The History of Anaesthesia Society Proceedings

Volume 51

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Papers and Abstracts from the Edinburgh Meeting

Friday 29th June 2018

Session 1. Symposium on the History of Subspecialties in Anaesthesia. Chairman: Dr John Pring.

Session 2. Symposium on the History of Subspecialties in Anaesthesia. Chairman: Dr Ann Ferguson.

Session 3. Free Papers. Chairman: Dr John Crowhurst

Session 4. Trainees. Chairman: Dr Alistair McKenzie

HISTORY OF ANAESTHESIA SOCIETY

Summer Scientific Meeting at the Royal College of Surgeons of Edinburgh

Organiser: Dr Alistair McKenzie

FUTURE MEETING 2019

Madingley Hall, Cambridge, 13th – 15th June 2019

Organiser (Programme): Dr Alistair McKenzie
Organiser (Administration): Dr Ann Ferguson

The History of Anaesthesia Society Proceedings
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HISTORY OF ANAESTHESIA SOCIETY

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EDITORIAL

This year's most successful meeting was held in the historic building of the Royal College of Surgeons in Edinburgh. Medicine is lucky that the profession has roots going back centuries and its professional organisations have, in the main, been well-endowed, albeit, now, with fine buildings and libraries, which can be very expensive to maintain.

Next year, the Society is to occupy Madingley Hall, a Tudor mansion (1534 AD) with additional modern bedrooms, on the outskirts of Cambridge, for its meeting. It is the home of the University's Institute of Continuing Education and is set in beautiful grounds.

Does the Proceedings of the History of Anaesthesia Society issue 'Instructions to Authors'? No! To be useful, such instructions would need to be comprehensive (and lengthy). When both the *'British Journal of Anaesthesia'* and *'Anaesthesia'* supply authors' instructions, it seems sensible to accept manuscripts prepared according to their instructions and make any editorial changes to maintain the style of the Proceedings. The two major differences are that the Proceedings quotes the first six authors and does not abbreviate the titles of referenced journals. The page setup is for A5 and Garamond 12 point font with unjustified right margins. Authors are requested not to embed their titles and references but to word-process them as normal text.

The final version of the Proceedings are delivered to the Printers in desktop publishing form ready for printing.

Deaths of Members 2017-2018

Dr B. Dworicek	Krimpen Ad Yssel, The Netherlands
Dr T. N. Calvey	Goostrey, Cheshire
Dr E. Holmes	Colby, Isle of Man
Dr W. MacDonald	Leicester, Leicestershire
Dr J. Smits	Ede, The Netherlands
Dr W. D. Turner	Leicester, Leicestershire
Dr Catherine Wisely	Edinburgh, Scotland

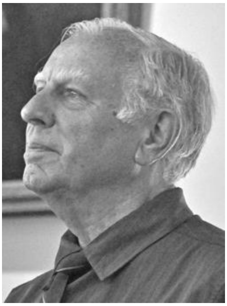
Edinburgh Meeting: Speakers' photographs

Dr Peter Farling

Dr Alistair McKenzie

Dr Declan Warde

Dr Peter Alston



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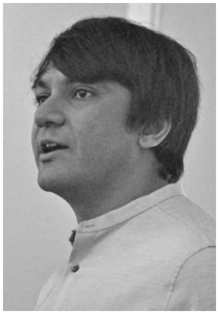
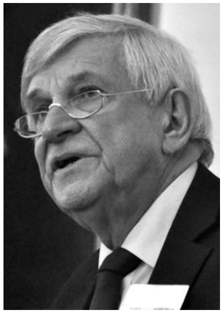

Dr Ahmed Gilani


Dr John Crowhurst


Dr Kentaro Dote


Dr Hiroshi Makino


Prof. Hirosato Kikuchi


Dr Patrick Magee


Dr Margaret Branthwaite


Prof. Walter Nimmo

LIST OF DELEGATES

History of Anaesthesia Meeting, Edinburgh, June 2018

Neil Adams
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George Bause
Colin Birt
Elizabeth Bradshaw
Margaret Branthwaite
John Crowhurst
Kentaro Dote
Michico Dote
Alan Dronsfield
Peter Farling
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Neil Handley
Ivan Houghton
Danielle Huckle
Sophie Johnson
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Sandra Kopp
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Kenneth MacLeod
Patrick Magee
Hiroshi Makino
Roger Maltby
Rajinder Mirakhur
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Erica Morris
James Mulvein
Walter Nimmo
Adrian Padfild
Gordon Paterson
John Pring
Michael Skivington
Philip Taylor
Declan Ward
Sampath Weerakkody
Patricia Willis
Edward Young

Neuroanaesthesia

Dr Peter Farling M.B., B.Ch., B.A.O., F.F.A.R.C.S.I, F.R.C.A. (ad eundem)

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It is appropriate that neuroanaesthesia has the first slot in this symposium, as it was the first sub-specialist group of anaesthetists to be formed and, in 2015, celebrated its fiftieth anniversary.

Perhaps this presentation could have begun with images of trephined skulls, such as those found in the anthropomorphic museum in Lima, Peru. Or perhaps mention could have been made of 'The Fool's Stone' or 'Operating on the Stone of Madness' as depicted in the paintings of Bosch or Hemessen in the Prado, Madrid. We may even have considered the priests carrying mandrake and poppies in Ur during the third millennium BC.

However I have chosen to begin with an American postage stamp that commemorates the life of Harvey Cushing, the Boston neurosurgeon. As a medical student Cushing was called down from the benches to administer ether to a patient undergoing a surgical procedure. To the young Cushing's dismay, the patient promptly vomited, aspirated and died. His seniors seemed unperturbed as they remarked, *'this happens all the time'!* [1] Cushing was one of the first clinicians to insist that the patient's vital signs were recorded throughout operations that he performed. He felt that neuroscience demanded teamwork, and is quoted as saying

> 'Regardless of the drug to be employed it is essential that it be employed by an expert - preferably by one who makes this his specialty'.[2]

A number of British neurosurgeons trained in North America during the 1920s. These included Mr Geoffrey Jefferson, Mr Norman Dott CBE and Sir Hugh Cairns, all of whom trained with Harvey Cushing in Boston. They returned to Manchester, Edinburgh and London respectively and brought with them the team model employed by Harvey

Cushing. On returning to London Sir Hugh Cairns adopted Cushing's approach and persuaded the Rockefeller Foundation to provide funding for the first specialist neuroanaesthetist, Dr Olive Jones.[3] Many other centres benefitted from the connection back to Cushing. For example, Mr Cecil Calvert, one of the first neuro-surgeons in Belfast, had worked with Hugh Cairns in the Royal Medical Army Corps.

In 2006 Dr Jean Horton passed the original Minute Book into my hands for safekeeping, and Dr Jim Jenkinson, who was Honorary Secretary from 1981, also sent me the minute book that he had maintained. Information gleaned from these original minute books, and from an article in *Anaesthesia News* in 2002, by Dr Jean Horton, has formed the basis of this presentation.[4]

This year celebrates the 70th anniversary of the National Health Service and, in the early days, anaesthetists had to fight for consultant status. By the 1960s, neurosurgical units existed throughout Great Britain and Ireland and a number of anaesthetists specialised in anaesthesia for neurosurgery. However, the meetings and conferences of that time did not fulfill their academic needs. For example, during the meeting of the British Medical Association in 1963 the Section of Anaesthetics had a short symposium on anaesthesia for neurosurgery. This symposium was chaired by Prof. Cecil Gray and consisted of four presentations.[5]

In an effort to fulfill academic requirements, Dr Allan Brown, Edinburgh, set up discussion groups, that met twice a year, for specialist neuroanaesthetists from Edinburgh, Glasgow, Aberdeen and Dundee.

In 1964 this Scottish group met in Newcastle and Dr Andrew Hunter, from Manchester, was present. He invited those present to Manchester and hence the first meeting of what was to become the Neuroanaesthesia Society took place in the Manchester Royal Infirmary on 18th September, 1965.

Dr Hunter was born in Glasgow in 1915, graduated in 1937 and had house jobs at Glasgow Royal Infirmary and Falkirk. He became a consultant in Manchester Royal Infirmary in 1943 and obtained a personal Chair in 1971. He wrote the first textbook of neuro-anaesthesia in 1964 and was active throughout his career in the Royal Society of Medicine, The Association of Anaesthetists of Great Britain and Ireland (AAGBI), the Royal College of Anaesthetists, The British Journal of Anaesthesia, the Anaesthetic Research Society and the Intensive Care Society.[6]

The 1965 meeting was chaired by Dr Hunter and took place in the Clinical Lecture Theatre of Manchester Royal Infirmary. There were 35 attendees including Dr Olive Jones, Dr Jean Horton, Dr Allan Brown, Dr Aileen Adams, Dr Harvey Granat, Dr Gordon McDowall and Dr John Barker. Twenty neurosurgical centres were represented, many of which either no longer exist or have ceased to provide neurosurgical services.

Six papers were presented as follows:

1. Dr Hewer. Hypothermia during neurosurgical anaesthesia.
2. Dr Campkin. Moderate hypothermia and circulatory arrest for operations on intracranial aneurysms.
3. Dr McCleery. Some aspects of anaesthesia for cerebral aneurysm – moderate hypothermia.
4. Dr Potter. A comment on the use of the ECG during Pudenz shunts.
5. Dr Brown. The treatment of status epilepticus.
6. Dr Keen. Variations in venous pressure during controlled respiration.

Following the meeting, Dr Hunter wrote to Dr P Dinnick, the Secretary of the Association of Anaesthetists of Great Britain & Ireland (AAGBI) explaining why the meeting had taken place. He wrote

> 'We discussed the question of the formation of some kind of organisation of neurosurgical anaesthetists in Great Britain, but decided emphatically against this for we were most anxious not to set up anything which would seem like a sectional organisation among anaesthetists'.

Rather than being named an association or society the members decided to form the Neurosurgical Anaesthetists Travelling Club.

The meeting in 1966 took place in London and there were 70 attendees. Among those presenting were Dr Harvey Granat. After his death his widow contacted the neuroanaesthetists in Glasgow and it was decided that the legacy would fund a Registrar's Prize. The Harvey Granat Prize has since been awarded at the Annual Scientific Meetings.

The paper presented by Dr John Barker in 1966 had two co-authors. They were Mr Byran Jennett, the co-founder of the Glasgow Coma Score, and Dr DG McDowall.

Professor Gordon McDowall was a graduate of the University of Edinburgh but moved to the Neurosciences Centre in Glasgow. His MD was on the effect of volatiles on cerebral blood flow and intracranial pressure. He was appointed as Professor to the anaesthetic department of the University of Leeds in 1969 where he worked until his untimely death in 1984. Interest on his memorial fund has sponsored a biennial lecture and the first McDowall lecturer was in 1987 by Prof. Jack Michenfelder of the Mayo Clinic. Other lecturers have included Dr Betty Grundy, Prof. Adrian Gelb and Sir Graham Teasdale.

The pattern of the early meetings of the Travelling Club became established. There was a visit to the host department where its research was displayed. There would be a number of scientific papers, a business meeting and a dinner in the evening. The meeting in Oxford was the first to send out advance information about the city's attractions and, of note, the price of the dinner, in the Randolph hotel, was £2 'exclusive of drinks'!

Relationships began to develop with the AAGBI and other specialist groups. A meeting took place in 1972 that was attended by the then office-bearers of the AAGBI and representatives of the following groups:

- Association of Professors of Anaesthesia
- Intensive Care Society
- Anaesthetic Research Society
- Neurosurgical Anaesthetic Travelling Club

- Obstetric Anaesthestists Association
- Intractable Pain Society

The President of the AAGBI, Dr Alfred Lee, welcomed the representatives and, while it was felt that *'an official relationship would be difficult,'* it was generally thought that an unofficial understanding was desirable!

In 1974 Dr Lipton, who was hosting the meeting in Liverpool, wrote to Dr Shapiro who was the Secretary/Treasurer of the Society of Neurosurgical Anesthesia and Neurologic Supportive Care in USA. This was the beginning of what has developed into a mutually beneficial association between the two groups. Combined meetings took place with other specialties and other nationalities. In 1988 there was a combined meeting of British neurosurgeons and neuroanaesthetists to celebrate 50 years of neurosurgery in Oxford. The meeting of 1991 took place in the College of Surgeons, Dublin and was attended by German and Austrian neuroanaesthetists and the Association of Cardiothoracic Anaesthetists.

During the business meeting in July, 1991, Dr Stuart Ingram, London, tabled a suggestion that the time had now come that the Travelling Club should have a formal structure and constitution. A working party was formed consisting of Dr Aileen Adams, Professor Bill Fitch, Dr Jim Jenkinson and Dr Ingram. This paved the way for the change from the informal Travelling Club to the Neuroanaesthesia Society of Great Britain & Ireland (NASGBI). The NASGBI became the 'voice' of neuroanaesthesia and the contact point for educational and political issues. A website was developed, a network of 'linkmen' was created and Travelling Fellowships established. 'Glossies' were co-written with the AAGBI on topics such as *Transfer of Patients with Brain Injury* and *The Provision of Anaesthetic Services in Magnetic Resonance Units.* An elected Council was formed in 2006 to cope with the expansion of membership and in 2015, at the 50th anniversary meeting, it was agreed to change the name to the Neuroanaesthesia & Critical Care Society of Great Britain and Ireland.

The original minute books are in safe keeping in the AAGBI museum in

London and can be viewed by contacting Trish Willis, Heritage & Records Manager, trishwillis@aagbi.org

During discussion it was mentioned that neurosurgery has developed thanks to advances in anaesthesia and the move to interventional neuroradiological procedures has been embraced by neuroanaesthetists. When propofol was first introduced, the concept of Total Intravenous Anaesthesia was not an issue for established neuroanaesthetists who had used this technique with such agents as Althesin.

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The Development of Obstetric Anaesthesia & Analgesia as a Subspecialty

Dr Alistair G McKenzie

Consultant Anaesthetist, Royal Infirmary of Edinburgh

In the early 1840s James Young Simpson, the Professor of Midwifery in Edinburgh, knew the value of a strong analgesic to facilitate turning the foetus when the uterus was contracting. He used 100-120 drops of laudanum, which took a long time to act.[1] So, of course the advent of general anaesthesia (GA) at the end of 1846 immediately captured his attention! On 19th January, 1847 Simpson was probably the first person in the world to administer ether in obstetrics.[2] He wrote in March 1847

> 'It will be necessary to ascertain anaesthesia's precise effects, both upon the action of the uterus and on the assistant abdominal muscles; its influence, if any, upon the child; whether it has a tendency to haemorrhage or other complications'.[2]

Unfortunately Simpson did not follow this up. Searching for a better anaesthetic agent than ether in obstetrics, Simpson famously was impressed by chloroform in the dining room of his home on 4th November, 1847.

Within two weeks he published a pamphlet describing the safe use of chloroform in 50 cases, including the first use in obstetrics.[3] On 1st December, 1847 he read a paper to the Medico-Chirurgical Society of Edinburgh, including several cases of chloroform administration in obstetrics. Describing Case VI, he wrote

> 'She entertained some mistaken religious feelings against ether or chloroform, which had made her object to the earlier use of the latter; but I now placed her under its influence'.[4]

Within a week or two, Simpson published another pamphlet *Answer to the Religious Objections Advanced Against the Employment of Anæsthetic Agents in Midwifery and Surgery*.[5] Lecture notes made by one of Simpson's students through 1848-49 listed objections to the induction of anaesthesia in labour in three categories: religious, moral and medical.[1]

The question, 'did drugs cross the placenta'? remained to be answered. In 1853 John Snow smelled ether on the breath of neonates delivered from mothers given ether, observing depressed neonatal breathing and motor activity – so surmised placental transfer.[6] However, physicians were reluctant to accept that anaesthetic practice needed to be modified to limit effects on the *baby*.

Simpson persisted with chloroform despite reports of deaths under its influence. However womankind is indebted to Simpson for championing the provision of analgesia and anaesthesia for childbirth. Following his death in 1870, a number of hagiographies embellished the religious objections to obstetric anaesthesia; the trend continued into the twentieth century. This topic has been covered in *The History of Anaesthesia Society Proceedings* (Volumes 28, 29 and 49). In summary, there were religious objections, but these were grossly exaggerated by many authors.

From the early 1900s there were concurrent developments in three fields: general anaesthesia and analgesia, spinals and epidurals. Working in Basel, Oskar Kreis was the first to use *spinal* anaesthesia for childbirth. He published a series of six vaginal deliveries, including four by forceps, in which he used 0.01 g cocaine for the second stage of labour; this provided analgesia, yet uterine activity maintained. However there was a high incidence of adverse side effects: half experiencing headaches, two thirds nausea and vomiting.[7] The impact of Kreis' paper was that it spurred new studies on the innervation of the uterus, new methods to block sensory nerves in the pain of childbirth and synthesis of new drugs for regional anaesthesia. But enthusiasm for spinals in *obstetrics* waned until 1928.

In the 1920s in the UK chloroform and 'twilight sleep' were offered, but *only* for women who could afford a doctor. The National Birthday Trust Fund for Maternity Services was launched at a meeting in London on 12th November, 1928. However, as late as 1933, the London County Council Public Health Committee reported *'Anaesthesia in labour is still* *outside the experience of the class of women coming into municipal hospitals'*. There was still some public opposition to analgesia in childbirth![8] In the early 1930s, for those who could afford it, chloroform was commonly given by a GP using a modified Junker bottle, e.g. Mennell's.[9] The aims of the National Birthday Trust were: to make analgesia available to all, and to develop a method of pain relief suitable for use by midwives in the home – in the belief that putting analgesia into the hands of midwives would reduce maternal deaths. An idea of the President of the Midwives Institute came to fruition: a crushable glass capsule (brisette) containing 20 minims of chloroform – crushed in a gauze roll which was tucked into a mask would provide analgesia for 7-10 minutes. From 1932 these 'brisettes' were sent out to the Commonwealth.[8] However in 1933 anaesthetists expressed concern with the dangerous administration of anaesthetics by unqualified persons – there was nothing to stop a midwife using more than 100 capsules on the same patient! [10]

In 1934 Dr Katherine Lloyd-Williams at the Royal Free Hospital, London published *Anaesthesia and Analgesia in Labour*. This included the use of barbiturates.[11] Robert James Minnitt in Liverpool introduced his nitrous oxide and air apparatus from 1933, and this gradually displaced the chloroform 'brisettes'. In 1936 a modification, the Queen Charlotte apparatus, was recommended (with restrictions) by the Central Midwives Board (CMB). Thus in the UK control of domiciliary obstetrics in the lower income groups increasingly passed from GP to municipal clinics – this was accelerated by the Midwives Act of 1936.[12] By 1943 Minnitt's apparatus (modified) became standard midwife's equipment – delivering 45% nitrous oxide with air.[8]

Meantime, from 1942 Robert Hingson in Philadelphia, popularised continuous caudal (sacral extradural) analgesia. But it never became popular in the UK, because its higher forceps rate was derided by UK obstetricians (although their idea of 'forceps' was not the same as the 'lift-out' in USA); also by this time in the UK obstetric analgesia was mainly given by midwives in patients' homes – and midwives were not trained to give caudals.[13]

In 1946 came Curtis Mendelson's (New York) landmark paper on aspiration of stomach contents into the lungs during general anaesthesia (nitrous oxide, oxygen and ether by facemask) for obstetrics.[14] This alerted obstetric anaesthetists to a serious and overlooked hazard.

Plans for the National Health Service (NHS) went through the British Parliament in 1946-47; the Association of Anaesthetists of Great Britain & Ireland (AAGBI) closely co-operated with the Royal College of Obstetricians & Gynaecologists (RCOG) and the CMB over obstetric analgesia, especially the training and examination of midwives in the use of nitrous oxide and oxygen.[15]

At this time the doctor/anaesthetist caring for the parturient was expected to help with neonatal resuscitation. In 1949 Prof. Virginia Apgar (Colombia) proposed a scoring system for the newborn. She showed that acidosis and hypoxia were *not* normal. After publication (1953) the Apgar score was used to guide resuscitation.[16]

As late as 1953 there were still reports of delayed chloroform poisoning in British obstetric practice.[17] Through 1954-56 the CMB approved the use of draw-over trichloroethylene inhalers by midwives for obstetric analgesia. Then in 1961 work by Michael Tunstall in conjunction with the British Oxygen Company (BOC) produced a premix of nitrous oxide & oxygen 50:50;[18] this (Entonox) was rapidly adopted for inhalation analgesia in labour.

In 1957 the first report of the Confidential Enquiries into Maternal Deaths (CEMD) in England & Wales (for the triennium 1952-54) was published.[19] The maternal mortality rate (MMR) was 70 deaths per 100,000 deliveries. There were a total of 49 deaths attributable to anaesthesia including 32 deaths following inhalation of gastric contents, six deaths under chloroform, two cases where the obstetrician 'managed' anaesthesia and delivery single-handed. In over 20 more deaths, anaesthesia was contributory.

The UK's response to Mendelson's paper in the 1950s was limitation of large meals during labour; also emptying the stomach (prior to anaesthesia) and alkalinisation of the stomach contents were encouraged.

In 1959 Hamer Hodges' technique of general anaesthesia for caesarean section was: atropine, thiopentone, suxamethonium, *intubation*, nitrous oxide with oxygen.[20] [*Note lack of pre-oxygenation and volatile anaesthetic agent – these were introduced later*.] After 1961 application of cricoid pressure was gradually adopted in British practice.

Frank Holmes in 1957 began work on the supine hypotensive syndrome of pregnancy, which was sometimes fatal with spinal anaesthesia; the elucidation was largely accomplished in Edinburgh over the next decade.[21] Practice then changed to provide up to 15 degrees lateral tilt of the obstetric patient until after delivery.

In 1952 John Bonica at Tacoma, Washington was one of the first to offer a 24-hour obstetric anaesthesia service with emphasis on continuous caudal or epidural analgesia.[22] Bonica was friendly with Pope Pius XII and through their collaboration the Pope issued a special encyclical in 1957:

> 'Although childbirth pain may have spiritual value – nothing in the tradition of the Catholic Church prohibits human beings from using appropriate methods to alleviate it'.[23]

Although Massey Dawkins was the pioneer of epidural analgesia in Britain, he initially provided this in general surgery and gynaecology – rather later in obstetrics.[24] The first '24-hour epidural service' in the UK was probably established at the Queen Mother Hospital (Glasgow) by Donald D. Moir in 1964.

In 1968 the new Birmingham Maternity Hospital opened with J. Selwyn Crawford being appointed full-time Consultant *Obstetric* Anaesthetist, probably the first in the UK. Also in that year an informal group of interested anaesthetists met in Liverpool and hatched the idea of the Obstetric Anaesthetists' Association (OAA). This was constituted in 1969 in Glasgow with Crawford being elected the inaugural President. Concurrent plans for a parallel organisation were made in Kansas City, Missouri and in 1970 at Nashville, Tennessee the Society for Obstetric Anesthesia and Perinatology (SOAP) was founded, with Robert F. Husted the first President.

The problem of awareness in general anaesthesia for obstetrics remained, because the patients were ventilated with nitrous oxide and oxygen *only* (at least until after delivery). In 1969 Wilson and Turner in Edinburgh investigated a series of 150 patients, finding unpleasant recall in 17.3% of cases.[25] After publication of this seminal paper the use of the 'Liverpool technique' declined.

Through the 1970s -1980s the CEMD reports revealed anaesthesia to be the third commonest direct cause of maternal death. As intubation became routine for general anaesthesia the deaths due to aspiration halved, but there was a concomitant rise in deaths due to difficulties with intubation. In 1987 the AAGBI with the OAA published a report with proposals for improving the quality and safety of obstetric anaesthesia in the UK. Notable were: a named consultant anaesthetist to be responsible for obstetric anaesthesia services in each unit; small obstetric units offering a substandard level of anaesthetic service should be closed.[26]

From the early 1990s the availability of pencil-point spinal needles (low incidence of post-dural puncture headache) caused a dramatic uptake of spinal anaesthesia for obstetrics in the UK – adding to the trend within the 1980s towards regional anaesthesia (epidurals) rather than general anaesthesia for caesarean section. In 1995 the OAA published *Recommended Minimum Standards for Obstetric Anaesthesia Services*.[27] The CEMD report of 1996 for the UK (triennium 1991-93) revealed that the MMR had fallen to 6 per 100,000 maternities – nearly 12-fold *less* than the figure of 70 for the triennium 1952-54. Also, anaesthesia had fallen to eighth position as a cause of maternal death, and *all* the eight anaesthetic deaths were associated with anaesthesia for caesarean section under general anaesthesia (no deaths under regional anaesthesia).[28]

The CEMD in the UK for the triennium 1997-99 included a case where the anaesthetist was distracted by resuscitating the baby.[29] This confirmed that the full attention of the obstetric anaesthetist was required for the mother, and endorsed the (already in progress) demission of obstetric anaesthetists from neonatal resuscitation.

In conclusion, obstetric anaesthesia developed into a subspecialty because:

- the combination of ‘two patients in one’ and associated complications required specialist expertise;
- having trained expertise reduced mortality.

Further Reading

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The History and Development of Paediatric Anaesthesia as a Subspecialty

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It is widely accepted that Crawford Williamson Long (1815-78), a physician working in Georgia, U.S.A., was first to administer a general anaesthetic for relief of the pain of surgery when, in March, 1842, he gave ether by inhalation to James Venable prior to excising a neck tumour.[1, 2] He later wrote that he also administered ether, for surgery, to two Negro boys, both of whom were slaves, in July, 1842 and January, 1845.[3] They have long been considered to have been the first children to undergo general anaesthesia. However Long never actually confirmed that the two were in fact children, and in 2013 Don Nakayama, a paediatric surgeon working in Georgia, questioned whether or not, where the 1842 patient was concerned, this was the case.[4] He pointed out that the derogatory term 'boy' was commonly applied to male slaves of any age, and that Census records indicate that this particular boy's owner may not have had any male child slaves in 1842. A witness present at the 1845 operation subsequently confirmed that the patient was a child at the time so that, one way or the other, Long should be considered to have been the first to anaesthetise a paediatric patient.

It was at the hands of John Snow(1813-58) that substantial numbers of young patients first underwent general anaesthesia - he anaesthetised over 800 infants and children between 1847 and 1858, there were very few complications and no mortality.[5] He expressed the view that the effects of chloroform were produced and subsided more quickly in children than in adults, because of quicker breathing and circulation.[6] It would be over 100 years before, through the use of sophisticated analysers and measurement of ventilation and cardiac output in children, he would be proven correct.[7] Following Snow's death, very little progress was made where anaesthesia for children was concerned throughout the remainder of the nineteenth century. No comprehensive accounts appeared in medical journals or textbooks – paediatric patients were simply regarded as small adults with no special needs. For example, less than one page of the first or 1888 edition of Dudley Wilmot Buxton's *'Anæsthetics: Their Uses and Administration',* was concerned with paediatric anaesthesia.[8]

Leonard Guthrie, of Paddington Green Children's Hospital in London, wrote, in 1894, of ten children with post-chloroform jaundice, of whom nine died,[9] but perhaps the earliest published paper that dealt specifically with anaesthetising them came from Samuel Kopetsky of New York in 1903. He advocated the elimination of chloroform for induction, and recommended that nitrous oxide should be used instead, diluted with five or ten per cent air i.e. one or two per cent oxygen![10] Two years later, Flora Murray (1869-1923), at the Belgrave Hospital for Children in Pimlico, London reported on the use of ethyl chloride for surgical procedures lasting from five to fifteen minutes, in 150 infants under one year old. She wrote *'For minor surgery, where one is anxious to shorten the period of recovery and let the child go home as soon as possible, it is invaluable'.* [11] Also around that time, James Tayloe Gwathmey (1862-1944), later to become the first President of the American Association of Anesthetists, recognising children's preoperative anxiety, advocated sprinkling a few drops of the mother's favourite cologne on the facemask, and having the child inhale it for a minute or two prior to commencing – he believed that this gave him or her confidence in the anaesthetist.[12] August Bier (1861-1949) was first to write on spinal anaesthesia. Two of the six patients described in his 1899 paper on the subject were children.[13] Between 1909 and 1910, Harry Tyrrell-Gray (1880-1935) Resident Medical Superintendent at the Hospital for Sick Children at Great Ormond Street, London at the time, but later to become a well-known surgeon both there and in other hospitals in that city, published two detailed papers based on a total of 300 cases of spinal anaesthesia in children. He concluded that the benefits to the child were absolute anaesthesia, no surgical shock, and minimal postoperative vomiting, particularly in younger children.[14, 15]

The most frequent British contributor to the paediatric anaesthesia literature during the 1920s was Harold Sington (1878-1956), also of

Great Ormond Street. He was another early pioneer of adopting a humane approach to children, establishing the use of premedication, suggestion and other means of reducing fear.[16-18] Christopher Langton Hewer (1896-1986) of St Bartholomew's Hospital in London was one of the first to promote endotracheal anaesthesia in younger patients. He wrote in his *'Anæsthesia in Children',* the first paediatric anaesthesia textbook, published in 1923,

> 'the endotracheal method is probably the safest possible way of administering a general anaesthetic, as a perfect airway is assured and in the event of any untoward occurrence the lungs can immediately be inflated with pure oxygen'.[19]

While his book includes much useful information, all the anaesthesia apparatus illustrated in it was designed for adult use and shown in adult sizes. Paediatric equipment was simply not available.

On the other hand, especially from the 1930s onward, major advances were taking place in paediatric surgery. Anaesthetists were being asked to look after ever smaller and sicker infants and children. It was down to individual practitioners to try and bring about improvements in anaesthesia care. One such was Philip Ayre (1902-79), a Londoner by birth, who spent his entire working life in the northeast of England. He had been attempting to use what is now termed the Mapleson A or Magill circuit in infants, but found that they did not tolerate the dead space and resistance to breathing that it imposed. He removed the reservoir bag and expiratory valve and came up with what is now known as Ayre's T-piece or the Mapleson E circuit, through which the infant breathed from an open-ended tube into which was delivered oxygen and ether. A length of tubing added to the distal end of the T-piece acted as a reservoir and minimised dilution of the anaesthetic mixture with air. Carbon dioxide elimination depended on the fresh gas flow. Ayre's T-piece, described by him in 1937,[20] was probably the first piece of anaesthesia equipment designed specifically to compensate for the special cardio-respiratory needs of infants and children.

In 1939, Noel Gillespie (1904-55) described his experience with endotracheal intubation of 197 infants and children for head and neck surgery, and also the first laryngoscope, the Shadwell, designed for paediatric use.[21] The work was carried out at the Princess Elizabeth Hospital for Children, in Shadwell, London, although Gillespie spent most of his working life in Ralph Milton Waters' department in Madison, Wisconsin, U.S.A. Six years later, Frank Cole (1909-82) of Minneapolis described the first endotracheal tube designed for use in babies.[22] Cole's tube had a wide lumen to allow free flow of gas but it narrowed for the last 2-3 cm so that it could easily pass beyond the larynx. It was also Cole who in 1957 proposed a formula to estimate the best endotracheal tube size for children, a modified version of which is still in use today.[23]

Morton Digby Leigh (1904-75), born in Jersey, Channel Islands, was raised in British Columbia. A Montreal graduate, he underwent anaesthesia training there, and also with Waters in Wisconsin. He was appointed Anaesthetist-in-Chief to Montreal's Children's Memorial Hospital in 1940, became Director of Anaesthesia at Vancouver General Hospital in 1947, and moved to the Children's Hospital of Los Angeles seven years later. He designed both a paediatric non-rebreathing valve and an infant circle filter, and authored numerous papers on paediatric anaesthesia topics.[24] Mabel Kathleen (or Kay) Belton (died 1980), Canadian-born, graduated in Montreal in 1941. After anaesthesia training in Montreal and Toronto, she was appointed Assistant Director of Anaesthesia to Leigh in the former city in 1946. She accompanied him when he moved to Vancouver (where she took charge of paediatric anaesthesia) and later to California. Leigh and Belton's textbook, *'Pediatric Anesthesia',* was published in 1948.[25] It was promoted as '*the first book concerned with the administration of anaesthetics to the infant and young child*'. Of course, Christopher Langton Hewer knew better. He reviewed Leigh and Belton for the *British Medical Journal* and included the following sentence *'All these and many other matters are discussed in this admirable book, but the publisher's claim that it is the first on the subject is in error by over a quarter of a century'.* [26] Hewer's book dealt almost entirely with inhalational general anaesthesia whereas Leigh and Belton also described both intravenous induction and neuromuscular blockade. Both had chapters on preoperative preparation and local anaesthetics but only the later book provided detailed information on either oxygen or fluid therapy. Overall, each comprehensively discussed the state of knowledge where paediatric anaesthesia was concerned at the time of publication. The advances made in the developing subspecialty over the 25 years between 1923 and 1948 are well-illustrated by comparing the two.

Gordon Jackson Rees (1918-2001) graduated from the University of Liverpool in 1942. He became interested in anaesthesia during World War II service in North Africa and later trained with Professor (later Sir) Robert Macintosh in Oxford and also in Liverpool. He became Consultant Anaesthetist to the Royal Liverpool Hospitals in 1949. At that time, Isabella Forshall (1902-89), senior paediatric surgeon at Alder Hey Children's Hospital, had become frustrated by the lack of development in anaesthesia necessary for operations on babies with major congenital defects. She asked Cecil Gray, Reader in Anaesthesia at the University of Liverpool, to find 'her' an anaesthetist ready to develop paediatric anaesthesia in the city. Gray recommended Rees (legend has it that the latter was told by Gray to *'go and sort out the children'*). With some reluctance, not least because he regarded Forshall, in his own words, as *'rather a formidable lady',* [27] he accepted the challenge. He studied neonatal anatomy and physiology in detail, and within a year had published a landmark paper in the *British Medical Journal* titled *'Anaesthesia in the Newborn'.* He wrote

> 'The newborn infant differs so greatly from the adult in his anatomy and physiology that the approach to anaesthesia in the two groups must be quite different. In the past there has been a tendency to adapt to infants those methods of anaesthesia which have proved to be of value in adults. The time has come to consider the problem of anaesthetising the newborn in relation to their peculiar physiology'. [28]

From 1953, Jack Rees, as he was known, devoted his professional activities solely to the care of infants and children. He was almost certainly the first full-time paediatric anaesthetist in the United Kingdom (U.K.), but not worldwide as Charles Robson (1884 -1969) had been appointed fulltime to the Hospital for Sick Children in Toronto as far back as 1919. He realised that the Liverpool technique of controlled ventilation with relaxants could be employed in children using a circuit with an open-ended reservoir bag added to the expiratory limb of Ayre's T-piece. In addition to controlling ventilation, the modified version (which later came to be known as Jackson Rees' modification of Ayre's T-piece) could be used to monitor spontaneous respiration. He also advocated the use of heavy premedication, and intravenous induction, and his technique resulted in a great improvement in the results of infants and children undergoing anaesthesia and surgery in Liverpool and further afield.

Rees was an educator par excellence – he travelled the world to teach, and hosted trainees and other visitors from home and abroad in the Liverpool department. His travels contributed to his own ongoing education and, during a 1963 visit to Australia, he was particularly impressed by, and later helped publicise, work carried out in Adelaide and Melbourne demonstrating that it was safe to secure for days the compromised airway of children with acute inflammatory upper airways obstruction, with endotracheal intubation via the nasal route, following induction with halothane. The established practice up to then everywhere had been emergency tracheostomy, often carried out by inexperienced practitioners in suboptimal conditions with high mortality. Along with his Liverpool colleagues, Rees also carried out important research into the use of muscle relaxants and positive pressure ventilation, in children.[29]

By the early 1950s intravenous thiopentone sodium was widely used for induction of anaesthesia in adults. However, as is the case today, inhalational induction remained popular in children. Ether, chloroform and cyclopropane were all still in use. This paper has not hitherto entered into detailed discussion of individual anaesthetic agents, because, while allowances must clearly be made for differences in the response to administered medications between the child and the adult, by and large, the same drugs, be they analgesics, local anaesthetics, muscle relaxants or whatever, are given for the same reasons and by the same routes. However an exception will be made in the case of the potent inhalational anaesthetics introduced from the 1950s onwards as, although they are generally used in adult practice for maintenance only, they retain a major role where anaesthetic induction in children is concerned. Much of the early work with them in paediatric anaesthesia was carried out in Britain or Ireland.

Halothane was first used in humans in 1956. Two years later McGregor and colleagues in Montreal published the results of the first controlled study with the agent in children.[30]

Gerald Black and Harold Love in Belfast were early European investigators[31] and halothane soon became enormously popular in both adult and paediatric practice. However, it had a number of disadvantages, both known and unknown at the time, and the search continued for better agents.

The results of the first clinical trial of methoxyflurane were published in 1960. Again, the Belfast group investigated its use in children, with satisfactory results.[32] The agent appeared to have a bright future. In 1966 however Walter Crandell and his colleagues in Vermont and New Hampshire reported a high incidence of renal failure in patients exposed to methoxyflurane for long periods.[33] It emerged that the damage was due to high circulating levels of fluoride ion following methoxyflurane biotransformation, and it was recommended that exposure be limited to 2 MAC hours, but the agent soon fell out of favour. Inorganic fluoride levels following comparable exposure were much lower in children than in adults and there appears never to have been a reported case of methoxyflurane-induced nephrotoxicity in a child – indeed, some paediatric anaesthetists were still lamenting the agent's demise many years after it had become unavailable. It has not completely disappeared, being licenced in some countries e.g. Australia, for use by metered-dose inhalation, as an emergency non-opioid analgesic.

Neither enflurane, introduced around 1970, nor desflurane, over twenty years later, ever made a major impact where paediatric anaesthesia practice is concerned. In the 1980s, Bill Wren and his colleagues in Dublin found isoflurane to be satisfactory for both inhalational induction and recovery in children, with a low incidence of airway irritation.[34] Most other workers could not replicate Wren's results where induction was concerned and the agent's role in paediatric anaesthesia practice, one that it retains, was soon to be confined to maintenance of anaesthesia. Over 30 years after its introduction, halothane remained the agent of choice for inhalational induction.

Sevoflurane had undergone initial investigation in the U.S.A. in the early 1970s, but because of a combination of commercial reasons and some initial concerns regarding its biodegradation, its further development was not pursued. In the late 1980s the rights to conduct further studies with the agent were acquired by Maruishi, then a relatively small Japanese pharmaceutical company. Investigators in Japan found that in adults, sevoflurane was safe and efficacious, provided rapid induction and recovery, allowed for precise control of anaesthetic depth, and gave good cardiovascular stability. The first study in children, conducted by Iwai and colleagues in Hiroshima, suggested that the agent would be useful in paediatric practice.[35]

Abbott Laboratories later purchased the rights to further investigation, potential regulatory approval and marketing in the Western world. However, as recently as 1992, an editorial with the title *'Whatever happened to sevoflurane?'* appeared in a major anaesthesia journal,[36] reflecting the agent's extremely low profile among the anaesthesia community at that time. Abbott funded and coordinated a series of international multicentre clinical trials of the agent, European centres participating in early paediatric studies included Dublin and London. The agent proved to be highly satisfactory for both induction and maintenance of anaesthesia in infants and children,[37, 38] was licenced in many countries by 1995, and while there were reservations about its use for maintenance because of cost, it was almost immediately embraced as the inhalational induction agent of choice for children. Just five years after the editorial referred to above, another appeared with the title *'Is there still a place for halothane in paediatric anaesthesia?'*[39] Most paediatric anaesthetists believed the answer to the question to be no, and within a short time halothane fell into such disuse as to be unavailable.

Harvey Cushing (1869-1939) referred as early as 1909 to the use of *'continuous auscultation of cardiac and respiratory rhythm during the entire course of anesthesia'* – he gave the credit for its introduction to his anaesthetic colleague S. Griffith Davis.[40] The technique had been forgotten for many years until its routine use in paediatric practice was advocated in the early 1950s by Robert Smith of Boston. It was also Smith who, shortly afterwards, pointed out the importance of continuous intraoperative temperature monitoring in infants and young children.[41] Code Smith in Toronto introduced the oesophageal stethoscope in 1954 - it proved to be useful in monitoring both normal and adventitious respiratory and cardiac sounds in infants.[42] Also in the 1950s, Malcolm Holliday and William Segar of the University of Indiana derived a formula for administration of fluids to children, on which the 4-2-1 rule still used by paediatric anaesthetists to calculate hourly fluid requirements is based.[43]

Leslie Rendell-Baker, who worked as a Consultant Anaesthetist in Cardiff prior to emigrating to the U.S. in 1957, and a dental associate, Donald Soucek, wrote in 1962 on facemasks that they had produced from casts they had made of the faces of intubated infants and young children.[44] These had much lower deadspace than those used previously and remained popular for decades.

In 1955, the first multidisciplinary paediatric intensive care unit in the world had been established by Göran Haglund in Gothenburg, Sweden.[45] Similar units were opened in various European cities in the early 1960s, followed in 1967 by the first in North America, in Philadelphia.[46]

By the mid-1960s, paediatric anaesthesia was being recognised as a subspecialty. Children's hospitals established full-time paediatric anaesthesia departments or services, some, especially in North America, with fellowship and research components.[46] Anaesthesia training programmes soon began to rotate trainees through supervised experience in paediatric anaesthesia. This led to an overall improvement in the safety and quality of anaesthesia for children. Furthermore, manufacturers of anaesthesia equipment finally came to realise that there was a large patient population for whom either specialised or miniaturised devices were required. The availability of appropriate 'tools' became much less of a problem for anaesthetists working with children. Paediatric anaesthesia research was being conducted on a more scientific basis than previously. Two very important 1969 contributions were the quantification by Gregory, Eger and Munson in San Francisco of the minimum alveolar concentration (MAC) of halothane as a function of age, establishing the ED50 of that agent, and subsequently other anaesthetics, in infants and children,[47] and also Rackow and Salanitre's paper,[7] referred to above, finally confirming the validity of John Snow's theories concerning anaesthetic uptake in children. A couple of years later, George Gregory and colleagues applied continuous positive airway pressure or CPAP to infants with respiratory distress syndrome(RDS) and demonstrated an improvement in survival.[48] This was perhaps the first of a number of interventions developed by paediatric anaesthetists that have made an ongoing contribution to the management of neonatal respiratory failure.

A group of anaesthetists who specialised in the care of children created a committee devoted to pediatric anesthesia within the American Academy of Pediatrics (AAP) in 1965; months later, the committee officially became the AAP Section of Anesthesiology,[49] the first organised grouping devoted to the subspecialty. Membership was limited to those who practiced full-time paediatric anaesthesia. The first meeting of the more broadly-based Society for Pediatric Anesthesia, also based in the U.S., took place in1987.[50]

In summer 1973, Douglas Shannon, working in Edinburgh, and Gordon France in Glasgow, suggested the formation of a World Society of Paediatric Anaesthetists. Following a series of informal discussions attended by Shannon, France and paediatric anaesthetists from the U.K.'s two largest children's hospitals (the Hospital for Sick Children at Great Ormond Street and Alder Hey Children's Hospital) it was decided to form instead the Association of Paediatric Anaesthetists of Great Britain and Ireland, or APA (*David Hatch and William Glover, both APA founding members and past-Presidents, personal communications, 2018*). There had been no organised meetings between paediatric anaesthetists in Britain and Ireland prior to that time and one of the aims of the new Association was to provide such a forum. It was agreed that initial membership would be restricted to those Consultant Anaesthetists who could contribute to the aims of the Association, either by furthering the science and practice of paediatric anaesthesia or the proper teaching thereof. The inaugural meeting was held in Bristol in September 1973, and was attended by 21 anaesthetists from all parts of Great Britain and Ireland, of whom twenty were male and one was female (Margaret Manford of Carshalton, Surrey). Robert ('Bob') Cope of Great Ormond Street was elected first President.

The first APA Annual Scientific Meeting was held in March 1974, while seventeen prominent overseas paediatric anaesthetists were admitted to membership by invitation in 1976. In 1979 the first joint overseas meeting was held at the Hospital for Sick Children, Toronto – it was the forerunner of many such successful meetings held around the world. Four years later, the first workshop-type symposium open to non-members, and established to meet the needs of consultant anaesthetists in general hospitals whose practice was largely adult but included some children, was held in Nottingham (*David Hatch, personal communication, 2018*).

A joint British Paediatric Association, British Association of Paediatric Surgeons and APA Liaison Committee was formed in 1985. Following the publication of the first National Confidential Enquiry into Perioperative Deaths (NCEPOD) report in 1989, guidelines were produced for paediatric anaesthesia in District General Hospitals, including a proposal that all should have a designated anaesthetist responsible for paediatric anaesthesia services. A very successful Interdepartmental Peer Review Scheme commenced in 1999.

Pressure from anaesthetists 'with an interest' as opposed to being full-time paediatric anaesthesia specialists gathered pace and membership was eventually opened to all Consultants at the turn of the century.[51] Trainees and staff grades soon followed. This allowed the development of links with almost all anaesthetists who care for children in Britain and Ireland – one end-result of this was the highly successful Linkman Scheme launched in 2005.

Current membership is over 1000. The business of the Association is conducted by the Council which includes Overseas, Trainee and Lay representatives, co-opted members from the Paediatric Intensive Care

Society, AAGBI and the Royal College, the Chairs of the four main APA committees, and a Non-specialist Centre advisor. From small beginnings, the APA has now come to be seen as the primary source of information and guidance on paediatric anaesthesia by the Royal Colleges and other regulatory authorities in the U.K. and Ireland – indeed there are now paediatric anaesthesia bodies filling similar roles all over the world, although Shannon and France's concept of a global organisation has yet to be realised.

Collaboration has resulted in a number of consensus statements. A recent example, from the APA, L'Association des Anésthetistes-Réanimateurs Pédiatriques d'Expression Française (ADARPEF) and the European Society for Paediatric Anaesthesiology (ESPA) on preoperative fasting guidelines for children illustrates just how much one aspect of paediatric anaesthesia practice has changed in recent times.[52] Modern electronic communications facilitate the early and wide dissemination of such evidence-based information.

It can be difficult to identify those recent events that in the future will be regarded as having had major historical significance. The first U.K. Professorship (appointee David Hatch) in the subspecialty was inaugurated in 1991, the same year that the journal Paediatric Anaesthesia was launched, with Gordon Bush of Liverpool as the first Editor. Patient safety has undoubtedly improved – safer agents, better monitoring, and more sophisticated anaesthesia delivery systems have all played a part, as has increased centralisation of specialist paediatric services. As recently as thirty years ago, there were still those who believed that because their nervous systems are immature, infants do not experience severe pain, and that some very premature babies undergoing surgery do not require much in the way of anaesthesia or postoperative pain relief at all. That is no longer the case, and while there is room for further improvement, neonatal anaesthetic and both acute and chronic pain services for infants and children are developing all the time. Anaesthetists continue to be involved in most Paediatric Intensive Care Units, while the role of the paediatric anaesthetist outside the operating theatre has expanded in other areas. Many painful or frightening procedures, for example in oncology patients, used to be performed using a combination of sedation and restraint, often by non-anaesthetists. The move away from restraint has led to increased demand for general anaesthesia, particularly from parents of children who have had previous experience of alternative strategies.[53] Anaesthetists are also involved in paediatric simulation and resuscitation training, and retrieval services. Perioperative fluid therapy has been influenced by an increased awareness that postoperative hyponatraemia in children is a more common and dangerous problem than was previously realised. As a consequence, fluid management has evolved away from the use of dextrose-containing fluids towards balanced salt solutions.[54] Another major advance in recent years has been the introduction of anatomically-based ultrasound imaging for facilitating nerve localisation in paediatric regional anaesthesia.[55] Ultrasound expertise has become an essential core skill for future paediatric anaesthetists.

What does the future hold? Significant questions remain regarding the possible adverse effects of anaesthetic agents on the developing brain and there is much ongoing work in that area.[56-9] More research is needed into the place of depth of anaesthesia monitoring in paediatrics – although the data in adults are reasonable, the use of such monitors in children remains questionable, especially in infants.[41] A Paediatric Anaesthesia Subspecialty Certification Examination was introduced in the U.S. in 2013.[60] Only time will tell whether a similar assessment becomes mandatory in other countries for those anaesthetists aspiring to care for the infants and children of the future. Crawford Willliamson Long could not possibly have imagined present-day paediatric anaesthesia when he first anaesthetised a child in the 1840s – the paediatric anaesthetist of today is similarly challenged when attempting to predict what the future holds for practitioners and their young patients.

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Conflict of Interest

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Seventy Fifth Anniversary of the Canadian Anesthesiologists' Society

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The first national Canadian anaesthesia society was the Canadian Society of Anaesthetists, founded 1920. It was dissolved in 1928 after the Canadian Medical Association (CMA) established a Section of Anaesthesia in 1927 that would have held competing annual meetings.[1]

The Royal College of Physicians and Surgeons of Canada, founded in 1928, initially granted Fellowship in only two titles - Medicine or Surgery - until 1937. In that year, modified Fellowship examinations were introduced for dermatology, ophthalmology, otolaryngology, paediatrics, radiology and urology but not for anaesthesia. Harold Griffith and others realised that anaesthetists were 'lost in the anonymity of the larger Association [CMA] . . . the special interests [of anaesthetists] could be looked after better in an organisation of our own.'[2]

Early in 1943, five members of the Montreal Society of Anaesthetists, supported by more senior Toronto colleagues, became the national Canadian Anaesthetists' Society. On 27 May 1943 the Memorandum of Agreement incorporating Bylaws of the Canadian Anaesthetists' Society (CAS) was signed by five well-known Montreal anaesthetists:[3]

President: H.R. Griffith, Homoeopathic Hospital

Secretary: M. Digby Leigh, Children's Hospital

Vice-Presidents:

W. Bourne, McGill University and Royal Victoria Hospital

G. Cousineau, Hôpital du Sacré-Cœur, Vice-President

R. Rochette, Hôtel-Dieu Hospital, Vice-President

Their visions were

> 'to advance the art and science of Anaesthesia and to promote its interests in relation to Medicine with particular reference to the

> clinical, educational, ethical and economic aspects thereof, to associate together in one corporate body members in good standing of the Medical Profession who have specialised in this particular science, to promote the interests of its members, to maintain a Society Library and Bureau of information, to edit and publish a journal of Anaesthesia, to acquire and own such property as may become necessary to carry out effectively the purposes of the Society, and to do all such lawful acts and things as may be incidental or conducive to the attainment of the above Objects'.[4]

Most of these objectives were achieved, at varying rates. Three hundred members attended the first Annual Meeting that was held in Toronto in May 1944. Membership increased from 5 in 1943 to 369 in 1946. A Refresher Course preceded the Annual Meeting, and World War II ended. In 1946 the Survey of Anaesthetic Services was undertaken to document anaesthetic services in all Canadian hospitals.

The Royal College of Physicians and Surgeons of Canada awarded Certification in Anaesthesia (CRCPS) without examination between 1942 and 1947 to doctors who were already practising anaesthesia.[5] Four years later, in 1951, the Royal College finally introduced a Fellowship examination in Medicine (FRCPC), modified for Anaesthesia. Training required one year of medicine and four years of anaesthesia. From 1970 onwards training had to be in university-affiliated hospitals. Training for Certification was gradually increased to equality with Fellowship and in 1972 Certification was discontinued.

Canadian Anaesthetists' Society Journal

The success of publishing *CAS Proceedings*, sponsored by Squibb Pharmaceuticals in 1952 and 1953, encouraged CAS Council to publish a quarterly *Canadian Anaesthetists' Society Journal.* The first issue appeared in July 1954, and contained summaries of papers from 1954 annual and regional CAS meetings. Dr Rod Gordon, Toronto, was appointed Editor with University of Toronto Press as printers.[6] Gordon established Editorial Board composition, bilingual presentation and in-house management of advertising. The early issues contained mainly reviews and papers by Canadians from Canadian regional and national meetings with case reports and descriptions of new drugs. Gradually manuscripts progressed to reports of original scientific studies and increasing numbers came from outside Canada. The number of issues per year rose from 4 per year in 1955 to 12 in 1993. The CAS Newsletter was incorporated in the Journal from 1957 to 68, and the Society's membership list from 1957 to 66. The Newsletter continues as a separate publication for CAS members. In 1983 the Journal title was changed *Canadian Journal of Anaesthesia* to indicate that its manuscripts and readers were international rather than national. Each manuscript was reviewed by a member of the Editorial Board and at least one other reviewer and the colour of the cover was changed from beige to deep green.

Anaesthetic Equipment

The Society was involved in the slow and frustrating evolution of Standardisation of Anaesthetic Equipment in the late 1940s. Colour coding for compressed gas cylinders was accepted during a CAS Council meeting in 1950 but other parties were slow to agree and not all manufacturers agreed. Rod Gordon, editor of the CAS Journal, was elected to membership in the Canadian Standards Association in 1957.[7] In 1962, Gordon Wyant from Saskatoon was chairman of a committee on standardisation of anaesthetic equipment and was the author of the book, *Mechanical Misadventures in Anaesthesia.* From 1963 CAS representatives and Industry held joint annual meetings.

The World Federation of Societies of Anaesthesia (WFSA)

Harold Griffith was elected as Founder-president when The World Federation of Societies of Anaesthesia (WFSA) was founded in 1955.[8, 9] The second World Congress was held in in Toronto, Ontario. The purpose of the WFSA was '*to make available better anaesthesia to more people throughout the world*' by forming national Societies of Anesthesiologists, recommend desirable standards of training, provide information postgraduate training and research and establish safety measures including standardisation of equipment. In 1964, Rod Gordon found he could not support the WFSA plan. Instead, he and other CAS members supported a foundation to finance regional training centres in developing countries.[10] He set up the *Canadian Anaesthetists' Society Training and Relief*

Fund to train physicians from Africa, Asia and South America in Canada, and supply educational material to Canadians teaching in those regions. Donations were adequate for only four years, suggesting little CAS membership interest in the project.

Research funding

Most clinical anaesthetists regarded research funds to be the responsibility of universities and industry. Gordon Sellery was a prise-winning resident at the 1967 CAS Annual Meeting. He proposed the establishment of a CAS Research Fund.[11] The Finance Committee accepted this and, in June 1976, announced that the CAS Research Fund had obtained Revenue Canada's approval for tax-deductable contributions to the voluntary CAS Research Fund. Donations could now be itemised with the annual membership dues and the first award was made in 1985

Guidelines to the Practice of Anaesthesia

The first phase of development of the CAS's *Guidelines to the Practice of Anaesthesia* in 1971 included the Canadian Council on Hospital Administration's guidelines (CCHA). These had reference to nurse anesthetists, inappropriate criteria for discharge of patients from recovery room and other concerns that could not be settled amicably. In 1973 a representative from Canadian Medical Protective Association (CMPA) addressed CAS Council in 1973 concerning increased medicolegal activity through the 1960s and early 1970s.[12] Action was urgent and the CAS task force produced the draft of *Minimum Guidelines for Practice of Anaesthesia* within five months. Council approved this comprehensive document in 1975 that continues to be reviewed and updated biennially.

ACUDA

Heads of university departments of anaesthesia met informally during CAS Annual Meetings from the 1960s. The Association of Canadian University Departments of Anaesthesia (ACUDA) was founded during the 1975 meeting with individuals representing education, research, management, and resident from each centre.[10] They meet during the CAS

Annual Meeting. One non-voting member from ACUDA attends Council meetings and one non-voting council member attends Council meetings.

Special Interest Sections

In the 1980s, Obstetric Anaesthesia became the first special-interest section of the CAS, followed by Regional Anaesthesia, Paediatric and Cardiothoracic Anaesthesia. The current special-interest sections are Anaesthesia Assistant, Ambulatory, Cardiovascular, Executive, Chronic Pain management, Critical Care, Neuroanaesthesia, Obstetric Anaesthesia, Paediatric (CPAS), Perioperative, Regional and Acute Pain, Residents and Education and Simulation (SESA).

Tribhuvan University in Kathmandu, Nepal

During the early 1980s the Faculty of Medicine, University of Calgary, Alberta was helping Tribhuvan University in Kathmandu, Nepal to establish the country's first medical school. Funding came from the Canadian International Development Agency (CIDA). Nepal also had a critical shortage of trained anaesthetists - five for 15 million population. I was asked to coordinate a series of senior Canadian academic anaesthetists to work for minimum three months with the Nepali anaesthetists in Kathmandu to establish a one-year DA program - the first medical postgraduate program in Nepal. Tom Boulton kindly supplied me with the British DA training requirements and former DA examination papers.[13, 14] The programme flourished so that, after four years, Canadian presence was reduced to six months for four more years. By then, several Nepalis who had completed the three-year MD Anaesthesia program in India had returned to Nepal. The Nepalis started their own three-year MD Anaesthesia program in 1996 and Nepal now has 14 centres for MD Anaesthesia training and a full supply of anaesthetists. The earlier CAS Training and Relief Fund was resurrected as the CAS International Education Foundation (CASIEF) that receives voluntary annual tax-deductible donations.

Fiftieth Anniversary History

The 50th Anniversary Meeting of the Canadian Anaesthetists Society took place in Halifax, Nova Scotia in June 1993. David Shephard's book, *Watching Closely Those Who Sleep. A History of the Canadian Anaesthetists' Society 1943-1993* was published. This book is remarkable for the details of progress from the birth of anaesthesia in 1847 to the founding of a National Society with a membership of five in 1943 that grew to 2,214 by 1993.

Pre-centennial changes

In 1998-99 significant changes to the Canadian Anaesthetists' Society. Members voted to change the name of their Society to Canadian Anesthesiologists' Society. The original crest with its Greek motto that meant, '*We watch closely those who sleep*' was replaced by a modern crest with the bilingual English-French motto, 'Science, Vigilance, Compassion'. Its new slogan became '*Canadian Anesthesiologists: Specialist Physicians in Perioperative Medicine, Critical Care and Pain Management*'.

World Congress 2000

The 12th World Congress of Anaesthesiologists was held in Montreal in 2000 with delegates from 118 countries. Since 2007, CAS International Education Foundation has sent more than 100 volunteers to teach anaesthesia in Rwanda. After the genocide, there was only one anaesthesiologist in the entire country. Now there are 18 fully-trained anaesthesiologists and 31 residents in training. Much of the credit goes to Angela Enright, who lives on Vancouver Island, was Chair of the WFSA in 2000 is a Past President of the CAS. The Annual Royal College Lecture was renamed the Angela Enright Lecture in her honour in 2012.

The Canadian Anesthesiologists Society celebrated its 75th anniversary just two weeks before this meeting of the History of Anaesthesia Society.

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A Museum of and for the Profession – how, why and so what?

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This paper is a preliminary outcome of my research into the historical museums of the medical professions during the twentieth century. The Anaesthesia Heritage Centre, formerly the BOC Museum, formerly the Charles King Collection, is a case study of a museum portraying the history of what, paradoxically, is a relatively new profession. I am going to outline how the museum came about. Then I am going to offer some explanations as to why that happened and finally, suggest a few reasons why any of this matters to the profession.

How?

The specialty of anaesthesia did not necessarily follow a set pattern in developing as a separate new profession. It obtained its Royal College late on in the last century (1992), but it already had a 'representative' body, in the form of the Association of Anaesthetists of Great Britain and Ireland (AAGBI), from as early as 1932. As the voice of the profession, the Association set about adopting many of the formal attributes of professions, amongst which we may include impressive headquarters, grants of arms, academic journals and badges of office. In 1961 it even obtained what the late Tom Boulton described as that 'ultimate mark of corporate identity' – an Association tie.

The sociological analysis of the professions was pioneered in the 1930s by Sir Alexander Carr-Saunders, who saw these 'traits' as status symbols or marks of maturity, and a means of defining the boundaries of a new and upcoming specialty; they help you to recognise a profession when you see it; you can tell who is in it and who is not. Surprisingly, however, the sociological studies since then have omitted serious investigation of one particular feature – the tendency of new medical professions to establish historical museums.

The very nature of a 'medical museum' was changing during the twentieth century. As late as the 1940s there were still those who argued that a medical museum could **only** be a systematically-arranged collection of specimens for teaching doctors about anatomy, pathology or *materia medica*, but the usefulness of this type of nineteenth century didactic museum was declining in the face of changes in educational techniques.

Table 1 - Historical Museums of medical professional bodies, still active or founded in the twentieth century.

1698 - Royal College of Physicians and Surgeons of Glasgow (RCPSG) – actively managed 1960s; accredited 2015

1809 - Royal College of Surgeons of Edinburgh (RCSEd) – refurbished 1988 and 2016

1813 - Royal College of Surgeons of England (RCS) - reopened 1954. Refurbished 2005

1818 - Royal College of Physicians (RCP) - museum largely mothballed 1921, Symons Collection presented in 1996

1819 - Royal College of Surgeons in Ireland (RCSI) – museum of surgical instruments planned from 1989

1827 - Royal College of Physicians of Ireland (RCPI) – College Treasures exhibition proposed 2002; accredited 2017

1841 - Royal Pharmaceutical Society (RPS) – 'historical collection' 1950s; refurbished 1980s; restructured 1998

c.1891 - Royal College of Veterinary Surgeons (RCVS) – museum closed 1925

1901 - College of Optometrists (COptom) – refurbished 1926, 1934 and 1990; accredited 2003

1919 - British Dental Association (BDA) – refurbished 1935, 1967 and 2004

1937 - Royal College of Obstetricians & Gynaecologists (RCOG) – refurbished 2004

1952 - Association of Anaesthetists of GB & Ireland (AAGBI) – refurbished 1987 and 2005; accredited 2001

1953 - Royal College of General Practitioners (RCGP) – refurbished recently

Table 1 is a list of UK and Irish medical professional bodies that had an **historical** museum during the twentieth century, and the dates at which the museum was founded, although not all these museums were historically-focused to begin with. The museum of the Pharmaceutical Society dated back to the 1840s, but it was not until the 1950s that it developed a collection of historical material. The Hunterian Museum at the Royal College of Surgeons of England was a mixture of a teaching and historical museum but, after about 1913, increasingly collected antique surgical instruments. Founding a museum might occur surprisingly early in the lifecycle of a new professional body. The Royal College of GPs opened a museum within a year.

Many of the older professional bodies got rid of their specimens. Where systematic teaching museums were retained they nevertheless displayed the specimens alongside paintings, busts and other historical 'treasures'. As time went on the 'treasures' were displayed more prominently and with greater thought. Alongside the artistic treasures they displayed 'tools of the trade', both antique and current. Such displays helped symbolise a profession and assisted engagement with members, potential sponsors or royal patrons. 'Diplomatic' gifts, often donated by other medical colleges, were deemed worthy of display and often presented with that in mind.

Historical museums recounted the story not only of the relevant medical specialty (for example anaesthesia), but also that of the profession itself (the anaesthetists), told through the display of personal objects, graphic panels and historic images. In particular they also recount the organisational history of the professional body that managed the museum, employing judicious use of the organisational emblem, making such displays highly branded.

It is remarkable, however, how many professional body museums retain little archival information on their own origins or development. Studying the history of the Anaesthesia Heritage Centre is by no means straightforward. The story has to be pieced together from newsletters and occasional journal articles. The very few photographs of the displays are undated and details such as the text of the captions are generally illegible. So, if any of you have photographs of the exhibitions held at the museum, then I (and indeed the museum) would be very pleased to hear from you.

The Anaesthesia museum was one of the later professional body museums to be founded. It did not originate with the professional body, but was presented to it. It needed to be a large gift, or it might have been declined. The first suggestion that the AAGBI should make a collection of its own had been made by a GP-anaesthetist from Yorkshire, at its

AGM in 1935. He was told that the Royal College of Surgeons already collected in this field, *'had a very good collection and members wishing to do so could add to this collection'*.[1] With no building and no permanent staff at that time, the AAGBI response seems both explicable and reasonable. It fell, therefore, to an outside interest to develop the core of a collection to represent the professional specialty.

Mr A. Charles King was not a member of this profession, but a prominent manufacturer. He had been too poor to attend medical school; this frustration needs to be borne in mind when attempting to explain his subsequent generosity to the profession whose ranks he had once aspired to join.[2 (p510-4)] The old devices he collected still had a practical function, as he used them as an external examiner for the Association's diploma, and he actually referred to some as 'specimens'. Nevertheless the collection's general character is confirmed by its usual title, the 'historical museum'.

The first indication that the Association had been identified as the possible future host for the collection came in 1952, when it was agreed that enquiries should be made as to whether the Royal College of Surgeons would have space to house it'.[3] The Association rented its office accommodation from the RCS at this time and the landlord may have given its tenant false hope in a letter that stated that after the first stage of post-war re-building there would be 'plenty of accommodation for museums'.[4] In the meantime, the RCS would help the Association look for temporary storage. So it seems that professional bodies had a clear conception that heritage was something with which they could and should concern themselves, particularly if considered in a long-term strategic sense, and they could sometimes collaborate on heritage matters.

In the event the museum remained at its donor's showroom into the 1960s. Yet, in this period, the Association also began accepting gifts of treasures from other donors, beginning with a replica of the statue of Hypnos in the Museo del Prado, Madrid, donated by a Spanish anaesthetist.[5] Some of these gifts were no doubt viewed in purely decorative terms. Specific additions to the historical collection were few, although one donation, by Dr Ronald Jarman, of the head of his personal McKesson Nargraf machine, was considered significant enough to be recorded in the Council Minutes.[6]

In 1956, Dr M. H. A. Davison was invited to accept the post of honorary curator. He was a member of the Association, and, despite being based at Newcastle upon Tyne, aged in his mid-forties and still in full-time practice, is said to have 'gladly accepted'.[7] Nine years later, he nominated his own successor in Kenneth Bryn Thomas, a Consultant Anaesthetist in Reading, a recommendation that appears to have been accepted without significant discussion. It seems therefore, that as a young profession, the anaesthetists did not yet feel that heritage should be the preserve of the retired generation. The tendency to encourage high levels of serving practitioner involvement and even to engage younger professionals in this sphere of activity continued throughout the rest of the century.

Thomas published an inventory and 'Historical Note' in the Association's academic journal in 1970. He admitted that the collection included some 'aberrations', but he also attempted to encourage its further growth: *'It is hoped that the publication of this catalogue will stimulate anaesthetists to resuscitate collections housed in odd corners of operating theatres'.*

By 1975 the interest thus aroused had spurred a full-length book, 'using the Collection as a basis'.[8] By the end of the 1970s therefore, the collection *in absentia* was nonetheless in the minds of the Association and considered useful. The surprising success of the book prompted an ambitious proposal by Dr Charles Foster, to compile a national inventory of surviving historical apparatus, a project that signals the realisation of the AAGBI that, through its museum, it had a means of engaging the profession throughout the country.

Why?

Why did the aforementioned developments take place? There are several reasons and in this paper I am going to concentrate on four:

Reason One: There seems to have been an unusual tendency of the anaesthesia profession to be interested in history.

In 1987, the medical historian Ghislaine Lawrence curated an exhibition on the history of anaesthesia at the Wellcome Institute. In the catalogue for this she commented: 'Among medical specialists, anaesthetists might justly claim to have taken the greatest interest in the history of their own discipline'. She noted the tendency even for clinical texts and monographs to begin with an historical synopsis and concluded that, *'Considered in proportion to its size and recent origin…anaesthetics is an historical industry'.*[9] Although Lawrence would later advise the Association's museum committee she was highly critical of their approach to heritage. The Association was barely involved in the Wellcome exhibition and only one loan from its collection, a Vernon Harcourt Inhaler, is recorded. The success of this public exhibition may, however, have been viewed as an important **test run**, that gave encouragement to those wanting to open up the profession's own museum to a wider audience.

In later years, David Wilkinson would write that he felt that his time as Honorary Curator coincided most usefully with a parallel growth in interest in the history of the specialty, as seen by the number of historical symposia being organised from the mid-1980s.[10 (p99-105)] These included the inaugural meeting of the Society for the Study of the History of Anaesthesia in 1985. Wilkinson was shown essential support from a sympathetic committee chairman, Tom Boulton. It is perhaps significant that Boulton not only wrote the principal history of the profession, but was also Chairman of the Archives, Library and Museum (AL&M) Committee from 1990.[11] Boulton is clearly still regarded with great reverence, a former colleague recounting that *'When he asked for things to happen they tended to happen'.* It is arguable that his support of the 'heritage', which to him also included books, photographs and archive film, was influenced by his unique historical overview of a profession in formation.

Reason Two. Professional bodies, by their very nature, understood the language of professionalisation and could hardly obstruct the development of their museums when it was justified in such terms. The museum working group argued the case for paid professional assistance, resulting in 1987 in the appointment of Dr Audrey Eccles as ICI

Librarian/Archivist. In 1993 the committee proposed she be given the title 'Keeper of Historical Resources', and she even used this title in publications, although Council declined to formally approve it. The ICI branding was removed once that funding stream ended.[12] Boulton also paved the way for professionalisation of the heritage service when he persuaded Council to restrict honorary posts to five-year terms.[13] It has been claimed that the committee was 'not much loved' within the Association, despite the powerful people who sat on it and the fact that 'any anaesthetist on the street' would have recognised their names. Fortunately the committee members were mostly in a position to **save** the AAGBI money, because they all knew people who could be called upon to get things done *gratis*, whether that be technicians to maintain a display case, suppliers who would transport an object or research departments who could take a photograph, to give some common examples.

The other key driver toward professionalisation was the decision, in 1988, to seek the status of 'Registered Museum', the process now known as 'accreditation'. The stipulations of this external standards scheme have often proved onerous to small museums, but the language of standards was familiar to professional bodies, and their museums have thus often been at the head of the queue to be registered. As part of the process, Boulton encouraged the museum to emphasise communicative outcomes, especially 'the supply of information to enquirers'.

By the 1990s the Keeper and her Honorary Curator counterpart could write an article for an academic *Journal of the History of Collections*, claiming that the museum *'exemplifies the role which a specialist collection can play in raising the consciousness and promoting the professional advancement of a special interest group'*. Looking beyond their own institution, they even passed comment that 'Royal Colleges all seem to feel the need for a museum as part of their corporate image'.[10 (p99&101)]

Reason three. It seems that the museum has been used, on more than one occasion, as a convenient pretext to help justify the acquisition of a permanent headquarters building. By 1971 the whole collection was accommodated in the Nuffield Building of the Royal College of

Surgeons, but there was practically no public access to it in this building. From May, 1972 there was the added complication that the Association itself was no longer present in the same building, having moved offices to Tavistock House, home of the British Medical Association, so it was once again geographically distant from its own museum.[14] By 1978 the collection was reported to be 'in a grotty corridor all covered in dust, in the dark'. Pieces had been moved, labels detached and rubber bags fallen off.[15]

An unusually detailed article by Derek Wylie (AAGBI President 1980-82) explains the background to the acquisition of the Association's first proper premises at 9 Bedford Square. According to Wylie, two big factors drove this move. Not just the sheer growth of the specialty, requiring yet bigger offices, but 'responsibility for the future' of the museum and library collections. He wrote:

> 'If future generations of anaesthetists and other interested persons were to have the opportunity to appreciate and learn from these collections then arrangements needed to be made for their proper display and use'.[16]

That the housing of heritage collections, in a manner permitting their increased use, should be given equal weight to broader administrative functions, is remarkable. Ownership of the collections was exploited to increase the chance of obtaining a 'headquarters of quality' (though this seems to have been Wylie's personal motivation and was not laid down by any committee). Wylie was from St. Thomas' Hospital and may have been used to seeing cabinets full of old equipment (displays set up by Charles Foster), inspiring him to desire something similar at the new headquarters.

The building they bought met perfectly the first professional criterion identified by the London School of Economics sociologist Geoffrey Millerson in his *'five marks of prestige': namely that Georgian houses offer 'quiet dignity'* and *'a sense of age impressive to the visitor'*.[17] That last word is crucial. The AAGBI would not just be resident there, but clearly envisaged various forms of visitor coming to encounter them there. The Association seemed to relish its new role as the latest custodian of an historic property, commissioning an architectural historian to write its history. This positioned the Association as a responsible and worthy occupant in succession to another professional body, the Institute of Electronic and Radio Engineers. The original intention had been to place the collection in the most prestigious space, on the first floor, or *piano nobile*, but minutes from an early planning meeting indicate disappointment at the need to move the museum to the basement because of the weight of exhibits.[18] Undaunted, David Wilkinson wrote of it providing a home for the 'nucleus' of a museum that he clearly envisaged as developing into something greater.[2 (p514)] Eventually, with 'generous' funding from the British Oxygen Company, half of the basement was allocated and 'BOC' added to the museum's official name. The museum collection was then moved there in a hurry in 1986, when the RCS made a snap decision to reallocate space in the Nuffield Building, and it was to be joined by other gifts made in anticipation of the new building, notably a sculpture by the Welsh artist Jonah Jones.

The result was what AAGBI representatives themselves called a 'real' museum as opposed to a 'tool-shop'.[10 (p103)] The Association even won a London Tourist Board Certificate of Excellence for its exterior floral displays and Council justified the expense by taking 'the view that 9 Bedford Square is the shop window of the specialty and this award confirms that our public image is in keeping with our professional one'.[19]

Reason Four. Now it had a home, the museum could lay on programmes. These reveal how the Association targeted an increasingly public audience. In the pre-internet age, museums of the medical professions provided a rare opportunity for a profession to engage with that audience, though not all museums embraced it with equal enthusiasm and there were often attempts to control or limit the extent of public reach. The anaesthesia profession went further than some, perhaps, because it had a bigger public image problem. It was reported in 1976 that *'It is a common cause of complaint amongst anaesthetists that they have an indefinite "image" with the public'*.[20]

At Bedford Square the museum laid on a series of 'imaginative exhibitions', electing to completely re-display the entire museum each year on a specific topic. The first of these, pain relief in childbirth, reflected a previous academic interest of the Keeper. The list of these labour intensive exhibitions (Table 2) suggests an impressive range of coverage and a more imaginative approach to the subject than the mere display of apparatus.

Two exhibitions were in large part biographical and the 1989 exhibition was promoted as a collaborative effort 'Including material kindly lent by the Science Museum and the British Dental Association Museum'. Later, a part of this exhibition even went on tour to Bristol.[21] In 1992 the origins of the museum were explored in the first attempt to reassemble the original Charles King Collection, a fitting way to mark the Association's Diamond Jubilee.[22] By contrast, in 1994, the whole display was given over to recent acquisitions. This even included a notice stating proudly that 'Many of the items that had to be borrowed for the first exhibition have since been acquired'.

It was not always possible to lay out these exhibitions in a strictly logical order, so a printed handout offered a ground plan with a suggested order of viewing. The handouts were also useful in the absence of any invigilation or interpretation staff. Opportunities to involve the membership were also highlighted; the 1993 exhibition featured contributions of material from 'several members with experience in the Defence Medical Services'.[23]

Table 2 – Annual Exhibitions at Bedford Square, 1987-2002

1987 (1st) - **The Pangs of Childbirth** – an exhibition illustrating obstetric anaesthesia and analgesia from Simpson to the present day
1988 (2nd) - **Magill in Context** – illustrating anaesthesia between the wars with a special section to mark the centenary of Sir Ivan Magill 1888-1986
1989 (3rd) - **Painless Tooth Pulling** – Illustrating the transformation effected in dentistry by anaesthesia, and the development of dental anaesthetic apparatus and techniques since 1846
1991 (4th) - **Let the Machine Breathe for You** – The Story of Artificial ventilation

1992 (5th) - **Home at Last** – an exhibition of the original collection presented by A Charles King
1993 (6th) - Anaesthesia in Wartime
1994 (7th) - **Thanks for Your Memories** – some of the items added to the collection since the Museum opened in 1987
1995 (8th) - **Dephlogisticated Nitrous Air** - 150 Years of Nitrous Oxide Anaesthesia
1996 (9th) - Ether 150 Years On
1997 (10th) - **Delightful Beyond Measure** – A History of Chloroform Anaesthesia (also promoted under the title 'That Blessed Sleep')
1998 (11th) - Concentration, Concentration, Concentration – Towards Safer Anaesthesia. The contribution of A.D. Waller
1999 (12th) - A Spoonful of Sugar
2000 (13th) - **The Heaven Sent Gift** – an exhibition to celebrate two hundred years of nitrous oxide and other matters
2001 (14th) **- Ironclad – The Monitor**. An historical review of anaesthetic monitoring
2002 (15th) - **Miscellany** – Vignettes from the History of Anaesthesia

The position of the museum within the wider museum sector was made explicit in the Annual Report: 'The Museum at Bedford Square is seen as having a special function in providing exhibitions and information services for specialist historians of anaesthesia in parallel with the Science museum's role in relation to the general public'.[24] In other words the BOC Museum declared itself to be not for the general public. The new visitor book, commencing in July 1987, even included a column for visitors to state the hospital in which they worked.

This Visitor Book suggests attendance figures in the low hundreds. Undoubtedly not every visitor signed, and there is at least one recorded complaint that visitors were not doing so,[25] but many entries share the same date suggesting that groups were admitted in conjunction with events, and were perhaps actively encouraged to sign. It is known that delegates to historic evening seminars, designed as 'an opportunity for members to bring guests to a non-technical event' were encouraged to view the exhibition, but to do so would have involved walking down two floors.

One visitor commented that the museum also had a fun aspect, writing it was: 'very good, the kids enjoyed it!', a noteworthy acknowledgment that even where professional body museums restrict their programmes to members, those members may bring friends and family with them, but the overriding impression is that the exhibitions were viewed, by member of the profession, as nostalgic: 'Brings back lots of old memories', was a typical comment.

So what?

What did it matter to the profession that its professional association was indulging in the heritage business? This is a question that needs to be asked on a regular basis because the answer may well impact upon the continuing survival of the museum.

When the Association entered the heritage business by accident, the prevailing view was that the public wouldn't be interested. Two scholars of the professions, Lewis and Maude, writing in 1950, argued that (professional) *'heritage can be held to be of no great account. The culture may be thought too exclusive'*.[26] If they were right it therefore follows that whatever effort went in to mounting displays or exhibitions there was never going to be widespread interest in them. Nevertheless the Association spent three decades working towards the physical display of the collection, during which time most Association members, let alone the wider profession, never saw it and it was a resource with a potential that went untapped.

By contrast, almost the first reference to the museum in the 2000s is a remark to the extent that its redecoration would be noticed by 'regular visitors'.[27] This comment came within a new dedicated 'News from the Museum' page of the Association's newsletter. It is clear that the parent body now regarded the museum as a defined entity and as a destination, with a news agenda of its own, that was worth pushing for the benefit of the profession as a whole.

The museum carved a specialist role for itself, seen as a distinct from the general public role performed by the national museum collections. By the end of the 1990s, with those collections facing cutbacks, the

Association's museum emerged confidently as a point of authority and as the depository of choice for large collections in need of rehousing.

So, a study of the development of an historical museum can be an important indicator of changing self-image – of a profession becoming aware of and secure in its place in history. There is certainly some question as to how well known it had become outside of professional circles, but it is nonetheless interesting that a collection that had previously been named after its founder, and then after a business sponsor should now almost unquestioningly be identified by the Association with itself.

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A Brief History of Depth of Anaesthesia Monitoring

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In 2013, an estimated 2.7 million general anaesthetics were given in the United Kingdom.[1] The growth and ageing of the population are forecasted to have a significant impact on the need for surgical and anaesthetic delivery in the coming decades.[2]

Yet, despite a higher case load and an increased complexity brought by modern technology and an elderly population, anaesthetic-related mortality has significantly reduced over the last century dropping from 6.4 per 100,000 anaesthetics in the period between 1948-1954 to 0.21 per 100,000 in 2003 as shown by an analysis of over two million anaesthetics.[3] This improved safety is due to the constant improvements that have been seen in the field of anaesthesia since its birth in the first half of the eighteenth century. One of these developments has been the attempt at improving depth of anaesthesia monitoring, evolving from the observation of clinical signs through to the development of electronic depth of anaesthesia monitoring devices. This lecture will address a few of these significant developments.

- A need for depth of anaesthesia monitoring

From the induction of general anaesthesia in operating theatres for elective surgery to the rapid induction of a trauma patient in the emergency room, delivering a general anaesthetic is associated with significant risks. In addition to the maintenance and monitoring of adequate ventilation and perfusion, it is essential that the anaesthetist maintains a suitable depth of anaesthesia in each patient.

The practice of anaesthetics concentrates on patient safety thus, in order to prevent the occurrence of accidental awareness, anaesthetists have been shown to over-titrate hypnotic agents beyond what is necessary to achieve surgical depth of anaesthesia. The excessively deep anaesthesia delivered as a consequence will produce an avoidable suppression of cardiorespiratory functions, increased recovery time and post-operative cognitive impairments.[4, 5]

First reported in a case series by Bedford in 1955, post-operative delirium and post-operative cognitive dysfunction following surgery have been shown to lead to reduced quality of life at five years post-surgery, decreased functional capacity, increased mortality and increased burden on health care systems through a lengthened hospital stay and increased long-term nursing costs.[6–8] Thus such post-operative impairments have far-reaching socioeconomic ramifications, including additional nursing needs, loss of independence and increased admissions to long-term care homes.

Reversely, the patients will be at risk of accidental awareness during general anaesthesia (AAGA) if the anaesthetic is delivered at too shallow a depth. With a reported incidence ranging from 0.1-0.2% in low-risk cases to much higher levels in high risk situations, such as obstetrics, cardiac, paediatrics and trauma, the volume of general anaesthetics delivered yearly put the incidence rate of AAGA in the thousands.[9] With the aim to obtain a better understanding to the current incidence rates of AAGA, the Royal College of Anaesthetists and the Association of Anaesthetists of Great Britain and Ireland targeted their fifth National Audit Project on this subject. The report, published in 2014, presented the incidence rate of AAGA as 1 in 19,600 anaesthetics within the population surveyed, with wide variations observed between surgical specialities and anaesthetic techniques.[10]

Yet whilst uncommon, intra-operative awareness has been shown to be a primary cause of pre-operative anxiety and a leading cause of complaints and litigation against anaesthetists.[11, 12] It significantly correlates with patient dissatisfaction, above other more common complications such as post-operative pain and severe post-operative nausea and vomiting.[11] Additionally, the experience often triggers long-term complications for the patient on top of the immediate trauma, with reports ranging from impaired sleep and intrusive flashbacks to the development of post-traumatic stress disorder and other serious psychiatric complications.[13]

The affected patients will then be less likely to engage with the medical community, and could suffer from the negative consequences associated with such disengagement.

The evolution of depth of anaesthesia monitoring

Since the first use of anaesthetic agents in surgery, monitoring their effects has been a preoccupation of prime importance for anaesthetists.

An early testimony of this concern was published by the English physician John Snow in 1837.[14] In the opening sentence of his treatise on the optimisation of ether vapour inhalation, Snow accentuates the importance of recognising when the administration of ether '*has been carried far enough*.' Snow goes on to describe and classifies the effects of ether inhalation into five degrees.

The first degree of etherisation (sic) presented in the classification is described as an alteration of sensations with conservation of intact consciousness and ability of movement. If the application of ether is maintained, the patient will progressively lose the ability to carry out voluntary movements while still conserving their mental functions (second degree). Following on comes the third degree of etherisation with cessation of all mental functions and voluntary movements. It is noted though that ether administration and external stimulation of the patient can still produce muscular contraction in the third degree of etherisation. The fourth degree is described as a state producing no muscular contraction, even during external stimulation, apart from respiratory movements. The fifth and last degree, which Snow states is not seen in humans, consists of a quasi-paralysis of the respiratory muscles with only few, irregular and weak movements.

Snow's five degrees, first published in 1847, remained the basis for anaesthetic depth monitoring for almost a century until 1937 when Arthur E Guedel presented his refined four stages classification (Figure 1).[15] Guedel's classification built on Snow's work on diethyl ether and relies on the assessment of clinical signs such as ventilation, lacrimation, pupil diameter, autonomic ocular and pharyngolaryngeal reflexes and muscular tone. In particular, the third stage of this classification, corresponding to an anaesthetic depth sufficient for surgical operations, is subdivided into four planes corresponding to changes in reflexes and evolving breathing patterns.

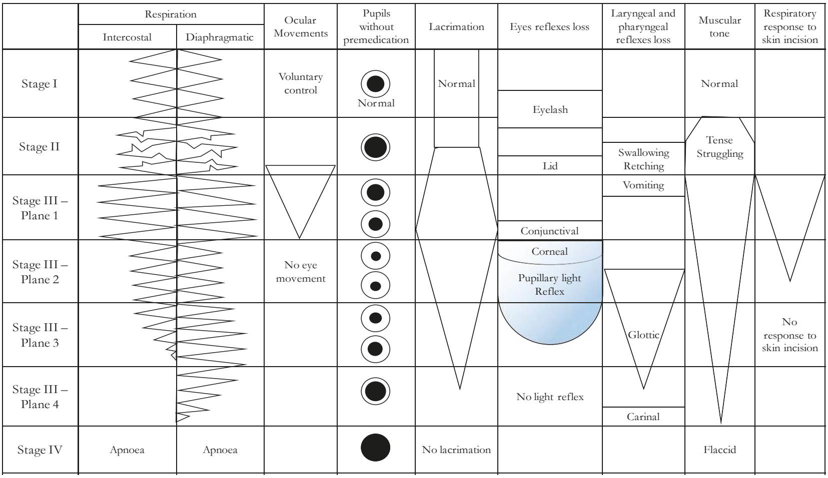

Figure 1. Diagram of Guedel's four stages of ether anaesthesia. Adapted from Guedel's classification.[15]

The classification - in addition to other factors such as drug concentration, heart rate, blood pressure and response to verbal commands -- provided basic clinical standards for depth of anaesthesia assessment, but the development of alternative anaesthetic gases as well as the cessation of ether anaesthesia in developed countries has rendered it slightly obsolete. Moreover, the classification, devised in 1937, predates the development of intravenous general anaesthesia and relies on muscular signs that will be abolished by the muscle relaxants used in certain types of surgery.

The next innovation of note came into the clinical field forty years later with the first description of the isolated forearm method by M E Tunstall in 1977.[16] This new method, allowing depth of anaesthesia assessment in the presence of neuromuscular blockade, was described in obstetric anaesthesia following the observation that this population was particularly at risk of AAGA. The isolated forearm method relies on the principle that by isolating the distal forearm from the systemic circulation, muscle power will be retained after injection of muscle relaxants and could be used as a way for patients to manifest their awareness. This is done by inflating a cuff around the patient's forearm above systolic pressure before injecting the muscle relaxant. Therefore, in the event of intra-operative awareness the patient can spontaneously move their non-paralysed hand, or be asked at regular interval to move so as to actively check for awareness. The ischaemia produced by the cuff remains a major limitation of this technique, necessitating deflation of the cuff after fifteen to twenty minutes yet the isolated forearm method is still employed, both in research and clinical settings, to this day.

Modern depth of anaesthesia monitoring systems

The technological advances enjoyed by mankind in the last decades have triggered the design and clinical use of computerised depth of anaesthesia monitoring devices. The development of those devices was brought forward with the rationale that they would provide a more objective and sensitive way of assessing anaesthetic depth when compared to the sole use of clinical signs.[17] The computerised depth of anaesthesia monitors currently used in clinical practice are divided into two categories; those using recorded evoked electrical-potentials and those deriving their assessment from a recorded spontaneous electroencephalogram (EEG) signal.

The first computerised devices were evoked potential monitoring systems. These monitors assess the electrical activity elicited in particular areas of the central nervous system in response to the stimulation of selected sensory nervous pathways. From the early 1960s, attempts have been made to use evoked potentials to assess anaesthetic depth, but it was the engineering and computer sciences evolutions of the 1970s and 1980s that have allowed the development of clinically-usable auditory, visual and somatosensory evoked-potentials analysis systems.[17] For example, multiple analyses of visually evoked potentials during anaesthesia with various agents have shown that most anaesthetic agents increase the latency and decrease the amplitude visual evoked potentials in a dose-dependent manner.[18] Therefore, visual stimuli delivered to an anaesthetised patient's retina via a pair of goggles containing light-emitting diodes will trigger a change in brain activity in the visual cortex. These visual evoked potentials can then be recorded by electrodes placed over the occiput, and their amplitude analysed to determine the anaesthetic depth.[17]

The evoked-potential monitoring system have now been supplanted by the introduction of spontaneous EEG-based monitoring devices. Indeed, we know that by crossing the blood-brain barrier, anaesthetic agents, both volatile and intravenous, exert their effects on the synaptic transmissions of the central nervous system. Although the exact mechanisms underpinning these effects are still to be discovered, an alteration of the EEG activity following induction of general anaesthesia has been repeatedly demonstrated.[19]

Introduced in 1992 by Aspect Medical Systems, the Bispectral (BIS) Index monitor (Covidien, Mansfield, MA, USA) was the first spontaneous EEG-based depth of anaesthesia monitors introduced in clinical practice. Many studies investigating accidental awareness during general anaesthesia have made use of the BIS monitor, and it has been the benchmark for most similar EEG-based devices developed subsequently.[17] To assess depth of anaesthesia, the monitor first obtains a spontaneous EEG signal through the use of four electrodes placed on the patient's forehead. The signal is then digitalised and analysed using a proprietary algorithm to extract a specific BIS dimensionless index between 0 (isoelectric EEG trace) and 100 (awake EEG trace).[17]

Another such device is the Narcotrend monitor (Monitor Technik, Bad Bramstedt, Germany), released in 2001. In a similar way to the BIS monitor, the Narcotrend records EEG and electromyogram (EMG) signals from forehead electrodes. The EEG signal will be processed by a EMG-based artefact removal algorithm and computerised by another proprietary algorithm to determine the Narcotrend Stage (A to F) and Index (0 to 100).[20]

Multiple other spontaneous EEG-based depth of anaesthesia monitoring devices have been marketed since their introduction in the 1990s. One of those is the Cerebral State Monitor (Danmeter A/S, Odense, Denmark) which processes the EEG signal to extract the dimensionless Cerebral State Index also ranging from 0 (isoelectric EEG trace) to 100 (awake EEG trace).[17]

Slightly differently, the M-Entropy monitor (GE Healthcare, Chalfont St Giles, UK) uses the increased EEG signal regularity and simultaneous decrease in its entropy seen with increasing anaesthetic depth to derive its assessment in the form of a dimensionless index.[17] Although published experiments have validated the depth of anaesthesia assessment provided by the Entropy index, no clinical trials have conclusively showed an association with reduced in AAGA incidence.

The future of depth of anaesthesia monitoring

Thanks to the information provided by the depth of anaesthesia monitors described above, some specific patients group have now been identified as at high risk of AAGA (e.g. patients who cannot tolerate adequate anaesthetic drug dosing, patients receiving muscle relaxants) or reversely at risk of excessive anaesthetic depth (e.g. elderly patients, patients with liver disease, patients with elevated Body Mass Index).[5, 21] In response to this observation, the Association of Anaesthetists of Great Britain and Ireland and the National Institute for Health and Care Excellence have published recommendations promoting the use of the spontaneous EEG-based anaesthetic depth monitors in patient group at high risk of over- or under-dosing of anaesthetic agents.[5, 22]

Nonetheless, recent clinical trials have reported significant limitations of the EEG-based depth of anaesthesia monitors, eliciting doubts in regards to their accuracy and safety. For example, whilst large clinical trials have shown that the BIS monitor reduces the incidence of AAGA, some others have pointed out the lack of effect of the monitor on awareness incidence,[23, 24] or even an increased incidence in the BIS-monitored group.[25]

It emerges from the literature that after almost 175 years of anaesthesia, we are still looking for a safe, reliable, and accurate methods to assess depth of anaesthesia to a high level of certainty. The ideal depth of anaesthesia monitor would have to be accurate and reliable regardless of the anaesthetic agent employed, readily useable in the operating theatre and financially affordable. While research is currently being undertaken in assessing current technology and developing new equipment, the future of depth of anaesthesia monitoring is still very much a work in progress.

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The Highs and Lows of Recreational Drug Use in Anaesthesia; A Historical Perspective

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Introduction

Great things have been born from the abuse of drugs. The Romantic Era in British literature hailed a time for huge advancements in both poetry and literature. Many argue that a contributing factor was the simultaneous increased use of opium within British Society. Opium's psychoactive properties had become abused. Poets initially used opium recreationally but it soon came to fuel their literary genius.[1] Eminent examples of this were Samuel Taylor Coleridge and Thomas De Quincey. The interaction of opium-induced hallucinations and the creative mind is well-documented in De Quincey's most famous piece of work, *'The Confessions of an Opium Eater'* (1821). De Quincey had a notorious addiction to opium. His autobiographical book aimed in part to share the marvels of opium with the world, and part as a warning as to the perils of its use. Amidst his praise for the drug however, De Quincey[2] makes a rather profound statement, *'Not the opium eater, but the opium is the true hero of the tale'*. Despite his admiration for opium, his acknowledgment that opium is the hero, aptly recognises how the drug, like all great heroes, has the potential to conquer its user. Whilst De Quincey and Coleridge exemplify how drug addiction positively contributed to their careers in poetry and literature, their drawn out suffering and ill health also demonstrate the many dark truths of addiction.

There are many similarities between these pioneers of Romantic Era poetry and to anaesthesia's own pioneers. Whilst opium abuse enhanced Coleridge and De Quincey's writing, this article will explore how drug abuse amongst physicians initially enhanced the development of anaesthesia and was in many ways fundamental to its discovery. This was the high in anaesthesia's relationship with drug abuse. Unfortunately, as

De Quincey profoundly observed, many drug-dependent anaesthetists were conquered by their drug of abuse. The article will therefore go on to explore the tragedy of drug dependence in anaesthesia; the personal loss and the loss to our specialty.

How drug abuse aided the discovery of anaesthesia

Ether

The first documented synthesis of ether occurred in 1540 by the great physician, botanist and chemist Valerius Cordus. It then took 300 years for the anaesthetic properties of ether to be revealed to the world by William Morton in 1846. During this hiatus ether sat on chemist shelves in a variety of preparations such as Sweet Vitriol and Hoffman's Drops. Such preparations were used for a wide array of ailments. One then wonders how ether made the transition from a quite ordinary medication on a chemist's shelf to the wonder drug of the global operating theatre. The answer - drug abuse.

The Enlightenment of the eighteenth century radically changed Europe. The movement's scientific foundations lay on the principles of reason and experimentation. Society increasingly turned to scientific methods as a means of reason rather than adopting traditional religious explanations. This became so popular that scientists of the time could make a living travelling town to town imparting their knowledge to the common person. It had become socially acceptable to experiment. Indeed, Erasmus Darwin, one of the figureheads of the British Enlightenment denounced those who rejected experimentation, *'A fool, you know, is a man who never tried an experiment in his life'.* [3]

This desire to experiment combined with a craving to explore the limits of the human mind that came with the nineteenth century Romantic Era set the scene for ether's birth into common society. It became popular to host parties during which guests sought entertainment and exhilaration through experimentation with ether. Such parties became known as 'ether frolics' and were well attended by influential scientists and physicians of the time. Key attendees and hosts of these parties were William Clarke,[4] Crawford Long[5] and Charles Thomas Jackson[6]. William

Clarke and Crawford Long's experience with ether is much like a mirror image. Whilst inhaling ether at parties both noted its ability to alleviate pain. Long[7] observed that in the aftermath of inhaling ether he often discovered, *'bruised or painful spots on my person which I had no recollection of causing'.* Additionally, he noted that his friends, *'received falls and blows which I believed were sufficient to produce pain'.* [7] Clarke and Long consolidated the knowledge they obtained from such parties and ventured to use ether as a surgical anaesthetic. Both did this successfully in 1842, independently and out of the glare and scrutiny of the public domain. Unfortunately, neither physician publicly reported their findings at that time.[4]

Whilst Clarke and Long missed the chance to reveal the secrets of anaesthesia, a later opportunity arose, again as a consequence of 'ether frolics'. Having witnessed Horace Wells' unsuccessful attempt to demonstrate the anaesthetic effects of nitrous oxide in 1845, William Morton was inspired to find a solution himself. Seeking guidance from his colleague, Charles Thomas Jackson, he was advised to apply ether topically to the gums prior to dental extraction instead of using inhaled nitrous oxide.[4] Jackson's recreational use of ether at university had also given him an appreciation of how the drug rendered the user *'dull and stupefied'*.[6] He shared this with Morton. Such insight proved crucial to Morton's subsequent success in experimenting with, and demonstrating, the use of ether as a surgical anaesthetic. This particular interaction between Morton and Jackson is well-documented and indeed forms the backbone to Jackson's later claim to being the father of anaesthesia. This author believes that Jackson's advice proved to be invaluable to Morton's success. John Warren, the surgeon for Morton's first demonstration, gives his account of the event. He states that the patient inhaled the ether and then, *'after four or five minutes he appeared to be asleep'*.[8] By this account the patient must have only been *'hovering between the first and second stages of anaesthesia throughout the operation'*.[9] Had he brought the patient fully into the second stage his demonstration may well have been a shambles. Jackson's advice to Morton to render the patient *'dull and stupefied'* ,[6] as at the parties he had attended, proved invaluable. Morton inadvertently aimed for the first stage of anaesthesia and thus avoided the potential stimulation of the second stage.

Nitrous oxide

The contribution of drug abuse towards the discovery of the anaesthetic properties of nitrous oxide is quite different to that of ether. Whilst the abuse of ether helped to reinvent its purpose as a drug, the abuse of nitrous oxide kept it in favour long enough for the medical community to find a medicinal use for it.

The first synthesis of nitrous oxide is credited to Joseph Priestley in the 1770s. Medicinal experimentation was then undertaken by the chemist Humphry Davy at the end of the century. He invested a year in this experimentation with his final report being published in 1800. His findings were truly commendable. Davy's[10] final paragraph stated, *'It (nitrous oxide) may probably be used with advantage during surgical operations in which no great effusion of blood takes place'*.

Davy's publication had pinned a potential medicinal use to nitrous oxide. Unfortunately, the medical community was disinterested. Without an accepted medicinal use, nitrous oxide was at risk of being cast aside. Nitrous oxide, however, had a saving grace. In the words of poet Robert Southey it could produce *'a delirium of pleasurable sensations'*.[11] Davy's focus therefore turned to researching the recreational use of nitrous oxide. Following his appointment as Assistant Lecturer in Chemistry at the Royal Institute in 1801 he became involved in delivering lectures to intellectuals that demonstrated the exhilarating effects of nitrous oxide (Figure 1). The gas he entitled 'Laughing Gas' became an instant sensation.

Figure 1. A lecture on pneumatics at the Royal Institute.[12]

Promoted across Great Britain and the United States in shows and lectures, over time few lacked the opportunity to experience the highs of nitrous oxide. Laughing gas fuelled parties, comic songs and the creativity of Romantic Era poets.

The fact that nitrous oxide was cherished by the medical community for so long, as a result of its abuse, was fundamental to its subsequent discovery as an anaesthetic agent. Indeed, the first demonstration of nitrous oxide as an anaesthetic was inspired by a 'Grand Exhibition' hosted by Gardner Quincy Colton in December, 1844. As members of the crowd were encouraged to indulge in the exhilarating effects of laughing gas, Horace Wells, a dentist and onlooker, noticed the increased tolerance to pain that one young man exhibited on falling over. Wells was inspired to experiment with nitrous oxide himself and went on to demonstrate his anaesthetic technique in January the following year at Massachusetts General Hospital. Whilst for various reasons this failed to be an instant success, hindsight acknowledges that his demonstration was brilliant and his inspiration was a public display of recreational drug abuse.

The tragedy of drug abuse in anaesthesia

Drug abuse within the specialty of anaesthesia in the nineteenth century demonstrated great triumphs, as did the collaboration of opium with Coleridge and De Quincey. As these poets succumbed to their drug abuse however, so too did many pioneers of anaesthesia and, as such, the specialty of anaesthesia.

The impact of drug abuse on the specialty of anaesthesia in the nineteenth century

Whilst the recreational use of ether and nitrous oxide proved necessary for the discovery of their uses as an anaesthetic agents, the abuse delayed their discoveries and subsequent progression of anaesthesia in the nineteenth century. It is argued that those who were experimenting with substances were distracted by their psychoactive effects. Davy's work with nitrous oxide is an excellent example of this. His initial endeavour was to make 'medicinal use' of nitrous oxide.[13] This was cast aside however following his snub by the medical community.[9] Snow[11] argues that this was a consequence of the era. He states that despite Davy's ability to

> 'Prove that gases could change bodily states… he was a product of eighteenth-century bodily understanding. The possibility of suspending sensation without endangering life could not be imagined'.

Davy, however, was not a man to observe the boundaries of an era. He was a scientific pioneer later credited with first isolating potassium, sodium, calcium, strontium, barium, magnesium and boron and for inventing the Davy lamp. His scientific ambitions would lead him to a Knighthood and to Presidency of the Royal Society. His experiments of nitrous oxide were naturally very thorough. He rendered animals unconscious with nitrous oxide and consequently noted, before experimenting on himself, that he *'was aware of the danger'*. [11] Despite these cautions he liberally used nitrous oxide on himself in addition to encouraging visitors of the Pneumatic Institute, where he was conducting his research, to try the pleasurable gas. All these actions do not portray a man who was fearful of the gas's effects, nor of someone who was afraid to stretch scientific limits. Additionally, Davy was closely connected to members of the Birmingham-based Lunar Society. He was surrounded by men like Joseph Priestley, Erasmus Darwin and William Wordsworth, whose lives were dedicated to questioning the status quo. Davy was a man and scientist who could contest disinterest by fellow physicians. One therefore wonders why this innovator decided to abandon his medicinal research of nitrous oxide, having both the character and intelligence to take on those who doubted him.

It appears that during Davy's research between 1798 and 1800 he became addicted to nitrous oxide. Whilst experimenting on himself he developed further compulsions to breathe more of the gas,

> 'I ought to have observed that a desire to breathe the gas is always awakened in me by the sight of a person breathing, or even by that of an air-bag or an air-holder'.[14]

Davy's abandonment of seeking a medicinal use for nitrous oxide appears to have been a consequence of his addiction to the gas - his obsession with its psychoactive effects and his desire to share them with the world. This drug abuse hampered his success as a chemist with nitrous oxide. It also appears to have hampered the work of those who were at the forefront of education at the time. The recreational use of laughing gas had become common place within intellectual society. John Scoffern, a chemist and surgeon, documented the consequences of this in his book, *'Chemistry No Mystery'* (1839).[15] He writes about his attendance of a lecture which quickly became infiltrated by rubber bags of laughing gas.

> 'As our instructor had predicted, we did not after this exhibition feel very much inclined to study philosophy, and therefore the Lecture, although short, was brought to a conclusion'.[15]

A visual representation of this scene is also demonstrated by George Cruikshank in Figure 2.

Figure 2. The use of nitrous oxide in a lecture theatre.[15]

Such experimentation in lectures hindered learning and validated the recreational use of drugs amongst Society's most intelligent. It also changed the way they perceived and therefore, studied them. An important example of this is both Clarke and Long's interaction with ether. Whilst both successfully used it as an anaesthetic agent in 1842 both failed to promote its use in this way. Ether could not be perceived as an anaesthetic agent beyond its role as a recreational drug.

The personal impact of drug abuse on nineteenth century anaesthetists

Humphry Davy was possibly the first scientist to become addicted to an anaesthetic agent. His experimentation with nitrous oxide quickly transformed into an addiction. Davy compulsively and frequently breathed nitrous oxide for the two-year duration of his research.

Fortunately, he recognised the problem and was able to restrain his use. Despite this, he noticed that the repeated exposure to nitrous oxide had caused detrimental effects on his health. The resulting inactivation of methionine synthase had caused

> 'Increased sensibility of touch: my fingers were pained by anything rough, and the tooth-edge produced from slighter causes than usual. I was certainly more irritable and felt more acutely from trifling circumstances'.[16]

Thankfully these effects were reversible and resolved once he conquered his addiction.

Long and Clarke are other examples of scientists who developed short-term adverse effects to the abuse of anaesthetic agents. Whilst experimenting with ether at parties both sustained physical injuries as proven by the bruises they were to notice following its use. Long[7] also documented instances in which recreational users of ether became so insensible they were thought to be dead. Such accounts highlight how asphyxia was a real risk to recreational ether users. Whilst neither Clarke nor Long were conscious of the fact that they were experimenting with a future anaesthetic agent, we now know that these experiments were key to their personal discoveries of its use as a surgical anaesthetic. Their experimental journeys with ether resulted in physical injury and risk of asphyxia.

Many attribute the most tragic story of drug abuse in anaesthesia in the nineteenth century to that of Horace Wells.[17] His unsuccessful attempt to demonstrate the anaesthetic properties of nitrous oxide in 1845 had a lasting legacy that was to consume him. Ridiculed as a failure, Wells was eaten up by the shame of his performance. Following the failed demonstration, his work as a dentist became sporadic and, with hindsight, it is clear that Wells was suffering from severe depression.[17] Morton's subsequent success in demonstrating ether anaesthesia in 1846 was all too much for Wells. Having taught Morton the concept of inhalation anaesthesia he was heartbroken that his personal contribution had been disregarded. He became fixated on promoting himself as the discoverer of anaesthesia, using his claim to endorse his business as a dentist. In 1848 he advertised his arrival to the city of New York in the *Herald* newspaper. Within his advert. he promoted the use of chloroform anaesthesia, describing it as *'highly pleasurable'*.[14] In his bid to master the practice of anaesthesia with chloroform, Wells had been experimenting on himself. He became addicted to the drug. Addiction combined with depression created a lethal cocktail. Wells is reported to have attacked two women whilst under the influence of chloroform.[14] He was arrested and imprisoned. Consumed by guilt and shame he committed suicide in his prison cell.

Conclusion

The exploration of drug abuse within the specialty of anaesthesia reveals both highs and lows. The initial high of drug abuse within the specialty was fundamental to the discovery of the first anaesthetic agents. It reinvented ether and kept nitrous oxide in favour with the medical community long enough for a medicinal use to be discovered. Unfortunately, that initial high was to be the last. History tells the tale of pioneers who were tragically consumed by the drugs they experimented with in their unfailing commitment to science and their conquest against pain. Sadly, their experiences continue to repeat themselves today. Since the birth of anaesthesia as a specialty, drug addiction has been consistently over-represented in physicians. Two studies performed in the United States since the millennium found that between 10-14% of physicians, at some point in their careers, contend with drug addiction.[18] Of these physicians, the number of anaesthetists was 2.7 times greater than in other specialty groups.[18] Many claim that such numbers are inaccurate[14] and that they will never truly represent the depth of the problem. Much like an iceberg, the personal turmoil that often fuels addiction, is hidden far beneath the surface. Additionally, these figures only extend to those who have a drug addiction and fail to acknowledge other aspects of anaesthesia that are affected; colleagues, patients and the specialty as a whole.

The high of drug abuse in anaesthesia is firmly in the past. It is important to consider how as individuals and as a specialty we detect and react to a colleague in distress. Let us discredit De Quincey and prove that it is us, the anaesthetists who master the drugs, not the drugs that master us.

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The Anaesthetic History of Delirium and Post-operative Cognitive Dysfunction

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Introduction

Europe's population is continuing to age; these elderly patients often have multiple co-morbidities which can impact on their care in the perioperative period.[1] It is reasonable to assume that our workload to anaesthetise such patients will increase. One major related-risk in the perioperative period is cognitive impairment; this is usually delineated as post-operative delirium (POD), post-operative cognitive dysfunction (POCD), and dementia. Despite this perceived sudden interest, the understanding of anaesthetic related cognitive dysfunction is not a new phenomenon. What I hope to show is how both POD and POCD have been known of, and alluded to, since the advent of anaesthesia for surgery (albeit with various terminology used for the same conditions we currently know and understand).

Post-operative delirium (POD)

Delirium is usually assumed to be an acute, fluctuating, transient and reversible condition caused by physical illness (POD being within the perioperative period). The first publication in relation to POD was written in 1887 for the *British Medical Journal* by Sir George (Henry) Savage (1842-1921), titled '*Insanity following the Use of Anaesthetics in Operations*'.[2] Sir George was a psychiatrist, famed in his day by *The Times* as an '*author on insanity*'.[3] He even appeared (the only psychiatrist in his day) in Vanity Fair's '*Men of the Day*' – a title akin to modern day celebrity status. This may be owing to his frequent interactions in literary circles, including attending Virginia Woolf during one of her depressive phases. His involvement in late Victorian asylum psychiatry, reaching the Board of Governors of Bethlem Royal Hospital, led to him adopting a case-based approach to research in the field of psychiatry.[4]

It was during his time at Bethlem Royal Hospital that Savage developed his ideas that led to the publication of '*Insanity following the Use of Anaesthetics in Operations*' (some 30 years after John Snow administered chloroform to Queen Victoria during labour). To a large extent the ideas he presents in his paper have not evolved substantially. He refers to POD as an '*acute delirious mania'* – emphasising its temporary nature. He leads on to state that this may lead to '*chronic weak-mindedness'*, which in turn may lead to '*progressive dementia'* – terms that we might identify as POCD, and the associative links which are still being researched to this day.

Using a case-based approach, Savage highlights risk factors to developing POD after anaesthesia including high alcohol usage, fever (which one might consider to be equivalent to the modern definition of sepsis), the use of chloroform and the elderly. One might postulate that hypoxia may also have exacerbated the relation between POD and the anaesthetic practice at the time.

Savage described the state of POD in the temporal context in relation to anaesthesia/surgery, an understanding of which, since then, has led towards more formal definitions of delirium such as that developed in the Diagnostic and Statistical Manual of Mental Disorders III (1980) (DSM)[5], which in turn has provided a basis of the Confusion Assessment Method (CAM) by Inouye (1990) to identify delirium in critical care patients.[6]

Post-operative cognitive dysfunction (POCD)

In contrast to delirium, the definition for POCD has been more elusive. The primary difficulty lies in there being no consensus definition of the phenomenon, and hence it not being recognised as a 'disease' by standards such as the DSM (at the time of writing, recent attempts have been made to create a standardised definition). POCD is understood to be a change, or decline, in cognitive function following anaesthesia/surgery that occurs typically weeks after the initial event.

Furthermore, it may present subtly and hence require extensive neuropsychological testing at multiple time-points.

The difficulty in defining the features of such a condition was highlighted originally by Bedford in his paper for *The Lancet* in 1955.[7] Dr Philip Derek Bedford developed his career in the field of elderly care medicine while in Oxford where he became a consultant physician at the Cowley Road Hospital.[8] Similar to Savage's style, Bedford developed a case-based approach which led to his identification of the concept of POCD. In his paper, titled '*Adverse cerebral effects of anaesthesia on old people*', Bedford described identifying some of his elderly patients post-operatively being '*not the same person since*'. What's more, he appreciates the subtle cognitive decline as '*gradual…defects which to an outsider would be obvious signs'* whereby loved-ones may have mistakenly attributed to the '*person's idiosyncrasies*'. Moreover, Bedford echoes the need for '*personal observation, accompanied by detailed psychometric testing before and after operations of all elderly patients requiring surgery*' to identify POCD.

He subsequently identifies events in the perioperative period which may lead to POCD. These included the usage of morphine, atropine, hyoscine and barbiturates – either pre- or post-operatively. What's more, he warns against the usage of sedation to '*control the very confusion they themselves have caused*'. He also identifies the change of environment as another causative factor. He is particularly scathing of the usage of '*hypotensive surgery'* stating it to be '*unjustifiable in people of any age-group, and particularly in the elderly*'. Furthermore,

> 'the onus lies heavily upon them (surgeons) to prove that their technique is free from risk…for the patient's mental state is also a matter of grave moment both to himself and his relatives'.

It was not until the 1980s where research in POCD in post-operative cardiac surgical patients occurred and suggested a link between anaesthesia and POCD. While initial studies such as that by Savageau *et al.*[9] and Shaw *et al.*[10] suggested a causative link between POCD and cardiac anaesthesia/surgery, subsequent research has shown this link to be overstated, with the causes to be more multifactorial than previously assumed.

Conclusion

It is reasonable to assume our current workload towards anaesthetising elderly patients will increase, and as such we will encounter cognitive impairment more frequently. As anaesthetists we have much to offer towards the perioperative care of such patients. It is disheartening that the recognition of POD and POCD have been known for so long, and yet the progress in research in their prevention and treatment is still sparse. It is hoped that with the recent drives in perioperative care, such as the Royal College of Anaesthetist's Guidelines for the Provision of Anaesthesia Services (GPAS), we might be able to offer better care to a population that is particularly at risk of cognitive impairment.

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Protocolised Resuscitation and Advanced Life Support: Was its original genesis by a surgeon? (Abstract)

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Cardiac arrest during anaesthesia and surgery was not an uncommon event in the early half of the twentieth century, with an incidence of 1 per 1000 patients, or potentially even greater as some have argued.[1] Hamilton Bailey was a British surgeon working at the Northern Hospital in London during this period, who gained notoriety for his acclaimed textbook 'A Short Practice of Surgery', which is still in use today.

He had a keen interest in improving the management of patients who suffered perioperative cardiac arrest, which he deemed to be a frequent occurrence for an emergency surgeon such as himself, working at a non-teaching hospital. During this period a number of notable surgeons of the time, such as Harvey Cushing and Ernest Codman, were engaged in the endeavour of attempting to improving the quality and consistency of patient care, often spurred on by tragic events they encountered in their own training and clinical practice.[2, 3] Peter Safar, an American intensive care physician is widely regarded as the Father of modern resucitation for cardiac arrest due to his seminal work on the subject in the 1960s.[4]

However, in 1947 Hamilton Bailey published an article entitled 'Impending death under anaesthesia', in which he discusses a protocol he developed for the management of cardiac arrest, which bears a remarkable resemblance in principle and practice, to the advanced life support models of today. Its examination brings about the possiblity that perhaps it was the surgeon, Hamilton Bailey, who may have been the original proponent of protocolised advanced life support and resuscitation, as it is practiced today.

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A Background to Anaesthesia in China (Abstract)

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References to surgery in China date back to 10,000 – 4,000 BCE, when blood-letting and excisions were done with sharp flint-like 'Bian' stones. However, it was not until the late Bronze Age (2,000-700 BCE) that refined casting techniques resulted in the production of needles, which ultimately gave rise to Acupuncture. Acupuncture was first described in the second volume of the 'Nei Jing', the classic books on Internal Medicine (305-204 BCE) written by Huang Di, the 'Yellow Emperor'. Surgical procedures were rarely performed however, even after the systematic description of acupuncture was published 500 years later by Huangfu Mi in 214-282 CE: '*The Systematic Classic of Acupuncture and Moxibustion*'.

The physician, Hua Tuo (140-208 CE), widely regarded as the first anaesthetist in China, used many herbal extracts, including cannabis mixed with wine to produce anaesthesia for surgery. The technique was called *máfèisàn.* And, arguably he was one of the first physicians to use opium poppy extracts as an analgesic. He was widely recognised as the first expert in the use of acupuncture and moxibustion. Sadly, Tuo burned all his books before he died resulting in his *máfèisàn* anaesthesia not being used, and surgery remaining a rarity until about 1,000CE. Despite this, *máfèisàn* anaesthesia was used in Japan.

During the Tang Dynasty (618-907 CE) the development of printing techniques enabled the Imperial Medical Bureau to publish and distribute many texts and detailed charts on acupuncture and moxibustion. Acupuncture was recognised as a special branch of what is now regarded as Traditional Chinese Medicine, a 'science' based on five elements: wood, fire, earth, metal and water. There were no gases; e.g. air, which at that time, was a fundamental 'element' of Western (Greek) science's four elements: air, water, earth and fire. Other differences in the understanding of anatomy and physiology were similarly bizarre, compared with such knowledge being elucidated by Europeans during the Middle Ages.

Traditional treatments included: herbal medicines; acupuncture; moxibustion; massage and qigong (non-physical exercise and meditation). Following increasing interaction, trade and exchange of knowledge with European societies after Marco Polo's meeting with Kublai Khan in the 13th century, acupuncture was suppressed and herbal medicine dominated therapies from the period of the Qing Dynasty until the 'Opium Wars' (1644-1840).

US physician, and member of the US Diplomatic Corps, Dr Peter Parker gave the first ether anaesthetic in China in October 1847, and chloroform in 1848. Cocaine and local anaesthesia followed in the 1890s. Acupuncture remained suppressed until Chairman Mao Tse-Tung's rise to power in 1949 when it underwent a resurgence in popularity, not just in the traditional sense, but also as an adjunct to modern anaesthetic techniques. After the 'Cultural Revolution' and Mao's demise (1966), a College of Anaesthesia was established in Xuzhou (1987) and the Department of Public Heath recognised anaesthesiology as a medical speciality in 1989.

Two English doctors Had an Influence on Modernising Japanese Medicine and Anaesthesia during the late nineteenth century

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Introduction

In introducing modern medicine before and after the Meiji Restoration (1868), Japan benefitted from numerous British and Dutch doctors. From a history of anaesthesia standpoint, we, therefore, researched several British doctors who influenced the introduction of modern medicine into Japan during the late nineteenth century. We then examined the backgrounds and circumstances of these British doctors.

Sources

After going through several books and internet resources on medical and anaesthetic history, we elucidated which British doctors helped to introduce modern medicine into Japan during the late nineteenth century.

Result

We discovered numerous British doctors who had come to Japan. Among those who practiced medicine were, Griffith R. Jenkins, J. B. Siddall, William Willis, Ferdinand Adalbert Junker von Langegg, George Newton, Frederick Victor Dickins, and E. Wheeler.[1] We also discovered two English doctors, who did not provide medicine and surgery in Japan, but are believed to have had a strong influence on Japan. They are Rutherford Alcock and Benjamin Hobson whom we will focus upon.

Rutherford Alcock (British Minister in Japan)

Figure 1. Sir Rutherford Alcock KCB. Her Britannic Majesty's Envoy Plenipotentiary in Japan. Photograph by F Beato, Yokohama c.1864.

Alcock was born in 1809 in Ealing, a western suburb of London, and obtained his MRCS in 1831 and his FRCS in 1843 from the Royal College of Surgeons. For four years beginning 1832, he was stationed in the war-torn Iberian Peninsula as a British Army surgeon. After returning to London, he worked as a Home Office Inspector of Anatomy and in other capacities. At the request of the Foreign Office, Alcock was once again sent to Spain and Portugal to deal with diplomatic problems in Iberia. There, he contracted arthritis from overwork and excessive fatigue. His thumbs were rendered immobile in the process, forcing him to give up his future as a surgeon.

Alcock later joined the Foreign Office and became a diplomat. In 1844, he was appointed Consul at Fuchow, and worked in China for 15 years where he was recognised for his skills and finesse as a veteran diplomat and a Far-East specialist. Alcock was sent to Japan, and arrived in Nagasaki on 4th June, 1859. Because he was ordered to exchange the instruments of ratification of the Anglo-Japanese Treaty of Amity and Commerce before 1st July, he left Nagasaki and arrived at Shinagawa on 26th June. On 6th July, Alcock opened a provisional British legation at the Tozenji Temple. On 11th September, 1860 he climbed Mt Fuji by using the trail beginning in Murayama. In spring 1864, after taking nearly a two-year leave of absence, Alcock returned to Japan. There, he found that the country's situation had completely changed. During his absence, the Namamugi incident had occurred, followed by the Anglo-Satsuma War, which broke out in retaliation. In addition, the Kanmon Strait became unnavigable because of the bombardment of foreign vessels by the Choshu clan. As such, Japanese hostility to foreigners (‘*jo-i*’) intensified. To appease supporters of anti-foreignism, the Shogunate dispatched a diplomatic corps to Europe to negotiate the closure of Yokohama Port. Attempting a breakthrough, Alcock played the leading role in the Bakan War.[1] However, the Foreign Minister John Russell refused to approve Alcock's interventions, and he ordered him to return home. The British Minister to Japan post was then passed to Harry Parks who had previously worked under Alcock while in China during the Qing Dynasty. However, in 1865, Alcock was appointed Her Majesty's Minister-Plenipotentiary at the Court of the Tycoon in Peking which was regarded as the highest status among all diplomats stationed in Asia at that time. Alcock remained in Beijing until 1869.

He retired as a diplomat during the same year, and later served in a number of posts, including president of the Royal Geographical Society and a member of government commissions. He died in London in 1897.[2, 3, 4]

1 The incident of gunfire at Shimonoseki involving the four countries' combined fleets

Figure 2. Rutherford Alcock (Image is from the Collection maintained by the Waseda University Library).

Benjamin Hobson (Chinese name: Ho Xin; British missionary and physician)

Hobson was born in 1816 in Welford, Northamptonshire. After graduating from University College London, he joined the London Missionary Society, became a missionary, and visited China. From 1839, he ran a hospital in Macao (Macao Missionary Hospital) before moving to Hong Kong in 1843. Later, he temporarily returned to England due to an illness incurred by his wife, but once again went back to Hong Kong in 1847. The following year, he moved to Guangzhou and opened a hospital (Wo Ai Clinic). While staying in Guangzhou, he wrote numerous books. When the Second Opium War broke out in October, 1856, Hobson fled to Shanghai, where he worked at Lester Hospital. He subsequently became ill and returned to England two years later in 1859. Hobson died in London in 1873.[5, 6]

Figure 3. Benjamin Hobson.

During his time in China, Hobson became fluent in Chinese and wrote numerous books. Of those, four were brought to Japan before and after the Meiji Restoration, where they were broadly accepted. These include, *Treatise on Physiology* (1851) (the first book that introduced Western-style anatomy to China), *Natural Philosophy* (1855), *the First Lines on the Practice of Surgery in the West* (1857) (introduced modern western surgery to the Orient), and *Treatise on Midwifery and Diseases of Children* (1858). Numerous modified editions reprinted and Japanese commentaries were also published.

In particular, *'the First Lines on the Practice of Surgery in the West'* was widely accepted by surgeons and medical students hoping to become surgeons. In 1858, the year after the original book was published, a Japanese language edition by Gonsai Miyake (1817-1868), a physician practicing Western medicine, was released by Tojuen as the publisher. This woodblock-printed book was published in numerous editions which indicates that this book was widely read in Japan and had a significant influence on the people.

Figure 4. Woodblock printed pages.

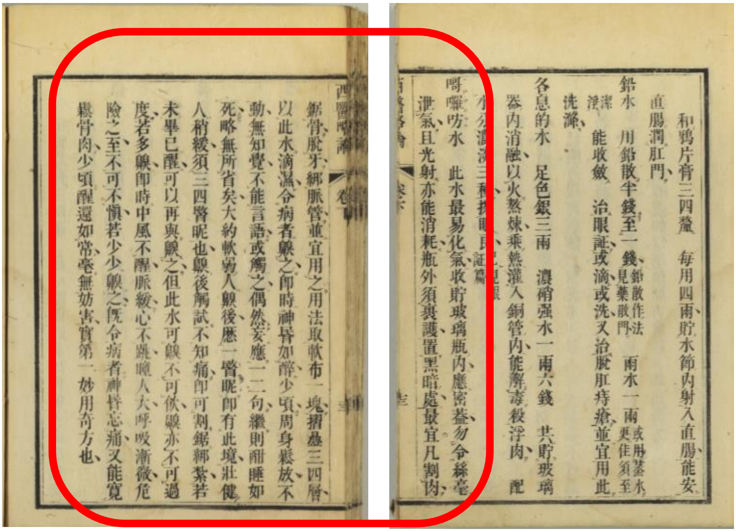
First Lines on the Practice of Surgery in the West (Tojuen Publisher edition) comprises three volumes (i.e., the Upper (Book 1), Middle (Book 2) and Lower (Book 3)). Book 2 consists of its own upper and lower volumes, so there are actually four volumes altogether. Book 1 features a general discussion on medicine and a discussion on Chinese and western medicine; it discusses theories on medications, inflammations, and ecthyma, among other topics. Book 2 discusses the symptoms and treatment methods of diseases in various parts of the body, such as fracture/breaking of bones, various types of osteotomy, brain inflammations, and the diagnosis of eye diseases. Book 3 explains drugs by dividing them into the following six categories: plasters, pills, powders, liquid medicines, medicinal liquors, and ointments. Camphor skin and gambier waters are listed in the liquid medicines category.[7, 8]

Discussion

Some may wonder why I chose to discuss Rutherford Alcock first. Although Alcock was originally a surgeon, the fact is that he had worked actively in Japan not as a physician, but as a diplomat. Along with Matthew Perry (commander-in-chief of the US Pacific Fleet), Townsend Harris (the US Consul-General to Japan), Gustave Duchesne, Prince de Bellcourt (French Minister to Japan), and others, Alcock was one of the individuals who helped **'awakening'** the Japanese people, who had been 'anaesthetised' by the Tokugawa Government, toward modernisation. Alcock used his boldness and delicacy, traits which he had cultivated as a surgeon, in diplomatic situations. He continued to negotiate with Japan, which had just opened to the world, at times in an overbearing manner. He did not rule out war, and at other times behaved tenaciously. By so doing, Alcock prompted the modernisation of Japan. Therefore, the modernisation of Japanese medicine was believed to have begun with Alcock. Although he introduced modern medicine into Japan, he did not provide medicine and surgery in Japan at all.[3, 4]

Hobson was a British missionary and physician who had stayed in China. He never visited Japan, therefore he did not provide medicine and surgery in Japan at all. However, by having his books translated into Chinese and imported into Japan while having a reprint edition published, he exerted major influence in introducing Western medicine into Japan before and after the Meiji era. Hobson had an especially strong impact with regard to the introduction of surgery and anaesthesiology, including chloroform anaesthesia. At the end of the first lines on *The Practice of Surgery in the West*, chloroform is mentioned as *'Hē luō fángshuǐ'*. The following are Hobson's descriptions of chloroform, which were originally written in Chinese (They were translated into Japanese, and subsequently translated into English by the author).[7]

Description of chloroform in《西醫略論》


西醫略論　卷下

和鴉片膏三四釐　每用四兩、貯水節內射入直腸、能安

直腸潤肛門、

鉛水　用鉛散半錢至一錢、鉛散作法見藥散門　雨水一兩或用蒸水更佳須至

潔淨　能收斂　治眼証、或滴、或洗、又治脫肛痔瘡、並宜用此

洗滌、

各息的水　足色銀三兩　濃硝強水一兩六錢　共貯玻璃

器內消融、以火熬煉、乘熱灌入銅管內、能解毒殺浮肉、　配

亦須濃淡三種、搽眼、見眼証篇

哥囉㕫水　此水最易化氣、收貯玻璃瓶內、應密蓋、勿令絲毫

泄氣、且光射亦能消耗、瓶外須裹護、置黑暗處最宜、凡割肉、

西醫略論　卷

鋸骨、脫牙、綁脈管、並宜用之、用法取軟布一塊、摺疊三四層、

以此水滴濕、令病者齅之、即時神昏如醉、少頃、周身鬆放、不

動、無知覺、不能言語、或觸之、偶然妄應一二句、繼則酣睡如

死、略無所省矣、大約軟弱人齅後歷一瞥睨、即有此境、壯健

人稍緩須三四瞥睨也、齅後觸試、不知痛、即可割鋸綁紮、若

未畢已醒、可以再與齅之、但此水可齅、不可飲、齅亦不可過

度、若多齅、即時中風不醒、脈緩、心不跳、噇人大呼吸、漸微、危

險之至、不可不慎、若少少齅之、既令病者神昏忘痛、又能寬

鬆骨肉、少頃醒還如常、毫無妨害、實第一妙用奇方也、

Figure 5. Description of chloroform.

'This liquid medicine evaporates extremely easily, so store it in a glass bottle and seal tightly. Since sunlight weakens the drug's efficacy, it is best to store it inside a bag and place it in a dark place. This liquid medicine should be used in surgeries that involve splitting the muscles, sawing the bones, and tying the blood vessels. As the usage method, fold a sheet of gauze in three to four layers, drop this liquid medicine over it in amounts as seen fit, and let the patient sniff it. The patient immediately feels as if he/she is becoming drunk; after a while, the entire body relaxes and becomes immobile. The patient loses all perceptions and can no longer talk. The patient then falls into a deep coma as if he/she had died, and does not recall, afterwards, the things that had occurred. Perform surgery once the patient falls into this state. If the patient wakes up before the surgery ends, make him/her sniff the chloroform once again. Make sure, however, to let the patient sniff and smell the chloroform, not drink it. He/she should not be allowed to sniff excessively, either. If he/she sniffs in excess, he/she will not wake up. The pulse rate becomes slow, the heart stops beating, pupils dilate, and breathing becomes faint. This is a dangerous state. Why should we not be cautious? Moreover, by sniffing this liquid medicine just a little, a patient can make his/her pain disappear, and becomes able to move his/her hands and feet. He/she awakens and regains consciousness like before. This is one of the good methods, too'.

Conclusion

The modernisation of Japanese medicine was believed to have begun with Rutherford Alcock and Benjamin Hobson. Although Alcock was originally a surgeon, he had worked actively in Japan not as a physician, but as a diplomat. He was one of the individuals who helped awakening the Japanese people, who had been 'anaesthetised', toward modernisation. Hobson was a British missionary and physician who had stayed in China, but never visited Japan. However, by having his Chinese-language books brought to Japan and reprinted as Japanese editions, Hobson exerted a major influence on introducing Western medicine to Japan before and after the Meiji Restoration. He had an especially strong impact on introducing surgery and anaesthesiology, including chloroform anaesthesia.

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Dr William Willis Who Provided a Modern Medical Service and Broadened Humanity during the Civil War in Japan

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Historical background

Figure 1. Ieyasu Tokugwa, the first Shogun, leader of Samurai

In 1603, Ieyasu Tokugawa (Fig. 1) established the Edo shogunate. The shogunate was a form of military government, and the Japanese Emperor became just a figurehead. In 1641, Japan isolated itself from the world. The Samurai Era continued peacefully for more than 200 years but in 1853, the U.S. Naval ship Commodore Matthew Perry arrived in Japan and forced the country to open its doors to international commerce. It spurred Japanese internal debate whether to open and modernise Japan or keep it closed. In 1868, a group of people demanded rapid modernisation and started a civil war. This group established a new Emperor-centred modern government and ended the Samurai Era. Through the civil war, Japan experienced rapid modernisation. It was during those violent times that Dr William Willis provided modern medical services and broadened the spread of humanity across the country.

Dr William Willis, childhood and education

Figure 2. Dr William Willis (1837-1894)

Dr William Willis (Fig. 2) was born in 1837 in Maguiresbridge, County Fermanagh, Ireland. He had an unhappy childhood because his father was harsh and sometimes brutal. His elder brother was a physician, and with his help, William was able to attend higher education. In 1855, he enrolled in the School of Medicine at the University of Glasgow, where he completed his basic sciences and preclinical training. His clinical training was at the Middlesex Hospital, qualifying MRCS (Eng) in 1858 and with the Licence of the Worshipful Society of Apothecaries (LSA) in 1859. Dr Willis then worked as a house physician at the Middlesex Hospital in London. In 1861, he was accepted for a medical post with Her Majesty's Legation in Japan.

On return to England in 1881, he became an FRCS (Eng) and an MRCP (Lond)

Dr Willis arrives in Japan

In May 1862, Dr Willis arrived in Yokohama (near Tokyo), Japan, where he began his duties as a medical officer and legation clerk. The Japanese people were amazed by him because he was a very tall man compared with the Japanese people. At that time, the average height of a Japanese man was 1.55 m and that of a woman was 1.45 m; Dr Willis was 1.91 m tall and weighed 127 kg making him 0.50 m taller than the average Japanese person.

Just after his arrival, the British Legation was attacked by a master-less samurai on the night of 26 September, 1862. During the attack, a British guard was killed, and two British diplomatic and consular officials were wounded. The attack was known as the 'Tozenji incident'. In September 1862, Dr Willis inspected the body of a British merchant who had been killed by a sword, a victim of the 'Namamugi incident'. He experienced many violent incidents due to the tense Japanese political climate. Japanese public opinion was divided between keeping Japan closed by eliminating foreigners or opening it up to modernisation.

Dr Willis treated many patients and taught Western medicine to Japanese doctors during the Japanese civil war,

The Japanese civil war erupted in 1868. Great Britain stood for the new government; therefore, Dr Willis worked for the new government during the civil war. During the first military clash in Kyoto, Dr Willis was asked by the new government commander 'Takamori Saigo' to be the head of medical operations. He established a military hospital in the Shokokuji Yogen-in Temple (Fig. 3) not far from the front line. At the hospital, he administered chloroform anaesthesia and performed amputations on wounded soldiers. From his practice, the efficacy of chloroform anaesthesia became well known in Japan with Dr Willis treating many soldiers in Kyoto. He was praised in the community for his efforts and highly-advanced medical skills.

Figure 3. Shokokuji Yogen-in Temple

As the civil war progressed, the main battlefields moved from the west to the northeast regions of Japan. Dr Willis was asked to join the northeast battle of Hokuetsu (Hokuetsu War), which was expected to become a major battle. In October 1868, he reached the city of Echizen Takada, where the relentless battle occurred, and many wounded soldiers were awaiting medical treatment. During the Hokuetsu War, Dr Willis treated numerous patients and performed amputations under chloroform anaesthesia. During this time, he noticed the lack of any wounded captive enemy soldiers and learned that all captive enemy soldiers were being killed. He asked the commander to stop killing all the captive enemy soldiers and to treat them humanely to which the commander agreed.

During the Hokuetsu War, Dr Willis' Japanese surgical assistant, Dr Genreki Akagawa, published a record of Dr Willis' medical practice. Dr Akagawa titled the record '*Hokuetsu Jugun Sou Zuroku*'. The record, which is of 130 mm × 170 mm in size, comprises 46 pages. It is currently owned by the Nagoya University Medical Library which has digitised it and made it publicly available.

The record focuses on 36 cases. One case (Fig. 4) records a left arm amputation performed by Dr Willis on 4th October, 1868. The use of chloroform was written up as was the dose (initially 60 drops and subsequently up to 100 drops). Fig. 5 records a left toe amputation performed by Dr Willis on the same day. He amputated one toe and the other one was amputated by Dr Akagawa.

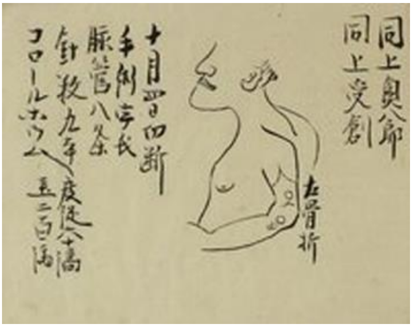

Figure 4 (left). Left arm amputation. Figure 5 (right). Left toe amputation. Fig. 4 & 5 are reproduced with permission of the Medical Library, Nagoya University.

The record includes only one case of treatment of sword injury. Although traditional images of Japanese wars show swords and arrows, the majority of patients treated by Dr Willis during the Hokuetsu War had gunshot wounds (34/35 in Akagawa's record) because the large number of guns and cannons that were used in the U.S. civil war (1861–1865) were imported and used in the Hokuetsu War (1868).

Seishu Hanaoka's herbal anaesthesia and Willis' chloroform anaesthesia

On 13th October, 1804, Seishu Hanaoka successfully performed a mastectomy under general anaesthesia using Mafutsusan. It was the first recorded case of using general anaesthesia in the world. Mafutsusan is herbal mixture that is administered orally. Hanaoka's method of herbal anaesthesia spread across Japan. Before the Japanese civil war, some leading Japanese doctors performed amputations using Hanaoka's anaesthesia; however, the numbers were not huge. During the civil war, numerous wounded soldiers had to have amputations. Hanaoka's anaesthesia was complicated and took two to four hours to take effect. Moreover, it was difficult to control the depth of the anaesthetic. During wartime, chloroform anaesthesia was more useful than herbal anaesthesia. Dr Willis' chloroform anaesthesia was highly praised during the Japanese civil war, becoming one of the reasons for the decline of Hanaoka's method of herbal anaesthesia.

Glory after the civil war

After the Japanese civil war, Dr Willis received award of the 'Imperial Brocade', which was the first time that it had been conferred on a European and a commoner, for his outstanding medical services during the civil war. In addition, he was nominated the chief doctor of the Imperial Medical School (now Tokyo University Hospital).

Disappointment after the glory

Dr Willis started British-style medical education in the Imperial Medical School. However, the Japanese government decided to adopt the German medical system. He resigned from the Imperial Medical School to become the chief doctor of the medical school in the Kagoshima prefecture. Located in the countryside, the Kagoshima prefecture is approximately 1,000 km away from Tokyo. Dr Willis decided to go to Kagoshima because his friend Commander Takamori Saigo lived there and had invited him.

Dr Willis' education in Kagoshima

Dr Willis started a medical practice and taught in the Akakura Hospital, Kagoshima, which has now become the Kagoshima University Faculty of Medicine. The Akakura Hospital was a Western-style building of red bricks. A stone memorial of the hospital stands in the Kagoshima city centre. Dr Willis educated more than 300 students in Kagoshima to become prominent doctors. Kanehiro Takaki, who was born in Kagoshima, was one of his famous students. He later founded the Yushi Kyoritsu Tokyo Hospital (now Tokyo Jikei Medical University Hospital) and became a physician general of the Japanese Navy. Statues honouring Drs Willis and Takaki titled 'Willis teaches Western medicine to Takaki' stands in the Kagoshima city centre (Fig. 6).

Figure 6. Statues stand in the Kagoshima city centre honouring Dr Willis

Dr Willis' clinical practice in Kagoshima

Dr Willis taught and practiced internal medicine, gynaecology, ear, nose, and throat surgery, ophthalmology and dentistry. He treated numerous patients in Kagoshima. However, surgical outcomes were not favourable because although Dr Willis studied chloroform anaesthesia in Edinburgh, he was not well-versed in antiseptic methods, which had been first published in *The Lancet* in 1866 by Joseph Lister.

Memorials of William Willis at Kagoshima University

Kagoshima University named its hall the 'William Willis Hall' (Fig. 7). In addition, there is a huge memorial stone honouring Dr Willis in the inner court of the Kagoshima University alumni building. Kagoshima University also has a heritage room in which there are many pictures of great contributors. More than half of the pictures are of Dr Willis.

Figure 7. Memorial plate on the William Willis hall

Later life

Dr Willis' best friend Commander Takamori Saigo, rose up in the Satsuma Rebellion in 1877 but failed. Dr Willis had to return to Great Britain that year. During his 15 years in Japan, he treated numerous patients with his modern medical techniques, and his sense of charity spread across the country.

He also educated many Japanese students, who later played a central role in Japanese medicine.

He passed away in 1894 at the age of 57 years.

Further reading

A former British ambassador, Sir Hugh Cortazzi, wrote a well-known biography[2] and paper[3] about Dr Willis.

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Seishu Hanaoka, A Notable Name in Anaesthesia in Japan

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Introduction

In 2013, the Anesthesia History Association`s 19th annual meeting was held in Hartford, Connecticut, U.S.A. where I met Prof. Roger Maltby, who he gave me a copy of his book, '*Notable Names in Anesthesia*'. I have personally met some of the notable names written about in his book and I realised that I should translate it into Japanese so young Japanese anaesthesiologists could read it.

Methods

I sent an email to him requesting permission for me to do the translation, and add some content in Japanese. After the agreement of Prof. Maltby, the translation was started and two Japanese, Mr Takuo Aoyagi, one of the innovators of pulse oximetry, and Seishu Hanaoka, who was the first physician to perform a surgical operation under general anaesthesia, were selected for inclusion.

Seishu Hanaoka

His father was a local doctor and studied Dutch medicine in Osaka. Seishu was born in 1760. He learned Chinese and Dutch medicine from his father. When he was 22-years-old, he decided to go to Kyoto to further his study of medicine by visiting many prominent doctors.

According to Prof. Akitomo Matsuki,[1] it may be reasonable to classify the development of anaesthesia in Japan into five significant periods. In Japan, the history of anaesthesia started from 1804 when Seishu completed a successful operation for breast cancer under general anaesthesia. This was not an accidental event. We should learn more about the prelude.

Prelude

On 4th May, 1771, Sugita Genpakuand, and his fellow doctors performed an autopsy on a criminal executed at the Kozukappara execution grounds. They found and confirmed the precise and accurate description in the *Dutch Textbook of Human Anatomy*. They realised that it was imperative to start a full translation of the textbook. This work was equivalent to the decipherment of complex codes, as in those days neither a Dutch-Japanese dictionary nor a translator in the medical field was available. It took three and a half years for the complete translation and shortly thereafter, a corrected edition followed. Through this work, they completed a Dutch-Japanese dictionary and also created many new Japanese medical terms such as nerve, duodenum, and prostate. Based on this project, many other medical textbooks were translated into Japanese and it resulted in an expansion of available medical literature in Japanese.

Paradigm shift

There was a paradigm shift, from traditional Chinese medicine to Western medicine. That is to say, that the rational foundation of Western medicine was based on human anatomy. This paradigm shift from traditional Chinese medicine to Western medicine, resulted in the work of general anaesthesia by Seishu Hanaoka in 1804.

The book *'Man Yo Zakki'*, (`Miscellaneous Travel Notes, The Latest Medical Information`, published in 1764 and written by Nagatomo Dokkyouan) inspired Seishu, as follows:

> 'It is widely accepted that cancer of the breast is that of an incurable nature. But according to the medical surgery in Dutch, breast cancer can be surgically excised in prune seed size'.

He believed that without adequate pain relief, the surgical removal of a breast cancer tumour could not be performed.

The first patient

Figure 1. The patient, Kan Aiyawas.

Kan Aiyawas a 60-year-old woman whose family was beset by breast cancer - Kan, mother of Rihei Aiya from Gohjo-Eki, Washu, came to Shun-Rin-Ken (Seishu`s clinic) for treatment of cancer in her left breast. She asked Seishu for a surgical operation while unconscious, because she had heard a rumour about a new technique. According to the list of breast cancer patients, she was the fourth. She also had beriberi which Seishu treated first. On 13th October, 1804, Hanaoka performed a partial mastectomy for breast cancer on Kan Aiya, using Mafutsu-San as a general anaesthetic. This is regarded today by some as the first reliable documentation of an operation performed under general anaesthesia. The agent used for general anaesthesia was Mafutsu-San.

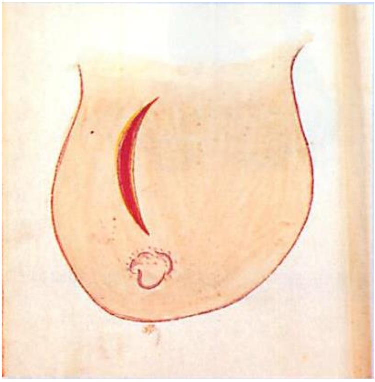

Figure 2. Breast showing incision. Figure 3. Removal of tumour.

Mafutsu-San

According to his friend`s diary, it took about 20 years to create an effective concoction of Mafutsu-San. He examined the effectiveness of the herb mixture on about 10 people.

About four grams of the mixture of herbs was put into approximately 360 ml of water, and concentrated to about 320 ml through boiling. He then administered this mixture to the patient. Within an hour, the patient would become insensitive to pain and then lapse into unconsciousness for 5-6 hours. For ages 5-10, half the volume of Mafutsu-San was administered and for patients aged 10-16, about 70% of a full dose was given.

Table 1. Concoction of 'Mafutsu-San'

		Ratio
Datura alba	:	6 - 8
Aconitum japonicum	:	2
Angelica dahurica	:	1
Angelica acutiloba	:	1
Cnidium officinale	:	2
Arisaema japaonicum	:	2

Seishu conducted 153 operations for breast cancer. Eight had a subsequent operation and two had a third operation.

In addition to breast cancer, Seishu performed operations for atresia ani, genital atresia, gangrene, haemorrhoids, cleft lip and palate, inguinal hernia and other surface operations.

The news of successful surgical operations without suffering spread all over Japan with about 2,000 doctors coming to study his medical practice before they returned to their own practices.

Seishu-No-Sato (Hospital and School of Seishu Hanaoka)

Seishu-No-Sato is located about 17 miles (27.5 km) from Wakayama railway station. No local bus service is available to the site. The railway runs two trains per hour from Wakayama City to the nearest station. It is about 22.7 miles (36.6 km) from Kansai international Airport (KIX).

Hanaoka's house has been preserved in his hometown of Naga-cho, Kinokawa, Wakayama. It has various interactive exhibits in both Japanese and English and is located adjacent to a nursing college.

The End of Anaesthesia by Mafutsu-San[1]

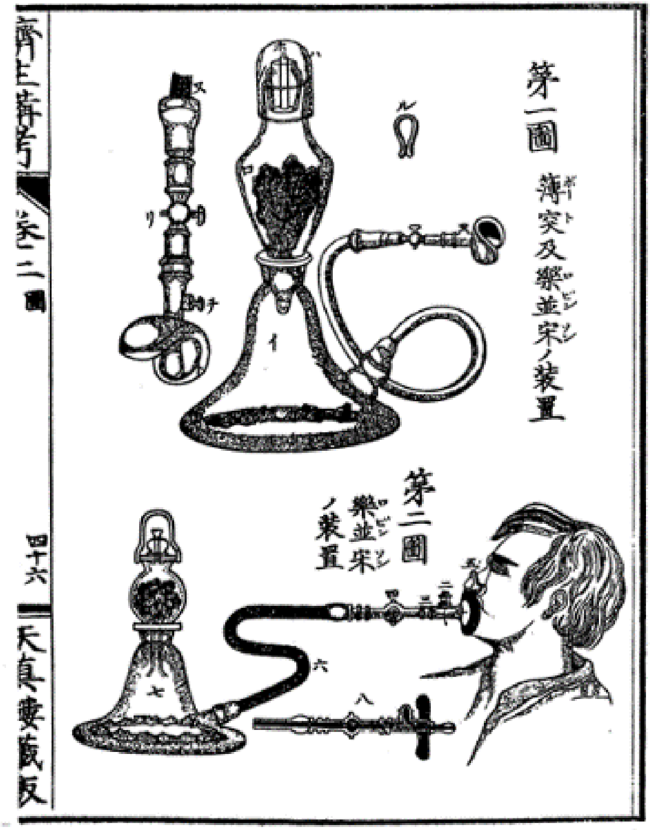

Figure 4. Boots (upper figure) and Robinson (lower figure) inhaler.
From the Japanese translation of the Dutch edition of J. Schlesinger's monograph, *Die Einathmung der Schwefel-Æthers in ihren Wirkungen auf Menschen und Thiere*, on ether anaesthesia.

In 1850, Seikei Sugita translated J. Schlesinger`s Dutch monograph on ether anaesthesia and coined a word, `*Masui*`, for anaesthesia. '*Ma*' means loss of sensation in the body, or analgesia. *'Sui'* means loss of consciousness produced by an agent or alcohol, or anaesthesia. Masui finally, means analgesia and anaesthesia. Note that figure 4 shows Boots and Robinson inhalers.

On 3rd June, 1861, the first chloroform anaesthetic was performed for amputation of the gangrenous right foot of Mr Yoshijiro Sakuragawa by Genboku Ito and in January, 1868, the second recorded chloroform anaesthetic was performed on a criminal, Mr. Nakamura, by Kenzou Yoshida.

The disappearance of use of Mafutsu-San and its rapid replacement by inhalational anaesthesia was strongly influenced by the civil war. However, it was in 1898 that the last abstract in a scientific meeting about anaesthesia using Mafutsu-San was recorded.

Discussion

Though some of his patients benefitted from Hanaoka's work, it apparently had no impact upon the development of general anaesthesia in the rest of the world. The national isolation policy of the Tokugawa shogunate (1633 to 1853) prevented Hanaoka's achievements from being publicised until after the isolation ended in 1854. By that time, different techniques for general anaesthesia had already been independently developed by American and European scientists and physicians.

The Japan Post published two stamps in memory of Hanaoka's contribution towards medical science in Japan. The stamp shown in Figure 5 was printed to coincide with the centenary meeting of the Japanese Society of Surgery.

Figure 5. The stamp was printed to coincide with the centenary meeting of the Japanese Society of Surgery

The Japan Society of Anesthesiologists, however, has incorporated a representation of *Datura alba*, otherwise known as Jimsonweed or the Korean morning glory flower in their logo in honour of Hanaoka's pioneering work.

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The Discovery of the Role of Breathable Vital and Other Gases in Respiration and Therapeutic Applications

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From Egyptian writings in the Ebers papyrus of 1534 BCE, through the ancient Greek philosophers, the importance to life of 'pneuma' entering the lungs and the circulation carrying it round the body and supporting life was recognised. Eristratus in 250 BCE, postulated that air was converted into a 'vital spirit', but it was neither clear what the vital spirit was, nor what it did. It was Galen of the Roman Empire who provided clarity about the separateness of the air in lungs, and of blood in the circulation.[1] He hypothesised an intracardiac interventricular septum with pores, through which blood passed and mixed with pneuma. A millennium later, at the height of the spread of Arabic science and culture, Ibn al Nafis in 1250 AD, hypothesised for the first time the existence of the pulmonary circulation.[2]

In the sixteenth century, Leonardo da Vinci supported some Galenic hypotheses and challenged others. He was a true Renaissance man, trained as an artist, a scientist and an engineer. He depicted in detail the two circulations to the lungs, differentiating between bronchial and pulmonary. Miguel Servetus (1509-1553), Spanish theologian and physician, in his religious treatise *'Christianismi restitutio'* challenged Galen's interventricular pores and wrote instead that *'blood urged forward through the lungs from the pulmonary artery to the pulmonary vein'*, and that the blood changed colour in this process. The Church regarded his theological work as heretical, and both he and his book were burned at the stake. William Harvey (1578-1657) of both Cambridge and Padua (where he was a contemporary of Galileo), showed that venous blood was dark and arterial blood which had passed through lungs was bright, findings which he published in *'de Motu Cordis et Sanguinis in Animalibus'* in 1628.[3]

Robert Boyle (1627-91), assisted by Robert Hooke, constructed a 'pneumatical engine', which was able to pump air out of a closed container, and showed that when this was done, a flame would extinguish, and an animal would die in the container, but survive longer than the flame. He concluded there was a vital element in the air necessary for both combustion and for life. He showed that these processes were accompanied by very little change in pressure and volume, and deduced (wrongly) that the vital element was present in very small amounts. Hooke demonstrated to the Royal Society in 1667, artificial continuous lung insufflation of a dog with part of the chest wall removed, and that the heart kept beating as long as the air supply to the lungs was sufficient. Richard Lower (1631-91) showed that blood changed colour in the lungs, not the heart, and only occurred in the presence of air.

John Mayow (1641-79), a chemist, thought he recognised an element of the air, which participates in respiration and combustion, but failed to show it experimentally. He wrote the *'Tractatus Quinque Medico-Physici'*, which brought together his results with those of Boyle and Lower. By using water to absorb carbon dioxide and longer experimental times than Boyle, he was able to demonstrate significant volume changes in an enclosed container, and deduced that the respiratory process must utilise and consume a vital component, which he called 'nitro-aerial spirit'; this supposedly combined with blood particles to produce 'fermentation' which ultimately led to muscular contraction; however, he failed to show this experimentally. His work was controversial and remained unknown for the next century. In this era Malphigi (1628-1694) used a microscope to elucidate lung microanatomy for the first time.

At this time there were thought to be different types of air. Georg Stahl (1660-1734) of Germany proposed that on burning a substance, 'phlogiston' is driven off from the substance, leaving 'calx' (ash), and that combustion in an enclosed space was extinguished when the air in the space became saturated with phlogiston. He could not explain the reduction in weight of burned metal oxides, but the phlogiston theory otherwise fitted all observations in relation to combustion. Joseph Black of Scotland (1728-99) showed that heating chalk gave off a gas with a reduction in weight, which did not fit with the phlogiston theory, and he found that the same gas was liberated with the processes of respiration, fermentation and combustion, which he called 'fixed air' (carbon dioxide) as he believed it to be the non-respiratory portion of air. The later discovery of 'vitiated air' (nitrogen) in 1772 showed that 'fixed air' was only a small proportion of air.

Joseph Priestley (1733-1804) initially believed the phlogiston theory. However he did some experiments in which 'pure air' (oxygen) was released from heating mercuric oxide with a lens, in which a candle glowed more vigorously than from a nitrous acid preparation, and a mouse survived for far longer than in 'common air'. He breathed the pure air himself with no ill effects. His plant experiments showed that vegetation reversed the gas exchanges of the respiratory cycle, commenting that the *'common air is restored by vegetables on the earth and may be a cause of purification of the atmosphere'*, a fact highly relevant for modern consideration. By doing some more experiments Priestley identified something by March, 1775, which Lavoisier subsequently called oxygen, and was able to say that this 'new air' was better than common air. However, he concluded wrongly that the 'new air' was a better absorber of phlogiston, and called it 'dephlogisticated air'. His belief in phlogiston led him astray in elucidating the true role of 'dephlogisticated air' (oxygen) in respiration. A separate piece of work of Priestley was the manufacture of nitrous oxide for the first time in 1772.

Antoine-Laurent Lavoisier (1743-94) did experiments which showed that when a metal oxide was heated, the total weight of reactants and products remained constant. By 1777 he knew that air had two components, only one of which supported these processes. He showed that when animals breathed 'pure' air (oxygen), they died before it was all used up, which led him to investigate the nature of carbon dioxide. By absorbing the carbon dioxide in acidified water, he was able to get an accurate value for oxygen consumption and showed that 'eminently respirable air' was an atomic element, which he named oxygen for the first time. In 1772 he experimented on combustion of phosphorus from which he came to know the composition of air. He knew that experiments with combustion would have to be linked to experiments with respiration. By 1777 further experiments showed him that there were two components to air, one which supported combustion and respiration, the other which did not. He also noted that exhaled air precipitated lime-water and that one sixth of respired air was 'chalky-acid air' (carbon dioxide). He noted that to recreate common air from exhaled air, not only did the right amount of 'eminently respirable air' (oxygen) have to be added, but the carbon dioxide also had to be removed. He concluded that in respiration, the eminently respirable air was either changed into chalky acid air by the lungs, or was given up to the lungs, to produce an almost (but not exactly) equal volume of chalky acid air. In doing some experiments on heat with the mathematician Laplace, he concluded that the only effect of respiration on air is the change of oxygen into carbon dioxide, but still did not fully understand the cellular process of respiration, which had to wait until Krebs' explanation of his eponymous biochemical cycle in 1953. Further quantitative experiments showed Lavoisier that not all of a sample of oxygen was converted into carbon dioxide and that easily breathable air must consist of 25% vital air (oxygen) and 75% azote (nitrogen). He also showed that oxygen consumption was independent of the concentration being breathed, rather it was dependent on temperature, food and work, all of which we now relate to the Respiratory Quotient. Lavoisier irritated Priestley and others by failing to acknowledge the contribution of their work in the advances he made. He was also involved in a number of financial dealings, which brought him to the notice of the French revolutionary authorities, and he was guillotined in 1794.

Even before the discovery of oxygen in 1772, Priestley suggested 'fixed air' (CO_2) could limit putrefaction (e.g. in beer), and that inhaling carbon dioxide could help ulcerative conditions of lungs. Once Lavoisier had clarified its nature, therapeutic oxygen also became popular to the public. As early as 1778 outside Britain, it was being used in cases of asphyxia from noxious gases. Thomas Beddoes founded a research Institution of Pneumatic Medicine in Clifton Bristol in 1794, The 'factitious airs', gases used at Beddoes' Institution were hydrogen, oxygen and hydro-carbonate, and used with caution, fatalities seem not to have occurred, probably because these gases were given with large quantities of air. Beddoes met the young Humphrey Davy while on holiday in Cornwall in

1798, and appointed him as superintendent of his Institution, where Davey undertook numerous experiments on factitious airs.[4] He showed that an increase in the amount of dissolved tissue oxygen helped treat carbon monoxide poisoning, and helped ischaemic tissues heal. As is well-known, he also obtained nitrous oxide, from zinc in dilute nitrous acid in 1799 and proceeded to experiment with it on himself. He experienced its partial anaesthetic effect, with the heightening of pleasurable sensation, its analgesic effect prior to any real anaesthetic effect, and its relative safety of use. Stating that it could be used *'to advantage in surgical operations'*, he never went as far as testing his own hypothesis. At this time oxygen therapy became popular at home and abroad; Berzalius (1824) described the sleep effect of substituting azotic air (nitrogen) with hydrogen in common air for inhalation; Pereira (1839) described the perceived antiseptic powers and respiratory stimulating effects of carbon dioxide.

In 1824 Henry Hill Hickman experimented on animals with inhalation of carbonic acid gas (CO_2) to 'suspend animation' for the purpose of eliminating pain to surgical stimulus, and to minimise haemorrhage, and proposed that such a technique could be used for human surgery. He realised that the technique was attributable to partial asphyxiation, but nevertheless thought it safe. Historical sources are not clear whether or not Hickman had tried also to use nitrous oxide for this purpose. He must, however, have been aware of Davy's work, which had caught the public's imagination, so that it became a popular pastime to breathe nitrous oxide for entertainment in the early 1840s, predating its formal use as an anaesthetic; it soon became known as 'laughing gas'. Others noted the lethargic state achieved with continuous inhalation and Faraday compared the effects of nitrous oxide and ether and noted the depression of the pulse with ether; 'ether frolics' became popular, particularly in America. These social experiences had a direct bearing on the subsequent first use of these agents for anaesthesia.

The first hyperbaric chamber had been constructed by the British physician Henshaw as early 1662, and was used to treat various diseases, without much evidence of any benefit. In 1772 Priestley described the benefit of a higher concentration of oxygen. By the 1830s the French were espousing a new fashion of enhancing bodily well-being with air chamber pressures of between two and four bar. Paul Bert published *'La pression barometrique'* in 1878 about the effects on the body of breathing compressed air. He showed that decompression sickness, 'the bends', first described in nineteenth century tunnel workers, was caused by nitrogen gas bubbles coming out of solution in tissues, and could be prevented by gradual ascent to the surface, and treated by return to higher pressures.[5] Bert also worked with high altitude physiology, and demonstrated the importance of partial pressure of oxygen rather than concentration. The concept of partial pressure had been elucidated by John Dalton (1766-1844), and his law of partial pressures could be combined with the well-known law of Boyle to calculate the volumetric concentrations of components in a gas mixture. Bert showed that the effects of hypoxia could be alleviated by giving oxygen, and he helped the first French high altitude balloonists survive.

It was the nineteenth century German chemist, Gustav Magner (1802-70)[6] who succeeded in demonstrating that arterial blood contained more oxygen than venous blood. Although Boyle and Hooke had extracted oxygen from blood in the pneumatic engine in the seventeenth century, it was Lothar Meyer in 1857 who showed that the extraction of oxygen by pressure reduction was non-linear, suggesting oxygen is not simply carried in solution in blood, but had a more complex mode of transport, namely by combination with haemoglobin. By 1888 Hüfner elucidated the relationship between oxygen content and haemoglobin concentration as well as oxygen tension. In 1904 the Dane, Christian Bohr showed the haemoglobin carriage of oxygen changed with carbon dioxide partial pressure, since the presence of acid in the form of carbon dioxide shifts the position of the dissociation curve, the Bohr effect.

John Scott Haldane, the Scottish physiologist, discovered the enhanced ability of deoxygenated haemoglobin to bind with carbon **di**oxide, the Haldane effect. In 1907, he proved that carbon **mon**oxide binds to haemoglobin in red blood cells two hundred times more readily than oxygen itself, thereby preventing the crucial role of haemoglobin in oxygen transportation. In studying decompression sickness, he discovered that the formation of bubbles *'depends on the existence of a state of supersaturation of the body fluids with nitrogen'.* Using a mathematical model, he was able to recommend staged decompression, especially at shallower depths. In 1911 he noted that the breathing reflex was triggered more readily by an excess of carbon dioxide in the blood, than by a lack of oxygen while studying the physiological responses of the human body at high altitudes. He wrongly postulated the oxygen 'secretion' theory, that alveoli themselves secrete oxygen. He did valuable work on recognising the danger of carbon **mon**oxide toxicity in mines, and developed a miner's breathing mask, as well as a mask for protection against poisonous gases in the trenches of World War 1. He classified the different forms of hypoxia, and he was the first to recommend oxygen therapy in clinical medicine based on a rational and scientific basis, and to describe pulmonary toxicity due to excessive oxygen therapy. He also described ventilation/perfusion mismatch, recognising that oxygen therapy has limited value in this situation.

In the development of breathing gas mixtures for diving, Bert, Haldane and others recognised that at sufficient depths air becomes a toxic mixture of gases. At sufficient partial pressure nitrogen has anaesthetic properties, ('nitrogen narcosis') and is the cause of decompression sickness alluded to above; because of its increased density at depth, it is also a cause of increased respiratory work. A high partial pressure of oxygen at depth can cause convulsions and lead to pulmonary irritation. Modern breathing devices for diving are able to change gas mixtures with depth, so that O_2 partial pressure remains low enough to avoid these effects, and so that nitrogen partial pressure is reduced by replacing it with helium (from 1919). Helium has a lower gas density and therefore reduces respiratory work, but has its own neurological toxicity, distorts voice communication and has a high thermal conductivity.

In the reduced ambient pressure of a space environment, early US spacecraft in the 1960s and 70s, in contrast to Russian spacecraft, had a pure oxygen environment at a reduced environmental pressure. This was in order to reduce the engineering demands of the spacecraft hull. The fire at ground level of Apollo 1 in 1967 demonstrated the hazard of a pure oxygen environment. Although all spacecraft now use air at sea level pressure, spacesuits still use low-pressure, pure oxygen environments to allow operational biomechanical mobility, which is both a potential fire hazard and requires a pre-breathing protocol to be taken to protect against decompression sickness before a spacewalk.[7]

It took philosophers and physiologists, anatomists and chemists, clinicians and engineers a surprisingly long time to discover the nature of the gases we breathe to maintain life, but the science has given us respiratory medicine and anaesthesia, an ability to explore extreme environments, and a respect for our atmosphere.

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Origin and Evolution of Domiciliary Ventilation in the UK: The Responaut Study

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Abstract

An unusual combination of clinical need, political development and administrative change in the early 1970s provided an ideal opportunity to explore the feasibility, desirability and economic implications of providing home care for patients requiring mechanical ventilation. Many were survivors from poliomyelitis and had other physical handicaps too. The trial was successful, popular and cost effective. It also identified the need for a comprehensive in-patient service with close integration between hospital and community care, a model which remains an objective to the present day.

Background

Rarely does an Act of Parliament contribute directly to a medical development but the Chronically Sick and Disabled Act 1970 did just that. The poliomyelitis epidemics of the previous two decades had left some patients with permanent respiratory insufficiency, often with other disabilities too. A few ventilator-dependent survivors were cared for at home but many remained in hospital indefinitely. In the late 1960s, one such group of about 25 patients cared for by the Western Fever Hospital, Fulham faced an uncertain future when the hospital was scheduled to close. Alarmed by the implications of obligatory relocation, the patients campaigned vociferously for transfer to care at home, suggesting their lives would be happier and more productive as a result, possibly at lower or at least comparable cost.

St Thomas' Hospital had recently assumed responsibility for the South-Western Hospital, Brixton which provided psycho-geriatric services locally and was in need of modernisation. Agreement was reached with the North West Thames Regional Hospital Board to fund a new unit at the South-Western Hospital for the polio survivors from the Western Fever Hospital and their often bulky negative-pressure equipment. It opened as Phipps Unit in December 1968 when in-patients from the Western Hospital were transferred and some of the staff familiar with their needs relocated at the same time. Dr Geoffrey Spencer, a Consultant Anaesthetist at St Thomas' with experience of the design, running and administration of intensive care units in both the UK and Scandinavia was invited to become the first Medical Director. Senior Nursing staff with experience of intensive care were appointed and an additional senior house officer post created by incorporating a two-month period at Phipps within the intensive care unit rota at St Thomas'. The patients were delighted by this new venture and coined for themselves the term 'Responaut'.

The timing was opportune. A Labour government was in power and a Private Members Bill intended to regularise health care provision for the chronically sick and disabled was under discussion. Richard Crossman had just been appointed Secretary of State for Health and Social Services and was invited to meet one of the polio survivors living at home, a forceful former Colonel in the Women's Royal Army Corps. He subsequently toured the in-patient facility at Phipps Unit. Very favourably impressed by both visits, he concluded *'this is a mini-integrated health service which is exactly what I want'.* To reinforce the message, a cavalcade of Responauts with plenty of cumbersome equipment was organised to cross Westminster Bridge and hand in a petition to Downing Street. Shortly afterwards, the Department of Health agreed to fund a three-year project to explore the feasibility, desirability and economic implications of home care for as many of these patients as possible. The grant covered the salary and subsistence costs of 17 home care attendants who were to be allocated individually to patients requiring assistance beyond what could reasonably be provided by family members. A multidisciplinary Responaut Panel Research Team was set up within the Social Medicine and Health Services Research Unit at St Thomas' Hospital to assess need, implement the care judged most suitable for each individual, and assess the feasibility and cost of providing it.

The study

Twenty patients were recruited. Each agreed to medical and social assessment to determine individual need for attendants, equipment and home alterations, and all consented to the preparation of a report on financial circumstances by a representative from the Department of Health and Social Security. This required participants to disclose details of their capital and income and incorporated an assessment of entitlement to benefits under current Social Security legislation. Each patient was invited to express a preference for future location, the majority preferring care at home with a few opting instead for a Cheshire Home. At the outset, seven patients lived at home, eleven in hospital and two in Cheshire Homes. Eight of those in hospital were assisted to live at home and two others transferred to a Cheshire Home, one subsequently moving to a Local Authority apartment. The seven at home remained there. A twentieth patient died before initial assessment and two more living at home died during the study. Hospital re-admission was required occasionally for episodes of acute ill-health, interruption of domiciliary care or more detailed assessment of current condition, but overall throughput increased as average length of hospital stay diminished.

A holistic approach to medical and social need was adopted and a relaxed atmosphere fostered within the unit. Regular home visits by nursing and technical staff and an on-call service for break-downs provided not only clinical supervision and preventive maintenance of equipment but also a sense of security, familiarity and support. Designated hospital staff were responsible for finance and administration, provision of facilities at home, and co-ordination of attendants and social services so that *ad hoc* arrangements could be avoided. An ambulance large enough to transport a patient in an iron lung was acquired and practical arrangements made for holidays or respite care at Netley Waterside House.

The final report of the Responaut Panel Research Team was submitted in 1974[1] and a comparison of hospital and home care costs published in 1977.[2] The results were presented at an international symposium in 1982[3] summarised by Goldberg and Faure in 1984[4] and discussed widely in the US as a paradigm for the development of home care.[5, 6] The study was numerically small but it was clear that even extreme physical and respiratory disability did not preclude care at home. Costs lay between those for inpatient care and residence in a Cheshire Home. The limiting factor was not finance but the need for and availability of trained care attendants, marked variation being noted in Local Authority services.[7]

Subsequent Development

The success of the programme generated increased demand which soon extended to other types of chronic respiratory disability and included patients from outside the immediate geographical area. Survivors of the new discipline of intensive care who had recovered from an acute illness but still needed respiratory assistance could also be cared for safely, and the relaxed environment and emphasis on rehabilitation favoured their recuperation.

In time, the separation between Phipps Unit and St Thomas' Hospital proved unsatisfactory, most notably when major surgery such as spinal fusion was undertaken at St Thomas' and followed immediately by a hazardous return to Phipps Unit. Facilities within the St Thomas' campus were needed and the patients themselves raised £1.3m for rebuilding and relocation. A sixteen-bed, purpose built, ground floor unit with integral workshop and radiology service opened in 1988 and was named in honour of Baroness Felicity Lane-Fox, polio survivor, fund-raiser and founder member of the patients' association who died shortly before the building was completed. A satellite Lane-Fox unit opened at Redhill in 2014.

Although a simpler, self-operated 'portable' tank ventilator had been designed at Phipps Unit, it was the advent of non-invasive positive pressure ventilation by nasal mask in 1986[8] and an increasing awareness of the prevalence of impaired ventilation during sleep that led to a massive growth in domiciliary ventilation. However, the quality of these services varies widely[9] and the establishment of a National Register of such patients is to be welcomed.[10] It is to be hoped that as the Chronically Sick and Disabled Act 1970 approaches its half-century, this new legislative requirement will define standards and enhance the provision of comprehensive and integrated care for patients requiring mechanical ventilation at home.

Acknowledgement

I am indebted for information and advice to Dr GT Spencer OBE, Professor F. Reynolds, Ms R.N. Tierney MVO and M. Mordaunt, Hospital Secretary.

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Erratum

Unfortunately the image of Frances Burney that was used in the paper:

> Kitamura S, Dote K, Keizo Ikemune, Hideyuki Nandate, Amane Konisi, Takeshi Yoshikawa *et al*. Surgical treatment of breast cancer in the early 19th century: a comparison between the United Kingdom and Japan. *History of Anaesthesia Society Proceedings* 2017; **50**: 111

was, in fact, '*A Portrait of a Lady as Evelina'* by the artist John Hoppner RA (1758-1810). Evelina was the principal subject portrayed in a novel written by Frances (or Fanny) Burney.

Below is an image of Frances Burney which should have been printed.

Artist: Edward Francisco Burney (1760-1848). *Frances Burney*. (*c*.1784-1785). Oil on canvas: 762x635 mm: NPG 2634: Purchased with help from the Art Fund, 1933.

Although the National Portrait Gallery (in London) believes that there are five portraits of Frances Burney in existence, only two by a relative, Edward Burney, are likely to be genuine.

BOOK REVIEW

Made in Hythe; A short history of Portex.

Christopher J O'Connor. London: Orbital Print, 2017.

ISBN 978-1-5272-1565-8 £9.99 + £2 post and packing from chrishythe@hotmail.com or telephone +44 (0)1303 260758

Equipment manufacturers have long been integral to the practice of anaesthesia, critical care and pain medicine, yet the corporate histories of the various companies involved have seldom been researched. This short (134 page) book by Chris O'Connor (a retired accountant and current member of Hythe Local History Group) goes some way to ameliorate this, and traces the development of Portex (originally Portland Plastics Ltd), from its foundation in a Great Portland Street flat in August 1940, through to the present day.

The Portex range of disposable plastic medical products will be well known to members of this Society, and for many decades, these were designed and manufactured in the small market town of Hythe, on the Kent coast. By the early 1970s the company employed around 1000 people and had become a pivotal part of the local economy. Realising that '*unless someone wrote about the company and how it affected the town and vice-versa, then all this would be lost in the annals of time*', O'Connor began to compile this account.

The history of Portex is presented over five chapters, each characterised by a particular style of management. These comprise: 'The early years', under the company's founder Dr Sidney Leader, 'The years of opportunity' under Walter Crossland, 'The years of expansion' under George Kennedy, 'The corporate years' under the management of Smiths Medical, and 'The new millennium', which extends to the present day (where Portex products continue to be manufactured in facilities in Mexico, the United Sates and Eastern Europe). A further chapter provides a biographical account of Sidney Leader, based largely on information contained in archived letters written by his son.

While O'Connor has drawn heavily on material presented in James Nye's authoritative history of Smiths Industries[1], his book supplies new insights into life inside Portex's offices and manufacturing floors, as well as the Sports and Social Club. In doing so, he identifies the essential ingredients for running a successful international export business.

Not everything in this account will please clinician-historians of anaesthesia. O'Connor's technical descriptions are sometimes clunky e.g. '*disposable tracheostomy tubes were used as an aid to breathing whilst the patient was in trauma, say, after an accident where normal breathing became difficult, or for long term respiratory care during times when normal breathing was impaired*', and I was irked by his repeated use of the term '*end-users'* for those who utilise the companies products. The book is nevertheless a worthwhile read.

1. Nye J. Along time in making; the history of Smiths. Oxford: Oxford University Press, 2014.

Dr Peter Featherstone