hg:

> "her unnecessary suffering from early postoperative pain delayed her recovery and prolonged her hospital stay".[5]

Advances in analgesic techniques

These deficiencies in postoperative analgesia persisted in the face of technical advances in analgesic administration. From the 1960s epidural analgesia had begun to be offered in obstetrics.[6] Patient controlled analgesia (PCA) was pioneered in the USA by Philip Sechzer, who introduced small IV doses of opioid given on patient demand by a nurse in 1968 [7], and by machine in 1971.[8] Peripheral nerve blocks were refined in the 1970s.[9] Use of epidural opioid was described in 1979.[10]

Looking at the team approach, in a letter to *The Lancet* (1971) James Parkhouse made a "plea for the employment of trained nurses, attached to departments of anaesthetics and surgery, with the primary responsibility for attending to the patient's comfort".[11] Parkhouse was the new Professor of Anaesthesia at Manchester. Unfortunately his suggestion was largely unheeded – perhaps he was ahead of his time.

Commenting on the reported advances in analgesic techniques in an editorial for the *British Journal of Anaesthesia* in 1980, AA Spence appealed to the consciences of anaesthetists, surgeons and nurses to put these into practice.[12]

First Acute Pain service

Brian Ready in 1988 published the first account of an Acute Pain Service (APS) in USA - at the School of Medicine, University of Washington in Seattle. This described 18 months' experience of a team comprising anaesthesiologists and clinical nurse specialists: the nurses managed PCA pumps and were taught to inject epidural opioids within protocols; the service included morning clinical rounds by the physician-led team. [13] One might ask why the UK lagged behind the USA in this initiative. The answer lies in the economics of health care delivery. Whereas in the USA a "fee for item of service" facilitated the creation of an APS, in the UK the notion had a relatively low priority and the required resources were not funded.[14]

UK report on pain after surgery

In 1990 came the landmark UK report on pain after surgery commissioned by a Working Party initiated by the College of Anaesthetists and the Royal College of Surgeons of England.[15] The Working Party was chaired by Prof Alastair

Spence and comprised representatives of the anaesthesia, nursing, surgery and pharmacy professions. The Report described the extent of the problem of postoperative analgesia and the methods available for treatment of acute pain, drawing attention to the roles of an APS and the High Dependency Unit (HDU). It made several important recommendations: to improve education in analgesia, to systematically record pain regularly after operations and to *establish acute pain teams in all major hospitals*. Furthermore it stated the requirements for staffing, resources and facilities. Publicity was directed at *patients* so that the doctors would have to pay attention – Prof Spence was recorded on UK radio, in fact the Jimmy Young show (personal communication, Prof Alastair Spence). The project was definitely a success, in that it instigated the first Acute Pain Teams incorporating clinical nurse specialists in UK hospitals, as well as numerous responses and audits.[14, 16-23] It is pertinent to note the state of British politics at the time of publication of The Report in September 1990: the Conservative Prime Minister, Margaret Thatcher had been forced to resign after the unpopular poll tax – John Major was about to emerge as the compromise successor.

Early Acute Pain Teams in UK

Two further surveys published in 1995-96 reflected the inertia inherent in the NHS. Harmer *et al* reported that 44% of the responding hospitals had *some* form of APS; intermittent IM opioid injection remained the most common technique – 47% of units using it in more than 50% of their patients.[24] Windsor *et al* found that 43% of the responding hospitals had established a multidisciplinary APS by the end of 1994 (compared with 2.8% before September 1990); 39% had an acute pain nurse (compared with 2.3% before 1990).[25] The influence of a dedicated pain nurse was highlighted in an audit of postoperative pain control published in 1996. This revealed that provision of PCA and epidural analgesia initially had a high incidence of side effects despite low efficacy. It was only after the establishment of a specialist pain nurse that significantly improved pain relief and reduction of side effects could be achieved.[26]

The NHS Executive's Scoping Study of 1996 was a survey of around thirty hospitals throughout England and Wales, which indicated that the majority had *some development* of an acute pain team.[27] Most had an anaesthetist in overall charge with a senior nurse running the day-to-day activities within predefined protocols. Finance was quoted as a limiting factor in the development of the team.

In a review of treating acute pain in hospital (1997) McQuay, Moore and Justins pointed out that training and education (rather than new drugs or "high tech"

delivery systems) were the keys to successful pain management – clearly the main tasks of acute pain teams.[28]

Standards in acute pain management

In 1997 the Audit Commission's (AC) report *Anaesthesia under Examination* noted that only 57% of hospitals surveyed had *formal* acute pain teams – many patients still suffered pain, some hospitals being better at controlling it than others.[29] The report recommended that an acute pain management strategy be implemented by the use of acute pain teams, emphasizing more effective collaboration between anaesthetists, surgeons and nurses. A target (for that time) of <20% incidence of severe pain was set, which was to fall to <5% by 2002. This was perhaps the first attempt at setting a standard in the provision of analgesia. Of course the Audit Commission received far more publicity for its proposal that, owing to pressure for better use of its resources, the NHS needed to consider non-medical personnel in the provision of anaesthesia services!

The same year came the fruit of a joint working party of the Association of Anaesthetists of Great Britain & Ireland and the Pain Society chaired by RE Atkinson with JE Charlton as secretary: *Provision of Pain Services* included a section on acute pain and an appendix on the job description for acute pain nursing staff.[30]

The Association of Anaesthetists published in August 1998 another booklet *The Anaesthesia Team*, which had a section on postoperative pain management.[31] A key recommendation was:

> "All acute hospitals providing inpatient surgical services must have an acute pain team led by a consultant anaesthetist".

The mission statement was:

> "A high quality postoperative pain management service should include identifying the patient's individual requirements on admission and then tracking the patient from the surgical ward, through recovery, the HDU and back to the ward."

Potential members of the acute pain team were then identified: consultant anaesthetist, trainee anaesthetists, specialist nurse, nurses in training, pharmacist, physiotherapist and operating department practitioner (ODP).

The question of standards was again tackled by the Clinical Standards Advisory Group (CSAG), which had been established in 1991 as an independent source of expert advice to the UK Health Ministers and was chaired by Prof Martin Harris. In response to a (Conservative) Government request in 1996 the CSAG had set up a committee, chaired by Prof AA Spence, to review NHS pain

services. This committee contracted two teams (Leicester and Manchester), which by 1999 had prepared a report *Services for Patients with Pain.*[32] Of 250 surveyed trusts, 88% had an APS and 81% had a whole time equivalent acute pain nurse. However data on patient outcome was limited to interviews with 117 postoperative patients on 10 sites. By the time the report was ready a New Labour Government was in power, and this Blair Government had decided to abolish CSAG, which was to be replaced by the Commission for Health Improvement (CHI). The excellent civil servants who had supported the Committee were disbanded, and it took threats from Sir Martin Harris and Prof Alastair Spence for the Report to appear at all. The Stationery Office inadvertently swapped the title page of the Report with that of another (on outpatient services) and there was no longer a responsible officer to re-bind the correct papers! Trusts were overwhelmed by Government dictats and, unless there were strong medical politicians in each hospital that should have been concerned, nothing happened (personal communication Prof AA Spence). "Standards" was alluded to above, but the CSAG Report was really a series of recommendations – this was aptly highlighted in an Editorial by Mike Harmer in *Anaesthesia* July 2001.[33]

The Royal College of Anaesthetists published in the year 2000 *Raising the Standard*, which again called for multidisciplinary acute pain teams.[34] The Pain Society prepared in 2001 *Recommendations for Nursing Practice in Pain Management.* [35]

In 2002 Dolin, Cashman and Bland drew attention to the Audit Commission's standard of less than 5% incidence of severe pain, which had been targeted for that year. Having performed a literature search on treatment of pain after major surgery by IM, PCA and epidural analgesia, they suggested that the AC's standard of care might be unachievable.[36]

The Royal College of Anaesthetists and the Pain Society in 2003 jointly produced *Pain Management Services – Good Practice.*[37]

Effectiveness of Acute Pain Teams

Of course the burning question is whether Acute Pain Teams improved patients' postoperative experience in hospital – a summary of 6 studies published soon after the CSAG Report follows. Brian Ready (USA) expounded on his database in the Gaston Labat lecture for ASRA in 1999. He found that 89% of patients under the APS rated their satisfaction as 8 out of 10 or higher. Interestingly neither pain levels nor PONV predicted patient satisfaction. It seems that *perceived efforts* made by the APT resulted in satisfaction, whether or not the

efforts were successful in meeting intended therapeutic goals.[38] Narinder Rawal (Sweden) stated an independent audit revealed 95% satisfaction with postoperative pain management.[39] Francoise Bardiau (Belgium) reported a major improvement in pain scores after APS inception.[40] In the UK Bernadette Power & Fiona Dobson (Nottingham) found that an APT using an algorithm improved the quality of postoperative pain control.[41] An audit by Tarnia Taverner (Yorkshire) of 14 sites found that those with pain management teams did *not* provide better pain management for postoperative patients.[42] A meta-analysis by Ann McDonnell (Sheffield) on the impact of APTs on post-operative outcomes or postoperative pain relief was inconclusive.[43]

Compliance with the call for acute pain services was investigated by Powell and colleagues (St Andrews and Dundee), who in 2002 sent questionnaires to 403 NHS hospitals with an 81% response rate. Of the responding hospitals 83% had an established APS, working Monday – Friday in 86% of these. Only 5% provided a 24 hours, 7 days a week service. Three categories of APS were described: thriving (30%), struggling (52%) and non-existent (17%).[44]

However, by this time recognition of the benefits of acute pain teams had already been established. Acknowledgement of the expertise of the APS was tacit in the proposal in 2001 that this should be a model for outreach critical care.[45] The role of the APS beyond surgical wards was aired in 2004 in a survey of pain on medical wards in a district general hospital; pain was reported by 52% of the patients – 20% severe, 12% unbearable.[46] The author's experience is that acute pain teams are now often called beyond surgical wards.

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'ANAESTHESIA AND THE PRACTICE OF MEDICINE: HISTORICAL PERSPECTIVES'
(a preview)

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Background

The authors first met when KS spent a year in H.K. Beecher's department at the Massachusetts General Hospital, Boston in 1954-5. We met again, by chance, in 2000 and agreed to co-author a book for the general public that would attempt to show how developments in anaesthesia on both sides of the Atlantic had changed the practice of medicine. Since a number of publishers considered that our text would not be economically viable in the public domain, we modified the approach to make it suitable for a medical and para-medical readership.

We have not attempted to write a history of anaesthesia, but have concentrated on major developments that have either altered surgical practice or have taken the anaesthetist out of the operating theatre. The choice of topics has been influenced by our participation in some of the events, and we have included our personal reminiscences where we felt that they would illuminate the story.

Early history

In the first two chapters we deal with the early history of general and regional anaesthesia. We describe how anaesthesia emerged from the "ether frolicks" and "laughing gas parties" of the time and show how the bitter controversy between Wells, Morton and Jackson destroyed their professional careers. The dispute between Freud and Koller, the ridicule of Schleich and his introduction of infiltration anaesthesia, and Halsted's tragic addiction to cocaine are part of the story of regional anaesthesia.

Development of the anaesthetic machine and tracheal intubation

We considered that the next major advance was the development of the anaesthetic machine by Gwathmey, Marshall and Boyle, for this not only enabled anaesthetists to control the concentrations of anaesthetic agents, but also supplied gases under pressure; this facilitated the use of assisted, and later, controlled ventilation—the first example of the anaesthetist controlling a body system. Of equal importance was the development of tracheal intubation. We

feature O'Dwyer's pioneering use of laryngeal tubes in diphtheria (his four sons had died from the disease) and review the contributions of Kuhn, Magill and Rowbotham in the development of practical methods of inserting the tube. The airtight connection with the trachea provided by the cuffed tube developed by Guedel and Waters in 1928 not only prevented aspiration (as illustrated by the "dunked dog" demonstration), but also enabled cyclopropane to be given in a closed circuit with the CO_2 absorption technique. Waters demonstrated this in London in 1936.

1930s

The two other major developments during the 1930s were the introduction of thiopental by Waters in 1934, and the development of academic anaesthesia in the USA and UK. Waters established the ideals of academic anaesthesia and many of his trainees have become leaders of the profession. Macintosh took leave from his London private practice to visit Waters in the 1930s and developed a great admiration for Waters' precepts, later adapting them to the English environment. The two became firm friends and both had an immense influence on the development of anaesthesia world-wide. But whereas Waters received strong support from his colleagues at the University of Wisconsin, there was active opposition to the establishment of academic anaesthesia in the Universities of Harvard and Oxford. We document the devious negotiations that finally resulted in the appointment of R.R.Macintosh to the Nuffield Chair at Oxford in 1937 and H.K.Beecher to the Henry Isaiah Dorr Chair at Harvard in 1941 and consider the role of other leaders such as McMechan and Lundy in the development of anaesthesia in the USA.

World War II

The Second World War had a major impact on the development of our subject. At the beginning of the war there were few whole-time specialists in anaesthesia, most of the anaesthetics being given by general practitioners, house staff or medical students. In the UK in 1939 there was a major reorganisation of hospital services that resulted in the formation of an Emergency Medical Service and National Blood Transfusion Service, and the employment of full-time anaesthetists to cope with civilian casualties. Many anaesthetists were trained in the armed services and during their service they helped to foster a team approach to triage, resuscitation, surgery and pain relief, often under appalling conditions. The unique experience gained during the Second World War, and the introduction of the muscle relaxant drugs in 1942, transformed anaesthesia in the post-war period; the new techniques provided a rapid and pleasant induction and recovery with minimal side effects. The avoidance of

deep anaesthesia and the improved operating conditions enabled surgeons to extend the range of surgery and to operate on very sick patients. Another development, that originated from the wartime experiences of H.K.Beecher and J.J.Bonica, was the establishment of a role for the anaesthetist in the treatment of chronic pain and we devote a chapter to this fascinating story.

The post-war period

Application of scientific principles

The post-war period was characterised by the establishment of a scientific base for the subject, by technical advances, and by the increased integration of the anaesthetist into the hospital environment. Anaesthetists began to apply their new expertise to the developing specialities of thoracic, cardiac and neurosurgery, and to the provision of obstetric analgesia. Experience with induced hypothermia and then cardiopulmonary bypass for open heart surgery in the 1960s led to a greater understanding of cardiovascular dynamics, resuscitation, acid-base balance and the benefits of monitoring. Another development was the 1948 introduction of induced hypotension to control surgical bleeding. The physiological changes produced by this technique provided new insights into the control of the circulation and provided a second example of the way in which anaesthetists learnt to control a physiological function.

Academic development of the specialty

There were two other major events in 1948 that were to be of immense importance for the development of anaesthesia. The first was the establishment of the Faculty of Anaesthetists of the Royal College of Surgeons. The Faculty subsequently metamorphosed into an independent College of Anaesthetists, and the College was then given Royal status in 1992. Shortly after its foundation the Faculty took over the responsibility for the Diploma in Anaesthetics, that had been initiated in 1935 under the control of the Conjoint Board of the Royal Colleges of Physicians and Surgeons, and created a two-part examination with a standard equivalent to the Fellowship examinations of the other major Royal Colleges. The first part was initially modelled closely upon the Primary examination of the Royal College of Surgeons with papers and *viva voce* examinations in the basic sciences of anatomy, physiology, pathology and pharmacology, while the second part covered clinical medicine and surgery and all the clinical aspects of anaesthesia.

In 1953 the examination was renamed the Fellowship of the Faculty of Anaesthetists of the Royal College of Surgeons (FFARCS) and the opportunity was taken to change the basic sciences examined in the first part to those more appropriate to anaesthesia (physiology, pharmacology, physics and clinical measurement). However, the standard was soon recognised to be equivalent to the Fellowship examinations of the other Royal Colleges. Although these developments were undoubtedly spurred on by the fear that anaesthetists might be given a subsidiary role in the planned National Health Service, the new academic credentials and extensive lobbying finally ensured that anaesthetists were given Consultant status when the Service was introduced in 1948.

Resuscitation and intensive care

In 1950 Eric Nilsson showed that the application of anaesthetic techniques for the care of the unconscious patient could reduce mortality in patients rendered unconscious by barbiturate poisoning, and in the1952 Copenhagen poliomyelitis epidemic Bjørn Ibsen dramatically demonstrated that tracheal suction and manual intermittent positive pressure ventilation provided by relays of medical students could halve the mortality in patients with bulbo-spinal paralysis. Within a year he had created an area where all the staff and facilities for applying this form of treatment were available in one place, so originating the concept of the intensive care unit that exists to-day. Simultaneously, mechanical ventilators began to appear in the market place. These developments led to the anaesthetist's involvement in intensive care, accident and emergency medicine and the transport of seriously ill patients. In the late 1950s a series of investigations by Peter Safar and other investigators in the USA revealed the anatomical basis for maintenance of the airway in the emergency situation and demonstrated the superiority of expired air resuscitation over the manual methods then in use. When closed chest cardiac compression was shown to be effective in 1960 it was natural that anaesthetists should lead the development of in-hospital resuscitation services.

New drugs

The other great advance of the second half of the century was the application of scientific method to the development of new drugs. A number of new analgesic and muscle relaxant drugs were synthesised and introduced into anaesthetic practice, and the use of drugs with a shorter period of action has been largely responsible for the rapid growth of day case surgery. But perhaps the most important development has been the introduction of non-explosive short acting inhalational agents. The first was halothane, introduced in 1956, and this was followed by others such as enflurane, isoflurane and, more recently, sevoflurane

and desflurane. Within a decade of its introduction suspicions were being aroused that halothane might be producing liver damage. John Bunker led a team of investigators that produced the National halothane study and he describes how this problem was tackled in the USA.

Safety

The safety of anaesthesia has also been of concern in the post-war period. We review the various studies that have attempted to assess the magnitude of the problem that Macintosh so courageously publicised in 1949, and we show how anaesthetists have taken the lead in improving the safety of anaesthesia.

Obstetrics and neonatal care

Finally we devote three chapters to the contribution of anaesthetists to the relief of pain in labour, to anaesthesia for operative obstetrics and to Virginia Apgar's contribution to neonatal care.

Conclusion

It has been our privilege to have been associated with a number of the developments in anaesthesia that have occurred during the past half-century. We hope that our examination of some of the characters and controversies associated with these advances will provide an interesting and useful perspective for those who have been denied the leisure to explore our past.

HISTORY OF INTENSIVE CARE MEDICINE

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Introduction

Critical care has evolved from an historical recognition that the needs of patients with acute, life-threatening illness or injury could be better treated if they were grouped into specific areas of the hospital. The philosophical concept of Intensive Care was first suggested by Florence Nightingale in the mid 19th century during the Crimean war when she designed a system of keeping the sickest soldiers together, adjacent to her nursing station.

The first Intensive Care Unit came into existence during the poliomyelitis epidemic in Copenhagen, Denmark in 1952[1] where almost 2700 patients suffering from polio were admitted out of which 316 required tracheotomy and artificial ventilation. The metropolitan area of Copenhagen was served by a single hospital for communicable disease, the Blegdam Hospital, which was equipped with just one Iron Lung and six Chest Cuirass Respirators. The large number of severely ill patients pouring in and high mortality rates necessitated urgent therapeutic improvisation. Thus, separate areas were set-aside in the hospitals for treatment of respiratory insufficiency with the aim to utilise the available equipment and expertise most advantageously. This innovation led to the creation of specially equipped areas to support critically ill patients, now called Intensive Care Units.

Intensive care has been defined as "A service for the patient with potentially recoverable disease who can benefit from more detailed observation and treatment than is generally available in wards and departments". It is high technology, life-saving care requiring a multidisciplinary approach and close interaction with other services, allied with the conventional disciplines of internal medicine, surgery, anaesthesiology and paediatrics. It provides an evidence based scientific knowledge for supporting failing organs. Respiratory care has been the driving force behind the evolution of Intensive Care.

Early landmarks in respiratory support

c. 400 BC: Hippocrates described endotracheal intubation in 'Treatise on Air'.
1543: Vesalius ventilated an animal via a tracheostomy.
1667: Hooke applied bellows to animal tracheostomy.
1775: John Hunter developed double bellows.

Early 20th century advances

Respiratory support

An artificial breathing device "Drager Pulmotor" was designed by Dragerwerk in 1907-11.
In the early part of 20th century there were frequent and severe outbreaks of poliomyelitis in the whole of western world. The epidemic of 1916 in the US resulted in 27000 people paralysed and 6000 deaths. Most of the deaths were attributed to respiratory paralysis due to bulbar polio. The enormous mortality from polio gave impetus to the development of negative pressure mechanical ventilators. Two designs became popular: the 'Iron Lung' and the 'Chest Cuirass'. The Iron Lung respirator was invented by Philip Drinker of the Harvard Medical School. It was first used on October 12, 1928 at Children's Hospital, Boston. It produced inspiration by generating a negative pressure around the body of the patient which was enclosed in an iron cylinder with the head protruding out of the end. Mechanical bellows were used to generate negative pressure inside the iron cylinder, which facilitated inspiration. The Chest Cuirass was a simpler device which provided negative pressure on the chest wall only.
The enormous success of these ventilators made them the mainstay treatment for polio patients during the mid-20thcentury. Hospitals developed "Polio Wards" equipped with scores of Iron Lungs, which could ventilate patients for weeks and months. These Iron Lung wards have been described by some as incipient forms of Respiratory Care Units.

Shock Wards

During the Second World War isolated rooms called "shock wards" were established to group together and resuscitate the very sick, wounded and post operative cases. These Shock Wards were similar in philosophy and function to our modern day Intensive Care Units.

Blood transfusion

Although Karl Landsteiner, an Austrian physician, discovered the first three human blood groups, A, B and O in 1900, the practice of blood transfusion still remained in incipient stages till the start of the Second World War. The new knowledge of matching different blood groups and the use of an anticoagulant, sodium citrate, facilitated indirect transfusion.
The post- World War II era witnessed a tremendous growth in the field of medicine and surgery leading to better understanding of the pathophysiology of

organ dysfunction and shock. The implications of fluid, electrolyte and acid-base imbalances were better understood and antibiotics were freely used.
The experiences derived from treating the soldiers of war helped in improvising surgical procedures. Surgery previously thought impossible now became widespread practice leading to an increased demand for higher level of postoperative care. The idea of a state funded healthcare delivery system was envisaged by the political parties, which took its final shape as National Health Service UK on 5th July1948, thus providing the infrastructure for further development of ICUs.

Copenhagen polio epidemic

In 1952, when the polio epidemic began in Copenhagen, negative pressure ventilation through Iron Lung and Cuirass ventilators was the only option for patients requiring respiratory support. This technique was largely insufficient in serving its purpose and resulted in almost 87% mortality in ventilated patients. An anaesthetist Bjorn Ibsen addressed this problem. He observed that the ventilated children maintained a persistently elevated plasma bicarbonate concentration, which was attributed to primary metabolic alkalosis by the paediatricians. He challenged this view and claimed that the phenomenon was secondary to hypercapnia resulting from ventilatory insufficiency due to Iron Lung ventilators. He subsequently proposed the technique of Positive Pressure Ventilation through Tracheotomy in these patients. On 27th Aug 1952, his theory was tested in a 12-year-old girl who was deteriorating in spite of negative pressure ventilation. A large size cuffed endotracheal tube was passed through the tracheotomy and positive pressure ventilation was initiated.
Her condition improved dramatically and thereafter Positive Pressure Ventilation became a widely adopted technique throughout the Western World. He also devised a bag and CO_2 absorbing canister system, which further improved the outcome of ventilated patients. Mortality associated with ventilation dropped from 87% to 26%. Unfortunately due to lack of mechanical devices, patients were ventilated manually by groups of medical students who worked in shifts of 8 hours and were paid 30c per shift. The instant popularity of Positive Pressure Ventilation encouraged the development of automatic mechanical ventilators like Engstrom, Lundi and the Bang.

During the 1960s volume controlled and pressure controlled modes of ventilation became popular. Other modes of ventilation like Assisted Ventilation (AV) and Controlled Mechanical Ventilation (CMV) and Synchronised Intermittent Mandatory Ventilation came together in a single piece of equipment giving birth to the modern era of multiple-choice respiratory support.

Intensive care in the NHS

Hospitals

The NHS thrived in the 1950-60s as hospitals became larger, more specialised, and equipped with state of the art facilities for diagnosis and monitoring. The consultants engaged in specialised practices and research activities giving birth to the concept of quality of care. With the advances in surgical practices, mortality was reduced while the range and invasiveness of surgical procedures expanded. Operations were undertaken on patients who would have formerly been deemed unsuitable because of co-morbidities, age or physiological derangements. The older population and those with chronic debilitating diseases were offered an option of palliative surgical relief in order to improve their quality of life. These factors lead to a steady increase in the proportion of very sick inpatients requiring higher level of care and organ support.

Laboratory and imaging services

The need for rapid and accurate bedside clinical decision-making necessitated the development of a dedicated laboratory, situated near the site of an intensive care unit. Advanced imaging procedures like Ultrasound, Computed Tomography, Magnetic Resonance Imaging became freely available, bringing substantial increase in efficiency in management.

Scoring

The development of scoring systems, mortality prediction models represented further constructive efforts towards achieving more objective outcome measurements.

Intensive care in North America

In 1958, Baltimore City Hospital set up a combined medical and surgical Intensive Care Unit[2]. The admitting consultant managed the cases while the Anaesthesiologists delivered expert resuscitation and organ support.The Unit was equipped with the Moerch Piston ventilator, which had the unique ability of ventilating two adult patients simultaneously, in an emergency. The tidal volumes provided for each patient was adjusted to some extent by changing the diameter of the tubing.

By 1961 Toronto general hospital[3] formed one of the first multidisciplinary teams of Anaesthetists, Physicians and Otolaryngologists to manage its Intensive Care Unit.

Organisation of intensive care

During this period, Intensive care developed in parallel with the development of medicine and surgery, but failed to achieve the strategic, coordinated expansion it deserved. It therefore grew in an erratic and unplanned fashion, managing to cater to the immediate clinical pressures of the hospitals and largely depended on the interests of the local clinicians for its development. The provision of critical care was characterised by considerable variation in organisation, delivery, quality and effectiveness. Some specialities like neurosurgery, cardiac and burns often developed speciality specific units while almost one third of hospitals in NHS still had to manage without High Dependency Units till 1999. In response to these issues government and professional organisations cooperated to produce a coordinated response to face the challenges posed by a developing system.

In 1962 the Department of Health published "Progressive Patient Care"[4]. This outlined the "systematic grouping of patients according to their illness and nursing dependence, rather than by classification of disease or sex". 'Progressive Patient Care' also suggested that between 2 and 5 per cent of a hospital's acute beds should be allocated for intensive care.

The Intensive Care Society was founded in 1970 on the initiative of Dr. Alan Gilston, Consultant Anaesthetist to the National Heart Hospital London. It is the oldest critical care society and represented all the professionals working to deliver high quality critical care service in the UK. The Society had a rapidly growing membership (presently 2500) amongst doctors, nurses and allied health professionals. It offers educational opportunities and is also responsible for maintaining professional standards by liaising with the various Royal Colleges.

In 1970 twenty nine physicians with a major interest in intensive care met in Los Angeles, California to discuss the formation of an organization committed to meeting the needs of critically ill patients, leading to the formation of The Society of Critical Care Medicine (SCCM). This was followed by formation of European Society of Intensive Care medicine (ESICM) in March 1982 in Geneva, Switzerland with the objective of promotion of the highest standards of multidisciplinary care of critically ill patients through education and research. Later, in January 1991, The Scottish Intensive Care Society was founded in Perth, under the able leadership of Dr. A.B.M. Telfer. The first formal intensive care training was established in 1986 via the Joint Advisory Committee for Intensive Therapy (JACIT), formed by the combined effort of various Royal Colleges. Initially, ten 'JACIT' training posts were set up with a comprehensive two-year training programme.

In the late 1980s and early 1990s the Intensive Care Society launched an ICS-(APACHE II) study involving twenty-six general intensive care units and a total of 8724 patients across Britain and Ireland[5]. While coordinating this study in 1991, the researchers realised the paucity of information available on organisation and management of patients in the intensive care units in UK. They submitted a proposal to the Department of Health, to set up a national centre to undertake comparative audit and evaluative research in intensive care.

Audit and research

In 1994 "Intensive Care National Audit and Research Centre" (ICNARC) and a national audit "The case mix programme" were established. The database provided a valuable resource for audit and research purposes. It also provided standardised information to enable comparisons to be made between critical care units thus facilitating regional and national discussions on critical care.

It was realised that the current critical care services were "fragmented, expensive and under pressure" and there was a dearth of useful management information about critical care resources, treatments given and their effectiveness. This prompted the Audit Commission to undertake an extensive audit of critical care facilities in England and Wales [6] in 1998. The recommendations were aimed at helping the individual trusts in improving their services in order to provide best value for money. It found that the median size of an intensive care unit in UK was 5.3 beds though a wide variation ranging from 2-22 beds was detected. An average 6-bedded ICU had 47 nurses and three consultants with fixed commitments. Nursing staff represented the largest component of costs with a median total nursing budget of £705311 in 1998.

In 1999 Edbrooke and colleagues[7] estimated the cost of caring for ICU patients to be almost six times more than conventional ward care (£1000 per patient day). It was realised that the actual costs are easy to estimate but the costs to society are very difficult to quantify. These may be positive by returning a wage earner to employment, or negative by producing a dependent survivor.

In 1999, another document "Review for the NHS Executive for adult critical care services – an international perspective" comparing the critical care services of UK with other European countries was published by the medical economics and research centre, Sheffield[8]. This document made some startling revelations regarding the organisation and funding of critical care services in UK. It concluded that UK spending on health care, as a percentage of GDP, was much less than most other European countries, while the severity of illness of patients and the pressure on critical care beds was relatively higher.

In April 1999, the Department of Health established a review of adult critical care services[9]. The document named "Comprehensive Critical Care" soon became popular and widely accepted through UK. It was a major step towards modernisation of the service and ensured that patients receive first class critical care services wherever they live, throughout the United Kingdom.

Comprehensive critical care was a whole "system approach" which concentrated on the process of care and severity of illness of the critically ill patient. It proposed that patient's needs are determined according to the level of care, which their condition requires, rather than the designation of the bed in which they happen to lie. The concept 'acute care pathway' was introduced, which is a continuum of care that integrates pre-hospital care, intra hospital care and community care following discharge.

The development of critical care networks was proposed. It consisted of several neighbouring intensive care units that raised standards by adopting common policies and protocols, and optimised resource usage by integrating their capacity. The document emphasised the training and recruitment of efficient medical and nursing staff and promoted a culture and practice of evidence based medicine.

The report also addressed key issues such as establishment of outreach teams, staffing, bed management and long term support and rehabilitation of critically ill patients. The outreach service was a clinician led, multidisciplinary team, whose principal role was to avert admissions by early identification of the deteriorating patient, providing continuity of care of discharged patients on wards.[10]

Intensive care in the 21st century

The Critical Care Modernisation programme, which ended in September 2004, was successful in delivering significant service improvement. An additional £145 million was allocated resulting in 30% increase in number of beds from 1400 in 2000 to 1711 in Jan 2002. However the number of patient transfers and the number of urgent operations postponed due to paucity of critical care beds still remains unacceptably high.

Critical care was recognised as a specialty and was awarded this status in the UK in June 1999. In 2000, The Intercollegiate Board of Intensive Care Medicine[11] took over the responsibility of supervising the training in Intensive Care Medicine, which has now adopted a competency-based framework. It

awards The Certificate of Completion of Specialist Training through dual accreditation.

Enormous advances were made in the epidemiology, pathophysiology, diagnosis and management of sepsis. American College of Chest Physicians and Society of Critical Care Medicine Consensus Conference came up with set definitions for systemic inflammatory response syndrome, sepsis, septic shock and multiple organ dysfunction syndrome. This was the first attempt to create a universal language for diagnosing and treating sepsis.

The establishment of ARDS Network in 2000 provided access to the latest principles for the treatment of "Acute Lung Injury". The concept of "Lung Protective Ventilation" emerged as evidence based approach to reduce the ventilator induced lung injury. Application of these principals produced a marked improvement in the mortality figures of ARDS patients.

The Surviving Sepsis Campaign launched in 2002, was an international collaborative effort by The European Society of Intensive Care Medicine, The Society of Critical Care Medicine, and The International Sepsis Forum to improve the treatment of sepsis and reduce the mortality rate by 25% in the coming five years. The second phase of the campaign began with the introduction of the "Surviving Sepsis Campaign guideline for management of severe sepsis and septic shock" in March 2004.[12] The third phase of the campaign aims to concentrate on the implementation and evaluation of these guidelines, an important step of which was initiation of "Sepsis Bundles" which will form the basis for the measurements of improvements in patient outcome with the changes in management.[13]

Conclusion

In summary, Intensive Care has developed over the years from a mere location for gathering patients together to a speciality in its own right. It therefore provides an organised, knowledgeable, evidence based approach to treating critical illness. In many ways the isolationist approach of early Intensive Care Units has been abandoned in favour of philosophy of critical care without walls, thus bringing Intensive Care to the patients rather than bringing patients to Intensive Care. The tremendous progress that has been made in the past few decades provides us with a solid foundation to deal with the challenges of the future.

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THE WIND OF CHANGE – EMERGENCY ARTIFICIAL VENTILATION IN THE 20TH CENTURY

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Introduction

Today, we are fortunate to have a reasonable working knowledge of respiratory physiology, adequate means of securing an airway and the availability of equipment for ventilation of the lungs. However, the most appropriate method of ventilating the lungs during emergency resuscitation is still a potent source of discussion. Over the last 100 years, the question of choosing the best method has taxed many of the best brains in our speciality. Experiments have been undertaken, some at great personal risk, to find an answer[1]. Even today, constant changes in the Basic Life Support guidelines indicate we are still not decided. Modern doctors, brought up on expired air ventilation, have little knowledge or understanding of other, sometimes equally effective, methods. They also have little knowledge of the history of expired air ventilation[2].

Early attempts at resuscitation

The earliest attempts at resuscitation are lost in the mists of time, but I would refer those interested to the excellent papers by AB Baker[2] and RV Trubuhovich[3]. They review "Elisha's method" of expired air ventilation (II Kings 4: 18-37), where apparent "mouth over mouth" saved the child of a Shunamite woman. When studied in depth, the resuscitation seems very dubious! However, they present evidence that Hebrew midwives probably did use some sort of expired air ventilation.

We then enter a long, dark passage of time, where attempts at resuscitation are stifled by religious objections and lack of scientific knowledge. Death was accepted and little was attempted to avoid it, with the exception of a couple of special cases - the newborn and the drowned sailor. The renaissance saw the re-emergence of Galenic teaching and the idea of tracheotomy and ventilation of animals, but not humans.

18th century

The mid - eighteenth century saw a changing of attitudes in Western Europe. The fledgling industrial revolution brought money and power, and with it a new altruism. This was backed by increased medical knowledge and a desire to apply

it. Cases such as that of a lifeless miner in 1732 resuscitated using expired air by Dr Tossach began to appear in the medical literature[2]. From 1767 Humane Societies were founded with the aim of saving the lives of unfortunate victims[4].

19th century

Many techniques were tried to inflate the lungs, some more bizarre than others. Bellows were popular, as was rolling on a barrel. Techniques emerged which involved manipulating the arms and chest wall to cause inflation and deflation of the lungs. When anaesthesia slowly gained popularity in the mid-nineteenth century, it is easy to understand why deep anaesthesia was avoided - early anaesthetists were not very successful in managing apnoea. Techniques such as Marshall-Hall (1856), Sylvester (1861) and Howard (1871) all had their advocates. In 1897, a committee was established under the direction of Professor Sir Edward Sharpey-Schafer to settle the matter of which was best. The result was the "Schafer" technique, a method of prone chest compression[2].

Eve

In 1932, a Dr Eve reported a case of a small child with temporary paralysis of the diaphragm that improved with rocking up and down. Subsequent investigation showed this rocking method also worked on adults, but it was not adopted. Seven years later all literature at the outbreak of World War II still recommended the Schafer method. It was used universally, but was rarely successful.

Pask

Squadron Leader Edgar Pask, an anaesthetist and physiologist in the RAF with Macintosh attempted to establish the best form of artificial ventilation for use in combat, specifically in RAF fast rescue launches[1]. He went back to the original papers on the subject, and devised an experiment, using himself as subject. On the 24th April 1943, the experiment took place. Premedication of morphine grs. 1/6, atropine grs. 1/50 was administered one hour before, and then the larynx and pharynx were cocainised. Induction was with pentothal sodium, then deepened with ether vapour and air. A gum-elastic endotracheal tube of 9mm. internal diameter, with a cuff inflated with water was introduced, and anaesthesia deepened until stage III, Plane 3 (Guedel). At this point forced ventilation with 15%v/v ether was applied until respiration ceased. The subject was then connected to a smoked drum, and the various techniques applied at a rate of 12 per minute. The record for Eve's method is shown (Figure 1), and the results of the experiment (Figure 2).

Following Pask's work, the Eve's rocking method was adopted by the RAF, and then the Navy. The experiment was repeated following one of the famous pool experiments at the end of the war. Pask had already been anaesthetised for 2 hours, and was then paralysed using the newly "discovered" curare, from Griffith in Canada. Similar results were obtained.

Aftermath of Pask's work

Subsequently, other researchers, often unaware of Pask's results, undertook similar work. In 1950 in Chicago a study on fresh corpses was undertaken, and when further results were needed, even fresher medical students were used in 1951! By the mid-1950s the Holger Nielsen method was adopted, and then in the 1960s the "discovery" of EAV. This became, with chest compressions, cardiopulmonary resuscitation (CPR) as it was taught and used for the next thirty years. Today, we are entering a time of change in CPR, when less breaths are applied, with the realisation that chest compression causes ventilation – just like 100 years ago!

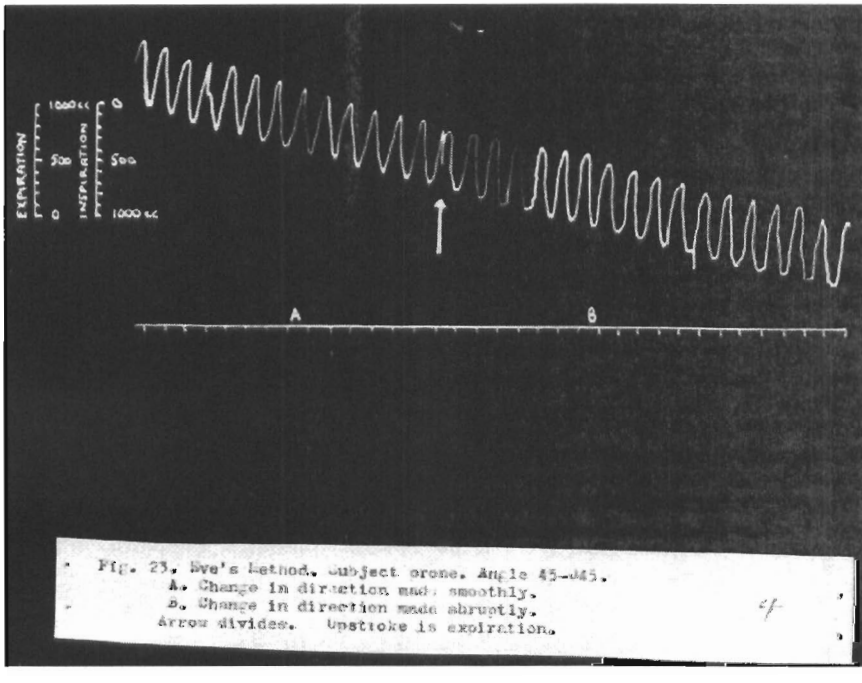

Figure 1 Record from experiment
Source: Department of Anaesthesia, Newcastle University

ethod	Position	Inspired minute volume (litres)
Schafer s	prone	3.44
Sylvester's	supine	4.12
Eve 45/45 smooth	prone	5.82
Eve 45/45 jerky	prone	5.91
Eve 30/30 smooth	prone	3.54
Eve 30/30 jerky	prone	3.65
Eve 45/45 smooth	supine	3.80
Eve 45/45 jerky	supine	4.09
Eve 30/30 smooth	supine	2.17
Eve 30/30 jerky	supine	3.03
Oxford inflator	prone	5.50 (estimated)
Oxford inflator	supine	4.12 (estimated)
Mouth to mouth	supine	6.16 (estimated)

Figure 2 Results of experiment
Source: Department of Anaesthesia, Newcastle University

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A LESSER KNOWN FIGURE IN THE HISTORY OF ANAESTHESIA

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Introduction

Those who attended the joint HAS and AHA Davy Bicentenary Meeting in Bristol in 1999 may remember a talk by Norman Bergman, from Portland, Oregon on *A Critical Re-Reading of Humphry Davy's Researches*.[1] He had just published an attractively bound and printed book, *The Genesis of Surgical Anesthesia*,[2] the fruit of much research, including libraries and Record Offices in Britain. Acknowledgement is given to one of our members, John Nunn, for hospitality during a sabbatical in 1982.

Davies Giddy (Gilbert)

I reviewed the book (very favourably) in the *British Journal of Anaesthesia*,[3] and noticed some references to Davies Giddy (who later changed his surname to Gilbert). He seems to be a little known figure, but he deserves a mention in the history of anaesthesia for three reasons at least; he was a lifelong friend of Thomas Beddoes, he played a significant part in the life of Humphry Davy, and he made a suggestion about inhaling a gas which appears to have been previously overlooked.
Although his name is in the *Dictionary of National Biography* (DNB) there was no life written until 1967.[4] *Memoirs on the Life of Thomas Beddoes MD*, published in 1811[5] is based on the correspondence between Beddoes and Gilbert. In Paris' *The Life of Sir Humphry Davy*, published in 1831[6] he is thanked, in the Preface, for 'ready and powerful assistance'.

Mathematician, Chemist, Landowner etc.

In David Wilkinson's Humphry Davy Lecture, also given at the Bristol meeting,[7] he is described as 'one of the new young intelligentia'. The DNB describes him as a scientific administrator and applied mathematician. Todd's biography goes further, and besides calling him a Cornish Philosopher, lists his abilities as accomplished mathematician, chemist, classical scholar, geologist, mechanical engineer, farmer and landowner.

Like many of his scientific contemporaries he seems to have been a polymath or Renaissance man. His mathematical calculations were useful to Telford in the building of the Menai Bridge with respect to the catenary curves and the height

of the towers, and to Hornblower and Trevithick in the design of rotary and high pressure engines. In correspondence with Davy he was able to keep up in discussions on chemistry. The farmer and landowner label relates to a property in Sussex which his fairly prosperous wife inherited.

Most of the information about him comes from documents in the Public Record Office in Truro, including correspondence with Beddoes and Davy, and particularly from his diaries which he kept for the greater part of his life. I had a brief unworthy thought that there might have been a Walter Mitty element because of the names that appeared in the diaries. Besides those already mentioned were the politicians Peel and Canning, the engineers Boulton and Watt, the Darwin family, the Wedgwood family and Babbage However the evidence is there to support his claims. He was elected to the Royal Society at the age of 25 and was later President. He was a Member of Parliament for 30 years. His work on the Menai Bridge and steam engines was addressed to the Royal Society and published.

Biography

He was born in St Erth, Cornwall in 1767, and was educated at Penzance Grammar School and privately at home, his father being a curate in the Church of England. He went up to Pembroke College, Oxford, which is where he attended Thomas Beddoes' lectures and started a lifelong friendship. (By a nice coincidence, it was Pembroke which awarded Robert Macintosh a Fellowship when he was appointed Professor of Anaesthetics at Oxford).

He went on to do an impressive amount of public service, which would have been remarkable even if he had done nothing else. He was MP for Helston (1802-6) and Bodmin (1806-32), i.e. for 30 years. He was offered ministerial posts more than once but always refused them. Most of his work was at the committee level, especially as chairman, and he took part in drafting legislation. He also did spells as High Sheriff of Cornwall and deputy Lord Lieutenant.

The Royal Society

He was also active in the Royal Society. He was Vice-President during Sir Joseph Banks Presidency and later Treasurer. (It was at this time that Hickman presented his pamphlet, though we do not know whether it ever reached the Royal Society). He actually succeeded Davy as President in 1827 when the latter resigned due to ill health, and served until 1830. He could be said to have walked the corridors of power and could have been a national figure, but temperamentally he seems to have preferred to stay in the background. It has

been suggested that he was over-cautious, indecisive, trying to please everybody and ending up pleasing nobody. Certainly his time in office was a rather stormy one, with much manoeuvring going on amongst the membership. Some thought that the President of the Society had too much patronage, and there was class distinction between the professional scientists and the so-called amateurs.

Beddoes

His friendship with Beddoes was life-long and they corresponded voluminously. The friendship was surprising in some ways since they were different in temperament. They were both, like not a few prominent people at the time sympathetic to the principles of the French Revolution, but Beddoes was politically impulsive and was on a Home Office list of 'disaffected and seditious persons'. Probably they paused for thought when Priestley's house was burned down and by the accounts of the terror of 1793.

Gilbert spent a few months in Bristol in 1800, thinking that he had consumption. One side-effect of this was that Beddoes' wife Anna fell madly in love with him, and made it clear that she wanted to be his mistress. The cautious Gilbert had in mind a brother/sister relationship, and there is no evidence that he betrayed his great friend's trust. On Beddoes death, however, Anna returned to the attack, but Gilbert had been appointed guardian of the children and trustee of the estate, and he still felt it inappropriate that the relationship should become more intimate. In fact he married Mary Ann Gilbert 6 months later. It was her bachelor uncle (a Gilbert) who persuaded him to change his name from Giddy, on the promise of a generous inheritance provided he preserved the name Gilbert.

He discharged his duties to Beddoes' children faithfully , occasionally putting his hand in his own pocket and paying off debts acquired at university (so there is nothing new under the sun).

Davy

A promising young student called Humphry Davy came to the notice of Gilbert (and others) in 1797. Despite virtually no personal contact with scientific knowledge he had devised an ingenious experiment related to the properties of heat and light. Gilbert offered him the use of his library, and gave him a copy of Beddoes' and Watt's publication *Factitious Airs*, drawing attention to 'gaseous oxide of azeote', which of course we know as nitrous oxide. He also introduced him to some of his eminent visitors, including the Wedgwoods. Gilbert wrote to Beddoes about him, and Beddoes was sufficiently impressed to offer him the job

of Superintendent at the Pneumatic Institute. Davy was indentured to a surgeon-apothecary in Penzance at the time, and Gilbert played a considerable part in negotiating his release.

He continued to support Davy and they corresponded regularly. Davy in a letter of 1805 referred to 'the good effects of your last exertions in Parliament', and in Paris' biography of Davy the author in his preface thanks Gilbert for ready and powerful assistance. As already mentioned he succeeded Davy as President of the Royal Society, and in a Presidential Address after Davy's death he paid a moving tribute to Davy's achievements.[8]

Inhalation of Gas

In a letter to Beddoes in 1795 Gilbert made a suggestion about inhaling a gas. Before that he made a comment about oxygen (or oxygene as he spelt it): 'I very strongly suspect that the presence of oxygene is somehow or other necessary to the secretion of excitability'. We don't use language like that nowadays, but it is not unreasonable to wonder whether he had some appreciation of the function of oxygen before this was fully established.

He wrote to Beddoes: 'the power of heavy inflammable air, as I take it to diminish the secretions of excitability in the brain may possibly be applied to many useful purposes. May it not be used before painful operations?' This was 5 years before Davy made his suggestion about nitrous oxide. But since heavy inflammable air is largely carbon monoxide it is as well that the matter was not actively pursued.

Conclusion

He died in 1839. There are memorials to him in churches at St Erth and Eastbourne, and there is a Davies Gilbert mountain in Alaska.

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ARTHUR GUEDEL – THE MOTORCYCLE ANAESTHETIST OF WORLD WAR I

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This is a short account of the life and contributions to anaesthesia of Dr Arthur E Guedel. The Guedel's stages of anaesthesia chart, cuffed endotracheal tube and oropharyngeal airway are some of his significant contributions to anaesthesia.

Dr Guedel was born in Cambridge City, Indiana in 1883. He had to overcome poverty and hardships early in life and educated himself in order to realise his dream of practising medicine. He graduated with honours in 1908 and established his own practice the following year. He provided part time anaesthesia for additional income.

When America entered World War I in 1917, he enlisted and served the casualties in France. He was entrusted to run the anaesthetic services for a region and had to train inexperienced people to administer open drop ether under war circumstances. In doing so he developed his chart of the stages of ether anaesthesia.

After the war he continued to work tirelessly to improve safety in administration of anaesthesia, and in 1926-28 he popularized the use of the cuffed endotracheal tube with his 'dunked dog' demonstrations. In 1933 he introduced the oropharyngeal airway.

He published a textbook of anaesthesia in 1937 titled *Inhalation Anesthesia, a Fundamental Guide* based on his research and experience in war and peace. He retired from clinical practice in 1941 due to ill health.

Dr Guedel received the Hickman Medal from the RSM in 1941 and the Distinguished Service Award from the ASA in 1950.

Arthur Guedel was married to Florence Dorothy Guedel for nearly 50 years and had two daughters. He died in Los Angeles in 1956.

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Introduction

Unknowingly I became interested in Dr Barton about five or six years ago when cataloguing surgical instruments in the Hawley Tool Museum. I couldn't identify this small item so I showed it at our Sheffield meeting, November 2002. No one recognized it, but Alan Humphries of the Thackray Museum, made an image and found it in a 1934 Mayer & Phelps catalogue. A chance remark by David Zuck last year ago reawakened my interest and I decided to find out more about Dr Barton. I started with Bryn Thomas' book on Anaesthetic apparatus and then after finding his obituaries in the BMJ & Lancet, I contacted the librarian at St Mary's hospital.

Early years

He was born in Hong Kong on 18th November 1865, but birth certificates were only issued there from 1st January 1873. His birth was not registered in England so there is no certificate at the General Records Office; they gave me Hong Kong contacts but they couldn't help. I then looked at old Medical Directories. In the 1887 edition there was a George Kingston Barton of Grantham who qualified in 1841 and had been Surgeon, the General Hospital, Hong Kong, also resident surgeon POSN (Peninsular & Orient Steam Navigation) Co. Hong Kong, so he may have been GAHB's father. His *BMJ*[1] obituary says he went to De Aston School in Market Rasen. The school has no archives: they were deposited at Lincolnshire County Archives. The Archivist was not able to help me; they didn't have the Register from 1871 to 1901. It was in the possession of a clergyman who had died... Another family link came from the 1887 Medical Directory where three Bartons are listed as GPs & surgeons to the local hospital in Market Rasen: father Maurice and two sons; one, Edwin, had MD Brussels 1881. The 1881 Census shows our Barton, a 15 year old scholar, lived with his uncle, Maurice S. Barton, in Market Rasen.

Medical training

Barton entered St Mary's Hospital London on 2nd October 1882, 6 weeks short of his 17th birthday having passed University of London Matriculation in January. At the age of 21 after only four years at medical school, he qualified from Mary's: LSA on 23rd December 1886 (resident in Kilburn) and MRCS

1888, the Hall & College duo. Now here's a curiosity; his obituary in the *BMJ*[1] states he was house surgeon at the Royal Berks Hospital. Marshall Barr kindly sent me photocopies of pages from the Annual Reports of the Royal Berks for 1885 & 6. In 1885 G.A. Barton, Esq. was Assistant HS but in the 1886 Report dated 22nd February 1887 he'd resigned (there was a rapid turnover of house staff in 1886). Also the 1886 Medical Directory has him as assistant HS though he's not in their list of doctors. After this he returned to his Kilburn address becoming clinical assistant and prosector at Mary's where he'd been a Prizeman (cousin Edwin William had also been all three). In the 1890 edition he's listed as being in Hull and in 1891 Leeds, then Frampton on Severn for two years. In 1894 he was a GP in Morchard Bishop, Devon where he stayed until 1900/1.

Career in anaesthesia

After gaining the LRCP in 1901 he was in partnership with Dr Gee in Westbourne Park Road near St Mary's by 1902. He'd become a member of the Society of Anaesthetists (as was Gee), also Assistant Anaesthetist to the City Orthopaedic Hospital. His MD Brussels is dated 1901 in his obituary but doesn't appear in the Medical Directory of 1902. I contacted Professor J. L. Scholtes, an HAS member in Brussels who kindly checked this and found the degree is dated 1902, but sadly there is neither thesis nor even a title extant; was it related to anaesthesia?

In February 1905, at a Society of Anaesthetists meeting, he diffidently described a method of administering ethyl chloride. By now he was senior anaesthetist at North West London hospital as well as anaesthetist to the Throat hospital, Golden Square and the Female Lock hospital. He was also late surgeon to the Royal Mail and Ocean Lines. In July he had a letter published in *The Lancet* entitled "Prolonged anaesthesia by chloride of ethyl in operations on the nose and throat", and this was mentioned in *The Lancet Annual Review* in December. Later in 1905 HK Lewis published his book: *A Guide to the administration of Ethyl Chloride*[2] price 1/6 (7½p) which was reviewed in *The Lancet*. In December 1906 Barton reported to the Society of Anaesthetists on 200 cases using the Chloroform-Ether, Ethyl Chloride, Chloroform sequence, written up in *Practitioner* in 1907[3]. In 1907 he moved to 15 Talbot Road and published a 2nd edition of his Ethyl Chloride book @ 2/- : it must have been fairly popular[4].

At the BMA meeting in Exeter that year, in a discussion about spinal anaesthesia (in *The Lancet*[5] before the *BMJ*[6]) he listed side effects and failures and said "If instead of our going to Germany to learn our business, the Germans would learn from us to employ specialists to administer anaesthetics, we should never have heard of the intraspinal method". In 1909 he spoke again on the

subject at the Belfast BMA meeting in similar terms (*Lancet*[7], *BMJ*[8]) and had an anti-spinal letter published in the *BMJ* in June 1910[9]. In the Medical Directory of 1911 one of his appointments is to the National Dental Hospital but in 1912 it becomes 'late'. This suggests he was not very involved in anaesthesia for dentistry.

Barton's anaesthetic apparatus

In 1908 Barton described his Ether Inhaler; the Association of Anaesthetists of Great Britain & Ireland has a specimen. No *paper* dedicated to the inhaler has been found, but it featured in Meyer & Meltzer's Catalogue at a cost of 10/6 (52½p). The apparatus was fully described in Barton's book *Backwaters of Lethe*, 1920[10]. By 1931 the inhaler cost 15/- (75p).
In 1910 Barton described in the *BMJ* a combined tongue clip and Junker terminal[11].

Views on intravenous anaesthesia

Hedonal or methylpropylcarbinol urethane infusion, an early TIVA, was the subject of a discussion at the Anaesthetic Section of the RSM in 1911[12] and Barton urged caution. Hedonal was given as a 0.75% solution in saline and was first used for anaesthesia by Krawkow in St Petersburg in 1905. It had a brief period of popularity and is mentioned in Sykes' Essays vol. II p.179 with two Barton references. It was much used at St Thomas' Hospital for intracranial surgery. In the *BMJ* June 1912[13] he corrected the report of a death that had occurred when using hedonal and again at the RSM[14] in November. The patient, an ill-nourished tailor, at autopsy turned out to have miliary TB. At the BMA meeting Liverpool in 1912 his views about I-V anaesthesia, both ether and hedonal, were reported over two pages in the *BMJ*[15] and these are repeated in his book *Backwaters of Lethe* 1920[10]. Dudley Buxton refers to Barton twice in both the 5th & 6th (1914/20) editions of *Anaesthetics*. The first is a caution about I-V hedonal and the second shows pictures of Barton's use of his own apparatus for ethyl chloride in prolonged airway operations.

Period following World War I

I've found only one reference during the 1914/18 War in which he does not appear to have been actively involved and that was a meeting at the RSM where he advocated the use of alkaloids before ether anaesthesia, in particular 'scopomorphine'. He had a second address at 7 Devonshire Street by 1918. In 1919 he wrote to the letters' pages of the *BMJ* about the dangers of chloroform

with praise of Goodman Levy who had been a colleague at the North West London Hospital[16]. Also in the same year he had a paper in *Practitioner* about Alkaloids in Anaesthesia[17] repeated as an essay in his second book and he was Acting anaesthetist at St Mary's. In early 1920 he took part in a discussion at the RSM Anaesthetic Section[18] opened by Rood, on anaesthesia for throat nose operations. His book *Backwaters of Lethe (Some Anaesthetic Notions)* published in 1920 (price 5/-) was not a textbook, but a collection of essays. In the Foreword he says he has been practising and studying anaesthetics for 20 years in perhaps half as many hospitals. This takes us back to 1900 and to me suggests that the subject of his MD thesis was most likely related to anaesthesia. He makes no apology for the 'entirely unconventional' form of the book quoting the words of Leonard Williams': "Why should medicine be dull as well as difficult?" There was a friendly review in the British Journal[19] of Surgery, the title being the only subject of criticism 'perhaps does not encourage the reader at the outset, and indeed rather belies the excellence of its contents.' He refers to an anaesthetic bag he'd designed 'in pre-war days' and made by Surgical Manufacturing Co. It is a practical book, clearly written and his views are forthright but not dogmatic. It is concise, witty and amusing, and a 'good read'. Not included was his gag, which appeared in *The Lancet*[20] Christmas issue of 1920; he compares it favourably with Probyn Williams' modification of Doyen's gag. His last paper in the *Clinical Journal* 1921[21] is a detailed account of 'The Eye in Anaesthesia'.

Barton the man

He seems to have become well known in the speciality when his career was cut short by his untimely death on 13th January 1924, which occurred when he was riding in Rotten Row, Hyde Park. The death certificate says: "Fracture of the skull. Fall from horse. Accidental. P.M; Coroner, inquest held 15th." The *BMJ*[1] obituary was factual and remarks on his active role as a member of the BMA and Harveian Society and that he was a voluminous writer and frequent speaker. It mentions his ether apparatus, his books and several of his papers. *The Lancet*[22] has a more personal view by 'A colleague' who, after describing his personal qualities '[he] was no ordinary man', continues: 'His sudden death is a great loss to his former colleagues as well as to the many patients who appreciated the value of his professional services and his professional character'. I think he was a single-minded individual who dedicated his life to anaesthesia but stuck to his own methods for ether and ethyl chloride: 'An apparatus he designed... was used by him for many years'[1] & 'the rather elaborate sequence...gave in his hands excellent results'[22]. He was married and left a widow, Mary Matilda, but no children. He may have been as interested in horse racing as horse riding.

Acknowledgements:

I'm very grateful for help given me by individuals not named in the paper: Dee Cook, Archivist at the Society of Apothecaries; Iris Millis, AAGBI, for finding Barton's bag in a catalogue & other images; Kevin Brown, Trust Archivist St Mary's hospital; RSM Library staff for producing old copies of the Medical Directory.

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'HE THAT SLEEPS, FEELS NOT THE TOOTHACHE'

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Introduction

The deliberate production of unconsciousness as a technique to relieve the pain of any surgical procedures had many false starts, these all relating to a failure to bring three components together:

1. An agent to produce insensibility to pain of surgical procedures;
2. Humanitarian attitudes which recognised the implications of the observed effects of such an agent; and
3. The systems for its effective and safe delivery to the patient.

My title is one of Shakespeare's lesser known insights (it is from 'Cymbeline'), but it is one which has long intrigued me because it was written about half a century after Paracelsus noted the hypnotic effect of ether. Thus it shows how scientific observation failed to be related to an everyday insight, and provides an apposite title for an overview of the development of pain relief in dentistry.

The emergence of general anaesthesia

What might be termed the 'preliminaries' to Anaesthesia, like most aspects of modern society, depended on the social stability which followed, and led to, 'The Age of Enlightenment'. From the work of Hunter, Black, Priestley and Watt in the period 1750-1800 a path can be plotted by way of Davy, Colton and Wells that ended with Morton's public demonstration in Boston in 1846, my reason for including Colton I hope becoming being apparent later. From Boston the word spread to the UK, to London in December 1846 and to Edinburgh the following month.

First concept of local anaesthesia

Most of Simpson's work on general anaesthesia is well known, but it is less well known that he was the first to describe the concept of, and use the term, local anaesthesia, and that he made extensive, but unsuccessful attempts to produce it. Nonetheless, he published his results in both *The Provincial Medical Journal* and *The Lancet*. The papers were identical, unacceptable by today's standards, but perhaps the way to ensure the widest possible audience for this work at the time.

General anaesthesia became widely used, but it was not long before chloroform and death became closely associated in public and professional minds (outside Scotland anyway) so that other methods were sought. I have yet to establish any direct link between Simpson's paper and the early clinical trials of the numbing effects of cold, but a little text on 'painless dentistry' written by one Walter Blundell in 1854 does quote Simpson. The book is high on the efficacy and benefits of what he called 'congelation', but low in description of the method of application, and leads me to wonder if it was more of an advertisement for his practice than anything else! Of course, it was only a few years later that Richardson introduced the ether spray for refrigeration anaesthesia so perhaps I am being unfair to Mr Blundell!

Resurgence of nitrous oxide for dental anaesthesia

Meanwhile back across the Atlantic, Colton continued with the scientific demonstration which had attracted Horace Wells's attention, including an account of the events of 1844. Nearly 20 years later, in 1863, a lady in his audience who was fearful of chloroform asked him to give her nitrous oxide for a dental extraction. This was successful and led Colton to set up his Dental Association, essentially a commercial organisation to provide general anaesthesia. Nitrous oxide achieved wide attention as a dental anaesthetic technique, reaching the UK in 1867, and meaning that Horace Well's great insight had been fulfilled by the end of the 1860s. It became, albeit with progressively more advanced methods of administration, the definitive dental general anaesthetic.

Local anaesthesia in dentistry

More definitive local anaesthesia did not arrive until 1884 when Koller identified the topical effect of cocaine. Dental application was early, with the first nerve block being of the inferior dental nerve, but the problems of cocaine as a local anaesthetic soon became apparent and it does not seem to have been used widely in dental practice. Natural and synthetic alternatives were sought, but it was not until the arrival in 1948 of Lidocaine, with the ability to penetrate tissues significantly better than its predecessors, that the supremacy of nitrous oxide for dental work could be challenged.

Resources and standards in dentistry

At about that time general anaesthesia was advancing rapidly, outwith dentistry anyway: well trained service anaesthetists returned to the civilian scene and the specialty was established definitively in 1948 with the arrival of both the NHS

and the then Faculty of Anaesthetists. This meant that the knowledge, skills, attitudes and resources were available to take advantage of subsequent pharmacological and other advances. The arrival of halothane was perhaps the most relevant to my theme because its introduction to general dental practice was not necessarily backed up with the appropriate support resources, the attitudes, of all the parties involved, being a key problem.

Patients wanted the apparently 'easy' option of unconsciousness. Dentists, to be generous, allowed their professional pride to rule decisions on what was provided and where it was administered, to say nothing of those determined to work in operator/anaesthetist mode. The problems extended to our own specialty with the absence from dental practice of the standards (which were insisted upon in NHS hospitals) not preventing some from taking the opportunity of some tax-free income, perhaps tinged with an over-confident view of their own abilities. Finally, the service providers had power over service funding without responsibility for clinical problems, all of which were judged to be the clinicians' responsibility.

Changes in dental practice in the UK

These attitudes were far from ubiquitous, but prevalent enough for a steady trickle of patients, usually very young and perfectly healthy, to pay the ultimate price, with the headlines through the 1990's becoming more and more strident, and without several professional attempts at improving standards seeming to stem the flow. The result was that, at the end of 2001, general anaesthesia was effectively banned from general practice in the UK. Many clinical settings were worthy of nothing else, but a good number of satisfactory services were closed while the pedants argued about the meaning of the word 'hospital' rather than focus on the way to provide good quality anaesthesia.

A FOOTNOTE IN THE STUDY OF SURGICAL RELAXATION: I

Dr Ann Ferguson, Retired Consultant Anaesthetist, Broadstairs

Introduction

This is a discussion about the paper written by Alexander Crum Brown and Thomas Richard Fraser, which won the The Makdougall Brisbane prize of the Royal Society of Edinburgh in 1868. Consisting of a gold medal (a component now discontinued on grounds of cost) and a sum of money, this prize was awarded biennially by the Council of the Royal Society of Edinburgh "to such person for such purposes, for such objects and in such manner as shall appear to them to be most conducive to the promotion of the interests of science."[1]

Entitled "On the Connection between Chemical Constitution and Physiological Action" this winning paper was in two parts. Part 1 "On the Physiological Action of the Salts of the Ammonium Bases derived from Strychnia, Brucia, Thebaia, Codeia, Morphia and Nicotia"[2] was read on 6th January 1868. Part 2, "On the Physiological Action of the Ammonium Bases derived from Atropia and Conia"[3] was read on 18th January 1869. It was the first part which won the prize. They were altering these molecules, and trying the resultant compounds on hapless rabbits.
The authors were two young men at Edinburgh University.

Alexander Crum Brown

Alexander Crum Brown, born in 1838, entered the University of Edinburgh in 1854, as an arts student, and then as a medical student, qualifying MD in 1861[4]. At the same time, he was reading for the degree of science at London University, and in 1862 was the first candidate on whom the Doctorate of Science was conferred in London. He then went to Germany to study chemistry, under Bunsen and then Kolbe, and became a lecturer in chemistry in Edinburgh in 1863. He seems never to have considered a career in medicine, although some of his papers, such as one on the semicircular canals[5] in 1875, which won the Keith prize, show that he retained an interest in the subject.

His thesis for the MD degree was entitled "On the theory of chemical combination." This was not well received at the time, although in the discussion he evolved a system of graphic representation of the valency and linking of

atoms in organic compounds, in all essentials identical with that still in use today. In 1869 he became Professor of Chemistry in the University of Edinburgh, a post he held until his retirement in 1908.[4]

He was president of the Edinburgh University Chemical Society in 1874.[6] His teaching was legendary; always known as Crummie, one student wrote "Crum Brown was a charming man and a very bad teacher. Some days the noise and interruptions were so great that the poor professor had to give up and flee. Then in a few minutes he would return with tears streaming down his cheeks and apologise for his inability to control his class. We all loved him."[7]

He set up a small museum, which is still there, the Crum Brown Museum. In it the most prized exhibit is a model of rock salt, made by Crum Brown with knitting needles stuck into different coloured balls of wool to show its structure. They don't know when this model was made, but they are currently developing a process to date the dye in the wool. He thought very much in three dimensions; papers by him include one on interrelated surfaces[8] and one on the half twist surface.[9] This interest seems to have continued, as also in the museum, are two examples of his knitting, which is extremely complicated. I knit, and I calculate that this first sample would have to be done on three circular needles, or twelve double ended needles. The date of these is unknown, and they do not want to unravel any of it to get sufficient wool for a dye analysis. Just as a sideline from chemistry and knitting, he became an examiner in Japanese.[10]

Thomas Richard Fraser

The second author was three years younger, and qualified a year after Crum Brown. Thomas Richard Fraser was born in 1841, in India. He graduated MD from Edinburgh in 1862, gaining the gold medal for his dissertation on the action and uses of the calabar bean, although possibly his more important work was "The antagonism between the actions of physostigma and atropia" read before the Royal Society of Edinburgh.[11]

He became lecturer in Materia Medica, was for a short time medical officer of health for Mid-Cheshire, and then returned to the University as Professor of Materia Medica in 1877. In his opening address to the newly formed section of pharmacology and therapeutics of the BMA in 1885[12] he discussed the virtues of experimental work on drugs rather than their haphazard empirical use in disease, and also made reference to the valuable results that have been gained by the examination of many substances elaborated by the chemist. He did valuable

research into the actions of extracts of plants, his work on strophanthin having been previously described by AG McKenzie.[13] He also worked on snake venoms. His obituary describes his findings as "some of them at least will permanently benefit mankind by reducing disease and suffering." and "He was one of the earliest, if not the first to aim at the accurate expression of dosage in terms of body weight and to analyse pharmacological action into its component parts."[11]

His published opinion on anaesthetics was that there was no difference in the relative mortality of chloroform and ether, thought that nitrous oxide might be more useful if only it could be given under pressure, but he thought, too, that the mental condition of a patient who was taken, while conscious, into an operating theatre with many onlookers, was decidedly prejudicial.[14] This is a view with which most anaesthetists would agree wholeheartedly.

He was chairman of the Indian Plague Commission and on his return from India received a knighthood. He should have been considerably less proud of his part on the Admiralty committee charged with an enquiry into an outbreak of scurvy on the expedition led by Sir George Nares, described in detail by Fergus Fleming. In my view this was a government whitewash.[15]

Contemporary knowledge about curare

At the time this paper was published, paralysis by a constituent of South American arrow poison was well recognized. Claude Bernard had shown conclusively, in the 1850s, that curare acted on the neuromuscular junction.[16] The use of curare was advocated in tetanus and hydrophobia[17], but was not without its problems. After nine attempts to treat tetanus with curare had been reported in *The Lancet*, seven of which were failures, the journal published the following summary. "It is one of the least promising characteristics of curare, that both in composition and effect it is uncertain and varying. Its chemical nature is not uniform, even its source is variable, and its energies are unequal in various specimens.....The therapeutic action of curare is unreliable; it cures rarely, but it can kill promptly."[18] This article was published in 1859, while these two men were medical students, so they would certainly have read it.

Serendipitous investigation of synthetic muscle relaxant

These prize winning papers, written in the leisurely and circumlocutory prose of the period, have considerable historical importance since their work constitutes one of the earliest attempts to make a systematic study of the relationship

between the chemical structure and pharmacological action of a drug.[19] It is a mistake to think that Crum Brown and Fraser set out to synthesize drugs which would cause neuromuscular blockade, rather, they were investigating how the change in chemical structure of a substance changed its physiological action, and they happened upon the fact that the drugs they investigated caused paralysis. Only 43 pages into the first paper did the word "curare" first appear - when they realized that they had synthesized compounds with a pharmacological effect that mimicked that of curare.

We do not know quite why the collaboration between these two men took place, but seven pages into the first paper is the statement (paraphrased) that this investigation arose principally from a statement by Stahlschmidt, that methyl-strychnium compounds are physiologically inert; he, a chemist, had missed the fact that they caused paralysis. Crum Brown is the more likely to have seen this paper, but would have needed Fraser's expertise to develop the work.
Whatever the change in pharmacological action that Fraser and Crum Brown found, they would have reported it equally enthusiastically.

Their experimental work consisted of instilling the drugs, in increasing doses into rabbits, and then observing the animal for spontaneous activity, head drop (this was the method used by Horace Halliday nearly a century later to quantify Intocostrin), corneal reflex, respiratory rate and pattern, and after death (described as *cessation of respiration*), heart action, peristalsis and galvanic stimulation of muscle and sciatic nerve.

When they found that they were causing neuromuscular blockade in these animals, they included frog preparations identical to those described by Claude Bernard, but described them as "a somewhat tedious preparation". These frog experiments do demonstrate as conclusively as they could at that period that neuromuscular blockade was produced by the compounds they had produced, although in two of the 104 rabbit experiments this is doubtful. One, unfortunately the first described in the paper, is said to have had muscle contraction immediately postmortem on sciatic nerve stimulation, but at that point they did not know that paralysis was what they were looking for, and the other may or may not have been paralysed according to how one interprets the grammar.

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A FOOTNOTE IN THE STUDY OF SURGICAL RELAXATION: II

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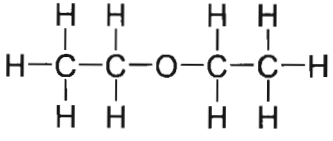
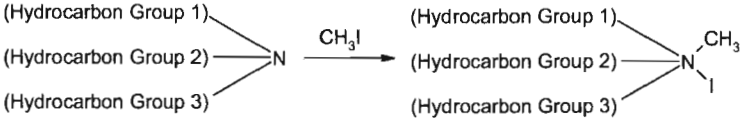
Chemical background to Crum Brown and Fraser's investigation of methylated strychnine

The second half of the 1860s was an exciting time in science. Although for the past 50 years it had been possible to analyse substances in terms of percentage carbon, hydrogen oxygen etc, the conversion of these data into molecular formulae was unreliable, owing to uncertainly as to which scale of atomic masses to use to calculate the results. Shortly after the Karlruhe Conference, called to sort out the confusion in 1860, agreement was reached as to which set of values could be confidently used. Thus it was possible by 1865 to go from the analysis of ether (C: 64.9%; H: 13.5%; O: 21.6%) to its molecular formula, $C_4H_{10}O$. Moreover, in the cases of some molecules it was possible, due to the work of Brown and others, to link the various atoms together via chemical bonds to give structural formulae.[1]



Diethyl ether

However this was only possible for the simpler of molecules. Linking up the atoms in a molecule as complex as strychnine, $C_{21}H_{22}N_2O_2$, defeated the chemists of Brown's generation. Nevertheless, it was possible, due to the burgeoning nature of organic chemistry in the 19th century, to gain some insight as to how *some* of the atoms were linked one to another. Strychnine reacted with haloalkanes such as methyl iodide, CH_3I, to form a crystalline salt. In 1851 Hofmann[2] had explained such a reaction in terms of attachment of the iodide on to a tertiary amine function:



A quaternary ammonium salt

It was likely, then, that strychnine contained one or more nitrogen atoms showing this type of connectivity.

The increasing appreciation of the structures of simple molecules enabled correlation with physical properties: adding a CH_2 group caused a predictable increase in boiling point:

CH_3OH	CH_3CH_2OH	$CH_3CH_2CH_2OH$	$CH_3CH_2CH_2CH_2OH$
(BPs) 65°C	78°C	97°C	118°C

Possibly a connectivity of this type might have stimulated Brown and Fraser, to speculate whether a relationship existed between increasing molecular complexity and an appropriate physiological property. Certainly, this was a new strand of research for Crum Brown, and nothing in his previous papers prepares us for this present work. His colleague, Fraser, had already shown an interest in naturally occurring poisons, and their chemical manipulation (a notion which we attribute to Brown) was the starting point of their paper.
They appreciated that chemical attachment could markedly alter the physiological properties of a substance. Included in their examples were:

CO	⟶	CO_2
As_2O_3	⟶	$AsC_2H_7O_2$ (kakodylic acid)
$C_{21}H_{22}N_2O_2$	⟶	$C_{22}H_{26}N_2O_3$ ("methyl strychnine hydrate")
All highly toxic		All regarded as non-toxic

Is it possible, they asked, to connect the manipulation of a chemical structure (C) with a physiological effect (Φ) ?
Thus, they conjectured:
C connects with Φ
So conceivably
C + ΔC might connect with Φ + ΔΦ.

So if an effect was observed on treating, say, strychnine with one alkyl halide, then (and this is speculating) replacing the halide with another might yield a product with similar, but not identical properties. With luck, a trend might be observed. They chose to investigate strychnine, readily available in a high state of purity, and with a dramatic and predictable physiological effect: it was a potent convulsant poison, 1/50 – 1/20 grain injected into a rabbit would cause it to exhibit tetanic convulsions within 15 minutes and it would be dead within 30. Yet a rabbit of similar size could receive 15 grains of methylated strychnine and "the following morning was found to be jumping actively about, and in apparently normal condition". Brown and Fraser admit that this basic discovery was not theirs, but attribute it to the work of Johann Carl Friedrich Stahlschmidt, reported in 1859. It is possible that Brown might have met Stahlschmidt whilst travelling in Germany, but it is more likely that he was showing good awareness of the recent literature (in this case, *Poggendorff's Annalen*, then a major European journal). However whereas Stahlschmidt reported that the methylated product was "inert", our Scottish workers found that it had a dramatic property that he had overlooked. It, and its related "condensation" products, were profound muscle relaxants. From this point onwards it is clear that the thrust of their investigation changed and there in no further mention of (C), $\Delta\Phi$ etc. Converting highly toxic alkaloids into relatively non-toxic muscle relaxants of possible medical application was going to be far more interesting and, from a results point of view, productive. They describe one of their procedures: "Fifteen grains of iodide of methyl strychnine was suspended and dissolved in warm distilled water (and injected). No effect was caused until 45 minutes, when the rabbit moved about uneasily, the limbs gradually yielded and soon lay on its chin and abdomen. When placed on its side it remained quiet, without any attempts to recover a normal posture....In one hour, when lifted by its ears, it hung in a perfectly flaccid and unreacting condition. There were no voluntary movements. In 1 hour 15 minutes, a few spontaneous movements occurred in its limbs.... In 2 hours 35 minutes, the condition of the rabbit had greatly improved. Efforts to rise were frequently made....The following morning the rabbit was found actively jumping about, and in apparently normal condition."[3]

In a subsequent experiment a poor rabbit was injected with 20 grains of the compound. This proved to be a lethal dose: "In 1 hour 10 minutes the rabbit was dead. On immediate autopsy the heart was (found to be) contracting with regularity and with considerable force, at a rate of 160 beats per minute. The intestinal peristalsis appeared normal and electrical stimulation of the sciatic nerve caused contraction of the posterior extremities at 4 minutes after death".

We find this last observation perplexing and wonder how effectively the rabbit had been paralysed. Possibly it might have been only lightly relaxed and that death might have resulted from some other, additional, toxic action of the strychnine methiodide. As we will see later, the doses used by Brown and Fraser to achieve rabbit paralysis were not inconsiderable.

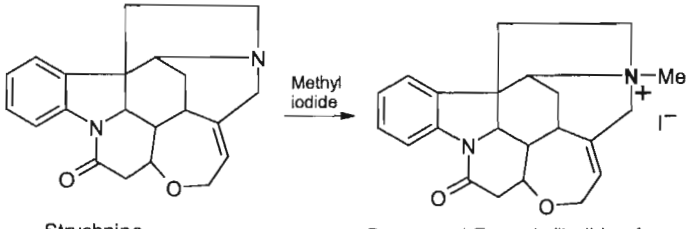
Main conclusions and suggestions

1. Similar results were obtained with other alkaloid derivatives. Their first paper lists those with the closest similarities to the strychnine observations: most strikingly, methylated brucine and thebaine, and to a lesser extent, methylated codeine, morphine and nicotine proved to be relaxants. Their second and final paper on this topic included those whose action was not as straightforward: methylated atropine and coniine, but nevertheless showed some similarity.[4]
2. When the iodide in the derivative was replaced by another anion to yield a more soluble quaternary ammonium salt, then less material was need to induce flaccidity or, on overdose, cause death.
3. The toxic character of the original alkaloid was reduced some 400 fold by this type of derivitisation.
4. Brown and Fraser noticed that the paralysing action of their products was similar to that of curare, though not as potent. Indeed, they perceived advantages of their derivatives: "*It is not only of great interest, but probably of some practical value, that five of these compounds should be found having the physiological action of curare. The great difficulty of obtaining this substance has hitherto proved a serious barrier to its therapeutic employment..... Moreover, they may be obtained in a state of perfect purity, and, therefore, of constant strength; and, in this respect, they possess a great advantage over curare.*"

To a degree Brown and Fraser downplay their discovery. However it is fair to credit them with a "first". Notwithstanding their use of a natural product, strychnine as starting material, their methyl iodide adduct is the first literature example of a *synthetic* muscle relaxant. Moreover, their methylated strychnine is only the second example of a relaxant known to humankind, the first being (of course) curare itself.

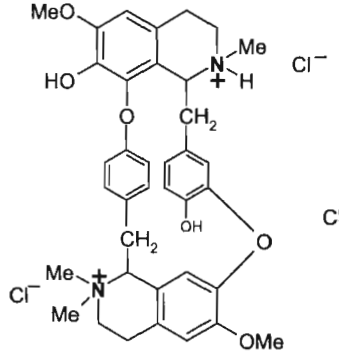
Their chemistry: the current interpretation

The structure of strychnine was elucidated in 1946 by Sir Robert Robinson.[5] The effect of the treatment with methyl iodide is shown below, and the product quaternary ammonium salt used by Brown and Fraser in their investigations, is compared with the structure of curare[6] and atracurium (benzene sulphonate), a widely used contemporary relaxant.

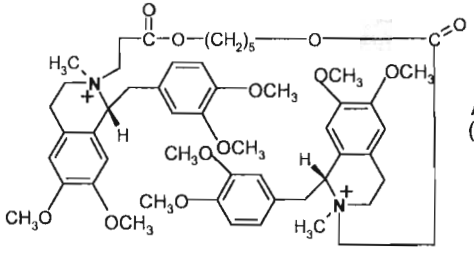


Strychnine

Brown and Fraser's "iodide of methyl-strychnine"



Chloride of tubocurarine



Atracurium
(as benzene sulphonate)

All three relaxants contain the quaternary ammonium function (indicated by the N in bold type). The potency of tubocurarine chloride, atracurium and other "post curare" relaxants is due to the presence of *two* quaternarised nitrogen atoms set an appropriate distance apart in the molecule, either by good fortune or design.

Brown and Fraser limited their researches to alkaloids the effects of which were easily monitored (convulsant poisons, mainly). Presumably this was why they did not report on two further alkaloids that found place in contemporary medical practice: cocaine and quinine. This latter substance contains two nitrogen atoms capable of reacting with methyl iodide and its diquaternary salts thus have some similarity in structure with tubocurarine chloride. Had Brown and Fraser included quinine derivatives in their investigations, they might have encountered a more potent relaxant than those recorded in their two papers. But whether such a discovery, had they made it, would have advanced the therapeutic applications of relaxants is a different matter.

What they didn't do

It is noteworthy that they observed in numerous autopsies that the rabbits' hearts continued to beat strongly "after death". They appear not to have tried to revive the animals with artificial ventilation applied until the effects of their relaxants had worn off, even though Benjamin Brodie had previously done so with a "she ass" as early as 1811.[7]

Though both researchers were medically qualified and presumably well aware of the practice (and by 1869, the limitations) of anaesthesia, they made no connection between their relaxants and anaesthetic practice. This is not surprising, as the potential of curare for relaxing the abdomen during surgery was not recorded until tried by Lawen in 1912,[8] and de Caux in 1928,[9] and it was not successfully used until the work of Harold Griffith and Enid Johnson in 1942, almost three quarters of a century after Brown and Fraser's pioneering work.[10] However, curare was repeatedly being tried as a cure for tetanus and other spastic states.[11]

And why a footnote?

In the early years of "curarisation", Intocostrin was the preparation of choice. Marketed initially as a relaxant to minimise cases of fracture of the spine or limbs attendant on the use of metrazol for convulsive therapy, this provided

practitioners with a standard dose of tubocurarine hydrochloride thus eliminating the risk associated with crude curare preparations of undetermined relaxant content.[12] But Brown and Fraser had drawn attention to precisely this advantage of their methylated strychnine over curare. Why then were their products ignored by the post-1940 anaesthetists? The answer lies if we convert the quantities of their products necessary to induce relaxation from their units of choice (grains, 1gr = 65mg) to milligrams and grams and scale up the rabbit dosage to that required for a man or woman, say of 70 kg.
Their rabbits weighed about 3.5 lb, or 1.6 kg, and required (typically) 20 grains of "iodide of methyl-strychnium" to paralyse breathing. This equates to a dose of 1300 mg injected subcutaneously into the poor rabbit. Now scaling up from our 1.6 kg rabbit to our standard man or woman we have to multiply the rabbit dose by a factor of 44. Our 1300 mg (= 1.3g) becomes a "man-dose" of 57g for relaxation. This is a truly enormous amount and would require a syringe of "garden" proportions for its administration. Even though large amounts of drugs are now given by infusion, injecting such a quantity of sparingly soluble material would prove an almost insurmountable challenge, even allowing for a reduction in required dose as this would be administered intravenously. Apart from the painful nature of the injection, the use of the Brown/Fraser relaxant has another drawback. The lethal dose of strychnine by injection can be as little as 40 mg. It would only require a trace (0.07%) of unmethylated strychnine to be present in their relaxant, unconverted, to condemn the patient to an agonising death.

Given that tubocurarine hydrochloride will induce surgical relaxation with a dose of about 30 mg, and given that Squibb's Intocostrin was substantially free from toxic impurities, it is no wonder anaesthetists chose to use the curare-derived material rather than the relaxant products developed by Alexander Crum Brown and Thomas Richard Fraser in their pioneering work of 1869.

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GUEST LECTURE – SUMMARY

THE MALVERN WATER CURE

Dr John Winsor Harcup OStJ
President Elect, Section of the History of Medicine, RSM

The hard rock of the Malvern Hills has fissures through which rainwater percolates, giving rise to springs lower down. This pure water has been appreciated for centuries – Queen Elizabeth I granted the "Holy Well" to the Lord of the Manor. In 1756 Dr John Wall published a book titled "Experiments & observations on the Malvern Waters", showing that the Malvern Water was practically devoid of minerals. Hence Malvern became widely known.

In the early 19th century Vincent Priessnitz originated (mountain) water therapy in Gräfenberg, which was then in Austrian territory. News of this reached Dr James Wilson, who had a medical practice in London and was looking for another form of treatment. He visited Gräfenberg and returned to set up at Malvern a Cold Water Cure establishment, which thrived. There was enough practice in the 1840s for Dr Gully to have his own establishment. Wilson and Gully wrote a book "Dangers of the Water Cure". They treated a well-to-do clientele (victims of self-indulgence) by wrapping in wet sheets, water-drinking, diet and walks on the hills.

The Malvern Water establishments had many famous visitors, including Alfred Tennyson, Charles Darwin and Florence Nightingale.

Dr Harcup has written a book "The Malvern Water Cure".

OBITUARY

Dr Douglas D C Howat

Douglas Howat was born on the 10th January 1920 in the Scottish borders and brought up in London, where his father was a general practitioner. He studied medicine at King's College, London, qualifying in 1943. Here he met his future wife Joan who was also a student. After service in the RAF he eventually became consultant anaesthetist to St George's and the Royal Masonic Hospitals in London.

He served on the Council of the Association of Anaesthetists of Great Britain and Ireland (AAGBI) and when in 1969 a Treasurer was due to be elected, someone was inspired to say 'let's make Dr-and-Mrs-Howat our Treasurer'. He became Treasurer, with Joan's help for she was always as much a part of his professional and public life as of his family life. Both contributed together.

Later Douglas was elected to the Board of the Faculty of Anaesthetists where he served with competence on numerous committees, as examiner for the Fellowship, and delivering the Frederick Hewitt lecture in 1977. When Vice-Dean he breathed new life into what was then a rather vague post, whilst his contribution to surgical affairs was so effective that in 1984 the surgeons elected him FRCS. He was elected Honorary Member of AAGBI in 1986.

Douglas soon became involved in international affairs. He had an ability to establish rapport with all sorts of people and where diplomacy was needed, he was asked to go. As early as 1966 he was one of the UK representatives considering the implications for medicine of Britain joining the European Economic Community. Not only his linguistic skills but even more his wise counsel was immensely valuable When the UK eventually joined in 1973 he continued to represent British anaesthesia on the Council of the UEMS and chaired its Anaesthetic Monospecialist Committee. From 1976-1980 he served as Chairman, and later Vice–President of the Executive Committee of the World Federation of Societies of Anaesthesiologists, and also chaired its European Section. He was involved too in the founding of the European Academy. During this period links with our overseas colleagues were notably strengthened and anaesthesia was established as one of the leaders amongst the medical specialties.

In his home country Douglas was President of the Royal Society of Medicine's Section of Anaesthesia and of the History of Anaesthesia Society. During his retirement he continued to pursue studies into the history of medicine, attending professional meetings and reporting his researches in a highly entertaining way.

St George's is the hospital where John Hunter worked as a surgeon over 200 years ago. It is tempting to suggest that they might have got on well together, John impatient, demanding and occasionally irascible, Douglas working in an unobtrusive yet effective way, never losing his sense of humour and always just as willing to carry out the mundane chores as the more prestigious ones. Although a national and international figure, he never forgot that the prime responsibility of a clinician is to serve his patients with skill and consideration, and to support his surgeons and his trainees.

Aileen K Adams

BOOK REVIEW

The American Society of Anesthesiologists: a Century of Challenges and Progress. Bacon DR, McGoldrick KE, Lema MJ (Eds.). ParkRidge: Wood Library-Museum, 2005. ISBN 1-889595-15-2. Hardcover, 225 pp, illustrated, indexed, US$55.

Produced for the Centennial of the ASA, this handsomely bound volume has a beautiful cover, within which there are 17 chapters written by 20 authors. The history of the ASA is traced from the inception of the Long Island Society of Anesthetists in 1905, through its name changes to the New York Society of Anesthetists in 1911, to the American Society of Anesthetists in 1936, and to the American Society of Anesthesiologists (ASA) in 1945. A good explanation is given of the initial difficulty the specialty had in establishing its own section within the American Medical Association (AMA). To summarize, FH McMechan, who headed the rival Associated Anesthetists of the United States & Canada (formerly American Association of Anesthetists), angered the AMA in 1933 when he turned down precisely this offer! A way forward was found in the creation of the American Board of Anesthesiology (ABA) as a sub-board of the American Board of Surgery in 1937; this offered its first written examination in 1939. The death of McMechan that year facilitated progress with the AMA, and also released the ASA from an agreement not to have a journal – *Anesthesiology* was born in 1940.

There are interesting chapters devoted to the Wood Library-Museum, the Annual Meeting, the Newsletter and Women Anesthetists. Each decade from 1950 to 1999 is allocated a chapter, the last chapter covering 2000-05: the focus is largely on political intrigues and administrative wrangles with anaesthetic associations and governmental agencies. While perhaps of interest to the US readers, I feel there is too much detail to retain the attention of those outside. However, attention to the (often hostile) relations with the American Association of Nurse Anesthetists (AANA) may be salutary to British practitioners, apropos the advent of Anaesthesia Practitioner training in the UK.

The book is lavishly illustrated with excellent photographs of notable personalities, many in their younger days - this, I feel, is a major strength.

For review purposes I read the book from cover to cover. In so doing I discovered much repetition. However, this will not be a problem and may be advantageous for those who dip into the book – perhaps the intention of the editors. Errors are few – I noticed "Magill" spelt for McGill University on page 37, this being repeated in the index. As chapter numbers are given in the table of

contents, one would expect the appropriate number to precede each new chapter title within, but these have been omitted. Finally, as the development of the ASA is quite complicated, I think that a chronology of important events should have been included.

Every library purporting to have a good range in the history of anaesthesia should have a copy of this book.

Alistair McKenzie