The History of Anaesthesia Society Proceedings

Vol 46

INCLUDES INDEX TO VOLUMES 36-45

Contents of Volume 46

We regret to report death of the following members:

Dr G M D Archer; London, Dr P J Brock; Reading,
Dr H B Hannah; Chippenham, Dr E T Mathews; Birmingham,
Prof J Pokorny; Prague, Dr J R Spears; Chelmsford.

HISTORY OF ANAESTHESIA SOCIETY

Meeting at Castle Green Hotel Kendal, 5^{th} & 6^{th} July 2013

Organiser: Dr Anne M. Florence

The organiser is most grateful to Liz Duncan and all her colleagues at Best Western Castle Green Hotel for the smooth running and for their courtesy. Nothing was too great a problem. Thanks are also due to Sue Adams for her welcome to participants, the efficient running of Registration and all the attendant issues and to Peter Featherstone for running the Audio-Visual presentations.

Thanks are also due to Miles Rucklidge and his wife, Margaret, for their major contribution to the Ladies Programme which was much appreciated by all the participants and, also, for arranging the Guest Lecture entitled 'Some Kendal Treasures' delivered by Trevor Jones, an active member of the Kendal Civic Society as a suitable ending to the meeting. I am also grateful to Trevor and his colleague, Patricia Hovey MBE for volunteering to conduct walks through the historic areas of Kendal on Saturday afternoon.

FUTURE MEETING

2014

19^{th} – 21^{st} June HAS Summer Meeting at West Dean College, near Chichester.

Contact: Dr Ken MacLeod (kenmacleod@doctors.org.uk

Proceedings of the History of Anaesthesia Society

Honorary Editor

Dr Adrian Padfield
351 Fulwood Road
Sheffield S10 3BQ
Email: a.padfield@sheffield.ac.uk

HISTORY OF ANAESTHESIA SOCIETY

Council and Officers – July 2013

President	Dr Anne M Florence, Cheshire	2012-2014
President Elect	Dr John Pring, Penzance	2013-2014
Honorary Secretary	Dr Christopher Woollam, Norwich	2011-2016
Hon Treasurer & Membership Secretary	Dr Kenneth MacLeod, Huntingdon	2012-2018
Honorary Editor	Dr Adrian Padfield, Sheffield	2012-2014
Honorary Archivist	Mrs Patricia Willis, London	2012-2018

Members of Council

Dr Peter Featherstone (Webmaster) Cambridge	2011-2014
Brig Ivan Houghton, London	2013-2016
Dr Ronald Lo, London	2013-2016
Dr Ian McLellan, Dorset	2013-2015
Dr Wulf Strätling, Cardiff	2013-2015
Dr Edward Young, Reading	2012-2015
1 vacancy	

Co-opted

Dr Neil Adams, Bury St Edmunds	2013-2014

Honorary Members, UK and Eire:

Dr Aileen Adams CBE
Dr T B Boulton OBE
Dr P M E Drury
Dr Jean Horton
Dr Ian McLellan
Dr Adrian Padfield
Prof Sir Keith Sykes
Dr David Zuck

Honorary Member Overseas:

Prof Roger Maltby; Jasper Alberta.
Prof John Severinghaus; Ross, California

For more information visit the website: www.histansoc.org.uk

EDITORIAL and LETTERS TO THE EDITOR

My experience of being your Honorary Editor is limited to two Proceedings. I agreed to fill the post on a temporary basis whilst a replacement for my predecessor, Alistair McKenzie was found. This Volume for various reasons has been more difficult than Volume 45. I hope it will be useful, however, in containing an Index to Volumes 36 – 45.

Please note the Statement by Prof. Tony Wildsmith about the College 'Lives of Fellows' project on page 8. It is likely that members of the Society will be able to help this project with biographical details of deceased Fellows especially if they have personal memories.

There are more Abstracts in this Volume for several reasons. Some of the speakers were publishing or reading their papers somewhere else, others had already published elsewhere either in print or on a website. This may be frustrating for any member seeking further information but the Society tries to avoid duplicate publication.

You will find enclosed a double flyer:

On one side; regarding the publication of a membership list in the next volume of the Proceedings.

On the other; asking if you wish to receive Society communications by email. The savings are obvious.

Letters

Dear Editor

I wish to declare an incorrect statement in my abstract "Insight (anaesthetic) into *Nineteen Eighty-four*" published in The History of Anaesthesia Society Proceedings Volume 45, page 102.

I incorrectly stated that Eileen Blair died after induction of anaesthesia and before the start of surgery. This has also been stated in at least two biographies of George Orwell and these sources were trusted by me when I submitted the abstract. However, since then I have traced the Coroner's Inquest documents, which reveal that in fact surgery had begun and progressed to the point of lifting out the uterus to prepare for removal – then cardio-respiratory arrest occurred.

The full paper will be published in the Proceedings of the 8th (Sydney) International Symposium on the History of Anaesthesia.

Alistair G McKenzie, Consultant Anaesthetist, Royal Infirmary of Edinburgh

Dear Editor,

The paper on early transfusion and infusion by Kubitzek & Levy; HAS Proceedings Vol. **45**: pp 86-93, reminded me of an account by Hans Selye, of the use of cadaveric blood for transfusion. During the First World War on the Russian front it was noticed that the blood of dying soldiers remained liquid after death, probably because of trauma coagulopathy (referred to by Wheble on p. 38 of Vol. **45**). Selye attributed this observation to vigorous fibrinolysis under the conditions on the Russian front.

After a great deal of searching I have been unable to find the reference to Selye's work and I'd be grateful if anyone can corroborate my memory.

Yours sincerely,

Richard H. Fell (old FFARCS) Grange over Sands

DR PETER ME DRURY

It is my pleasure to deliver this citation to mark the election of Dr Peter Drury as an Honorary Member of the History of Anaesthesia Society.

Peter graduated MA, MB BChir at Cambridge in 1957. After house jobs at Lewisham and Beckenham, he undertook junior anaesthetic posts at Southmead Hospital, Bristol and the United Liverpool Hospitals. He proceeded on military service from 1960, beginning at Catterick Military Hospital and transferring to Bahrein in 1961 – becoming O/C 111 Field Transfer Team until 1962. He obtained the FFARCS in 1965 and was appointed Consultant in 1967 at the Royal Southern Hospital and ENT Hospital, Liverpool. He moved to another Consultant post at the Royal Liverpool Hospital in 1978 where he continued working until 1997.

In 1975 Peter (with R Finn) published a useful book: *A Guide to the Intensive Care Unit*. He also wrote the chapter on Anaesthesia for ENT Surgery in the 4th edition of Gray, Nunn and Utting's textbook *General Anaesthesia* (1980). He was President of the Liverpool Medical Institution in 1989.

Peter first attended a meeting of the History of Anaesthesia Society exactly twenty years ago – 1993 in Llangollen. His enthusiasm was soon evident: he became a Council Member in 1996, Hon Editor from 2000 to 2006, and never missed a single meeting for fourteen years. He organised HAS meetings in Liverpool in 1997 and 2004. He has presented quality papers at many meetings of the Society. Most notably in 2007, Peter produced the Proceedings of the Sixth International Symposium on the History of Anaesthesia, which was held in Cambridge in 2005. The book provides a valuable record of the study of history of anaesthesia in the new millennium.

In conclusion I commend Peter Drury as most deserving of Honorary Membership of the History of Anaesthesia Society.

Alistair G McKenzie
Consultant Anaesthetist, Royal Infirmary of Edinburgh www.histansoc.org.uk

THE COLLEGE 'LIVES OF FELLOWS' PROJECT

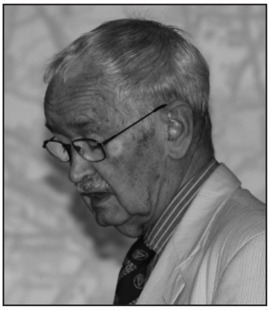
Prof Tony Wildsmith, Honorary Archivist, Royal College of Anaesthetists.

Over the years there have been a number of attempts (notably by Tom Boulton) to establish a biographical database recording the careers of UK anaesthetists, but various factors have intervened. In Aileen Adams's memorable phrase "Council has always been too busy with the present to worry about the past", and the fledgling organisation did not have the resource to support others in this pursuit. With the College now well established, resource is not quite the problem that it was and a part-time (two days per week) archivist post has been established to support work in this area. In addition, Council wishes to mark two anniversaries (2017: 25th of the granting of the Royal Charter; 2023: 75th of the founding of the Faculty) in some way and it is hoped that the establishment of a definitive 'Lives' project will be part of that.

However, there are other difficulties to overcome, not the least of these being the large number of current Fellows (circa 11,500), an unknown number of the deceased, and lack of both a unique identifying number and any records from the early years of the Faculty. There are some published accounts of the formation of the Faculty, and the recent identification of much relevant material in the minutes of the Council of the Royal College of Surgeons of England should provide much of the missing detail. Electronic submission of biographical material should help overcome the numbers issue and the files will probably be stored as part of an individual's membership records at the College. A loosely structured form for this has been devised and approved, and it is hoped that it will go 'live' in the near future, but the project is entirely voluntary so it is the Fellows who will decide the success of the project.

This leaves dealing with those who are no longer with us. Initially there was concern about simply being able to identify them all, but the material at Lincoln's Inn Fields includes lists of all Fellowship awards no matter what the route (Honorary, Election or Examination). The intention is to compile three yearly lists (the term of office of each Dean/President) and, to start with, produce biographies of everyone. In the first year about 150 Fellowships by Election were awarded, and this is a manageable number, but obviously later reviews will have to selective about how many biographies are produced. Initially, trainees will be given the opportunity to write the biographies, but if that does not produce a complete set, members of HAS will be asked to help.

KENDAL MEETING


Dr Adrian Padfield


Dr Aileen Adams


Dr Anne Florence


Dr Sukumar Desai


Yassar Mustafa

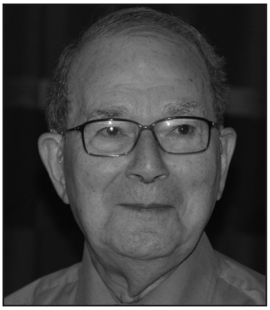

Prof. Tony Wildsmith


Sir Keith Sykes


Dr Ann Robertson


Dr Anthony Gilbertson


Dr Cliff Shelton


Dr David Zuck


Dr Henry Connor


Dr Peter Featherstone

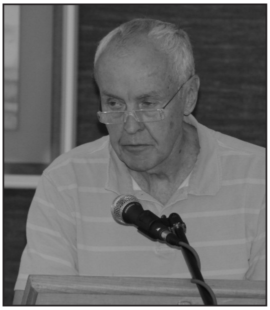

Dr John Pring


Dr Kathleen Menard

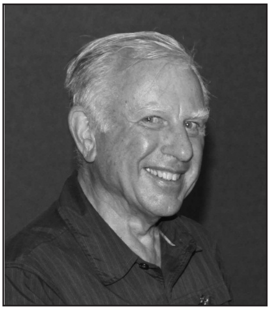

Dr Mary Camossie


Dr Rachel Adler


Dr Rini Vyas


Dr Robert Palmer


Dr Rod Westhope


Prof. Roger Maltby


Dr Rosalind Stanwell-Smith


Dr Samantha Clayton


Dr Sebastian Brown

DELEGATES
(HAS Annual Meeting, Kendal, July 2013)

Aileen Adams	Cambridge	John MacKenzie	Windsor
Neil Adams	Bury St Edmunds	Ian Maclellan	Gillingham, Dorset
Rachel Alder	Teddington	Kenneth MacLeod	Huntingdon
Moyna Barton	London	Roger Maltby	Jasper, Canada
Colin Birt	Paglesham	Colin McLaren	Royal Wootton Basset
John Blizzard	Chelmsford	Kathleen Menard	Boston, USA
Elizabeth Bradshaw	Lewes	Ronald Millar	London
Seb Browne	Snodland, Kent	Iris Millis	Paddock Wood, Kent
Mary Cammosie	Boston, USA	Peter Morris	Crewe
Henry Connor	Hereford	James Mulvein	Bristol
Samantha Clayton	Bury St Edmunds	Yassar Mustafa	Birmingham
Ian Coral	Rainham	Adrian Padfield	Sheffield
Peter Drury	Liverpool	Robert Palmer	Portsmouth
Manisha Desai	Boston, USA	Gordon Paterson	Linlithgow
Sukumar Desai	Boston, USA	John Pring	Penzance
Alan Dronsfield	Swanwick, Derbyshire	Ann Robertson	Aberdeen
Robert Edmondson	Harrogate	Miles Rucklidge	Lancaster
Peter Featherstone	Bury St Edmunds	Cliff Shelton	Lancaster
Ann Ferguson	Broadstairs	John Sill	Rochester, USA
Anne Florence	Frodsham	Ian Smith	Aberdeen
Tony Gilbertson	Liverpool	Rosalind Stanwell-Smith	London
Paul Goulden	Dewsbury	Wulf Stratling	Cardiff
Geoffrey Hall-Davies	Redditch	Keith Sykes	Budleigh Salterton
George Hamlin	Blackburn	Yoav Tzabar	Carlisle
Jean Horton	Cambridge	Rini Vyas	London
Ivan Houghton	London	Rod Westhorpe	Kew, Australia
Michael Inman	Yelverton	Tony Wildsmith	Broughty Ferry
Reg Johnstone	Ulverston	Trisha Willis	London
Richard Knight	New Plymouth, NZ	Catherine Wisely	Edinburgh
Ronald Lo	London	Ray Wise	Blandford Forum
David MacCallum	Edinburgh	David Zuck	London
Alistair MacKenzie	Edinburgh		

John Snow

The Life of John Snow 1813 – 1858.

Time Line:	*Year*	*World Events*
Frances (Fanny) Askham (Mother) born	1789	French Revolution
William Snow marries Fanny	1812	Napoleon's retreat from Moscow
John Snow born	1813	*Pride & Prejudice* published
Family living in North Street, York	1815	Battle of Waterloo & Apothecaries Act
William Snow becomes a carter	1818/19	Faraday and electromagnetism
Snow family moves to Wellington Row	1821/23	Rugby invented, Lancet 1st published
House bought in Queen Street, York	1825	Hickman & 'suspended animation'
John Snow goes to Newcastle	1827	Ohm's Law
William Snow buys 4 more houses	1830	Liverpool to Manchester Railway opens
William Snow listed as a farmer	1832	Great Reform Act
John at Newcastle medical school	1832	Cholera epidemic in Europe/GB
John walks to London	1836	Colt revolver patented
Joins Westminster Medical Society	1837	Victoria becomes Queen
Passes MRCS and LSA	1838	*Oliver Twist* published
In general practice in Soho	1840	Penny Post introduced
Passes MB London	1843	'*The Flying Dutchman*'
Passes MD London	1844	Nitrous oxide used for anaesthesia
Designs Ether vaporisers/writes book	1847	First use of Chloroform
Cholera in London & Britain	1848	Year of Revolutions
The Mode of Communication of Cholera	1849	Decimalisation: the florin introduced!
Passes LRCP (= modern MRCP)	1850	American Express by Wells & Fargo
Establishing anaesthetic practice	1851	The Great Exhibition
Administers chloroform to Queen	1853	Smallpox vaccination compulsory
Removal of Broad Street pumphandle	1854	Start of Crimean War 1856
2nd Edition of Cholera book	1855	First London letter boxes
Visit to Paris with Charles Empson	1856	Bessemer process for steel
Administers chloroform to Victoria again	1857	Indian Mutiny
Death & posthumous publication of	1858	'The Great Stink' & start of GMC

'On Chloroform and other Anaesthetics', with a memoir by Dr Benjamin Ward Richardson

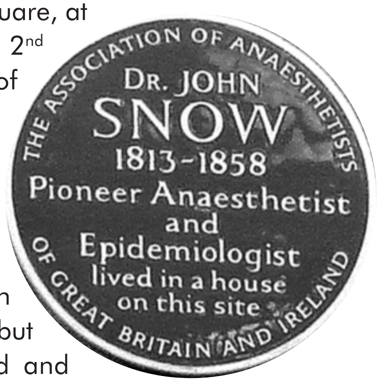
THE LIFE OF JOHN SNOW 1813 – 1858

Dr Adrian Padfield. Past President HAS. Retired Consultant Anaesthetist, Sheffield

This is a shorter version of a lecture given on 15th March 2013; the bicentenary of John Snow's birth. I then suggested to our President that it would be fitting that Snow should be venerated at our meeting, especially as the John Snow Society's meeting on 15/16th March was entirely devoted to epidemiology with no mention of anaesthesia. As this is a biographical essay, *references* are as mentioned in the text. You will see that I owe a great debt to Dr David Zuck for the help he gave me in preparing this paper.

Snow is perhaps best known to doctors and the general public for the 1854 cholera epidemic and removal of the Broad Street pumphandle. His studies in anaesthesia are less well known but they were recognised in his lifetime, unlike his cholera work, and are of at least equal importance. A Blue Plaque was put by the AAGBI in 1987 on his house: 54 Frith Street off Soho Square, at the suggestion of the late Dick Ellis after the 2nd International Symposium on the History of Anaesthesia in London. (*See also next paper).*

Snow's early life is derived from a memoir by Dr (later Sir) Benjamin Ward Richardson which follows his preface to Snow's book: *On Chloroform and other anaesthetics* published after his death in 1858. Richardson held Snow in great esteem. Some details are slightly mistaken but he was affectionately mourning a great friend and mentor.



Snow was born in York on 15th March 1813 the eldest of nine children. His father William was a labourer who several years later became a carter (driver). His mother, Frances or Fanny was the illegitimate daughter of John Empson and Mary Askham. She was born in 1789 and they married when she was nearly three. In his will (1850), John Empson recognised Fanny as his 'natural daughter'. William married Fanny in 1812 and they lived in North Street, York by the River Ouse, an insalubrious area. Between eight and ten years after John's birth, the family moved to Wellington Row and in 1825 William bought a house in Queen Street just outside the old walls to the south west. He was described as a farmer in 1832 and soon after bought and rented four houses in Queen Street. A remarkable transition from labourer to landowner; there is no explanation. It seems likely William must have got funds from a benefactor, perhaps his father in law? It seems most likely that John, the first born, was named after him. In 1841 the Snow family moved to a farm in Rawcliffe, a village north east of York. By this time John had left the family home after being educated in York up to the age of 14. He went to a local 'private' school paid for by parents of poorer classes at about 6d (2.5p) per week: a large part of William's probable weekly wage of 15s (75p). Whether he learnt Latin there is unknown but he would have needed Latin for his profession. On 22nd June 1827 aged 14 he was apprenticed for 5 years to William Hardcastle, a surgeon, 80 miles away in Newcastle upon Tyne, a surprising move when medical apprenticeships could be gained in York. But Hardcastle had served <u>his</u> apprenticeship in York and was said to be a friend of Charles Empson, John's uncle; his mother's younger brother. Empson had business connections in Newcastle, amongst other things he was a dealer in fine arts and furniture, but not until after John had gone there. An apprenticeship was expensive: a fee: 100 guineas (£105) and then outlay on books, instruments and travel. It is highly unlikely that a carter with a family to support could afford this.

Hardcastle was a respected member of the local community. He was doctor to Robert Stephenson and his family who lived in Killingworth, north east of Newcastle. During his apprenticeship John became one of the first regular students at the newly formed medical school (1st October 1832) in Newcastle. Hardcastle was appointed to attend the poor during the cholera epidemic 1831/2 and Snow treated the miners in a virulent outbreak at Killingworth Colliery. It's said that down the mine he noticed the miners' canaries were unaffected by the 'miasma' by which cholera was thought to be transmitted. Was this an early indication of his scientific approach to medical problems? In 1833, at the end of his apprenticeship, Snow became an assistant to Mr Watson, a practitioner in Burnopfield, SW of Newcastle. He only stayed a year; Richardson says *'he worked too hard for his money'*. Perhaps not the whole truth; Snow never avoided hard work. Following this he went much further from Newcastle, returning to Yorkshire, to work as assistant to Mr Joseph Warburton in Pateley Bridge, Nidderdale. Though the living was hard in this small lead mining town with small farms around, Snow seems to have enjoyed his eighteen months there.

He returned to York for a few months in 1836 when he helped start the York Temperance Society. From there he walked to London via Liverpool, Wales and Bath, where he visited his uncle, Charles Empson. In October he arrived in London and enrolled for one year in the Hunterian School of Medicine. Founded in 1746 by Dr William Hunter, the school was in Great Windmill Street on the edge of Soho where, later, Snow was in practice. A 'perpetual' student paid £34 for all lectures and demonstrations, it was among the cheaper of the many schools but it ceased to exist in the late 1830s, Snow was one of its last pupils. Academic opinion then was that such education was the culmination of developments in medical science and provided didactic and practical experience, hitherto generally neglected. He had lodgings in 11 Bateman's Buildings off Soho Square, probably not a very salubrious area; Soho was declining as prosperous families moved westwards. It was easy walking distance from the school and about a mile from Westminster Hospital. He shared his lodgings with the equally hard-working Joshua Parsons. On 28th October 1837 he joined the Westminster Medical Society and eventually becoming a distinguished member and then President. In October 1837 Snow also enrolled at the Westminster Hospital for six months surgical practice; he 'walked the wards' and attended the relatively few operations performed. After this he applied for the post of apothecary at the Westminster. He was well supported; Hardcastle, Warburton and others including Hunterian lecturers as well as surgeons at the Westminster supplied testimonials. The post began in July 1838 but could be held only by a member/ licentiate of the Society of Apothecaries. Snow had passed the Royal College of Surgeons' examination (MRCS) in May but had not yet sat the Apothecaries' examination (LSA). He was not allowed to take it in July 1838 perhaps because his previous training and experience in Newcastle was not recognised, or even undeclared personal bias by the members of the Court of the Apothecaries and had to wait until October. He passed, of course, and so held qualifications known as 'College and Hall', but too late for the Westminster post. It was a severe disappointment and a check in his career; an appointment to a hospital was an honour and a sound basis for starting general practice.

In September 1838 he moved from his dingy lodging to rented accommodation at 54 Frith Street, the site of the plaque, and set up in practice. Frith Street runs south from Soho Square, parallel to Bateman's Buildings. To provide some small income, while waiting for patients to consult him, he was medical officer for several sick clubs and was a 'visitor' or volunteer at Charing Cross hospital in the out-patient department. This was hard work for little reward and continued for seven years as his practice was slow to develop until the advent of anaesthesia. He became active in the Westminster Medical Society from December 1838 attending 90% of the meetings for his first five years as a member. It must have been a way of getting noticed, in modern terms: 'networking'. The Society's meetings were regularly reported in the Lancet and the London Medical Gazette and these show that Snow took part in most of the debates and his contributions were apposite and stimulating. In 1849/50 the Medical Society of London reformed in amalgamation with the Westminster Society. Snow also tried to produce local anaesthesia, trying out freezing mixtures and chloroform. In 1854 at the Medical Society of London, he described the effects of applying solid *carbonic acid* (carbon dioxide) to the skin.

In November 1843 he passed the qualifying M.B. degree (second division honours) of the recently created University of London (1836) and in December the following year passed M.D. He didn't need these extra qualifications and most family practitioners did not publish papers; Snow had five listed in the 1845 Medical

Directory when 92% of GPs published none. He worked hard and was ill in the summer of 1845 with acute renal symptoms and may have been seen by the famous Dr Bright. Richardson says he was advised *'to change his mode of living, and even take wine in small quantities.'* He took a holiday in the autumn and evidently his health improved. Soon after he became a forensic lecturer at the Aldersgate School of Medicine, earning perhaps £50 pa but the school folded in 1849 for lack of students. Something drove him on but as yet he had no particular special interest. That changed after 19th December 1846 when James Robinson, a dental surgeon, successfully used ether to extract a molar tooth. Two days later, Robert Liston famously said: *'Gentlemen, this Yankee dodge beats mesmerism hollow'* after amputating the leg of a patient anaesthetised with ether. However, patients frequently were not anaesthetised satisfactorily (James Robinson soon had failures) because the physical principles were not understood. Most etherists (<u>not all were doctors</u>) did not realise that a free flow through the vaporiser and tubing was needed for unrestricted inhalation and exhalation by the patient, and that ether cooled as it vaporised so reducing the concentration. Inefficient vaporisers made of glass with a sponge inside meant a patient could not breathe easily and the ether vapour concentration got less. On 28th December, nine days after Robinson's first use of anaesthesia, Snow observed him using ether (not completely smoothly) and put his enquiring mind to work. On 16th January 1847 Snow explained to the Westminster Medical Society the scientific principles of inhalation of ether and its effects on the body (in the London Medical Gazette). He had recognised the need for an inhaler that maintained a steady and controllable concentration. Over the next few months he designed and had made a series of vaporisers/inhalers and on 23rd January demonstrated the first to the Westminster Medical Society less than four weeks after watching Robinson. Very few have survived. Dick Ellis classified all Snow's inhalers and he designated the ether ones Marks I - IV. A Mark II, described by Snow on 12th March 1847 was spotted by Henry Connor in the archives of the Royal College of Physicians but it had been labelled as a chloroform apparatus. He and David Zuck thoroughly investigated it and their paper is in *HAS Proceedings 2009 Vol. 41 pp 105-141*. It is complete with carrying case in which there is also a glass stoppered bottle and a unique thermo-etherometer, never before described. The mask was labelled as by Francis Sibson but it is one of Snow's. The wing nut on the mask probably was the attachment of a simple expiratory flap valve allowing control of the ether to air concentration. A Mark IV is described in Snow's first book. There is a warm water bath surrounding the ether chamber or drum to reduce cooling and a spiral within the drum to promote even vaporisation. A replica was made in Charles King's workshop but with a significant mistake. Both are in Bryn Thomas's book *The Development of Anaesthetic Apparatus*. The one made by King failed to allow the 1/16" gap at the bottom of the spiral. The tubing has an internal diameter larger than the trachea. Once the principles were established, he started in earnest. In early February he had used ether for eight operations at St George's Hospital. Snow had found his calling and became the leading anaesthetist in London working with eminent surgeons of the time including Robert Liston, Caesar Hawkins and William Fergusson. He perfected his ether inhaler or vaporiser in August and in October 1847 published his book *On the Inhalation of the Vapour of Ether in Surgical Operations.* As you see he'd approached the task of providing consistent concentrations of ether in a wholly scientific manner at an impressive speed. David Zuck has described him as a reductionist: he seemed to be able to get to the root of things and formulate a solution, as he did in the 1848 cholera epidemic.

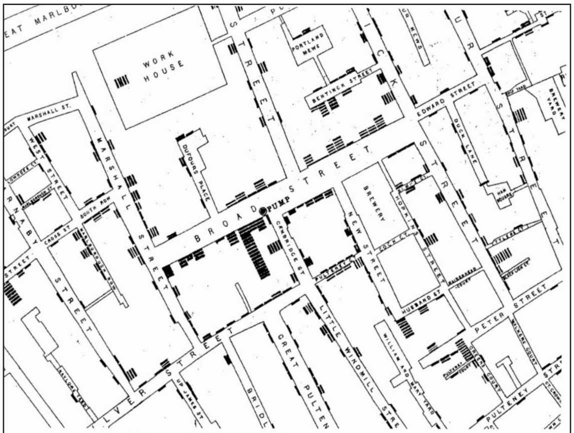
The Royal College of Anaesthetists has a copy of Snow's portrait (the original is privately owned). In 1847 it was exhibited at the Royal Academy Summer exhibition. In both this and a later photograph, he is indoors without a hat. Almost certainly he would have worn a top or stovepipe hat when out and about as in this contemporary cartoon. Hats could be useful, things could be carried within: surgical instruments particularly catheters, maybe even anaesthetic sundries!

Following publication of his book, which was favourably reviewed, he wrote eighteen papers in the London Medical Gazette between 1848 and 1851, describing amongst other matters, experiments he carried out on different agents which produce anaesthesia. These were gathered together by the late Dick Ellis and in 1991 published by the RSM: *On Narcotism by the Inhalation of Vapours.* In November 1847 Simpson first used chloroform and within a week Snow carried out experiments, prepared a similar table to the ether schedule we've seen and inhaled it himself. He used it in practice but always felt that ether was safer. When asked why then he used chloroform he replied *'I use chloroform… for the same reason you use phosphorus matches instead of a tinder box. An occasional risk never stands in the way of ready applicability.'* He tried various combinations of agents most notably alcohol, chloroform and ether. He described five stages of anaesthesia preceding Guedel by about 75 years; he hoped to interpret a patient's responses to the anaesthetic and consequently change the agent's concentration.

His reputation led to him being called to administer chloroform to Queen Victoria for the birth of Prince Leopold (7th April 1853) and of Princess Beatrice (14th April 1857) using a silk handkerchief; the famous *chloroform à la reine*, a method he didn't really approve of! Hostility to the use of anaesthesia in labour was more by conservative members of the medical profession rather than by religious objectors. The Queen's acceptance *(*she wrote '*the blessed chloroform'* in her journal*)* helped quell this opposition. According to Richardson when Snow was asked about how the Queen reacted; *'his usual reply was: "Her Majesty is a model patient"*. It is followed in the memoir by an amusing account of how he dealt with a loquacious lady he was anaesthetising with chloroform. *The lady declared she would inhale no more of the vapour unless she was told what the Queen said, word for word, while she was taking it. "Her Majesty", the dry doctor replied, "asked no questions until she had breathed very much longer than you have; if you will only go on in loyal imitation, I will tell you everything" So in a few seconds she forget all about Queen, Lords, and Commons"*…! When she awoke Snow had gone home for dinner. Unsurprisingly the fame that he gained improved his finances no end. After this he earned nearly £1000 a year and charged up to fifty guineas (£52.50) per anaesthetic. Richardson said that *'he exhibited…anaesthetics about 450 times annually* as *an average of his last ten years. In a large number of these cases his services were gratuitous.* Richardson also said he would never leave a poor patient for a fee paying one.

We'll now step back a few years. Snow had his first contact with the disease during an epidemic in Newcastle over the winter of 1831/2. In London cholera appeared in 1848 and, despite his burgeoning anaesthetic practice and experimental work, Snow took an early interest. He studied the progress of the disease and decided that it originated in the alimentary canal. He suggested that cholera was water-borne and ingested and set out the evidence in *'On the mode of communication of cholera'*, a pamphlet published in 1849 by John Churchill. Therein he argued that in all the cases he studied there was evidence that drinking water contaminated by excrement from sufferers could spread the disease. It wasn't well reviewed; an anonymous reviewer in the London Medical Gazette pointing out that Snow's theory could only be proved by taking suspected infected water some distance away and there causing cholera in anyone who drank it. The book didn't sell very well and didn't displace the 'miasma' theory which held that cholera spread in the air.

As his practice improved and his income increased Snow moved in late 1852 to 18 Sackville Street, a smart Georgian terrace house in a more fashionable area close to Piccadilly. A plaque was put up in 1956 but in 1965 the building was demolished. At that time policy was that the plaque could not be placed on the new building. Cholera returned in 1854 and Snow published a second edition of his pamphlet. Now more a book or a monograph, according to Richardson it cost him £200 and he sold very few, but by this time he could afford it. He'd investigated water supply in south London. In 1849 he'd noted that cholera fatalities were high in districts supplied by the Southwark & Vauxhall, and Lambeth water companies. By 1854 the Lambeth company had moved its waterworks to Thames Ditton above London and the tidal Thames but Southwark & Vauxhall was still taking sewage laden water from the Thames in London. In the latter district the mortality rate was up to fourteen times that of the district supplied by Lambeth. Snow was able to distinguish between houses supplied by the companies by analysing the salinity of the water supplied. In Soho with the evidence he'd collected of the deaths in the vicinity of the Broad Street pump he persuaded the local authorities to remove its handle. 500 had died in ten days from 31 August and though the epidemic was declining when the handle was taken off, it triggered local intervention and a cholera inquiry was set up. I had always believed that the map, showing the deaths in the houses surrounding the pump, had been drawn before the handle was removed but that is not so. In all likelihood it was drawn for the second edition and amended slightly for the cholera commission.



Part of John Snow's map (Snow 1855) showing deaths from cholera. Each black bar represents one death.

Probably Snow had the position of all the deaths in his mind; the map was drawn later. The source that contaminated the pump was found and dealt with. However, the citywide improvement in sewage management culminating in Bazalgette's great sewer outfalls was still predicated on miasma as the cause of cholera. Snow was sure that his investigations had confirmed his theory that cholera was waterborne but few agreed. It was years after his death that the cause of epidemic cholera was accepted. In 1856 he visited Paris with his uncle Charles Empson and was introduced to the Emperor, Napoleon III. Snow lodged a copy of his second cholera treatise in competition for a prize of £1200 *'for the discovery of a means of preventing or curing the disease'*. He didn't win it and wasn't acknowledged.

I'll finish by attempting to portray a view of Snow's character and personality. His family at first were poor but he must have shown promise for his parents to pay for him to go to a local school. Richardson says *'he learnt all he could learn there* and *was fond of the study of mathematics, and in arithmetic very proficient'*. Aged about seventeen in his third year in Newcastle he took up vegetarianism after reading about it in the course of his studies. About the same time he convinced himself, also by reading, of the merit of abstaining from alcohol and so became a teetotaller. He was not however a completely law abiding citizen; someone had to bail him for £50; he'd caused a '*disturbance of peace'* by setting off a fire-cracker in a vestry! Prosecution has not been traced. Before leaving for London in 1836 he had visited his family in York for a few months and helped set up the York Temperance Society. In 1837 Joshua Parsons who lodged with him, converted him to what we'd call a vegan diet; after ridiculing the fact that Snow ate eggs and drank milk. Comments by friends and colleagues were not entirely complimentary. Joshua Parsons, his fellow lodger, described him as: *'not particularly quick of apprehension, or ready in invention, he yet always kept in the foreground by his indomitable perseverance and following up whatever line of investigation was open to him…the naked truth…was what he sought and loved'*. Richardson says that when he first attended the Westminster Medical Society *'he was very timid'* and no one replied to what he said. He also had: '*A peculiar huskiness of voice*', and possibly a Yorkshire accent? After a time he became noticed and recognised, he was first referred to as *'the last speaker'* and then by name. After Snow had started his practice in Frith Street he didn't attract many patients. Richardson ascribes this to the fact that he '*was an earnest man, with not the least element of quackery… with a retiring manner'* but he had an *'amiable but firm nature [He] was reserved with strangers* but he *became less…with increased popularity'.* Richardson says also that he was very humorous with droll stories which *'If…written…he would have ranked as one of the humorists of the age.'* In *HAS Proceedings; Volume 33 p 36*, David Zuck recounts a secondhand account by the grandson of the niece of his uncle, Charles Empson, describing Snow as *'decidedly of the uncouth type'*. He had failed to thank the 'donors' when he got a diploma (his MD?). Snow supposedly replied that he had: *'earned it myself, it is no real gift'*. That sounds like a true Yorkshireman!

Snow was obsessive and I suspect fairly blunt in his presentations and discussion, possibly dogmatic: '*Snow's views on epidemics were extreme'* (Richardson). So he might easily have antagonised his peers. His analysis of the cause of cholera though accurate was not accepted. No one knew of micro-organisms so the miasma theory prevailed. Snow inhaled many vapours in the course of his experiments, some extremely unpleasant, so the fact that the air smelt bad was irrelevant as far as he was concerned. Anaesthesia was a novel subject and he mastered it. No one approached his expertise both theoretical and practical in his lifetime; he was without peer as a scientific anaesthetist. Was his reply about using chloroform even though he thought it less safe than ether a prototypical example of risk/benefit ratio? To understand Snow's scientific thinking one should read

David Zuck: *'John Snow - Reductionist' pp 221-233 Proceedings of the Sixth ISHA*, Cambridge 2005.

No one surpassed his work, carried out in the earliest days of analytical science. His tombstone in Brompton Cemetery, which had become neglected by the 1930s, was renovated in 1938 by the Section of Anaesthetics of the Royal Society of Medicine with the help of American anaesthesiologists. Then it was destroyed in the war in 1941. A replica was erected in 1951 by the Association of Anaesthetists of Great Britain and Ireland. Only in the final quarter of the 20th century has his greatness has been acknowledged. On a final personal note, about 30 years ago I got as a 'free' gift from the Folio Society: *Chambers Biographical Dictionary*. I looked up Snow but there was only CP Snow of the *Two Cultures*. There was Wells and Morton, and Simpson, whose entry included the use of chloroform for the birth of Prince Leopold, did this lead to many gynaecologists insisting that Simpson gave chloroform to Queen Victoria? I wrote to the publishers in Edinburgh asking why John was omitted. I got a self-serving and inadequate reply. I don't think his merit had been appreciated then or for a few years after. More recently a medical newspaper poll voted him the world's greatest doctor. On the 15th March this year I was instrumental in laying a wreath on behalf of the Society on John Snow's gravestone.

THE JOHN SNOW PLAQUE: WHERE WAS 54 FRITH STREET?

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Introduction

A plaque on the present 54 Frith Street, Soho, commemorates the London home of Dr. John Snow from 1838 to 1852, but questions about the accuracy of this placement prompted further investigation. This became more urgent in early 2013 when 61 Frith Street was put up for sale, associated with the claim to be the house where Snow lived. The plaque was erected by the Association of Anaesthetists in 1987 following research by Dr. Richard Ellis into its site.[1] There is ample documentary evidence that John Snow moved into lodgings in 54 Frith Street in 1838 and lived there for fourteen years, relocating to 18 Sackville Street in 1852 where he died in June 1858. Ellis found no evidence of renumbering of Frith Street after Dr. Snow's time after examining successive editions of Kelly's Post Office Directories[2], rate books and maps for the period 1838 to 1856. Ellis commented that these consistently showed that the house on the south-west corner of the intersection of Frith with Bateman Street [formerly Queen St] was number 55, which placed no. 54 south of the intersection.[1] A late 19th century painting of the corner house, number 55, also showed a narrow strip of number 54 attached to it.[3] On the basis of this research, the plaque was placed on the modern building now numbered 54.

The challenge

Ellis appears not to have known about Richard Horwood's detailed map of central London,[4] produced between 1792 and 1799, with each house numbered. On Horwood's map, 54 Frith Street is clearly north of the Queen Street intersection. This original Georgian house, now numbered 61, was acquired by a new owner in 2004, who claimed that it must be the same as that numbered 54 on the Horwood map and therefore Snow's home. The claim received some support from a web site devoted to Dr. John Snow, stating the plaque location as 'debatable.' [5] This opinion was based largely on the Horwood map and the finding that maps after Snow's time showed different numbering. The John Snow Society was approached and asked to confirm whether or not the claim for 61 Frith Street was correct.

History of Frith Street and its numbering.

Frith Street was laid out during the late 1670s and early 1680s by Richard Frith, a speculative builder who leased vacant plots from the Duke of Portland.[6] The plots were often not contiguous in parts of the street and houses were not built consecutively.[6] Numbering in any consistent pattern dated from the mid 1700s, becoming more established after the Postage Act of 1765,[7] although this Act did not specifically require numbering and owners could more or less do as they pleased, resulting in chaotic numbering systems. The Metropolitan Management Act of 1855 brought in powers over numbers and street names and a major renumbering exercise in London was undertaken in 1888.[8] An example relevant to the history of anaesthesia is that Peter Squire's pharmacy in Oxford Street changed its address from 277 to 413.[9] As in some other old London streets, the numbering of Frith Street started on the east side and ran down the street and up the west side, which is where numbers 54 and 61 stand today.

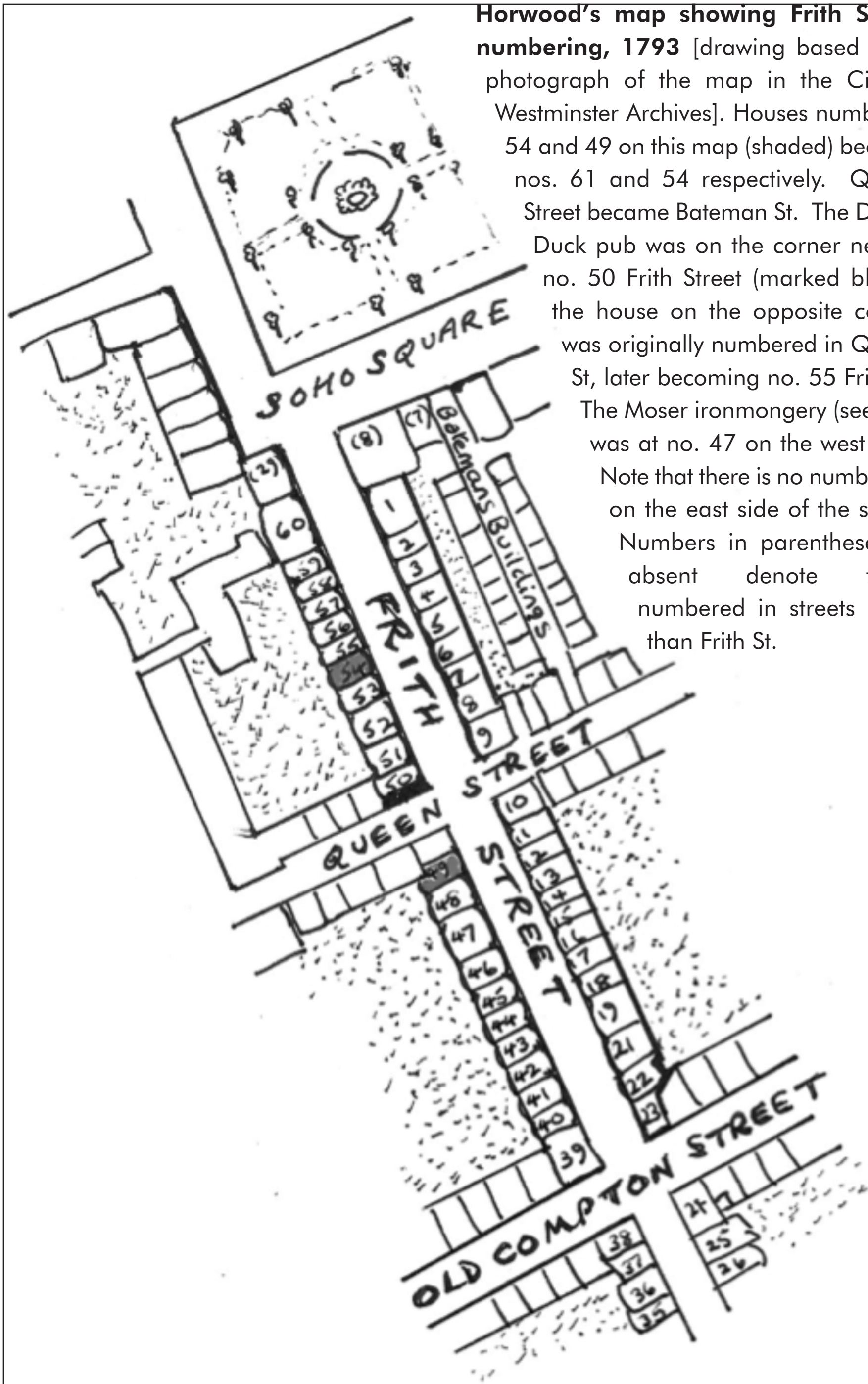
Research sources

Details of archives examined are listed in the notes.[10] Initially the focus was on maps, examination of commercial and post office directories from 1800 and census returns from 1841, the earliest date when names and other details were recorded in a London census. These were examined in particular to determine if residents changed their street number or seemed to move up the street 'en bloc'. As both properties would have been part of the Dukes of Portland estate, the catalogue of transactions in the early 1800s was accessed from the Nottingham University archives. Photographs, fire insurance records and contemporary newspapers were consulted to pinpoint when renumbering might have occurred.

Results: Maps, census returns and directories

Horwood's meticulous numbering of the street in his maps from 1792 to 1799 proved to be unique until the 1880s, with later cartographers either not showing numbers or paying little attention to precise locations of house numbers. Even 20th century maps were confusing at this level of detail, including Ordnance Survey and other London survey maps. The only Victorian map on a scale similar to Horwood's, the 'Master' Large Scale (1 yard to 1 mile) Ordnance Survey map of 1871, was completely unnumbered. As for the houses numbered 61 to 67, they were built around the 1780s [6] and the absence of these numbers in Horwood's map thus appeared to confirm the assumption of renumbering. The 1819 revised edition of the Horwood map of Frith Street did not differ from earlier versions, indicating that, probably, the number change occurred after that date.

Rates and land tax records showed that Dr. Snow's landlady, Mrs. Sarah Williamson, was paying these charges during his residence in the street, although rate-books earlier in the century were unhelpful, since house numbers were not recorded. Land Registry records date only from the 1970s, with many old deeds having been destroyed as they are no longer needed for house sales. Original deeds could not be traced for either property, but they would only have shown the



Horwood's map showing Frith Street numbering, 1793 [drawing based on a photograph of the map in the City of Westminster Archives]. Houses numbered 54 and 49 on this map (shaded) became nos. 61 and 54 respectively. Queen Street became Bateman St. The Dog & Duck pub was on the corner next to no. 50 Frith Street (marked black): the house on the opposite corner was originally numbered in Queen St, later becoming no. 55 Frith St. The Moser ironmongery (see text) was at no. 47 on the west side. Note that there is no number 20 on the east side of the street. Numbers in parentheses or absent denote those numbered in streets other than Frith St.

freehold owner. This was unlikely to have been Mrs. Williamson, a widow who was incorrectly listed as Williams in the 1841 census, and whose death was registered in St. Luke's Parish, Soho, in the first quarter of 1852. This, together with the change of his professional activities from general practitioner to anaesthetist, must have spurred Snow to move to 18 Sackville Street in that year. He took Jane Wetherburn, the general servant from number 54, with him as housekeeper.[11] Kelly's Directory for 1853 shows completely different occupants of 54 Frith Street.

The first Post Office directory to show the intersection with Queen [now Bateman] Street on the west side was 1855, with 55 Frith Street south of that intersection. Number 54 was not listed for that year, presumably containing no professional residents. Earlier directories showed other intersections and the omission of the important one with Queen Street appears to have been an error repeated from year to year. Census returns recorded only the number of each house, rather than any guide to position, despite a search through original pages for any notes made by the enumerator. There was no evidence that addresses had been renumbered in the period 1841-1911. On the contrary, several residents present in Snow's time were still living at the same addresses in later decades. This included residents at numbers 61 to 67, providing evidence that these houses had these addresses during Dr. Snow's time. John Snow consistently used the same address during his residence there, [1] making it most unlikely that renumbering occurred between 1838 & 1852. Snow's immediate neighbours on either side, such as George Minter, upholsterer at no. 51, a jeweller at no. 50 and an electroplater at no. 58 were still listed at these addresses in 1855 in Kelly's directory, the year in which the Queen St. intersection was marked, placing his former neighbours south of the intersection. The disputed address at 61 Frith Street was occupied by Mr. John Clark during Snow's time, while the surgeon Alexander Angus and his descendants were recorded at no. 66 from the 1840s to 1880s. Snow's Casebooks[12] recorded clinical visits to nearby patients, some of whom could be confirmed from other sources, such as George Minter at no. 51, but it did not include consultations in the numbers 61 to 67. Finding a case apparently visited in 1848 at number 66 suggested that Dr. Snow had made a rare, but not unknown, error in his casebooks, or that the number had been mis-transcribed: the name of the patient was shown in Census return for 1841 to be resident at number 56.

Evidence from Frith Street events, people and their businesses

Photographs and the Emslie painting confirmed that the numbering of businesses at corner properties and some other locations in Frith Street differed from those on the Horwood map, but gave no precise indication as to the date of renumbering. The Old Bailey Trial records showed that Frith Street was a dangerous place to live, before and after Snow's time, experiencing frequent assaults and robberies,[13] with the advantage for this investigation that occasionally the description of the crime indicated where properties were located. One case stood out: in 1887 number 56 Frith Street, the home of a tailor, Mr. Stuart, was robbed. Hannah Cooper, a barmaid at the Dog and Duck pub, gave evidence:

> *"I live at the Dog and Duck public-house, Frith Street, Soho, next door to Mr. Stuart—…. when we closed at 12.30 the four men went over to the opposite side to a lamp-post, and remained there ten minutes or a quarter of an hour—Wilson, who showed us his arm tattooed with a crucifix, carried a roll of canvas, it looked like a small sack—the prisoners then crossed the road, and almost immediately I heard a crash, and a dog barked—the other two stood by the post, and I heard them use a foul expression to the dog, and I saw no more of them…"*[14]

She and another barmaid had observed them from a window. The Dog and Duck had been at this location from the early 18th century. If number 56 had been south of the Bateman Street intersection, beyond the shop present on the opposite corner, neither barmaid could have heard the crash, nor describe the house as next door to the pub. This meant that number 56 was at its present site in 1887 and number 54 was also at its modern location, south of the shop on the other side of Bateman Street. This confirmed the location given on the Goad insurance map of 1885[15] and the Kelly's directory for 1889, which meant that renumbering had occurred between 1819 and 1885, the Census information suggesting the earlier part of this period.

A catastrophic event in Frith Street provided a further clue: a fire in 1803 had destroyed several houses on the west side of the street and part of Old Compton Street:

> *"A lamentable fire occurred in this locality, December 2nd, 1803, which consumed nine houses, besides a long range of manufactories, warehouses, an auction-room, &c., between Dean Street and Frith Street. Burning through into Compton Street, … [the] fire commenced at the manufactory of Messrs. Jackson & Moser, ironmongers…"* [16]

The fire damaged section was rebuilt and records show that other houses were pulled down in due course. Rebuilding occurred throughout the century and the possibility of renumbering in the late 19th century, or in the 20th century was investigated by studying the history of various prominent businesses in the street.

This included checking for any possible renumbering after WWII. For example, the first espresso bar in London opened at number 29 in 1953, remaining there until 1972 and Ronnie Scott's jazz club was at number 47 from 1965. The Bar Italia has had the same address from 1949 and the first Greek restaurant in London, Jimmys, had the same number from 1946 to its closure in 2012.

The leaseholder of the ironmongery destroyed by the 1803 fire was Roger Moser. In March 1805 the estate catalogue[17] listed the sale of the property to Moser at a bargain price, as now "unfit for production." While no number was given, the 'messuage' (premises) was described as:

> *"…on the west side of Frith Street (on whose site a messuage consumed by fire formerly stood)* ***(the fourth house south of Queen Street)****,… subject to a lease of 1752 for 34 years from Michaelmas 1799… Consideration: £ 490 by Moser."*[18]

The catalogue also mentioned a 21 year lease in 1800 to a publican located "seventh north of Queen Street" on the west side of Frith Street. From directories and the 1841 census, this public house, the Coach and Horses, was at number 62. It did not survive much further into the 19th century, being converted for residential use by the time of the 1851 census. Later in the century, the Moser 'messuage' was consistently recorded as at numbers 51 and 52, staying as an ironmonger until the 1870s, when it became a perfumery.

The investigation then turned to early 19th century Sun Fire Company insurance records for the street, in the expectation that those affected by the 1803 fire would be particularly keen to insure their properties against this hazard. In 1806, shortly after purchasing the property, Moser insured it:

> *"1 February 1806. Contents: Insured: Roger Moser, 47 Frith Street Soho, smith and ironmonger."* [19]

In 1828, the same property, occupied by 'Moser and Co.' was insured again, but the number was now given as number 52.[19] In 1834 the property had absorbed number 51 and both were insured by Roger and Robert Moser.[19] The ironmonger was listed as at 51 in the Post Office Directory for 1841, while one of Moser's partners, William Methley, was enumerated at 51 in the 1841 Census. The Moser family lived nearby but not in Frith Street. The publican at no. 62 insured his property in 1828, showing that the Coach and Horses was at the same address as in Snow's time.[20] Other insurance policies from this time could be traced to residents with the same street numbers in the 1841 census return, for example a baker at no. 44 and a jeweller at no. 18.

The evidence was now pointing to any renumbering having occurred during the 1820s. The Morning Post, 23rd December 1822, included an announcement about the sale of the Moser property in Frith Street:

> *"A Valuable FREEHOLD ESTATE, comprising Two Sub-stantial Brick Residences, with a private entrance to each, spacious Shops, Ware-rooms, Show-rooms, Counting Houses and numerous conveniences, very advantageously situated,* ***Nos. 51 and 52 Frith-street, Soho. The whole newly erected by the late Roger Moser, Esq,,*** *within the last twenty years and long established in a most lucrative Wholesale and Retail ironmonger business, - Also an extensive LEASEHOLD ESTATE, forming a valuable appurtenance to the above…"* [21]

So the address had become 51/52 by the year 1822. This prompted a search of the London Gazette, which documented bankruptcies and changes in business partnerships. A couple of solicitors based in Frith Street were often named as dealing with bankruptcy and insolvency. One of these, Mr. Blacklow, was listed as based at 44 Frith Street on 10 April 1821.[22] He had the same address in the commercial directory for 1817.[23] In the London Gazette of 19 May 1821, Mr. Blacklow's address is given as number 48.[24] This suggests that the renumbering occurred in 1821, in late April or early May. The evidence of renumbering by four premises on the west side of Frith Street is confirmed in a few other instances, such as a shop on the corner of Old Compton Street and Frith Street, numbered 39 in 1792 but at 43 by 1862 and shown in photographs to have retained this number ever since. The renumbering particularly applied to the houses on the west side of Frith Street: Johnstone's commercial guide for 1817[23] reported 61, rather than 60, houses in the street but showed the Howletts, a printing family, at no. 10, which remained constant in the censuses of 1841 and 1851, while the Woodward family on the west side of the street had the number 39 in 1817 but 43 in the 1841 census. Numbering by the 1830s appears to have conformed to the present day, from names traced in the Robson's directory for 1831.[25]

Conclusion

The plaque commemorating Dr John Snow is on the correct building, the present 54 Frith Street, the evidence indicating that this location had this number since 1821, seventeen years before Dr. Snow moved in. It is significant that all the names and businesses that could be traced showed that renumbering had occurred during the 1820s, with no contrary evidence after that time.

The study has also demonstrated that the current house at no. 61 was likely to have been numbered 54 before 1821. While Dr. Richard Ellis's conclusion was correct,[1] we have added considerably to the evidence, benefitting from the availability of detailed historical data on-line since the 1980s. Recurring names of some residents at the same addresses in census returns, particularly in the houses 61 to 67, were not sufficient to locate the position of no. 54, since it could have been argued that these houses were renumbered later in the century. The key to this mystery was recognising the importance of the 1803 fire at the Moser ironmongery. The proximity of their ironmongery to no. 54 was the strongest indicator of the position of Dr. Snow's lodgings, with the associated evidence of the location in the estate record and the dates for the street numbers of these premises in fire insurance and newspaper sources. The constant numbering for other businesses or professional people provided corroborative evidence from the 1820s and 1830s, with the busy Mr. Blacklow allowing identification of the likely date of renumbering. Although few directories gave street listings prior to the 1850s, sufficient names could be traced to confirm their street number in particular years or decades. The renumbering appears to have been a local arrangement and to date no documentary evidence of it has been uncovered.

The red herring in this investigation was the baffling evidence from maps, which rarely showed street numbers after Horwood's time and then added to the confusion because of apparent inconsistency in the way numbers were marked. Initially it had seemed entirely logical that the numbering issue would be solved by finding an accurately numbered map for the 1840s, which turned out to be a fruitless search. The doubt expressed about the position of the house by the UCLA website was understandable,[5] as the administrative chaos of London streets before regulation is difficult to appreciate from the modern perspective. The use of maps alone would always have left the possibility that renumbering occurred in the 1850s after Dr. Snow moved away and before a more standardised system was in place. Richard Horwood's project of detailing the numbers on his maps is now an invaluable historical source as a unique record of London at the cusp of the 19th century, although it was not a financial success for him and he died in poverty in 1803.[26] The map engravings contained the offer that they could be updated "at a trifling expense" if either commissioners or Parishes deemed it proper *"at any future period to make a regulation in numbering…"* This offer had not been taken up for Frith Street by the time of the revised edition of the Horwood maps in 1819 and the next set of accurately numbered streets did not appear until required for fire insurance in the 1880s.

Given the importance of cartography in the legacy of Dr. Snow, such as his use of the now-named Voronoi technique in demonstrating the pump as the cause of the Broad Street pump outbreak of 1854,[27] it is ironic that in this case, the answer was not in a map. Rather, it was to be found in the time honoured epidemiological tradition of focusing on people, places and time.

Note: This paper was presented in outline to the History of Anaesthesia conference in Kendal, 5th to 6th July 2013. The John Snow Society has run two series of commemorative lectures in honour of his founding contributions to the two specialties of epidemiology and anaesthesia. The Pumphandle Lectures have been held since 1993 and the Blessèd Chloroform lectures since 1995. As the present communication represented a joint investigation by an anaesthetist and epidemiologist, an enterprise that Dr. Snow surely would have appreciated, we dubbed this 'The First Blessèd Pumphandle Lecture.'

Acknowledgements

We gratefully acknowledge the assistance of staff at the Guildhall Library, City of London, London Metropolitan Archives and Westminster Archives in this investigation, in particular to Joanna Buddle, Archives and Local Study Assistant at the City of Westminster Archives Centre, who traced further evidence to confirm our findings and to Jeremy Smith of the London Metropolitan Archives, who provided corroborative links to the on-line Sun Fire Office registers and advised on maps.

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IAN DONALD: OBSTETRICIAN, INVENTOR AND PATIENT

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My interest in Ian Donald was stimulated initially by his work on the respiratory distress syndrome of the newborn at St Thomas' Hospital and Hammersmith Hospital from 1952-4. Later, I encountered him as a patient in Hammersmith Hospital where he underwent cardiac surgery in 1969 and 1976. His experiences during these two admissions were encapsulated in two papers published shortly after his discharge from hospital. Each was written with his characteristic style and wit and provided salutary lessons for those of us who were involved with cardiac surgery at that time. It was only in the 1970s, when I was writing a chapter on ultrasound for the second edition of our book *Principles of Clinical measurement*[1] that I realized what an important contribution he had made to the development of clinical ultrasound and its application to obstetrics.

Ian Donald was born in Liskeard, Cornwall in 1910, the eldest in the family of two sons and two daughters of John Donald, a Scottish general practitioner, and his wife, Helen Barrow Wilson, a talented pianist.[2 3] John did his best to provide a broad education for his children and encouraged them to converse in French and to memorize passages from Shakespeare and the Bible. Ian was educated at Warriston School, Moffat, Dumfries-shire, and Fettes College, Edinburgh (which he hated) but in 1925 the family moved to Capetown, South Africa in the hope of improving John Donald's chronic tuberculosis. Ian went to the Diocesan College, in Rondebosch, near Capetown where he learnt to sail and developed an interest in mechanical and electronic devices. However, eighteen months after their arrival, when Ian was just 16, all the family except John Donald and his daughter Alison were struck down with an infection diagnosed as diphtheria. Ian's mother died from heart failure and, although Ian and his sister Margaret survived, they were left with cardiac disease from what had probably been a streptococcal infection that resulted in rheumatic fever. John Donald died three months later and left the family in charge of their housekeeper, Maud Grant, who had only been with the family for a few months. She remained with the family for many years and Ian was greatly influenced by her Anglo-Catholic religious views. [4]

In 1927 Ian moved to Capetown University where he obtained a First Class Honours BA in French, Classics, English, and music in 1930. After his graduation the family moved back to England and Ian enrolled at St Thomas's Hospital Medical School, London, graduating MB BS in 1937. In the same year he married Alix Mathilde de Chazal Richards, the daughter of a farmer in the Orange Free State, South Africa, the couple subsequently bringing up four daughters.

The advantages and disadvantages of an education in the one of the best known London Medical Schools have been well discussed in a recent book that details Ian

Donald's role in the development of ultrasound.[4] Suffice it to say that the great emphasis was on clinical medicine and that science did not feature predominantly on the agenda. In 1937 the maternal mortality rate throughout England, Wales and Scotland was very high[5] and although St Thomas' Hospital Obstetric department was better than most, the specialty was generally looked down upon by those working in other medical disciplines. Donald decided to take up the challenge and became a House Officer in the department of Obstetrics and later Resident Obstetrician. It was during this period that he designed an automatic bladder irrigator that utilized a water tank mounted on a 7 or 8 foot high stand with numerous tubes that caused considerable consternation amongst the nursing staff. He later demonstrated an improved model at the Royal Society of Medicine in 1940.

Donald served in the Royal Air Force medical branch from 1942 to 1946 and was mentioned in dispatches and appointed MBE (military, 1946) for saving airmen from a blazing plane. After the war he returned to St Thomas' Hospital and gained his MD and MRCOG in 1947 (FRCOG 1955). In 1949 he was appointed Tutor in the new Department of Obstetrics and Gynaecology of St Thomas's Hospital Medical School and in 1951 was made Reader in Obstetrics and Gynaecology. In 1952 he became Reader at the Postgraduate Medical School at Hammersmith Hospital, London. In 1954 he accepted the position of Regius Professor of Midwifery at the University of Glasgow, a post he held with distinction until his retirement in 1976 (the title of the post was amended to Regius Professor of Obstetrics and Gynaecology in 1992). He received honorary DSc degrees from London (1981) and Glasgow (1983), was awarded the CBE in 1973, received the order of the Yugoslav Flag with gold star in 1982, and was the recipient of many other honours. He died in 1987.[3]

Respiratory distress syndrome

Donald started to investigate problems associated with respiratory distress at birth at St Thomas' Hospital in association with Maureen Young, a physiologist who had trained with Sir Joseph Barcroft and who was, therefore, familiar with fetal and neonatal physiology. She also held an animal licence. Donald constructed a ventilator that incorporated two chambers, one surrounding the head and one the body of the infant. The infant's head was embedded in an alginate mix that set solid to provide a seal to separate the head chamber from the body chamber. When the infant inspired spontaneously, it drew air or an air /oxygen mixture into the head chamber through a flap valve, the movement of which was detected by light focussed on a photo-electric cell. This signal could then be used to open solenoid valves that connected the body chamber to large tanks that were maintained at preset positive or sub-atmospheric pressures, thus enabling ventilation to be assisted by changes of pressure in the body chamber. This system produced a rapid change in body chamber pressure in response to the initiating signal and there were electronic controls that enabled the duration of inspiration and expiration to be modified. There was also a system that could provide a similar pattern of breathing if the baby was apnoeic. The electronic control mechanisms were very complex and the apparatus utilized such items as ex-RAF altimeters to set the pressures in the tanks. Ian Donald later recorded his gratitude to Commander Patrick Slater, an electrical engineer in the Fleet Air Arm, who played a major role in the design of the apparatus and taught Donald some of the finer points of electronic engineering. The machine was demonstrated at a meeting of the Physiological Society at the Royal Free Hospital, London, in January 1952.[6]

Donald continued to work on this project when he moved to Hammersmith Hospital, London and, in 1953, he described the clinical application of the device with Josephine Lord, a Registrar in the Premature baby Unit, citing three cases where the machine may have resulted in survival of the infant.[7] Donald also developed an intermittent positive pressure ventilator that could be used to ventilate a baby through a face mask.[8] This was used successfully on some adult patients in Hammersmith Hospital and was later developed by the British Oxygen Company as the "Pneumotron ventilator"[9] but it was not a commercial success. When he moved to Glasgow Donald continued to develop ventilators in association with the electronic engineer J. R.Greer.[10]

While he was working at the Postgraduate Medical School, Ian Donald collaborated with Albert Claireaux, the pathologist at the Institute of Child Health and Queen Charlotte's Hospital, and Robert Steiner, the head of the radiology department at Hammersmith Hospital on histological and radiological studies of hyaline membrane disease. In 1953, Donald and Steiner published the first radiological study of a series of cases. The success of this research stimulated Donald's interest in imaging technologies.[11,12,13]

The development of clinical ultrasound

Donald became interested in radar and sonar when working as a medical officer in the RAF from 1942-6. In 1942, his sister Alison (then Mrs Munro) was appointed as personal assistant to Sir Robert Watson-Watt; Scientific Advisor to the Air Ministry and a pioneer of radar. Since she was closely involved with Watson-Watts' work, she was able to acquaint Ian Donald with current developments in radar and sonar. She also introduced him to Watson-Watt, an experience that he found very stimulating. Donald was first posted to a Coastal Command Unit in the Western Isles where the medical load was relatively light, and he was able to gain hands-on experience with the latest echo-location technology. In 1943 he was posted to a unit in the Azores where he was kept busy treating epidemics of polio, typhoid and typhus. His Squadron moved to Cornwall in May 1944 in preparation for D-Day and Donald then found that he had to deal with the psychological problems associated with the stress and fatigue resulting from a heavy load of combat missions. At this time he seriously considered a career in psychiatry, but when demobilized he found that he was only entitled to government financial support if he went back to a specialty in which he had already trained. He therefore returned to St Thomas' and immersed himself in clinical work.

The use of ultrasound in medicine was pioneered by several workers amongst whom were Douglass Howry in Denver, Colorado; a group based at the Massachusetts Institute of Technology working with the neurosurgeon GD Ludwig at the Massachusetts General Hospital in Boston; Lars Leksell, a neurosurgeon in Lund, Sweden, Valentine Mayneord, a physicist at the Royal Cancer Hospital, London, and John Wild in Minneapolis.[4]

John Julian Wild had qualified from Cambridge in 1942, and trained as a surgeon before joining the Royal Army Medical Corps. In 1946 he realised that he was not suited to a career as a clinical surgeon and emigrated to the University of Minnesota in Minneapolis, hoping to establish a career as a clinical scientist. Wild started his investigations into the use of ultrasound in clinical practice in 1949 and published his first paper on the subject in 1950.[14] He went on to show that ultrasound could be used to detect tumours in the human breast[15] and was invited to lecture in London in 1954. During that visit he met the Oxford Professor of Obstetrics, Chassar Moir, who was interested in the possible use of ultrasound for imaging the site of the placenta, and he also visited Ian Aird, Professor of Surgery, at the Postgraduate Medical School, who introduced him to Ian Donald. Donald was aware of Wild's work in this field and they had a productive discussion.

Donald moved to Glasgow in September 1954 and began to liaise with workers in the Regional Board's Department of Medical Physics, directed by John Lenihan. There, he teamed up with the physicist and engineer JR Greer, to continue the investigations into the neonatal respiratory distress syndrome. However, it was becoming apparent that the success rate with ventilator treatment was poor (this was before the role of surfactant deficiency had been discovered) and Alice Stewart had recently demonstrated a significant correlation between diagnostic radiation in utero and the occurrence of leukemia in childhood, so Donald felt that he had to discontinue his radiological studies of the neonatal lung.

In the spring of 1955, one of Donald's patients introduced him to her husband W A Slater, who was a director of Babcock and Wilcox, an industrial fabrication company. Donald was invited to visit the factory and saw ultrasonic detectors being used to detect flaws in metal welds. The operator tested the machine by eliciting a signal from his thumb and this so impressed Donald that he arranged to take some pathological human tissues (including a fibroid and an ovarian cyst) to the factory to see if he could obtain a signal with human tissue. Babcocks produced a large steak as control material! Donald found that he could differentiate the cyst from the fibroid. Donald now embarked on a series of experiments using an industrial scanner made by a local firm Kelvin Hughes with his registrar John MacVicar but found it difficult to obtain satisfactory images in patients. Fortunately a young engineer, Tom Brown, who had been working with ultrasound detectors, heard of Donald's work and volunteered to help.[16] He and MacVicar worked tirelessly studying patients during the evenings but the results were disappointing. Then they studied a patient who had been diagnosed as having an inoperable stomach cancer and demonstrated that the tumour was, in fact, an easily removable ovarian cyst. This case helped to silence the critics who had ridiculed the technique and in 1958 Donald, MacVicar and Brown published the groundbreaking paper *"Investigation of abdominal masses by pulsed ultrasound"* in The Lancet.[17] For a full description of the further development of clinical ultrasound see [4,16,18,23].

Medical problems

Throughout his early years in Glasgow Donald suffered increasingly from mitral valve disease and his sister Margaret was similarly affected. Donald arranged for her to be operated upon in Glasgow but, tragically, she died during the operation. Donald developed atrial fibrillation when in New York in 1961 and returned to the Glasgow Western Infirmary for a successful mitral valvotomy by the cardiac surgeon George Smith. However, he found this procedure quite distressing and, when his condition deteriorated again in 1969; he decided to consult old colleagues at Hammersmith Hospital. Donald had been present when Cleland and Melrose had performed the first cardiopulmonary bypass at Hammersmith Hospital in 1953 and had a great respect for the cardiac surgeon Bill Cleland and the cardiologist John Goodwin who were key figures in the cardiac surgery programme at the Hammersmith at this time. Donald's preoperative angiogram was performed by Robert Steiner, who was head of the radiology department and who had helped Donald with radiological studies of the new-born lung when Donald moved to Hammersmith in 1952.[12]

Shortly after leaving hospital Donald was persuaded to record his impressions of his hospital stay. In the report of his experiences during the admission to this hospital in 1969[21] Donald gave a graphic description of the preoperative angiogram and wrote *" ....at the end of it all the elbow of my friend the senior radiologist , was applied with bar-counter precision to my femoral pressure point while a number of pleasantries were exchanged"*. He went on to remark that the procedure had been performed while he was under the full influence of warfarin and so he was alert for signs of residual bleeding and *"…..presently felt a double mass in my own pelvis through the abdominal wall. I suspect that my enthusiastic colleagues were not at first convinced that I was developing a retropubic haematoma tracking up into the pelvis, and I had the subsequent satisfaction of proving that I was right by going over to a neighbouring hospital with the necessary equipment and getting an ultrasonogram taken, which demonstrated it well. I immediately had copies made together with slides for my next American lecture on the subject of ultrasonics and was able to pull the legs suitably of my radiological friends."*

In this paper[21] Donald made a strong plea for the provision of information about the operation for the patient preoperatively and described how he had been warned not to attempt to perform a neurological examination immediately after the operation. He stated that this had prevented him from worrying about the severe intention tremor that he experienced postoperatively. He describes being visited preoperatively by *"two merry anaesthetists"* (John Beard and Betty Lloyd Jones) who helped him *"with a little whisky which I had tucked away in my locker".* He also described his experiences in the intensive care unit: *"I woke up, it was still daylight, and as I expected I found a tube in my trachea. I greeted my wife momentarily, observed her dress, and it is said that I embraced the sister of the department on both cheeks, but of this I have no recollection, so can give no opinion as to whether this was instinct, habit or mistake."*

He went on to complain about the discomfort produced by dehydration and by the bandage that had been used to tie in the tracheal tube and described the difficulties of establishing communication with those looking after him. He found that pain control was adequate initially but that pain was worst on the third postoperative day and he described his experience of, and fear of pain on removal of the chest drains.*

Donald concluded by describing his convalescence that *"……proved so strenuous, including the launching and commissioning of a small yacht on the south coast of England that I decided to return to my own department for a rest."*

In the highly entertaining and philosophical report published after a second valve replacement in 1976 [22] Donald noted the improvements in treatment since his first valve replacement and recorded that he had asked a fellow scot (the senior registrar anaesthetist Peter McCormick) to take photographs during the operation with Donald's Polaroid Colour camera. Some are reproduced in the article.

**Having experienced the excruciating pain of this procedure on two occasions and been denied any form of pain relief the present author would like to strongly support Donald's contention that all patients should be offered short-term pain relief for chest drain removal. The present situation is quite unacceptable.*

He describes in detail the psycho-somatic disturbances after operation and devotes a section to the work of the physiotherapists. There follows a vivid description of a late faecal impaction and its delivery by the ward sister that could only have been written by a practicing obstetrician. Both of these articles reveal Donald's knowledge of English literature and the classics and should be essential reading for all those involved in anaesthesia and intensive care.

Donald, the man

Donald was an extremely hard worker and excellent teacher. He always said that the basis of good teaching was enthusiasm, and this he displayed in abundance. His lectures were memorable and his book "Practical Obstetric problems" [20] was a best seller and ran to five editions. He was an excellent clinician who was proud of the NHS and was largely responsible for the development of the Queen Mother's Hospital* that replaced the Royal Glasgow maternity hospital in 1964.[19] He held strong views on the sanctity of life and vigorously opposed the 1967 Abortion Act. He often showed ultrasound images of the fetus to a mother requesting an abortion to try and dissuade her from proceeding with the operation. His wife Alix recorded on one occasion[18] "I was also reminded of the date of Ian's meeting with the Pope in 1979. Ian was invited to speak in Milan. He showed a real-time film of an eight-to-nine-week fetus, perfectly formed, with all four limbs moving energetically, which infuriated a lot of Italian women in the audience who hoped for an abortion law in Italy. The film seemed to make it unthinkable. Ian was hurried out by the back door in case of trouble. The Pope was, of course, delighted and received Ian very kindly in Rome speaking excellent English. Ian was surprised to notice that a Cardinal in attendance on the Pope carried a small tray on which lay some of his reprints!

His last research effort, pursued in retirement, was an attempt to achieve a perfect method of natural family planning using a device to warn the woman of the approach of ovulation. Throughout his life he was a keen sailor, musician and painter. His influence on medicine and his colleagues has been carefully recorded in the excellent memoir written by James Willocks and Wallace Barr.[23]

**The Queen Mother's Hospital was closed in 2010 when the regional obstetric services were re-organised. Donald had predicted that it would only last for 25 years.*

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AVICENNA ON ANAESTHETICS *(Abstract)*

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This paper provides an introduction to ongoing research into the analgesic and anaesthetic practices of Avicenna, the medieval physician, as recorded in one of the most phenomenal and definitive works of his age, The Canon of Medicine.

Medieval medicine from the Arab world represents a tradition whose origins are multi-faceted. It marks the preservation of classical Greek and Roman medical traditions, augmented with practices from Persia, India and China, embodied in a corpus of literature that was advanced significantly by Muslim physicians. Of the latter, the oft-cited great triumvirate includes Rhazes of Persia (d. 925), Albucasis of Andalusia (d. 1013), and arguably the most influential, Avicenna of Transoxiana (d. 1037). He wrote the five-volume encyclopaedic *al-Qanun fi'l-Tibb* (The Canon of Medicine) with the herculean intention of distilling all extant medical knowledge and practice. Such was the significance of the completed book that it was translated into Latin by Gerard of Cremona (d. 1187) and formed the bedrock of medical curricula in universities across the world, from Baghdad to Montpellier and Leuven, for over six hundred years, from late antiquity to the dawn of the Renaissance.

Avicenna contributed much to the practice of analgesia and anaesthesia, with relevant passages found throughout the five volumes of The Canon of Medicine. These include both a challenge and development of Galen's ideas on pain, wherein he categorises different aetiologies of pain, and also details various *taskin*, or analgesic treatments, including linseed, chamomile and temperament changes. Moreover, Avicenna details various *mukhaddar*, or anaesthetics, in the fifth volume; the Pharmacopoeia, that can be utilised before surgery, including mandragora (a nightshade), opium, henbane, hemlock, solanum, wild lettuce and ice. He provides practical recipes for these agents and details both the optimum doses and also signs and symptoms of toxicity.

Furthermore, in the chapter on chest diseases, Avicenna describes how to manage stridor and respiratory distress. He comments on clearing upper airway secretions and obstructions using a long reed or something similar with cotton-wool attached at its end. If unsuccessful, he recommends intubating using a silver or gold tube, one of the earliest recorded references to oropharyngeal intubation. In cases of imminent death, he further describes for the first time in practical detail the procedure for a tracheotomy.

The majority of The Canon of Medicine has, unfortunately, never been translated into any modern language. Therefore, using an original Arabic manuscript dating back to 1593, this paper introduces these intriguing insights using direct translations that highlight Avicenna's tremendous contribution to the field of anaesthetics. Furthermore, where appropriate, the analgesic and anaesthetic practices described will also be contextualised using modern evidence-based medicine.

THE CASE OF ANN PARKINSON

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Introduction

Interest in the early deaths associated with anaesthesia has been well documented, both in the History of Anaesthesia Society Proceedings and elsewhere.[1, 2, 3]

Hannah Greener, who died in January 1848 whilst receiving chloroform anaesthesia during an operation on her toe, is widely quoted as the first person to die under anaesthesia. More recent evidence, however, has found that this dubious accolade may in fact belong to Alexis Montigny, who died about 6 months before Hannah Greener in Auxerre, France. [4] Earlier still, within months of Liston and Squire's first successful demonstration of ether anaesthesia in England in December 1846, there are three deaths reported in the medical and lay press, which occur in association with anaesthesia. The first of these, Thomas Herbert, is a 53 year old man from Colchester, who died two days after the administration of ether during lithotomy. Nine days later, an 11 year old named Albinus Burfitt died following ether anaesthesia in Mere, Somerset. And on March 11th 1847, Ann Parkinson, a 21 year old from Grantham, Lincolnshire, died two days after an operation for the removal of a mass on her left thigh. Her death certificate records the cause of death as "the effect of ether, administered for the purpose of alleviating pain during a surgical procedure to remove an osteo-sarcomatous tumour of the left thigh." This is believed to be the first death certificate to specifically name anaesthesia as a cause of death, warranting further investigation of this significant case.

Background

Grantham today is a small market town in South Lincolnshire, home to a population of approximately 35,000. It is situated on both the East Coast mainline railway and on the A1, linking the north and south of England. A strong engineering centre in the early 20th Century, this has now almost completely vanished, leaving the town dependent on the food processing industry to support the local economy. The town would have looked somewhat different in 1847. It was an important stage-coaching town, again due to its location on the Great North Road. Grantham had a population approaching 11,000 in the 1851 census; gaslight had recently arrived in the town, the waterworks were in the process of being built and in 1850 the railway arrived, changing the nature of the town forever. There was no hospital in the town until the opening of Grantham and Kesteven Hospital in 1874.

Ann Parkinson

Ann Parkinson was born in Newark, Nottinghamshire, in 1826. The daughter of a haymaker, she married John Parkinson at Newark Parish Church on 24th June 1845. John Parkinson was the son of a yeoman – a freehold farmer, who possibly owned some of his own land, and who would have been held in high regard. John himself worked as a hairdresser, in those day probably another term for wigmaker, and was probably a skilled craftsman, earning slightly more than a labourer. The couple made their home in Spittlegate, Grantham, possibly close to relations of John Parkinson in the Sandpit Lane area. Close to the centre of town, this was the domain of working class trades people and labourers. Sanitation was poor, with no mains water until the later part of the century. It was here, in 1846, that Ann gave birth to their son, John Thomas Parkinson.

The Case

Reports following the death of Ann Parkinson describe her as being in *"a state of delicate health"* at the time of her marriage and as a person who was *"subject to cold upon the slightest occasion."* [5] Shortly following the birth of her son in July 1846, Ann complains of a mass on her left thigh, which grows in size until the point at which she can barely walk, sit or sleep. The family consult William Robbs, the local surgeon, who initially prescribes leeches and puncture, but ultimately advises that surgery would be the best way to proceed. William Robbs was born in Horncastle, Lincolnshire, graduating from Glasgow University, before becoming a member of the Royal College of Surgeons and the Worshipful Society of Apothecaries of London (*College & Hall*). He published widely in the medical press, including medico-legal articles and case reports, and practised at Elmer House in Grantham, which remained as a medical practice in the Robbs family until the 1930s.

Ann Parkinson had read recent reports about ether anaesthesia, and asked Mr Robbs for his opinion. At the time of his first consultation he is sceptical, announcing that he has little faith in the new technique, but by the time of the operation in March, Robbs has successfully used ether for dental extractions and a toe operation. Ann Parkinson contacts the patient involved in the latter case, who speaks highly of his experience and recommends the ether anaesthesia. Robbs visits Ann on two occasions prior to the operation to trial the ether – on the second of these occasions he successfully induces loss of consciousness and she recovers well.

The operation begins at Ann Parkinson's home at 12 noon on the 9th March 1847. Mr Robbs is accompanied by three other medical men, Messrs Rogers, Priest and Dibben. The ether is administered by Mr Dibben, and it is reported that a state of unconsciousness is achieved after about ten minutes. At the first skin incision, however, Ann cries out. Attempts are made to reapply the ether, but she continues to struggle and moan throughout the operation. The procedure lasts approximately 55 minutes in total, though Robbs later states that the actual surgical time was probably around 30 minutes. They report there was minimal blood loss. Ann is given brandy and water and is put to bed. She appears conscious at this point, however she fails to rally. Robbs notes that her pulse is very feeble and rapid and that she fails to pass any urine, before prescribing a variety of medicines in order to try and provoke a reaction. The following day she remains in the same low state; she complains of numbness in her legs and lower back, and on Thursday the 11th March, Mr Robbs is called at approximately 5am. Twenty minutes later Ann Parkinson dies "without the slightest reaction having taken place".

The Inquest

The death is referred to the coroner of the district, Mr George Kewney, who feels that death has resulted from the application of ether and so orders an inquest, which is held at The Brewer's Arms, in Spittlegate, on Saturday 13th March 1847. The pub was a relatively new establishment at the time, built in the late 1830s on Brewery Hill, Grantham, and was popular with workers from the nearby maltings. The building itself no longer stands; the pub closed in 1921, and the building was demolished soon after. At the inquest Kewney states that this is one of the most important cases he has presided over. He recommends that should they find the death does result from the effects of ether, then the question of the accountability of those administering the ether must be raised. The witnesses at the inquest include Elizabeth Leake, Ann Parkinson's sister in law, William Eaton and Robert Shipman, who conducted the post mortem examination, and William Robbs.

Eaton and Shipman recall that the post mortem findings are, for the most part, unremarkable. There is some congestion in the lungs and the heart is more flabby than usual, containing rather less blood. The brain looks healthy, with the exception again of some congestion of the upper anterior lobes. They confirm that the tumour was of an osteosarcomatous nature, but deny that it held any immediate threat to life. They state the wound looks clean, noting there is nothing to suggest wound infection or bleeding as a cause of death. Finally, William Robbs takes to the stand, listing up to 27 cases in which ether has successfully been used and states that nothing has been done in this case "but what had been fully warranted by the practice of the leaders of the profession." After deliberating for a short time, the jury concludes that the deceased died from the effects of the vapour of ether, and not from the effect of the operation or from any other cause. William Robbs initially concurs with the verdict, stating that he will avoid the use of ether in the future. Shortly afterwards, however, he publishes a full case report in the London Medical

Gazette stating that the evidence given at the inquest was scanty and unsatisfactory, and that it failed to embrace anything beyond a presumptive opinion that the death had been caused by the ether. The results of the inquest were widely reported in both local and national lay press, and in the medical journals of the time. The day after the inquest, the body of Ann Parkinson is buried in Grantham Churchyard, next to the imposing spire of St Wulfram's church, in front of a large crowd of mourners.

Conclusions

The case of Ann Parkinson remains of considerable historical interest for a number of reasons. It is certainly one of a number of early deaths which occurred in association with anaesthesia, and which were widely reported in the lay and medical press of the time. This case may be of particular significance as the first of these in which referral was made to the coroner, and the first in which anaesthesia is named as the cause of death on the death certificate. Whilst we can continue to speculate as to the accuracy of this conclusion, in truth we will never know exactly what caused Ann Parkinson's untimely demise. Clearly, she did not die under anaesthesia, as had Hannah Greener and Alexis Montigny, but almost 48 hours afterwards. With the benefit of hindsight, and a more modern medical understanding, other causes such as blood loss, sepsis or pneumonia may be more likely.

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WEAVING OUR WEB

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"…Nobody pointed out that the web itself is a miracle."

EB White. *Charlotte's Web*. New York: Harper and Brothers 1952.

Introduction

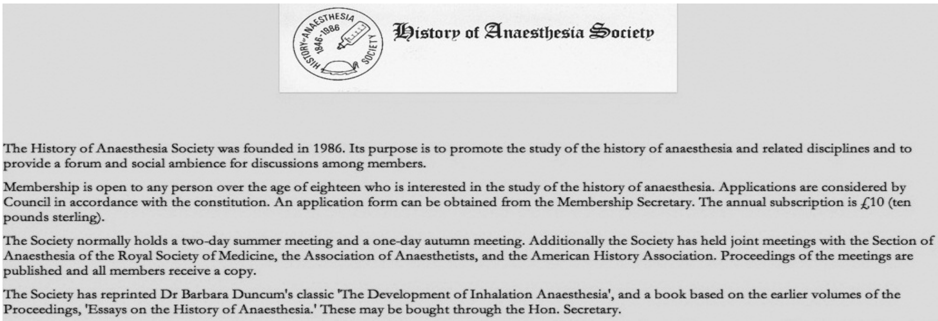
Love it or loathe it, little more than two decades since its invention the world wide web and network of computational networks (internet) by which it operates have revolutionised almost every facet of modern living. Today the web is used by more than two billion people annually across the globe, providing access to in excess of six hundred million websites, [1] include the History of Anaesthesia Society's own pages. These have been live, in a variety of guises, for the past thirteen years and this short paper aims to record and reflect upon the work of the Society's five webmasters during this period. In doing so it briefly outlines the origins and conceptual basis of the world wide web before focusing on the development of the Society's webpages from the late 1990s through to the present day. Finally it highlights some statistics relating to use of the current HAS site over the past eighteen months and ask what, if indeed anything, such data might teach us about wider interest in the work of this Society and the history of anaesthesia as well as the role of the web in preserving and promoting the history of our specialty.

The origins of the world wide web

Far from ancient, the origins of the world wide web can be traced back to 1989 when thirty-four year old Oxford physics graduate and computer scientist Tim Berners-Lee found himself working as a fellow in the computing and networking division of the Conseil Européen pour la Recherche Nucléaire (CERN) in Geneva. At that time it was difficult for CERN's scientists to share electronic documents on account of the multitude of different and often incompatible types of computational hardware and software in use in the institute's many laboratories. Berners-Lee envisaged a novel solution - a system by which information stored on a computer produced by any manufacturer could be freely exchanged with any other computer - and realised that this could be accomplished with the marriage of two existing technologies. The first of these was hypertext. Developed in the 1960s hypertext allows non-linear formatting of documents in which pages incorporate links to one, or many other pages. The second existing technology was the internet. Whilst today the terms internet and world wide web are often used interchangeably, they are not in fact the same. The internet is a network of computer networks that employs standardised protocols to allow different types of computer hardware and software to communicate. The web meanwhile is just one of the many services that runs on the internet. In March 1989 Berners-Lee submitted an initial proposal to develop an information system using hypertext and the CERN network[2] and began working on this formally six months later, aided by Belgian computer scientist Robert Cailliau. By December the same year the pair had built all the tools necessary for a working web including a system of globally unique identifiers for resources known as the uniform resource locator or URL, a hypertext document publishing language called hypertext markup language (HTML) and a hypertext transfer protocol or HTTP - the language computers use to communicate hypertext documents over the internet. In addition he had programmed the first browser to retrieve and view hypertext documents and designed the first webserver software, which hosted the worlds first webpage. This went live online on 6th August 1991 and was dedicated to information about the world wide web project, describing its basic features, how to access documents and set up a server.[3] Berners-Lee subsequently made his browser and server software freely available and the web began to take off as computer enthusiasts in other academic institutions throughout Europe and the rest of the world built their own servers and websites. Two years later Marc Andreessen and Eric Bina at the National Center for Supercomputing at the University of Illinois in Urbana-Champaign developed Mosaic, one of the first graphical web browsers.[4] Such developments made the web accessible to the home computer-user and before long, the global phenomenon we know today.

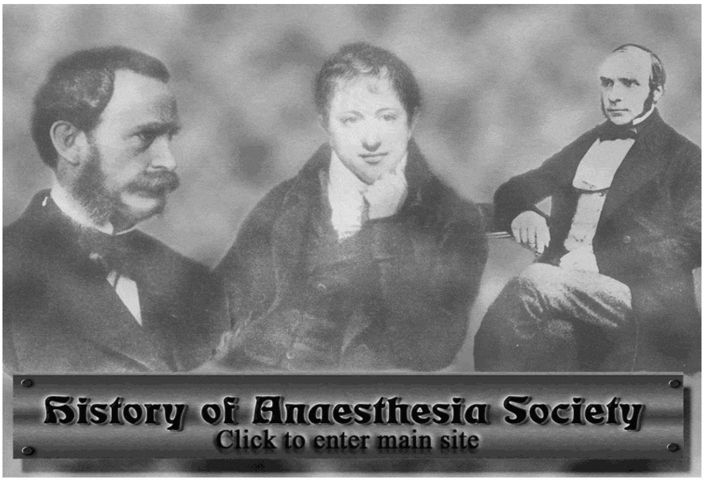
The History of Anaesthesia Website

By the end of the last millennium it was becoming fashionable for small societies such as the HAS to have their own website and the minutes of the 1999 Annual General Meeting of the Society held at the Watershed Conference Centre, Bristol record that David Zuck had volunteered to serve as its first webmaster. Having taught himself the intricacies of coding with HTML by trial and error, David had a site ready to upload by early 2000 and had chosen his preferred web hosting company. All that remained was to register a domain name. Whilst the obvious choice for this was www.has.org.uk, it became apparent that this already belonged to someone else - the Hampshire Autistic Society! www.histansoc.org.uk was therefore the closest the Society could get and version one of the first HAS website, went live in the spring of 2000. It listed officers, council members, future events and meetings as well as links to the Association of Anaesthetists of Great Britain and Ireland (AAGBI) and Newcastle Museum of Anaesthesia. In addition the home



Above: Screenshot of the first HAS website developed by David Zuck, Spring 2000.

page featured a chloroform bottle with drips falling onto an open mask below and a moving banner along the bottom of the screen with information about the current exhibition in the AAGBI Museum. This latter feature, which was very easily set up, brought comments of approval from a number of members; the much more difficult chloroform drops however were rather taken for granted! The minutes of the year 2000 AGM record the Society's thanks and David continued to keep the site up to date, adding book reviews, reports of meetings and links to other relevant sites over the course of the following 12 months. In August 2001 however he became concerned about the sites future administration, his daughter having quipped a year or so earlier that there couldn't be many septuagenarian webmasters about, and then aged 78, he decided it was time for Neil Adams, then Honorary Secretary, to source a younger, preferably much younger, successor. By mid-2002 Neil had persuaded Mike Palmer to become the second webmaster. Mike redesigned the site completely, his proposal was sent to Council for approval on the 16 November 2002 and it went live shortly afterwards. The new front page showed Morton, Davy, and Snow and the homepage led to a diverse range of pages including historical questions and answers. In 2007 Dr Gary Enever took over as the third webmaster.



Left: Screenshot of the front page of the HAS website showing Morton, Davy and Snow developed by Mike Palmer, 2002.

His site, hosted at the Northern School of Anaesthesia ran from 2007 to 2010 after which Neil Adams aided his son Jonathan, became the fourth webmaster. Neil remained in post until late 2011 when the current incumbent (Peter Featherstone) was handed the reins. Following a great many hours of self-directed learning/trial and error, the website was once again radically overhauled and an extensive amount of new content added. The first version of the site in its current guise went live on 16th December 2011, closely followed by an HAS Facebook page and Twitter account.

Screenshot from the current HAS website developed by Peter Featherstone, Autumn 2011.

Website statistics

In late December 2011 proprietary tracking cookies were added to the site's code and as a result, the Society has been able to collect and collate statistics on the use its website for the last eighteen months. Cookies comprise small strings of arbitrary data which are sent from a website and stored in a user's web browser, unless they have specifically set their computer to block them. When the user visits the same website in the future, the data stored in the cookie is sent back to the website to notify it of the user's previous activity. Although cookies can't carry viruses or install malware, they present a privacy concern that prompted European and US lawmakers to take action in 2011. The HAS site conforms with current Cookie law directives and there is a link to the site's privacy policy on every page of the website. Visitors are free to block the cookies without it affecting their browsing, but this does mean we fail to capture data from such individuals.

Data collected between 1st January 2012 and 30th June 2013 shows that during this period the site recorded more than 60,000 page views during 18,226 separate visits from a total of 16,180 unique visitors. A page view is a request to load an individual page of the site and shouldn't be confused with the older, less useful metric of 'hits'. A 'hit' refers to a request for any file from a server and since an single webpage can be made up of several hundred files, there can be a great many 'hits' recorded per individual page loaded. As might be expected, almost 70% of these 16,180 visitors came from the UK and United States. The remaining 30% however came from far and wide across the globe.

Approximately three quarters of the total website traffic originated from search engines such as Google. 'History of anesthesia', 'history of anaesthesia', 'anesthesia history', 'history of anaesthetics', and 'history of anaesthesia society' proved to be the top five search terms resulting in visits during this 18 month period. 9.1% of traffic meanwhile was referred via external links from Wikipedia and on line dictionaries as well as the Wood Library-Museum of Anesthesiology, Anesthesia History Association and AAGBI. The remainder of traffic was direct - i.e. someone typed the website address into their browser and hit the return key. The most popular webpages proved to be the historical timeline, followed by the proceedings archive, photograph gallery and events page.

What do these statistics tell us? and how much should we really read into them? Well probably very little, though the 'fact' that the HAS website had at least 16,180 unique visitors in the last year and a half is perhaps worthy of a little more consideration. As of July 2013 the HAS has 391 members. Even if every one of these members used the website between January 2012 and the 30th June 2013, that leaves 15,789 non-members from across the globe visiting our website – a statistic and that is, at the very least, an enormously positive sign both for this Society and the history of the anaesthesia in general.

Conclusion

This paper has briefly outlined the origins and conceptual basis of the world wide web before moving on to highlight the development and changing appearance of the Society's webpages from the late 1990s to the present day. Statistics relating to use of the current HAS website over the past 18 months serve to demonstrate worldwide interest in the history of anaesthesia and bolster the suggestion that the web has a very definite role to play in the preservation and promotion of the history of anaesthesia. For the last 13 years the website has been History of Anaesthesia Society's virtual shop window. It is good to know that people are still looking in!

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WOMEN IN SURGERY

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Women in mid-19th century Britain who wanted to become doctors faced an enormous struggle. It was not until 1865 that they won the battle and Elizabeth Garrett Anderson (1836-1917) became the first woman to qualify in England. But those wanting to become surgeons had to start all over again. Even if they managed to gain surgical experience in hospitals, they were not permitted to take the Fellowship examination of the Royal College of Surgeons of England (RCSEng). Their only opportunity to practice was to work in the tiny number of hospitals set up and staffed by women only, or go abroad, which many did. However the battle was eventually won and in 1909 the RCSEng agreed to allow women to take the FRCS, but the take-up was slow, there were still numerous obstacles. As recently as 2009, the centenary of this permission, still little over 5% of consultant general surgeons are women, though more have become consultants in smaller specialities such as gynaecology, eyes and paediatric surgery. In the last ten years or so career patterns have changed. In 1961 24% of medical students were women. For the last 3 years the figure has consistently been 55-60%.

This paper looks at what role, if any, has been played by women surgeons in Europe throughout history. Whilst women in the home always played a large part in general medical care, it looks specifically for those who acted as surgeons, although surgery was of course very limited in scope until the introduction of anaesthesia and asepsis.

Egypt

In pharaonic Egypt nothing changed much for thousands of years, probably because the area was endowed with a favourable environment; living was easy with fertile agricultural land from the annual Nile floods. There was time for culture, religion and science. Doctors were highly organised and were based on the priest-hood. Much is known about their medicine, because Nunn, a well-known anaesthetist, learnt to read hieroglyph and published the definitive book on Egyptian medicine[1]. He found one well-documented woman surgeon. She lived in Old Kingdom 5th dynasty roughly 2500 years BC. Her name was Peseshet and she has her own stela in the tomb of her son in Giza. Her hieroglyph reads "(female) supervisor of (female) physicians." Clearly therefore she was not the only female physician; there must have been a cadre of others. We know they practised surgery because paintings exist showing Peseshet and her colleagues doing Caesarean sections and breast operations using stone knives. She is perhaps the earliest female surgeon to be documented.

Greece

The Greeks separated medicine from religion and developed it into a highly complex study. but they gave women no public role. However, Hagnodice in the 2nd century AD is well documented[2]. She is said to have reacted against the exclusion of women from the medical profession because it inhibited women from seeking medical advice for childbirth and gynaecological complaints. A description of her work records:

'*The ancients had no midwives, and therefore women died (in childbirth) led on by their sense of shame. For the Athenians had taken heed that no slave or woman should learn the art of medicine. A certain girl, Hagnodice, as a young woman desired to learn the science of medicine. Because of this desire, she cut her hair, put on male clothing, and entrusted herself to a certain Herophilus for further training. After learning the science, when she heard that a woman was having labour-pains, she used to go to her. And when the woman refused to entrust herself [to Hagnodice], thinking she was a man, Hagnodice lifted her undergarment and revealed that she was a woman. In this way she used to cure women*'.

Fortunately this gesture is no longer necessary. Hagnodice had a hard time; she was arrested, charged with illegally practising medicine and sentenced to execution. She was saved by a riot of her women patients and eventually she was allowed her to go free and continue to practice.

Medieval Europe

Salerno in Italy was the first medical school in Europe and from at least the 11th century was accepting women both as students and instructors. Trotula, a woman, was famous and many influential publications have survived that are attributed to her, mostly but not all concerned with gynaecology. However she has never been precisely identified or dated, though the general consensus amongst historians seems to be that Trotula did exist, that she was female and was indeed the author of these publications. Chaucer in the *Canterbury Tales* mentions her as Dame Trot[3,4]. Italy continued for several centuries to admit men and women equally to their medical schools and thereafter to practice equally as doctors.

Much is known about medieval medical practice in England thanks to Rawcliffe's detailed researches[5]. She records that women surgeons were fairly common at this time and were encouraged, particularly in York, Norwich and Lincoln, where they were admitted to the Guilds equally with men. A document in York stated that:

> "*no man or woman whatsoever was permitted to practice surgery . . . unless under a master barber or licensed by a guild.*"

Thus there were both men and women surgeons. Also it was common for wives and daughters to work with their surgical husbands or fathers and to take over their practices when they died. Other practitioners were nuns working in religious institutions, whilst some were free-lance. Unfortunately Gilbert Kymer (*c* 1385-1463), one of the leading surgeons of the time, opposed them and in 1421 he petitioned Parliament to stop women practising. Unfortunately he was successful for after this women ceased to be admitted to the Guilds. However as late as 1529 York had a bylaw that allowed women:

> "*To occupy their husbands' crafts, occupations and misterys*"[5]

In spite of Kymer's efforts to ban them, there is a reference 200 years later from John Aubrey's (1625-1697) *Brief Lives*, which reads:

> *"a rare shee surgeon, Mrs Holder treated King Charles II for a hand injury with such a good result "to the great grief of all the Surgeons who envy and hate her".*[6]

Later Europe

Probably the best-known and well-documented female surgeon before the present day was James Barry (1795-1865). Born Margaret Bulkeley she went as a teenager to Edinburgh with her mother, disguised as a man and taking the name of James Barry, to study medicine. She qualified in 1812 aged 17, thus making her by far the earliest women to qualify in medicine at a British University. She then went to London, still in disguise, studied at Guy's and St Thomas' Hospitals and was examined and passed by the RCSEng as a military surgeon.[7] There followed a 40-year career in the Army, serving in numerous military hospitals including Malta, Corfu, Cape Town, and the Crimea. Barry's army career was distinguished. Whilst keeping his private life to himself, he was no shrinking violet, but seems to have sought publicity. He was noted as a disciplinarian and was in trouble more than once with the military hierarchy for his outspokenness. He instigated many hygienic practices and as a result during the Crimean War the mortality in his hospital was the lowest in any including Florence Nightingale's. It was only when he died in 1865 and was being laid out for burial that the orderly noted that he had a female body. There seems little doubt that the body was a normal female, not a hermaphrodite and that the impersonation as a man was not because of gender doubt but in order to pursue the career she wanted.[8]

Barry was not unique. Male impersonation in the 18th century was not uncommon. Friedli, in *"Passing women - a study in gender boundaries"* (quoted [9]) records thirty-four others, sixteen of whom were soldiers, sailors or pirates. Many fought in battles, one lived her retirement as a Chelsea pensioner. Not all sought to conceal their gender; they merely chose to live life as a man. In the same year that Barry died, an American woman doctor Mary Walker, who had adopted male clothing in order to serve in the Confederate Army, was awarded the Congressional Medal of Honour. She frequently cross-dressed, both in civilian and army life but apparently for convenience rather than to impersonate.[9]

Barry died in 1865, the time when women in England were at last permitted to qualify as doctors, amongst the last of the western European countries to do so.

The battle with the RCSEng

Women doctors did not want restrictions on what they could practice. Garrett Anderson, on behalf of her hospital, petitioned the RCSEng several times between 1895 and 1906 to allow women to take their fellowship examination and they were angry when they were firmly rejected. In 1876 the Board of Examiners for the Fellowship resigned *en masse* rather than examine the three women who presented themselves. The College was behind the times for 20 years earlier the Irish college had allowed women to sit their surgical fellowship, with the Scottish Colleges following suit soon after. It was not until 1909 that the English College relented. The women did not rush in. Ten years later there was only one female fellow of the English college, whereas the Irish and Scottish colleges had about 24 each by this time.

This first English FRCS was Eleanor Davies-Colley (1874-1934).[10] Her father, grandfather and both her brothers were surgeons. Eleanor was educated in London at the Church of England School in Baker St and Queen's College in Harley St. She was keen to study medicine but found herself working in the East End branch of the Invalid Children's Association, living in a workman's flat in Wapping. Her father died when she was only 28 but he had settled some money on her and this enabled her to study medicine. She proceeded to the London School of Medicine for Women qualifying in 1908. Two years later she achieved an MD and then went back to her medical school to teach anatomy. This she loved and felt that unpicking the human body was a good forerunner for surgery. She became surgical registrar at the Royal Free Hospital and then was appointed consultant surgeon to the Elizabeth Garrett Anderson (EGA) and the South London Hospital for Women, both hospitals exclusively staffed by women, where she was highly regarded by her patients and colleagues. In 1911 she passed both the Primary and the Final Fellowship exams and was admitted as the first woman Fellow of the English College. Her life was very different from that of most woman surgeons today. She joined with an older surgeon Maud Chadburn and they acquired 2 Harley St, where they had both their residence and their consulting rooms, with five staff to run their establishment. Chadburn adopted three children to whom Eleanor became "Aunty Elly". They led a full and active family life with the children. It was not uncommon for the early women doctors to set up house in this way and adopt children as these two did - after all by women's standards they were wealthy. Some however did marry and have children whilst continuing to practice.

It may seem strange that after Davis-Colley in 1911 no more women became fellows until 1919. In fact they found a role for themselves during the First World War that even the male surgeons could not gainsay.

The First World War (1914-1918)

War makes huge demands for manpower. Women were reluctantly allowed into the civilian posts at home that had been vacated by men. As soon as war broke out, many women surgeons offered their services in France as well as at home and predictably the War Office promptly turned them down. The women took matters into their own hands.

Louisa Garrett Anderson, daughter of Elizabeth, set up the first Women's Hospital Corps near Boulogne but later concentrated on the Endell Street Military Hospital in London. She was as dynamic as her mother but a much better surgeon. She had been very active as a suffragette, including going to prison for breaking windows, but treating war casualties seems to have concentrated her mind on surgery.[11]

A major leader in Europe was Elsie Inglis (1864-1917).[12] Born in India her parents came to live in Edinburgh when her father retired. Educated in Edinburgh and Paris she was a lady of leisure until Sophia Jex-Blake (1840-1912) opened the Edinburgh School of Medicine for Women where Inglis promptly enrolled. She qualified and continued training at Glasgow Royal Infirmary and EGA Hospital in London. In 1894 she set up a practice for women in Edinburgh and was very active in the women's suffrage movement in Scotland. When war broke out she volunteered to serve in France and was told by War Office "*my good lady go home and sit still*". This so infuriated her that on her own initiative she set up what became known as the Scottish Women's Hospitals, to serve close to the front lines and she had no difficulty in getting support from the increasing number of women surgeons. The French were supportive for they granted them the Hotel Claridge in Paris and also a site near Boulogne at Royaumont. At both sites Inglis set up hospitals with all-female staff. McKenzie has described the role of women as anaesthetists in these hospitals.[13] The soldiers at once accepted the women and were very appreciative of the care they received and did not want to leave. A Senegalese soldier was so impressed he said he would never beat his wives again. The following year Inglis set up female-staffed hospitals in Serbia, Salonika, Romania, Russia and Corsica. Sadly in 1917 she was taken ill in Russia and repatriated to Edinburgh where she died soon after from cancer. Arthur Balfour commented:

> "*She was a wonderful combination of enthusiasm, strength of purpose and kindliness. In the history of the world war alike by what she did and by her heroism, driving power, and the simplicity by which she did it, Elsie Inglis has earned an everlasting place in history*".

Dr Elizabeth Courtauld described one night's activities:

> *'Then came an order for the hospitals to evacuate . . . then an order that heaps of terribly wounded were expected and we could stay on . . . All night we were hard at it and working under difficulties. Terrible cases came in. Between 10.30 and 3.30 or 4 am we had to amputate six thighs and one leg, mostly by the light of bits of candles, held by the orderlies. . . air raids were over us nearly all night and sometimes we had to blow out the candles for a few minutes and stop when we heard the Boche right over. . . next morning (30 May 1918) at 11am we were told the whole place must be evacuated, patients and all . . . some practically dying, all wanting urgently operating on. But we had to stop operating, dress the patients' wounds and splint them up as best we could, and all day ambulances came up and we got patients away.'*[12]

Throughout all this the War Office persisted in treating the women with disdain. They gave them no encouragement and they persisted in not giving them the status, pay or privileges of officer rank, which sometimes made relationships with male Army officers difficult. Eventually they permitted them to wear nurses' uniforms, which solved nothing, but in spite of this there was no shortage of volunteers.

Royaumont in France and Endell St in London between them treated over 40 000 casualties with results that were at least the equal of those achieved by the Army military hospitals. They were often pioneers in advancing surgical practice, indeed the hospital in Royaumont was chosen by the Pasteur Institute in Paris to try out new treatments for gas gangrene. Lydia Henry (1891-1985), one of the first two women to qualify in medicine at the Sheffield Medical School in 1916, served at Royaumont and was later awarded an MD for her thesis on gas gangrene. More importantly she was awarded the Croix de Guerre by the French government, and it is significant that it was the French who recognised her contribution, not the British.[14]

A pioneer amongst the home-based surgeons was Maud Forrester-Brown (1885-1970) who became the first British - probably world - female orthopaedic surgeon. She practised in Edinburgh and in Bath and the South-West of England and in both centres made major advances in both the science and clinical practice in what was then an embryo speciality, and was active into her old age.[15]

Post-WW1

Whilst the fact that women took the place of absent men in civilian hospitals was welcomed, their position was not maintained post-war. There was little problem in provincial cities where all medical schools were co-educational, but London and Oxbridge went back firmly to their refusal to admit female students. However those who did qualify as doctors were free to follow Davis-Colley's example, take the FRCS and practice surgery. Amongst the first 24 Fellows were three DBEs, three professors, the first female president of a medical Royal College (Dame Hilda Lloyd of the RCOG) and the first to be a professor in any subject in Oxford University. The latter was Ida Mann (1882-1965), FRCS in 1924, who became an ophthalmic surgeon, first working at the all-female Elizabeth Garrett Anderson Hospital, though as she resented its feminist atmosphere she soon moved to the Royal London Ophthalmic Hospital, now Moorfields. During the Second World War she volunteered to go anywhere and was sent to Oxford where she set up a major research centre. Her whole career combined clinical practice with important research. She was appointed to a personal chair in Oxford in 1942, the first women to hold a chair in any subject at Oxford. Later she became DBE.[16]

The present-day RCSEng has done much to encourage women into surgery by starting a "Women in Surgery group" some 20 years ago. It was instigated and first chaired by Averill Mansfield, a vascular surgeon and the first female professor of surgery in Britain at St Mary's Hospital in the University of London. Since then the number of women trainees has more than doubled and the proportion of consultants is rising slowly. Figures quoted recently[17] show that it is not just in medicine that women students are out-numbering men; it applies throughout the whole of the university, where women now exceed 50% of the entrants. Both medicine and academia are changing, something that future historians will certainly study.

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17 Universities and Colleges Admissions Service. *The Times* 2013; **April 15**: 27

THE SCHIMMELBUSCH VARIATIONS

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The Schimmelbusch mask is possibly the best known historical anaesthesia mask in the world. Curt Schimmelbusch was not an anaesthetist himself, nor did he attract recognition in his lifetime as a result of the mask that bore his name. Indeed, the mask recognised by many as synonymous with his name is not the same as the one that he first described, and the popular belief that it was designed to prevent liquid anaesthetic from running onto the patient's face appears to be a myth.

As a surgeon, Schimmelbusch became famous for his work on asepsis and sterilization. He was born in West Prussia on November 16, 1860, and studied medicine in Würzburg, Göttingen, and Berlin, before obtaining his doctorate in Halle in 1886. He first researched thrombosis with Karl Eberth in Halle, before training as a surgeon in Cologne under Professor Bernhard Bardenheuer, who had introduced Listerian asepsis in 1875. In 1889, he returned to Berlin as assistant to Professor Ernst von Bergmann at the Charité Hospital. It was von Bergmann who introduced heat sterilisation of surgical instruments.[1] In 1892, Schimmelbusch published his famous work *Anleitung zur aseptischen Wundbehandlung,* ("Guide to aseptic treatment of wounds"), which was subsequently translated into almost all European languages.[2] He devised a method of steam sterilization that enabled instruments to be autoclaved within a storage container that could then be transported to the operating theatre while maintaining sterility. Also in 1892, he described a cystadenoma of the breast, a condition that came to be known as Schimmelbusch's disease.[3]

Before the two latter publications, in October 1890, he described his mask "*für Chloroform und Aethernarkosen",* in Dr Beck's Medical Almanac (*Dr G. Beck's Therapeutischer Almanach)*.[4] He had, however, previously applied to the United States Patent Office for a patent, in June 1890. The patent application was filed on October 18, 1889, and the Patent Number 429, 287 was granted on June 3, 1890, 4 months before the description in Dr Beck's Alamanac.[5] The Patent is titled "Mask for Chloroforming", and the specification describes the mask, beginning with the words *"Be it known that I, CURT SCHIMMELBUSCH, medical doctor, of Berlin, in the Kingdom of Prussia and German Empire, have invented a new and useful Mask for Chloroforming….."*

This description is, in itself curious, as no mention is made of "ether" throughout the Patent document. The description continues, to convey the justification for his design by referring to chloroform wire masks in common use; "The repeated use of one and the same covering for several patients is undesirable in view of cleanliness and contagion of disease." He describes the reduced perviousness to air that accompanies prolonged use and repeated washing of the covering material, "….which is a serious matter, since the patient with safety to his life may only inhale chloroform mixed with air." "To supply for every separate case a new specially made covering is very expensive, and the medical man is therefore in the difficulty of either disregarding the question of expense or considering the risks of the repeated use to which I have just referred."

He then describes the advantages of his mask. "The present invention purposes… to effect the renewal of the covering material cheaply, simply, and with expedition." "The mask consists of an oval grooved ring, adapted to the shape of the face, rounded on its inner side, and made of metal." "…at the one side with a hinge… , and on the other side with a convenient handle." "…there are two wires bent in the axes of the oval." He describes how a new piece of pervious material is placed over the wires, and a hinged loop of wire then used to clamp the material in place. "The material overlapping the ring is then cut off with a pair of scissors."

"…any kind of material which is pervious to air may be used without requiring any special preparation."

While it is widely believed that the prime feature of his design was the trough shaped rim, preventing irritant liquid ether or chloroform from running onto the patient's face, the Patent makes no mention of the prevention of liquid contamination. Instead, in keeping with Schimmelbusch's primary interest, the principal feature is one that facilitates cleanliness.

His October 1890 publication, in German, is titled *Maske für Chloroform und Aethernarkosen*, clearly recognising that anaesthesia did not involve just chloroform! The paper describes his invention in much the same way as in the Patent, albeit with more graphic language. "Chloroform and ether masks are often applied in the presence of infectious diseases like erysipelas and diphtheria, and during nearly every general anaesthetic, they are contaminated by saliva and vomit." Again, there is no mention of the prevention of liquid anaesthetic contamination of the patient's face.

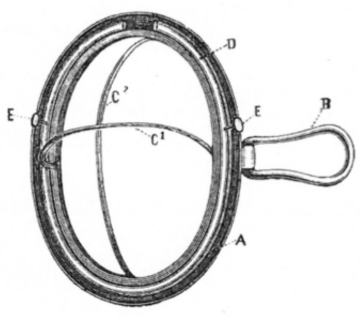
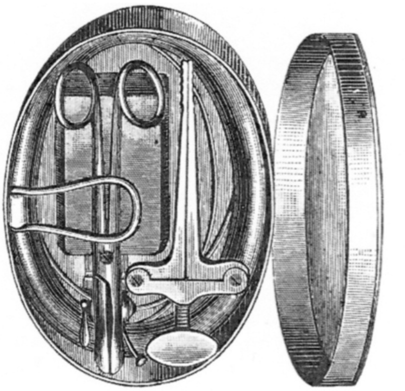


Fig. 1.

Schimmelbusch mask. From Schimmelbusch C., *Anleitung zur aseptischen Wundbehandlung*, Berlin, Verlag von August Hirschvald, 1892

Schimmelbusch also described how the mask might be sterilised and stored in an oval metal box with a removable lid. He advised that the box could also contain tongue forceps, Heister's mouth gag, a bottle of chloroform or ether, a piece of oiled cloth, and some folded gauze.

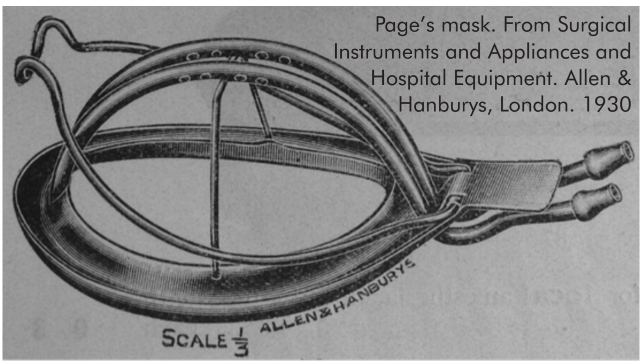


Metal box containing mask, tongue forceps, Heister mouth gag, bottle and gauze. From Schimmelbusch C., *Anleitung zur aseptischen Wundbehandlung*, Berlin, Verlag von August Hirschvald, 1892

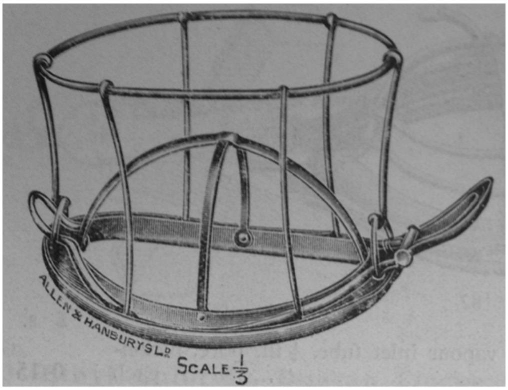
The mask that had been designed by Schimmelbusch was soon modified to the pattern that became well known around the world, with many subsequent variations appearing. Many of these variations were named after "inventors" whose identities have become lost with time. Apart from being supplied in a range of sizes including a paediatric size, the most common variation relates to the method of securing the "ring clamp". The Chadbourne (sometimes referred to as Chadborn) modification, while often attributed to a "square" shape of the supporting wires or straps for the cloth covering, is probably more correctly applied to the screw mechanism of securing the ring clamp. Another variation of the clamp is the "Karslake Eccles' lever clip".

A mask with a triangular shaped "trough" is known as "Levy's mask", possibly after Goodman Levy. An adaptation of the grooved ring or trough to Esmarch's mask is known as "Kirchoff's mask". Other variations included "De Prenderville's" and the "King" mask, devised by Charles King to hold up to 24 layers of gauze. "Carnac Rivett's" modification included a small clip under the dome for a chloroform capsule. The Schimmelbusch mask was modified with a gas inlet on the side, for use during insufflation from a Shipway apparatus. Other variations with gas inlets included "Ironside's", and the "Page" mask, with two tubes for additional oxygen and insufflation of ether. The tubes curved longitudinally under the mask covering, with multiple small outlet holes on the inferior surface. An adaptation of "Page's" mask has an attachment for a carbon dioxide sparklet to be applied.

An "Ogston's frame" was devised for attachment above the Schimmelbusch mask, allowing greater concentration of ether in the tower, while also restricting the entry of fresh air. The "Killian's" mask was a similar device where the tower is

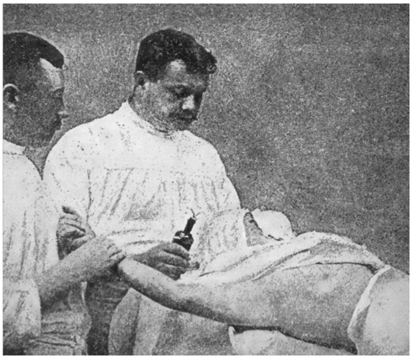


Page's mask. From Surgical Instruments and Appliances and Hospital Equipment. Allen & Hanburys, London. 1930 permanently attached and has solid walls. "Picton's" mask was an even more extreme variation with a tall closed tower for concentration of ether vapour. The "Yankauer" mask may be considered as a variant of the Schimmelbusch mask, with early versions having a wire supporting frame over the facial ring, and differing only in the use of a circular spring to secure the cloth covering. Later versions replaced the wire frame with a metal mesh.



Ogston's frame attached to Schimmelbusch mask. From Surgical Instruments and Appliances and Hospital Equipment. Allen & Hanburys, London. 1930

Schimmelbusch contracted tuberculosis, and died in 1895, at the age of 35. The mask that carried his name was not only used for chloroform and ether, but also ethyl chloride and ACE mixtures. It became the most widely used ether mask in the world, and was subject to many variations.


The only known portrait of Curt Schimmelbusch. From Schimmelbusch C., *Anleitung zur aseptischen Wundbehandlung*, Berlin, Verlag von August Hirschvald, 1892

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ANAESTHESIA & THE DEVELOPMENT OF INTENSIVE CARE IN ADULTS IN ENGLAND & WALES

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My research interest for the last 20 years has been the development of intensive care in England and Wales. But this is the History of Anaesthesia Society so I am going to concentrate on the relationship between some developments in anaesthesia and their effects on the development of intensive care, focussing later on developments in England and Wales.

The conventional view of the start of intensive care

The development of modern intensive care is usually taken to have started during a poliomyelitis epidemic in Copenhagen in 1952-1953.[1] In the early weeks of the epidemic there was a very high mortality; patients were dying from respiratory failure. The physicians asked the anaesthetist Bjørn Ibsen for help and he used a regime which was already well-known to anaesthetists at that time: namely intermittent positive pressure respiration (IPPR) to support respiration and a cuffed tracheal tube to protect the lungs from contamination. To ventilate the patient's lungs Ibsen simply squeezed the reservoir bag of Water's circuit. He used cyclopropane via a cuffed endotracheal tube for general anaesthesia while the surgeon performed a high tracheotomy. Once the tracheotomy tube was in place he attached the circuit to that and the patient's lungs were ventilated by medical students who squeezed the bag continuously for as long as it took for the patient to recover. This technique reduced the mortality dramatically and indeed became the basis for modern intensive care. However I have learnt that the story had started much earlier and that in the early years *after* Copenhagen anaesthetists do not seem to have been the dominant practitioners of intensive care. I will start by discussing the period before 1952 and then say more about the Copenhagen polio epidemic, and finally I will discuss developments after 1953.

Earlier roots of intensive care – before 1952

Between 1904 and 1913 surgery had reached the stage at which thoracic surgery was technically possible, but surgeons were beset by the 'pneumothorax problem'[2] The problem was that when the thorax was opened for surgery of the oesophagus or lung the lung on the open side collapsed and the patients died. How could that be prevented? From then on patients did not simply have to be made unconscious during surgery; they had to be kept alive. People have still not grasped that that is what anaesthetists do, but it has been necessary for almost exactly 100 years! This was a problem for surgeon and anaesthetists, but a solution to that problem might have led on to maintenance of life in respiratory failure outside the operating room: early intensive care.

There were three approaches to the solution of the pneumothorax problem:

1: Differential pressure cabinets.

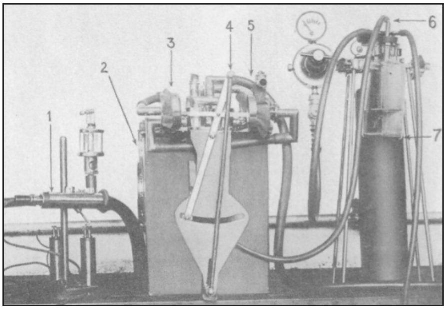
2: Intermittent positive pressure ventilation using a cuffed endotracheal tube and a mechanical lung ventilator.

3: Insufflation anaesthesia.

Differential pressure cabinets were one (ineffective) solution to the pneumothorax problem. However they had no bearing on the development of intensive care and they will not be further discussed. The second solution could have led to intensive care, but I will show why it did not. I will describe this technique and then will describe insufflation anaesthesia, which for many years became the technique of choice for perhaps the majority of anaesthetics for thoracic surgery.

Anaesthesia by intermittent positive pressure ventilation of the lungs through a cuffed endotracheal tube was described by an experimental surgeon from New York, Henry Janeway (1873-1921). He wrote a two-part paper in 1913[3]. In part A he described an intermittently closed circuit used with a cuffed endotracheal tube with the object of economising on the cost of nitrous oxide. In the second part (Part B) he described a mechanical lung ventilator.

It consisted of the rebreathing bag described in Part A of his paper, enclosed in an aluminium box. The pressure inside the box (and outside the bag) could be raised to compress the bag intermittently and so ventilate the lungs. The rate of compression was regulated by pressure activated valves. The valves could detect a sub-atmospheric pressure in the bag if the patient inhaled, and would respond by compressing the bag, thus providing triggered ventilation. If the patient was incapable of spontaneous inspiration the controls could be set to provide a desired rate of constant IPPR. The description of this equipment in 1913 could be seen to have provided a method of supporting respiration for patients other than thoracic surgical patients. However, it was quickly forgotten, even by thoracic surgeons. The reasons for this neglect of such a potentially useful technique are two-fold. First, Janeway was an experimental surgeon and soon developed other interests. The second factor was the state of anaesthesia in the early 20^{th} century. There was almost no academic anaesthesia,



Janeway' apparatus for assisted or controlled respiration (1913).[3]

and there were few expert or professional anaesthetists; exemplified by a statement by an anesthetic nurse:

> *"Anesthesia at that time was crude and given by the house staff who were not at all interested in the subject. During my time in New York…positive pressure was invented and Doctor H H Janeway had his machine at Presbyterian Hospital. I learnt its use but it was too cumbersome ever to be popular."*[4]

So Janeway's IPPR was forgotten but nevertheless, thoracic surgery did develop in the early 20th century using insufflation anaesthesia:

An electric pump blew heated humidified air at controlled positive pressure through an ether vaporiser to a small E/T tube in the trachea *down to the bifurcation* of the trachea. The pressure kept the lung inflated during thoracotomy, it did not ventilate the lungs. Insufflation anaesthesia was remarkably effective. It should not have been effective during thoracotomy because it did not inflate the lung (and the patient could not inflate the lung on the side with the chest opened). However Charles A Elsberg (1871-1948) showed in his paper of 1911 that patients anaesthetised in this way did survive a wide variety of operations including many thoracotomies.[5] The method was relatively simple and provided a way for anaesthetists in the early twentieth century to avoid using IPPR in thoracic surgery. Elsberg remarked *that "On account of the simplicity and apparent safety of the method it may take the place of the more complicated positive and negative pressure cabinets."* The better alternative; anaesthesia with IPPR was not mentioned but Elsberg was writing two years before Janeway described the method.

However in the years leading up to 1952, other developments were leading anaesthetists to introduce IPPR into their practice in the 1940s and early 1950s. Cyclopropane was introduced in 1934 by Ralph Waters.[6] Its respiratory depression was at first welcomed; it provided a quiet field for the surgeon, but in 1940 Arthur Guedel said that IPPR was necessary with cyclopropane.[7] In 1952 Cecil Gray wrote that IPPR was mandatory with curare.[8] So by 1952 anaesthetists (or at least some of them) were *technically* ready for was intensive care.

But it is necessary to consider other barriers which would have discouraged anaesthetists from practicing intensive care in the years before 1952. In the 19th Century anaesthetics were given by anyone available (Students, porters, a dentist's grandmother!). There were only a handful of experts. Anaesthesia was regarded as, at best, a sessional occupation. After the First World War, expertise became recognised (e.g. Magill, Nosworthy), but most GAs were still given by GPs. Anaesthesia was described as a 'Cinderella specialty'. However events were taking place which began to shape the modern specialty of anaesthesia. In 1908 the Section of Anaesthesia was started in the Royal Society of Medicine. Learned articles appeared regularly in the RSM *Proceedings.* Experts emerged, but most anaesthetics, even in teaching hospitals, were not given by experts. In 1939 the Armed Services asked the Association of Anaesthetists of Great Britain and Ireland (AAGBI) for criteria by which they should recognise a specialist anaesthetist and give him a military rank equivalent to that of other recognised medical and surgical specialist. Criteria were agreed.[9] With the imminent formation of the National Health Service (NHS) in Britain in 1948 Lord Webb Johnson, President of Royal College of Surgeons, told the AAGBI that to be consultants in the new NHS they would need an examination comparable to the fellowship exam of the Royal College of Surgeons or the Membership of the Royal College of Physician.[10] The Faculty of Anaesthetists was founded and examination for the Fellowship of the Faculty of Anaesthetists of the Royal College of Surgeons (FFARCS) was instituted.[11] Anaesthetists were recognised as consultants of rank equal to that of surgeons and physicians. They could then look after their own patients in ICUs.

I started this paper by stating that the development of modern intensive care is usually taken to have started during a poliomyelitis epidemic in Copenhagen in 1952-1953. The physicians asked the anaesthetist Bjørn Ibsen for help and he used a regime which was already well-known to anaesthetists at that time: namely intermittent positive pressure respiration to support respiration and a cuffed tracheal tube to protect the lungs from contamination.

The Drinker respirator had been invented in 1928.[12] Patients whose respiratory muscles were paralysed by polio were put from the neck downwards into an iron cylinder (Iron Lung) from which the air was sucked out to expand the chest about 20 times per minute. This was called intermittent negative pressure respiration. Iron lungs kept thousands of people alive (some for more than 50 years): *this was early intensive care*.

To revert to the Copenhagen polio epidemic of 1952-3. We first knew of it from Lassen's dramatic paper in the Lancet in January 1953.[1] Here are some of the details:

> 2722 patients were admitted to Blegdam Infectious Diseases Hospital with polio.
>
> 316 had respiratory or pharyngeal paralysis or both (1:8 of the total)
>
> In four months the number of such patients was 3 times as many as in previous 10 years
>
> At times they had 70 patients needing artificial respiration at once
>
> They had one full-size cabinet respirator and six cuirass respirators, which fitted over the patient's chest. The latter were usually used for weaning recovering patients from the cabinet respirators. As Lassen wrote; "WE WERE IN A STATE OF WAR!"

In the first month of the epidemic (24th July - 26th August) 31 patients were admitted with respiratory and/or laryngeal paralysis. Treatment was by tank respirator or cuirass with or without a tracheotomy. 27 of the 31 patients died (87%), 19 within 3 days of admission.

In his article in *The Lancet,* Lassen wrote:

> *'We consulted our anaesthetist colleague, Dr B Ibsen and on August 27th the first patient was treated with what was to become the method of choice for patients with impairment of swallowing and reduced ventilation - namely tracheotomy just below the larynx with insertion of a rubber cuffed tube into the trachea and manual positive pressure ventilation from a rubber bag.'*

Between August 26 and November 6 1952 Ibsen and an army of medical students (who squeezed the bags) treated 172 patients, and 77 died (42%). This was still a high mortality rate but a tremendous improvement over the nearly 90% who died before Ibsen's regime was introduced. Late in the epidemic the mortality rate was reduced to about 11%.

Ibsen's success was not simply due to his application of a technique known to anaesthetists. Only Ibsen realized that the patients were dying of respiratory failure. The physicians had dismissed respiratory failure as a cause of death because the patients (on high F_IO_2) were not cyanosed. Ibsen had evidence that in spite of the absence of cyanosis, the patients **were** in respiratory failure: First, he had seen with a device known as Brinkman's Carbovisor, which measured carbon dioxide concentration in expired air, the effects of underventilation (raised blood pressure, sweating) in thoracic surgical patients.[13] He saw these signs in the dying polio patients so he realized that they were not being adequately ventilated. He was possibly the only person to understand this. Second, he had gone to the post mortems of those who died and seen the stiff, solid lungs. Ibsen realised that if patients could not swallow, the secretions from the nose and mouth trickled into the lungs and damaged them. Ibsen took steps to protect the lungs and to ventilate them more effectively

It might be assumed that after Ibsen had shown that the application of anaesthetic techniques could save the lives of patients dying of respiratory failure. anaesthetists would take over the care of such patients; they would become specialists in intensive care medicine. Some did, but that did not happen immediately after 1952. Respiratory failure largely continued to be treated by the people who had always treated it – Infectious Disease Physicians (and some neurologists). The physicians often used improved cabinet respirators (iron lungs) with a tracheotomy when necessary, or sometimes they used IPPR (bag ventilation) with or without an anaesthetist. Several units have been described in literature: William Ritchie Russell, lecturer in clinical neurology in Oxford University had had previous experience of the problems of bulbo-spinal paralysis during the polio epidemic of 1947. After the Copenhagen epidemic he began to prepare for the setting up of a respiration unit in Oxford. He realised that to replicate Ibsen's methods he needed an anaesthetist to join him. He recruited Dr Alex Crampton Smith and they set up a Unit in the Churchill Hospital in 1955.[14] Their team invented a mechanical positive pressure respirator and a humidifier but also continued to use 'iron lungs' on occasion.[15] James Macrae (Ham Green, Bristol), did it all himself! An infectious diseases physician, he changed over to IPPR after Ibsen used it in 1952. He did his own tracheostomies and invented his own lung ventilator.[16] W Howlett Kelleher at the Western Fever Hospital in Fulham, West London invented improved cabinet respirators and used IPPV when required.[17]At Fazakerley Hospital for infectious diseases in Liverpool Dr Andrew Barnett Christie (1909-1992) was medical superintendent and consultant physician. Christie defended the use of tank respirators (convincingly) as late as 1974.[18] Dr John Marshall ran a respiratory unit in the National Hospital for Nervous Diseases, Queens Square. He used both cabinet respirators and IPPR and he acknowledged the help of Robert Beaver, anaesthetist to the Unit, who invented one of the first respirators to be commercially available. They did not only treat polio patients: other causes of reversible respiratory failure were treated in the early respiratory unit. They treated respiratory failure of diverse causes and they got good results. However after infectious diseases (polio and tetanus) became rare after immunisation was introduced in the 1960s, physicians gradually took a smaller part in intensive care.

At the same time changes in anaesthesia facilitated the practice of intensive care by anaesthetists. In 1961 the Platt Report on hospital staffing reported a 'lack of an adequate number of trained candidates for consultant vacancies' in some specialties, including anaesthetics. As a result, many more consultant anaesthetists were appointed. In 1968 the number of consultants in all specialties was still increasing at the rate of 280 additional consultants per annum.[19] Other developments in the 1960s helped equip and encourage anaesthetists to become involved in intensive care: cardiac surgical patients needed post-op intensive care; respiratory failure when for example, relaxants resisted reversal. Automatic lung ventilators became more commonly available and barbiturate poisoning, flail chest, asthma, myasthenia gravis etc. were treated. The first purpose-built ICU in England was built at Broadgreen in 1964, and expanded in 1971.[20] In general hospitals anaesthetists had to treat post-operative IPPV. Perhaps most importantly young consultant anaesthetists who had been involved in intensive care during their training were inspired to set up intensive care facilities in their hospitals. They involved themselves in renal and cardiovascular support. A National Audit of General Intensive Care Units in the United Kingdom published in 1992 by the Royal College of Anaesthetists showed that 82 percent of ITU directors were anaesthetists.[21] However intensive care medicine was still a pursuit of dedicated amateurs.[22] It was not recognised as a specialty with a training structure and qualifications. There was clearly recognised progress towards the recognition of intensive care medicine as an independent specialty. Perhaps the first was the foundation of the Intensive Care Society (ICS) in 1970 following an initiative by Alan Gilston. In 1982 John Nunn's demission speech as he retired from his Deanship of the FARCS led to the formation of the Liaison Group of representatives from the Royal Colleges of Medicine & Surgery, the Faculty of Anaesthetists and the Intensive Care Society in 1987 and the Joint Accreditation Committee for Intensive care in 1988.

In 1999: intensive care medicine was recognised by the UK Department of Health as a specialty. The culmination of this process was the foundation on the 7th May 2010, of the Faculty of Intensive Care Medicine in the Royal College of Anaesthetists, as a result of the collaboration of no less than seven Royal Colleges. Intensive care medicine had come of age.

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SOLVING SHOCK DURING THE GREAT WAR *(Abstract)*

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During the Great War Geoffrey Marshall, a young physician was given the job of working out the relative merits of different anaesthetic agents when used in the wounded soldier. The shock of surgery following wound shock could prove fatal and working out the best method of anaesthesia was vital. He found that spinal anaesthesia despite being thought to protect from shock resulted in profound drops in blood pressure especially if the wound was new and the blood dilute. Furthermore the only safe method of anaesthesia in a soldier with a low blood pressure was nitrous oxygen and air.

Captain Ernest Cowell worked close to the front line establishing normal physiological parameters for the wounded soldier and demonstrated how blood pressure fell during a long journey to a casualty clearing station. Thus he mapped the development of wound shock but couldn't understand why a soldier who appeared well at an advanced dressing station might be in extremis when they arrived at a CCS.

The causes of wound shock were poorly understood and in 1917 the Medical Research Committee appointed a special investigative committee comprising surgeons and physiologists and headed by Starling to co-ordinate efforts to solve the problem. Not only was shock killing soldiers in the first 24 – 48 hours after wounding but it was predisposing to the development of gas gangrene. Walter Cannon arrived from Harvard University full of ideas. Initially he felt that shock was the result of the pooling of blood in the splanchnic bed but when this was disproved he worked with John Fraser an Edinburgh surgeon at a CCS. When they discovered a concentration of blood in the capillaries he concluded that the blood must be pooling there. Subsequently finding that shocked patients were acidotic he presumed that this was the cause of shock. The fact that blood was lying on the fields of Flanders or that fluid extravasated into wounded tissues was not appreciated.

It took Sir Almroth Wright, a British pathologist to explain that the acidosis was the result of shock and the end result of poor perfusion to the tissues. Little by little it was understood that fluid replacement was required for the massive blood loss that had been suffered. Professor Bayliss a physiologist developed gum Arabica as the first colloid to be used to replace blood. The Canadians and the Americans introduced blood transfusion in 1916 and although soldiers received only 500-1000mls of blood it was enough to enable some of them to survive surgery.

Casualty clearing stations developed systems whereby teams of doctors would resuscitate patients before surgery. In 1918 the Australians conceived the idea of a field ambulance resuscitation team. Two medical officers supported by four other medical workers would use a motor ambulance to find casualties and institute warming, infuse gum acacia, ligate bleeding vessels and amputate shattered limbs. This ensured that wounded soldiers reached casualty clearing stations in the best possible condition.

Taken from my chapter on anaesthesia, shock and resuscitation in: ***War Surgery 1914-1918*** *Editors Scotland & Heys; Helion and Company Ltd, Solihull 2012.*

ANAESTHESIA AND THE SPANISH CIVIL WAR:

The Delivery of Anaesthetic Care in a Divided Spain

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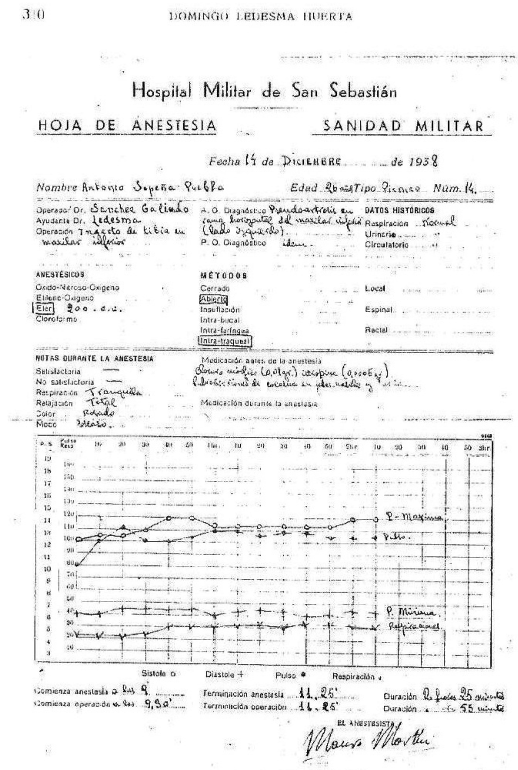
Before examining the delivery of anaesthetic care during the Spanish Civil War - but more specifically general anaesthesia - and the relevance of an empty battered tin of Golden Syrup, I thought it might be useful for those who may not be that familiar with this tragic conflict to offer a brief outline of its causes and course. Spain in the summer of 1936 was a country that in many respects was outside the Western European mainstream. Poorly developed industrially, with a largely illiterate population, and vast inequalities of wealth, especially in the south and west of the country, it was nevertheless arguably one of the most politicised countries in Europe at the time. There was an increasingly active social polarisation and marginalisation in process as a result of the escalating clashes between the socialist and anarchist forces on the left against conservative and fascistic elements on the right. This in part had resulted from the election of a left-leaning Popular Front Government in February that year.[1] Failed land reforms, an education system still largely controlled by the church despite earlier efforts to reform it during the Second Republic that had followed the fall of Alfonso XIII in 1931, and with state expenditure on public health consisting of only 0.71% in 1933, and efforts by conservative elements coupled with an increasingly vocal fascist right wing within Spanish Society to prevent the implementation of the limited gains, meant that tensions throughout the country were running high.[2]

An army command which had shown little in the way of scruples when it came to interfering in the political process over the previous decades, with a failed coup attempt by General Sanjurjo in 1932 still fresh in the memory, were busy plotting in the wings. The tit for tat murder of the right wing monarchist leader Jose Calvo Sotelo in response to the murder of a leftist officer of the Republican Assault Guards, Jose del Castillo, was all the excuse needed by the military plotters to launch their coup and on July 18, 1936, the insurgents rose up in mainland Spain in an attempt to overthrow the legally elected government, in the process starting a civil war lasting nearly three years and which culminated in the victory of General Franco in the Spring of 1939. With Mussolini's rise to power in Italy in 1922 and the invasion by Italian forces of Abyssinia in 1935 to 1936, coupled with Hitler's ascendancy to the chancellorship of Germany in 1933 there was growing concern by those on the left that the rise of fascism might become unstoppable. Within a very short time it became apparent that the insurgency was supported by arms and men from fascist Italy and Germany, and in response thousands of anti-fascist volunteers from all four corners of the globe seeing an opportunity to defeat fascism went to Spain. Including amongst their numbers were hundreds of medical personnel, both trained and untrained, who volunteered their services to the Republican Government. Millions of pounds worth in medical and humanitarian aid was also raised with contributions gathered in Britain totalling £2,000,000 by the end of the conflict.[3] With the majority of the different components of the Spanish army under insurgent control, including much of the military medical establishment, the Spanish Republic benefitted enormously from this medical aid which contributed towards saving countless lives in a conflict that saw over 200,000 battlefield deaths alone between July 1936 and March 1939.[1]

Alarmingly high casualty rates meant that in some instances existing practices were combined which advanced anaesthetic techniques within Spain, such as the use of Evipan (hexobarbitone), as an induction agent - a practice new in Spain, with ethyl chloride also frequently used for this purpose -with anaesthesia then most commonly maintained with ether. In Salamanca a young Moroccan patient being prepared for surgery in March 1938 asked not to be given the 'water that makes you stupid', i.e. ether, which he thought was alcohol based, and the doctor in deference to his wishes and his religious sensibilities, induced the patient with Evipan, before then giving ether to maintain anaesthesia.[4] Chloroform despite its known risks continued to be used in areas exposed to the risk of fire or explosions, as unlike ether it was not flammable. Evipan and ethyl chloride also proved invaluable due to their short duration of action in the treatment of cases requiring rapid but short surgical intervention. Spinal anaesthesia would seem to have been the least used technique for the obvious reason that many of the patients in the frontline hospitals were compromised by shock, leaving ether, normally administered via an Ombredanne mask, although the Schimmelbusch mask was also used, alongside local and non-spinal regional techniques as the main forms of anaesthesia. There were variations in practice but due to the lack of reliable data no accurate statistical analysis can be offered for the frequency of use of any one form of anaesthesia. One should also bear in mind that there were numerous occasions when no anaesthetics were available and surgery had to proceed in its absence.[5]

Despite the difficulties encountered within the Republican Zone, especially at the start of the conflict in providing adequate medical care many important medical developments came to fruition during this period, such as the mobile blood transfusion service of stored citrated blood established in Barcelona shortly after the outbreak of the conflict by the Catalan Federic Durán-Jordà and which delivered its first consignment of blood to the Aragon Front in a converted fish truck in August 1936. A near parallel development also took place within the Insurgent Zone under Carlos Elosegui, with both sides during the conflict transporting conserved blood to front line hospitals throughout Spain.[5] It was within the Insurgent Zone however that in September 1937, in the Hospital Militar General Mola in San Sebastian that the first ever recorded intubation in Spain took place. It was carried out by the New Zealand born anaesthetist Sir Robert Reynolds Macintosh, who had gone to Spain at the invitation of Eastman Sheehan an American plastic surgeon to enable him to carry out maxillo-facial surgery and who had encountered considerable difficulties operating due to the anaesthetic practitioner, a nun, insisting on keeping the mask clamped tightly to the patient's face.[6]

This is the appropriate moment to return to the aforementioned battered tin of Golden Syrup. When Macintosh visited Spain in 1937 he found that in order to provide the anaesthesia required by Sheehan, improvisation was necessary. The Flagg Tin that he improvised, a simple piece of apparatus that entrained air over ether and was connected by a catheter mount to the endotracheal tube, he owed to the lucky find of an empty tin of Golden Syrup, a useful find as the tin had a lid which made the topping up with ether a more practical affair. As an Operating Department Assistant in 1991, I was witness to the use of a home-made Flagg Tin in action when Dr Simmons at the Royal Northern Hospital in London, as a demonstration to medical students, would anaesthetise the occasional patient with diethyl ether, and providing the correct head position was maintained, anaesthesia was effective.[7] Macintosh's brief three week presence and that of his colleague Kenneth Boston who went out to Spain at the start of 1938 (and who left some fairly detailed anaesthetic notes which are held as part of Macintosh's papers at the Wellcome Library in London) enabled Sheehan and his colleagues including Jose Sanchez Galindo who received training in intubation during this period to carry out maxillo-facial surgery on a number of intubated patients, a practice that continued in San Sebastian right through to the end of the Spanish Civil War.[8] To illustrate this, the image shows an anaesthetic chart dated 14 December 1938. It records an operation by Sanchez Galindo to carry out a graft from the tibia to


310 DOMINGO LEDESMA HUERTA

Hospital Militar de San Sebastián

HOJA DE ANESTESIA — SANIDAD MILITAR

Fecha 14 de DICIEMBRE de 1938

Nombre Antonio Sopeña Puebla — Edad — Tipo — Núm. 14.

Operador Dr. Sanchez Galindo
Ayudante Dr. Ledesma
Operación Injerto de tibia en maxilar inferior

A. O. Diagnóstico Pseudoartrosis en rama horizontal del maxilar inferior (lado izquierdo).
P. O. Diagnóstico idem.

DATOS HISTÓRICOS
Respiración Normal
Urinario
Circulatorio

ANESTÉSICOS
Oxido-Nitroso-Oxigeno
Etileno-Oxigeno
Eter 200 c.c.
Cloroformo

MÉTODOS
Cerrado
Abierto
Insuflación
Intra-bucal
Intra-faríngea
Intra-traqueal

Local
Espinal
Rectal

NOTAS DURANTE LA ANESTESIA
Satisfactoria —
No satisfactoria —
Respiración Tranquila
Relajación Total
Color Rosado
Moco

Medicación antes de la anestesia

Medicación durante la anestesia

P. Maxima
Pulso.
P. Minima
Respiraciones

Sistole o — Diastole + — Pulso • — Respiración v

Comienza anestesia a las 9
Comienza operación a las 9,30'
Terminación anestesia 11,25'
Terminación operación 11,25'
Duración 2 horas 25 minutos
Duración 1 h. 55 minutos

EL ANESTESISTA

the inferior maxilla, with Domingo Ledesma Huerta as his assistant, who also wrote the article for the *Revista Española de Medicina y Cirujia de Guerra* from which *the chart* is taken. The method described was an intra-tracheal anaesthetic with ether which involved preparation of the nasal passages with a 10% cocaine solution, induction with ethyl chloride, a deepening of the anaesthetic with an Ombredanne mask and ether, before proceeding to nasal intubation with a greased tube. This was assisted by the use of a laryngoscope and Rovenstine forceps to pass the tube into the trachea taking advantage of the epiglottis lifting during respiration to do so. This technique is not radically different in many respects to what would happen now, except that with muscle relaxants the process would be quicker and smoother.[9]

This use of endotracheal intubation proved to be very much the exception rather than the rule and it was not until Macintosh returned to Spain in 1946 that modern anaesthesia in Spain, with one or two notable exceptions, really took root.[10] Local anaesthesia as discussed was widely employed. Reconstructive surgery using it was much more commonplace, especially as traditionally Spanish surgeons had dominated anaesthetic practice and often favoured procedures they could employ themselves or alternatively supervise their own medical students in the administration of such techniques.

Although the birth of modern general anaesthesia in Spain is closely linked with Macintosh, there is evidence, of attempts to provide up to date general anaesthesia in the hospital of Onteniente, a new thousand bed hospital with four operating theatres and a blood transfusion unit opened in the spring of 1937, close to the border with Alicante in the Republican Zone, prior to the arrival of Macintosh in Spain. At the Modern Records Centre at the University of Warwick as part of the digitalised collection, 'Trabajadores: The Spanish Civil War through the eyes of organised labour', there are a series of documents relating to the creation of a memorial for Ray Cox, a young man from Southampton who was killed in action in Spain in November 1936.[11] In a letter dated April 2, 1937, The Joint Council of the Southampton Trades Council, Labour Party and Co-operative Society, decided to commemorate 'the Southampton lad … killed whilst fighting for the international Brigade' in Spain, by purchasing an anaesthetic machine. The assistant secretary wrote, 'further to my letter to you yesterday in regard to the above matter, I have now had a word with our Dr. Morgan' (the TUC medical advisor) 'and he thinks that it will be possible to secure quite an effective anaesthetic apparatus for between fifty and sixty pounds. For this figure he is of opinion that an apparatus can be obtained which would not only be suitable for the administering of ether, but also nitrous oxide'.[12] On April 8, it was decided to go ahead with a purchase of 'one Boyle's Nitrous Oxide, Oxygen, Ether Apparatus Hospital set, consisting of metal stand to take two - 200 gallon N_2O Cylinders and two sixty gallon oxygen cylinders, four fine adjustment valves, sight feed and ether bottles, Facepiece, three way Stopcock, Bag, Tubing and Spanner, and additional Bottle for Chloroform'.[13] In a further letter dated June 4, 1937, it was recorded that, 'A nitrous Oxide, Oxygen and Ether Apparatus from Messrs' Down Bros. Ltd., London, had been purchased, with the necessary equipment, cylinders, reserve supplies and a supply of chloroform. The apparatus was now in use in the International Hospital in Onteniente and a plaque affixed stating it was the Ray Cox Memorial'.[14] More research is needed to find out if possible for how long this apparatus was in use, and by whom, but this last letter would at least indicate that even though this machine would seem to have been used, albeit briefly, for non-intubated inhalational anaesthesia, at least some patients seem to have benefitted from oxygen; and the analgesic properties of intra-operative nitrous oxide, normally unobtainable in Spain at the time.

Despite important beginnings, and the developments of new techniques, anaesthesia during the Spanish Civil War was still dependant by and large on its administration by medical students and nurses. The Swedish/Norwegian Hospital in Alcoi, funded by donations from Scandinavian countries, with modern theatres and strict aseptic techniques that even included the use of single use disposable items, nevertheless, had no anaesthetic equipment beyond the usual Ombredanne Mask or inhaler.[15] Nurses and other staff were frequently called upon to administer anaesthesia, and despite there being centres where specialist anaesthesia was provided, the English nurse Penny Phelps', observation that "I was anaesthetising the wounded with ether or chloroform, then I'd hand the face mask to an orderly while I scrubbed up to assist the surgeon" reflected the realities in so many hospitals.[16] Priscilla Scott Ellis who worked in numerous hospitals throughout the Insurgent zone during the conflict, recorded in her diary that, '*a patient came in who had to be amputated above the knee. Ramon operated with Pepe Luis as assistant and me as anaesthetist. I assured them I knew all about it and had done it before, which was a lie*'.[17] The experiences of these nurses were by no means atypical. Anaesthesia did make some important advances within Spain during the Civil War, and there were move towards specialisation during the conflict, but these were highly localised efforts which were to have more of an impact, well after the conflict had ended, with anaesthetic practice during the Spanish Civil War reflecting more what had gone before, rather than what was to come.

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I would like to express my gratitude to Dr. Avelino Franco Grande, retired anaesthetist from the University Hospital of Santiago de Compostela, for his unparalleled generosity in presenting me with so many documents gathered over years of research into the history of anaesthesia in Spain.

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A longer version of this paper was given at the European Society of Anaesthesiology Summer Conference which was held in Barcelona 1-4 June 2013. A shortened version of the paper presented at the conference in Barcelona is currently under editorial review for publication in the *European Journal of Anaesthesiology*.

A HISTORICAL PERSPECTIVE ON PROCEDURAL ULTRASOUND

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Introduction

Ultrasound describes any sound wave with a frequency greater than the upper limit of human hearing, however medical ultrasound typically uses sound with a frequency greater than 2 MHz[1]. Though it has therapeutic uses, it is most commonly used as an imaging modality. Sound waves emitted from a handheld 'probe' placed on the patient's skin are reflected from structures in the human body, then converted into information that can be interpreted by the practitioner, either as an image on a computer screen or an audible signal.

In anaesthesia, ultrasound is often used to guide procedural skills such as central venous access and regional anaesthetic techniques. As with many new technologies, procedural ultrasound began as the specialist interest of a few pioneers, but has evolved into a core competency, and is described as 'an indispensable tool in anaesthesia and intensive care' by the Royal College of Anaesthetists, Association of Anaesthetists of Great Britain and Ireland and the Intensive Care Society[2]. The popularity of ultrasound in anaesthetic practice has exploded over the last decade with the introduction of cheaper and more-portable ultrasound machines, national guidelines supporting its use, and innovative practitioners discovering ever-more applications for the technology. However, the path that has lead up to this point spans several centuries and results from technological advances motivated by disaster and conflict, and involving some of history's most notable scientists. This manuscript tells the story of the development of ultrasound, and its migration from its industrial and military origins to the forefront of medical technology.

The Discovery of Echolocation

The use of sound to 'see' was first proposed by Italian priest and biologist Lazzaro Spallanzani. In 1794 he conducted an elaborate series of experiments to investigate how bats are able to fly in the dark[3]. This project was notable for its elaborate nature and strict scientific method: each experiment that Spallanzani conducted would be repeated by colleagues and reported back before progression to the next step. The experiments involved sequentially depriving bats of their senses and observing their ability to navigate an indoor obstacle course composed of silk threads hanging from the ceiling. The initial experiment removed the sense of sight, and when it was found that this did not impede the bats, the experimenters moved on to the sense of touch with characteristic thoroughness, inventiveness and disregard for animal welfare:

"if you prepare a varnish of sandarach and spirit of wine and, with a small brush, coat the body of a blinded bat including snout and wings, it will at first have difficulty in flying. But, having regained its vigor after a while, the bat will fly, avoid obstacles, and pass between the aforementioned silk threads. Now, if the bat were endowed with this supposed delicacy of touch, how much would it lose from even that light varnishing! It is to be noted that a second and even a third coat does not hinder the normal flight of the animal."

(Quotation courtesy of the University of Chicago Press [2].)

It is notable that Spallanzani's experiments almost failed to reach the correct conclusion, as his initial experiment of stuffing bats' ears failed to affect their ability to navigate. This combined with the fact that he could not hear any sounds emitted by the bats lead him to conclude that bats must possess a *"sixth sense"*. However his colleague Louis Jurine repeated the tests with the bats ears more thoroughly blocked and found that they *"blundered helplessly into obstacles"*, allowing Spallanzani to eventually deduce that sound must somehow be used to navigate.

This conclusion flew in the face of the opinion of the scientific community at the time, who remained convinced by the 'delicacy of touch' theory that Spallanzani had effectively disproved. Shortly after Spallanzani conducted his experiments, French zoologist Georges Cuvier refuted Spallanzani's findings[4], and despite Cuvier's assertion being based on opinion rather than scientific enquiry 'delicacy of touch' became the established theory until 1939, when Harvard graduate students Robert Galambos and Don Griffin generated conclusive proof of ultrasonic echolocation using equipment designed for converting the ultrasonic noises made by insects into audible sounds[5].

The Technological Antecedents of Medical Ultrasound

Sound-based navigation remained the preserve of the animal kingdom until the sinking of the Titanic in 1912 motivated a flurry of interest in echolocation to permit mariners to navigate in the absence of direct vision. Shortly following the disaster, Canadian engineer Reginald Fessenden, best known for his pivotal role in the development of two-way radio, began testing the first echolocation device: the 'Fessenden Oscillator' which was essentially a rudimentary sound navigation and ranging (SONAR) device designed to be employed in the detection of icebergs[6]. The Oscillator's design was similar to that of a loudspeaker, involving the application of a magnetic field to a mobile core. Though initial tests aboard the *USRC Miami* proved promising, its low operating frequency made it unsuitable for detecting the reflections of small targets, and the Oscillator was relegated to use in ocean-floor surveys and ship-to-ship communication rather than its intended purpose. In order to address the shortcomings of Fessenden's design a higher operating frequency was required, and electromagnetic technology was superseded by piezoelectrics for signal generation and detection[7].

The piezoelectric effect is the generation of electrical potential by a crystalline material in response to mechanical stress. It was demonstrated by Jaques and Pierre Curie in 1880, and in 1881 the reciprocal effect of a conformational change in response to an electrical potential was also demonstrated[8, 9]. Therefore, in the same fashion that a speaker can also be used as a microphone, a piezoelectric circuit can be used both to generate and receive a signal. Pierre Curie and his wife Marie used the reciprocal piezoelectric effect in the quartz-piezoelectrometer, an instrument they developed to measure the ionising radiation emitted from radium salts[10].

Piezoelectric crystals are capable of generating frequencies several orders of magnitude greater than mechanical speaker systems and therefore produce short-wavelength sound, which is required for adequate imaging resolution. Piezoelectrics were first employed in SONAR by Russian Engineer Constantin Chilowski and French physicist Paul Langevin, who filed patents for their technology in 1917[11, 12]. Chilowski and Langevin's pioneering work in the maritime application of piezoelectrics was conducted at the same time as similar work lead by Ernest Rutherford, however Langevin's previous role as a doctoral student of Pierre Curie (and possibly as a lover of Marie) afforded him a superior experience and understanding of piezoelectrics which lead to his eventual recognition as the inventor of ultrasonic echography[13, 14].

During the build-up to the Second World War, radio detection and ranging (RADAR) was pioneered by military scientists in Britain, Germany, the Soviet Union and the United States of America[15], and by the end of World War II, RADAR was used in both defensive and attack roles, and SONAR was used in multiple naval applications.

In 1929, Soviet researcher Sergei Sokolov had proposed that ultrasound could be used for the detection of imperfections in metals[16], and experimented with the use of ultrasound transmission across a sample to accomplish this aim. This experimental method produced poor spatial resolution and was therefore impractical for industrial use. American physicist Floyd Firestone subsequently improved on the technology by using reflection rather than transmission, and presented the 'supersonic reflectoscope' to the Acoustical Society of America in 1944[17]. In the aftermath of the Second World War, ultrasound equipment that had been used by the military became available to medical researchers. In 1949, United States military doctor Lieutenant George Ludwig pioneered the use of ultrasonic metal-flaw detectors such as Firestone's to diagnose gallstones: the first description of diagnostic medical ultrasound[18]. Ludwig's ultrasound apparatus would be difficult to recognise in comparison with modern ultrasound machines: its display was simply an oscilloscope, whose amplitude varied depending on the depth of echogenic structures. This mode of ultrasound, known as amplitude mode (or A-mode), is no longer used in the context of diagnostic imaging.

The generation of a two-dimensional monochrome image (brightness, or B-mode), the ancestor of the modern ultrasound display was developed in 1952 by British surgeon John Julian Wild and American engineer John Reid by adapting an ultrasound instrument that had been designed by the US Navy to be immersed in a water tank containing a submerged scale-model landscape, in order to simulate RADAR on a miniature scale as a aircraft navigation training aid[19]. According to Reid, recorded for the Institute of Electrical and Electronic Engineers (IEEE) Oral Histories Collection, Wild had heard about the RADAR training device from a colleague at a party. He subsequently took a resected bowel tumour to the simulator and submerged it in the water tank, and found that the structure of the tumour could be observed, and thus imaging ultrasound was born[20]. Subsequently, Wild and Reid enlisted a friend, Don Neil, to adapt the ultrasound instrument for transcutaneous use:

"He built Wild a little chamber that would hold one of the transducers. This was a fifteen megahertz X-cut quartz airbacked transducer. It had a little water column in it, and they sealed it with a piece of condom rubber over the end. So, Wild had a portable probe that he could put on people."

(Quotation courtesy of the IEEE History Center[20].)

The Use of Imaging Ultrasound to Guide Anaesthetic Procedural Skills

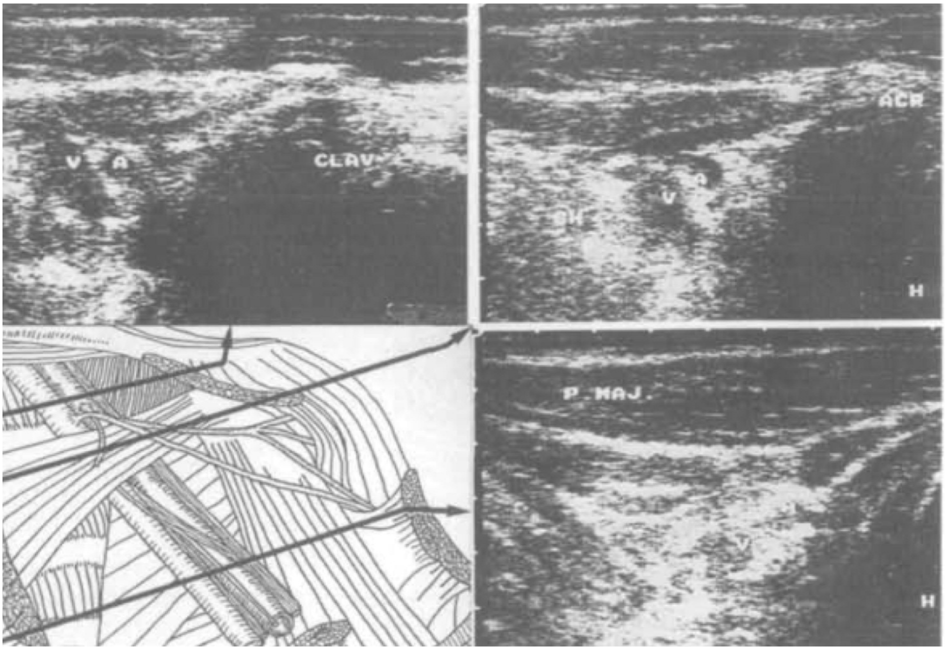
The earliest description of the use of imaging ultrasound in the guidance of medical procedural skills of relevance to anaesthesia is found in the Russian literature: Yuri Bogin and Igor Stulin described the use of ultrasound to determine the anatomical landmarks prior to lumbar puncture in 1971[21]. According to Bogin's personal website, however, they had been practicing this technique in the laboratory setting since 1968 using Soviet UZD-4 and UZD-5 ultrasound scanners[22]. Further information on the origins of these ultrasound machines remains elusive, however Bogin's background as a medic in the Soviet Navy and then as a physician at the Central Clinic Number One of the Russian Railways Ministry suggests that he, like Ludwig and Wild, may have had access to military and industrial equipment.

Nine years after Bogin's description of ultrasound-guided lumbar puncture, American anaesthetists Randall Corr, Joseph Kryc and Robert Vaughan reported good concordance between ultrasound measurement of the depth of the ligamentum flavum, compared with its actual depth found on performing lumbar epidural injection at the same site[23]. This publication probably represents the beginning of the current vogue for practice-based innovation in ultrasound by anaesthetists. By the time of this publication, ultrasound was beginning to be used routinely for diagnostic purposes, and for procedural guidance in other specialties such as for amniocentesis in obstetrics and renal cyst aspiration in urology. Corr, Kryc and Vaughn do not cite any previous use of ultrasound to guide access to the spinal canal despite Bogin and Stulin's earlier innovations. This is likely due to the difficulty of searching the medical literature at the time, especially literature in a foreign language and from a country that was hesitant to share information outside its own borders. In 1986, Japanese anaesthetists Akitomo Yonei, Tadahiko Nonoue, and Atsuo Sari published a 160 patient case-series of ultrasound guided central venous catheterisations in *Anesthesiology,* reporting a 100% procedural success rate[24]. Safety and ease were described as the benefits of using ultrasound in the cannulation of the internal jugular vein. It is notable that the technique described by Yonei differs from that which appears to be most common in current UK practice as the probe is placed in longitudinal alignment with respect to the vein, not transverse, and the needle can be seen 'in plane.'

The first randomised control trial involving ultrasound in central vein cannulation was published in *Chest* in by Mallory et al in 1990[25]. This trial appeared to use the now-conventional transverse ultrasound probe alignment, though this is not stated explicitly in the study design. The paper indicated a higher success rate with ultrasound compared with the traditional 'landmark' technique, and that fewer attempts were needed before cannulation was achieved. In the discussion, the authors suggest that making fewer attempts may make central venous cannulation safer. Whilst this appears intuitive, no data is reported in the study to support this opinion.

Ultrasound use in central venous cannulation was enshrined in National Institute of Health and Clinical Excellence (NICE) guidance in 2002[26]. Though strongly supportive of the use of ultrasound to guide elective central venous cannulation in every instance, this document contains a curious dichotomy: a statement that the 'landmark technique' should be maintained and taught should a central line be urgently required when ultrasound is unavailable. How clinicians are able to do this when compelled to use ultrasound for every elective case is not addressed. It is also notable that this guideline does not state how ultrasound should be used in the insertion of central lines, only that it should be used. It can be seen from Yonei and Mallory's papers that multiple techniques are possible, and recent publications suggest that the optimal technique for ultrasound guidance of central lines remains open to debate[27, 28].

Singapore anaesthetists Ting and Sivagnanaratnam reported the first use of ultrasound for peripheral nerve blocks in the *British Journal of Anaesthesia* in 1989[29]. They presented a case series of ten patients, all of whom had successful



Ting and Sivagnanaratnam's ultrasound images of the axillary brachial plexus[29] *(Image courtesy of Oxford University Press*)

nerve blocks of the axillary brachial plexus, without injury to the nerve or the adjacent artery. Enhanced safety is not explicitly mentioned in their letter, but it is implied in that surrounding structures were not injured. Ting's article contains multiple images, introducing the reader to the sonoanatomy of the brachial plexus at different levels.

The first randomised control trial which compared ultrasound to a landmark technique for peripheral nerve blockade was published by Kapral et al in *Regional Anaesthesia* in 1995[30] and this suggested that ultrasound may be more effective than the landmark technique in blocking the stellate ganglion, with less possibility of causing complications. However this trial was very small, recruiting only 20 patients. Kapral had previously published a trial in 1994 comparing two different ultrasound-guided block techniques for the brachial plexus, and showed that the supraclavicular technique could be done as safely as the axillary approach when guided by ultrasound[31]. Marhofer et al, part of the same research group, went on in 1997 to publish a randomised control trial comparing guidance with ultrasound and electronic nerve stimulator for 'three-in-one' nerve blockade, demonstrating a faster onset and fewer instances of injury to the adjacent artery in the ultrasound group[32].

Guidance on ultrasound guided peripheral nerve blockade was issued by NICE in 2009. This document appears equivocal in its support for the use of ultrasound - simply stating that the evidence appears to support ultrasound, and that clinicians wishing to use it should be appropriately trained [33].

Ultrasound Guided Procedural Skills: Future Directions.

Though ultrasound technology has been embraced by anaesthetists in the guidance of procedural skills, complications and failures are still encountered in practice when ultrasound is used and the technology in still under development in many respects. From the technological perspective, three-dimensional ultrasound is now frequently used in the cardiac and obstetric setting, and has been reported in the guidance of brachial plexus blockade and central venous cannulation[34, 35]. This technology gives the user the opportunity to consistently image the needle tip, preventing complications arising from 'overshoot' during insertion of the needle[36]. From the operator perspective, the training that new anaesthetists receive to support the development of competence in ultrasound practice remains inconsistent, and has been the topic of a recent consensus document focused on central venous access[37]. Furthermore, the transition from competence to excellence is even less well defined, and is a topic for further research.

Conclusion

Since its introduction to anaesthetic practice by Bogin and Stulin in 1971, ultrasound has become an indispensable component of the anaesthetist's tool-kit. Its development as a medical imaging modality is the culmination of a process of innovation that has addressed problems including the mystery of bat navigation, the measurement of ionising radiation, the detection of icebergs and submarines, and the training of World War Two aircraft crews. As with many modern inventions, human conflict has been instrumental in providing the resource and impetus for much of the development process and it is therefore somewhat ironic that ultrasound is primarily a patient-safety intervention in the anaesthetic setting. Much of the recent development of ultrasound in anaesthetic practice is owed to the innovation of individual anaesthetists at work, and the willingness of journals to publish individual case reports that describe these innovations.

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PREOPERATIVE FASTING GUIDELINES: COMMON SENSE, DUBIOUS DOGMA, MODERN EVIDENCE

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During my training in Sheffield and Nottingham in the late 1960s, a 'theatre breakfast' of tea and toast was commonly given to patients 4-5 h before the scheduled time of surgery. When I immigrated to Canada and joined the university-affiliated Foothills Hospital as a full-time clinical anaesthetist in Calgary, Canada in 1970, standard fasting orders were 'NPO (nothing by mouth) after midnight'. This order applied to clear liquids as well as solid food, irrespective of the scheduled time of surgery. A senior colleague explained that the order was "easy to write on the patient's chart, easy for the patient to understand, and easy for nurses to enforce". It seemed futile to challenge the *status quo* when colleagues believed that patients would be at increased risk of "full stomach" and pulmonary aspiration of gastric contents.

Professor Leo Strunin, then at King's College Hospital, London was appointed chairman of our university department in 1980. He and I agreed that clear oral fluids should be allowed on the day of surgery. We also agreed that the established standard could only change with evidence of safety from randomized clinical trials. In 1981 the Canadian Anaesthetists' Society's (CAS) *Guidelines for the Basic Standards of Practice of Anaesthesia* "suggested" a minimum 5 h fast with the caution that complete emptying of stomach could not be guaranteed in the presence of pain, trauma, apprehension, gastrointestinal disorders or narcotics[1] – a list that encouraged 'NPO after midnight'.

My involvement in clinical research for evidence-based fasting guidelines came about by chance when, in 1983, a colleague cancelled a patient's surgery because he arrived at the hospital, chewing gum. Strunin commented that "We have got to do something about this problem." In 1984 I accepted the challenge and a university appointment with 50 per cent non-clinical time for research. A succession of senior registrar research fellows from the United Kingdom and Australia became co-investigators.

Before preparing our research protocol I undertook historical reviews of fasting guidelines, gastric physiology, and frequency of pulmonary aspiration of gastric contents.

Preoperative fasting guidelines

Preoperative fasting guidelines in the early years of anaesthesia did not recognize the danger of aspiration of gastric contents. In 1847 Snow mentioned only that a full meal made the administration of ether more difficult but he did not discuss the possibility of aspiration of gastric contents.[2] Eleven years later he wrote, "The only direction which it is usually requisite to give beforehand, to the patient who is to inhale chloroform, is to avoid taking a meal previous to the inhalation; for chloroform is very apt to cause vomiting, if inhaled whilst there is a quantity of food in the stomach. The sickness is not attended with any danger, but it constitutes an unpleasantness and inconvenience which it is desirable to avoid."[3] The surgeon, Joseph Lister, made the first distinction between preoperative solids and liquids in 1883 when he recommended that there should be no solid matter in the stomach, but that patients should drink clear liquid about 2 h before surgery.[4] For the next 80 years until the 1960s most textbooks warned of the danger of vomiting and aspiration when anaesthesia was administered soon after a full meal, recommended a 4-6 h fast for solids and 2-4 hours for clear liquids.

Table 1 Fasting guidelines 1847-1984

Year	Author	Clear liquid	Food
1847	Robinson[5]	no guideline	no guideline
1847	Snow[2]	no guideline	2-4 h 'slender repast'
1858	Snow[3]	no guideline	2-3 h light meal, c.5 h full meal
1881	Lyman[6]	4 h	4 h light meal
1883	Lister[4]	2 h	'no solids in stomach'
1901	Hewitt[7]	avoid milk	4 h meal
1914	Gwathmey[8]	3 h	2-3 h gruel of barley or rice
1920	Buxton[9]	3 h tea, beef tea	7 h bread boiled in milk, fish
1943	Woodbridge[10]	4 h grape juice	4 h cream of wheat, milk
1947	Macintosh, Bannister[11]	3 h sweet tea, soup	3 h bread and butter
1947	Lee[12]	no guideline	6 h
1948	Minnitt, Gillies[13]	3 h tea, orange juice	3 h sweetened tea, biscuit
1949	Hunt[14]	2-3 h	NPO midnight
1951	Guedel[15]	no guideline	no guideline
1955	Eliason et al[16]	4 h	afternoon surgery: breakfast
1964	Lee, Atkinson[17]	6 h or NPO midnight	6 h or NPO midnight
1970	Cohen, Dillon[18]	NPO midnight	NPO midnight
1971	Wylie, Churchill-Davidson[19]	5 h	5 h
1976	Collins[20]	NPO midnight	NPO midnight
1982	Dripps et al[21]	NPO midnight	NPO midnight

The evolution and subsequent adoption of 'NPO after midnight' for healthy patients with no risk factors undergoing elective surgery appears to have begun in the 1960s.[22] Cohen and Dillon's instructions for outpatients inferred that gastric emptying ceased at midnight any liquid ingested would lie in the stomach indefinitely: "Do not eat or drink anything after midnight of the night before surgery. Do not have anything in the morning – NO COFFEE, NO FRUIT JUICE, NO WATER. It is extremely hazardous to have anesthesia and surgery with a full stomach."[18]

The change was widely accepted although the reasons for acceptance have been lost in the mists of time. Pulmonary aspiration was known to be one of the leading causes of anaesthetic related mortality. Concern about the risk of acid aspiration syndrome in obstetric patients was fuelled by Roberts and Shirley[23] who, in 1974, defined patients with 0.4 $mL.kg^{-1}$ (25 mL in adults) gastric juice with pH < 2.5 to be at high risk of Mendelson's syndrome[24] if pulmonary aspiration occurred. They later revealed that that they had drawn their conclusion after instilling 0.4 $mL.kg^{-1}$ acid into the right mainstem bronchus in one experiment in one monkey.[25] They did not establish a relationship between volume in the stomach and volume aspirated into the lungs. The myth of 25 mL in the stomach being a surrogate marker for high risk of aspiration was later discredited by Raidoo et al who demonstrated that 0.8 $mL.kg^{-1}$ in the trachea of monkeys (equivalent to > 50 mL in adult humans) is required to produce pneumonitis.[26] For this volume to reach the lungs, the volume in the stomach must be greater, even if the lower and upper oesophageal sphincters are incompetent.

Gastric physiology

The difference in gastric emptying times between liquids and solids was first described by William Beaumont, an American military surgeon in 1833.[27] He treated a young Canadian fur trapper in 1823 for a severe musket wound to his left chest and upper abdomen. The wound healed, leaving a permanent gastrostomy through which, ten years later, he observed that digestion and emptying easily digested meals (meat, potatoes, and bread) was usually complete in 3-3½ h. He also recorded that, "Water, ardent spirits, and most other fluids are not affected by gastric juice, but pass from the stomach soon after they have been received."

The dual isotope technique, in which solids and liquids in a mixed meal are tagged with different radioactive isotopes have been confirmed by Beaumont's observations.[28] Easily digestible solids (bread, lean meat, boiled potatoes) must be broken down to particles < 2 mm before they can pass into through the pylorus into the small bowel. Total emptying is normally 3-5 hours. Clear liquids empty exponentially, 50 per cent in 20 minutes, 90 per cent within 1 hour and virtually all within 2 hours.

Pulmonary aspiration of gastric contents

The cause of death of Hannah Greener under chloroform on 1st February 1848 has been misrepresented as the possibly the first case of death from pulmonary aspiration of gastric contents.[29] the description of events was consistent with sudden cardiac death. Water was dashed on her face (not poured into her mouth), and a little brandy was given orally. Autopsy showed her stomach distended with food but none in her trachea.[30] The first documented case of death from inhalation of vomitus was that of a soldier in the Burmese War in 1853 who vomited during surgery under chloroform for a severe thigh wound, after a full meal. He died soon afterwards. Autopsy showed the trachea full of vomitus.[31]

The danger of pulmonary aspiration of gastric contents during general anaesthesia was recognised in textbooks from 1881 onwards but its frequency was not documented until 1946 when Mendelson, a New York obstetrician, reviewed 66 cases of aspiration in 44,016 maternities 1932-45.[24] Immediate deaths from complete respiratory obstruction occurred in two of five mothers who aspirated solid food and there were no deaths in the 40 mothers who aspirated liquid. In 1951 Morton and Wylie reviewed 43 deaths from regurgitation and vomiting, mostly in 'full-stomach' or 'high risk' cases, but the denominator number of anaesthetics was not known.[32]

Large-scale reviews of pulmonary aspiration deaths, survivals and total number of anaesthetics in general surgery were published during the years of our studies. Olsson et al in Sweden reported 83 aspirations with 4 deaths in 185,358 anaesthetics;[33] Tiret et al in France reported four aspirations, none fatal, in 40,240 paediatric anaesthetics;[34] and Warner et al reported 67 aspirations, four fatal, in 215,488 general anaesthetics.[35]

Randomised clinical trials

Millar et al in Glasgow had already shown that there were no significant differences in gastric fluid volume (RGV) and pH of patients who consumed a theatre breakfast 2-3 h compared with those who fasted for 15 h overnight.[36] Our primary purpose was to determine whether gastric emptying of clear liquid was as complete in 2-3 h in healthy patients undergoing elective surgery as in physiological research volunteers. Our review of the evolution of fasting guidelines, gastric physiology, and frequency of pulmonary aspiration of gastric contents satisfied the University of Calgary Research Ethics Board that those patients who drank clear liquid would not be at increased risk during anaesthesia.

Our first study included 140 healthy females aged 18-30 years.[37] The protocol was for one researcher to interview the patients, obtain consent, randomise them to one of four groups. The same individual supervised their ingestion of liquid and tablets 2-3 h before their scheduled time of surgery. Each patient swallowed a non-absorbed marker dye bromosulphthalein (BSP) 50 mg in 10 mL water with ranitidine 150 mg or a placebo tablet, followed by either water 150 mL or no further oral intake. (Table 2) Following induction of anaesthesia, a second researcher, blinded to randomization, aspirated gastric contents through an 18 Salem sump tube and volume, pH and BSP concentration were recorded.

Table 2 Is a five-hour fast justified prior to elective surgery?

	Preop fast (h)	RGV (mL)	pH	BSP %
NPO midnight + placebo + BSP	16.8	27 ± 19 (0-80)	1.9 ± 1.3	0 - 0.05
150 mL water + placebo + BSP	2.4	18 ± 15 (0-56)	1.8 ± 0.9	0
NPO midnight + ranitidine + BSP	16.4	10 ± 8 (0-35)	5.0 ± 1.8	0 - 0.09
150 mL water + ranitidine + BSP	2.4	8 ± 7 (0-24)	5.5 ± 1.8	0 - 0.08

Mean RGV was greatest in patients who followed the traditional 'NPO after midnight' with placebo. The lower mean RGV in patients who drank is explained by the stimulation of gastric peristalsis by the 150 mL bolus of liquid.[38] Retrieval of < 0.1 per cent BSP demonstrated that complete gastric emptying of ingested liquid had occurred in the 2-3 h between its ingestion and induction of anaesthesia. The higher RGV with low pH in the placebo groups indicated that the fluid was swallowed saliva and gastric acid secretion. The lower RGV with higher pH in the ranitidine groups indicated that this was swallowed saliva alone. Our second, similar study in 100 patients of both sexes, aged 18-60 years, produced similar results.[39]

We assumed that most people would prefer a morning drink with more taste than water so our next studies compared 150 mL coffee or fruit juice versus 'NPO after midnight' in 300 patients. Volumes and pH were almost identical in the three placebo groups.[40] Volumes were lower and pH higher in each of the three ranitidine groups with no statistically significant differences.[41] Over the next several years researchers in Britain, India, France, Hong Kong and Norway conducted similar studies that confirmed our findings.[22]

Table 3
Preoperative oral fluid: Residual gastric fluid volume (RGV) and pH

			Drink on day of surgery		*NPO midnight*	
Year	Author	Oral Intake	Mean Fast	RGV (mL)	Mean Fast	RGV (mL)
1983	Miller et al (UK)	toast and tea/coffee	3 1/4 h	11 (0-43)	9 h	9 (0-42)
1986	Maltby et al (Canada)	water 150 mL	2 1/2 h	18 (0-56)	16 1/2 h	27 (0-80)
1987	Sutherland et al (Canada)	water 150 mL.	2 1/2 h	21 (0-50)	13 1/2 h	30 (2-75)
1988	Hutchinson et al (Canada)	coffee/juice 150 mL	2 1/2 h	24 (0-96)	14 1/2 h	23 (0-75)
1988	McGrady et al (UK)	water 100 mL	2 h	17 (4-52)	12 h	35 (0-58)
1989	Agarwal et al (India)	water 150 mL	2 1/2 h	21 (0-50)	12 h	30(0-75)
1989	Scarr et al (Canada)	coffee/juice 150 mL	2-3 h	25 (0-90)	>8 h	26(0-120)
1991	Maltby et al (Canada)	coffee/juice no limit	2-3 h	22 (3-70)	>8 h	25(0-107)
1991	Ross et al (USA)	water 225 mL	1/2 h	21±18	>8 h	30 ± 2
1991	Mahiou et al (France)	Clear liquid 1000 mL	2 h	38±18	11 h	35 ± 15
1993	Lam et al (Hong Kong)	water 150 mL	2-3 h	26 (3-66)	11 1/2 h	22 (1-78)
1993	Phillips et al (UK)	clear liquid, no limit	2 1/4 h	21 (0-80)	13 h	19(0-63)
1993	Søreide et al (Norway)	water 300-450 mL	1 1/2 h	23±20	13 h	31 ± 30

Values are mean (range) or mean ± SD

Implementation of change

Cooperation of anaesthesia colleagues, surgeons and nurses were essential for implementation of new guidelines in Foothills Hospital. We presented our evidence a meeting of our anaesthesia department, then to a joint meeting of surgeons and anaesthetists, and also to a meeting of head nurses of our surgical wards. The clinical heads of anaesthesia and surgery then sent a joint letter to all consultant and trainee surgeons and anaesthetists, and to head nurses with details of the revised guidelines. Clear liquids were allowed until 3 h before the *scheduled* time of surgery so that a change in the surgical schedule could be made and still allow 2 h before the *actual* time of surgery. Clear liquids include water, apple juice, carbonated beverages, clear tea and black coffee. The guidelines were then used to revise the fasting instructions in the hospital's nursing policy manual.

There appeared to be little national or international interest in challenging 'NPO after midnight', although the Canadian Anaesthetists' Society (CAS) modified its guidelines in 1989 to: "Recognizing that there is currently no fixed period of fasting before all procedures, departments must establish policies concerning oral intake before elective induction of anaesthesia."[42]

Two eminent American anesthesiologists addressed the issue. Coté, in his 1990 editorial in Anesthesiology, reviewed the evidence and made a strong plea for a reappraisal of fasting guidelines for chilren.[43] He was followed by Stoelting who, in his 1991 Rovenstine lecture at the American Society of Anesthesiologists (ASA) annual meeting, also reviewed randomized clinical trials and concluded that "Clear fluids could increase the risk of pulmonary damage only if they increase residual gastric fluid volume. All studies demonstrate that this is not the case."[44] The CAS guidelines were changed in 1996 to: "No solid foods may be taken on the day of surgery but clear fluids may be taken by mouth up to 3 hours before surgery".[45]

The American Society of Anesthesiologists (ASA) formed a task force on preoperative fasting guidelines in 1996 to review all relevant clinical human research studies published 1966 to 1996. There were 10 anesthesiologists from academic, clinical and private practice, plus two fulltime PhD epidemiologists and a fulltime librarian. Over 3,000 citations were initially identified, of which 232 articles contained relationships between preoperative fasting and pharmacological prophylaxis of pulmonary aspiration. Expert opinion on the first draft was also obtained from international anaesthesia and gastroenterologist consultants. Final clinical guidelines for preoperative fasting and pharmacological prophylaxis in healthy patients undergoing elective surgery were approved by the House of Delegates at the 1998 ASA Annual Meeting and published in 1999.[46] The main recommendations were:

> Light meal (dry toast and clear liquid) not less than 6 h before surgery;
>
> Unrestricted clear liquid (water, fruit juice without pulp, carbonated beverages, clear tea, black coffee) until 2 h before surgery;
>
> No routine use of gastrointestinal stimulants, gastric acid secretion blockers or oral antacids for healthy patients undergoing elective surgery.

Conclusion

Evidence from a multitude of sources has confirmed what Beaumont described 180 years ago – clear liquids, unlike solid food, empty very rapidly from the stomach. They contain no large particles that require digestion to break down to particles less that 2 mm diameter. Saliva is still swallowed and gastric juices are secreted during fasting, so the stomach is rarely completely emptied. The peristalsis stimulating effect of the liquid bolus explains why gastric fluid volumes were consistently smaller 2 h after the 150 mL drink than after a prolonged fast of 15 h. Our aim was to suggest evidence-based fasting guidelines for the comfort of patients, especially for those whose surgery was scheduled in the late morning or afternoon. The volume of evidence from so many randomized clinical trials makes it difficult to understand why some surgeons and some anaesthetists resist change while others are investigating the potential benefits of ingesting larger volumes of preoperative carbohydrate-rich drinks to improve surgical outcomes.[47]

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RAPID SEQUENCE INDUCTION: From Mendelson to Rocuronium

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The Rapid Sequence Induction (RSI) is a method of inducing general anaesthesia in patients at risk of aspiration of gastric contents. It is designed to minimise the time between loss of protective airway reflexes and tracheal intubation. The components of a RSI are:

Pre-oxygenation

Intravenous induction of anaesthesia

Cricoid pressure

Rapidly acting muscle relaxant

Tracheal intubation

The concept evolved following the introduction of suxamethonium in 1951 and cricoid pressure in 1961. However it wasn't until 1970 that the components were published together as a RSI technique.

This paper looks at the history behind some of the main components of the RSI, some of the changes that have occurred since the publication of the initial technique, and some of the controversies surrounding the RSI.

Mendelson – the origins of RSI

In 1946 Curtis Lester Mendelson, an American cardiologist and obstetrician, described the syndrome of chemical pneumonitis following the aspiration of gastric contents in the obstetric population.[1] In the 1950s an investigation by the Association of Anaesthetists of Great Britain found 43 deaths caused by regurgitation and aspiration. They had found a further 110 deaths by 1956.[2] This led to the need to develop an intubation technique to prevent aspiration during the induction of general anaesthesia.

Thiopentone and other intravenous induction agents

Thiopentone is the induction agent traditionally used in a RSI. It was discovered in the 1930s and first used in humans in Wisconsin in 1934. Three months later its use was introduced at the Mayo clinic in Minnesota.

Thiopentone was used for emergency anaesthesia during World War Two. The use of intravenous anaesthesia in the military had numerous advantages over inhalational anaesthesia, including simplicity to administer, ease of portability, and inflammability. Thiopentone was responsible for many deaths at Pearl Harbour in World War Two. Reports describe the injection of 500 milligrams of thiopentone being rapidly followed by 'cyanosis decolletage', the immediate precursor of death. There was a lack of oxygen and ability to administer continuous oxygen to patients, which made the management of these respiratory arrests very difficult. A year later, an account by Charles Adams of the Mayo clinic was published outlining the safe use of thiopentone in trauma patients. He described the injection of one to two millilitres of 2.5% thiopentone, with additional small doses throughout the operation. For many years, rumours stated that thiopentone was responsible for more deaths at Pearl Harbour than the Japanese. Recently the US freedom of information legislation has meant that wartime documents have become available, and these rumours had been greatly exaggerated.[3] Several other intravenous induction agents have become available since the introduction of thiopentone. Ketamine was first synthesised in 1962. In 1965 were the first reports of recreational use, and in 1966 it was patented as an anaesthetic for use in humans and animals. Ketamine has the advantage of maintaining airway reflexes and providing cardiovascular stability. It was first used for field anaesthesia by the USA in the Vietnam War, and remains the induction agent of choice for mass casualties in the field and in the developing world.[4] Etomidate was discovered in 1964 and introduced as an intravenous induction agent in Europe in 1972. It had the advantage over thiopentone of cardiovascular stability; however its use is limited by its potential adrenal suppression.

Propofol was developed in the UK and underwent its first clinical trials in 1977. There was a high incidence of anaphylaxis. It was therefore re-launched as an emulsion in 1986.[5] It is now the most commonly used induction agent in the UK, and commonly used in rapid sequence inductions due to anaesthetists' familiarity with the drug.

Neuromuscular blockade

Curare, a neuromuscular blocker obtained from a variety of plants, has been used for centuries to kill animals in South Africa, Borneo and other Aboriginal countries. When a dart covered in curare penetrates an animal's skin, the curare enters the circulation and causes death by respiratory muscle paralysis. However it is poorly absorbed through the gut wall of the person eating meat killed in this way, and is therefore a very specific poison. Curare was first used in humans in New York in 1858 for the treatment of tetanus. Modern clinical use of curare-based preparations began in 1932 for the treatment of tetanus and spastic disorders. Its use then spread to electroconvulsive therapy to prevent fractures and dislocations, and then to general anaesthesia in 1942. Two major problems with curare were its limited availability and the wide variation in neuromuscular blocking strength between different samples of curare. This resulted in work to find a synthetic chemical with curariform action.

In 1949 the curariform action of suxamethonium was described by three independent groups from the UK, USA and Italy. It was tested in humans in the early 1950s and found to be generally successful. However, this wasn't the first discovery of suxamethonium. It was synthesised in 1906 but used on anaesthetised and curarised animals so its neuromuscular blocking properties were missed. It was used again in the 1920s to observe the effect of choline derivatives on peristalsis in rabbit intestine, its neuromuscular blocking properties were missed once again.[6]

Cricoid pressure

Cricoid pressure to prevent the pulmonary aspiration of gastric contents during tracheal intubation (Sellick's manoeuvre) was described in the Lancet in 1961 by Brian Sellick. Brain Sellick was a British anaesthetist who lived from 1918 to 1996.[7] Sellick found, using a cadaver, that by applying backward pressure to the cricoid cartilage against the cervical vertebrae he could occlude the upper oesophagus and prevent regurgitation of fluid into the pharynx. He demonstrated this effect by showing lateral neck x-rays with the oesophagus containing a latex tube filled with contrast medium to a pressure of 100cm of water. Cricoid pressure was shown to obliterate the oesophageal lumen. Sellick then tried this same maneuver during the induction of anaesthesia in 26 patients at high risk of aspiration. None of the patients experienced regurgitation or vomiting whilst cricoid pressure was applied, despite three patients having immediate reflux into the pharynx upon release of cricoid pressure after intubation.

Sellick's was not the first description of cricoid pressure. In 1774 the use of cricoid pressure by Dr Alexander Monro Secundus, a Scottish anatomist, was described during the resuscitation of the drowned to prevent gastric distension during inflation of the lungs. In 1776 John Hunter, a Scottish surgeon, again described the use of cricoid pressure during the resuscitation of the drowned. This time to prevent gastric insufflation during inflation of the lungs by a bellows. He states in his article: "If during the operation of the bellows the larynx be gently pressed against the oesophagus and the spine, it will prevent the stomach and intestines be too much distended by the air…This pressure however must be conducted with judgement and caution, so that the trachea and aperture into the larynx may both be left perfectly free."[8] In 1911, Otto Roth (1863-1944), a German surgeon, recommended cricoid pressure for use with the Dräger 'Pulmotor' ventilator to prevent gastric insufflation. His recommendations were adopted by Dräger and deemed mandatory for use with 'Pulmotor' ventilators around the world. [9]

Before the introduction of cricoid pressure into routine practice there were two options to prevent aspiration of gastric contents. The first was an awake intubation using topical anaesthesia, and the second was to intubate quickly in the head-up position to avoid the need for positive pressure ventilation.

The original RSI technique

In 1970, in Anaesthesia & Analgesia, Stept and Safar published a fifteen-step Rapid Sequence Induction and Intubation (RSII) technique[10]:

Start an intravenous infusion

Check equipment

Insert large bore nasogastric tube to decompress stomach prior to intubation – controversy over whether this should be removed prior to induction of anaesthesia as it may facilitate regurgitation

Clean mouth and pharynx of foreign material including dentures

Denitrogenate lungs with 100% O2 for at least two minutes

Place the patient in a semi-sitting V position with the trunk raised to about 30 degrees to aid gravity in preventing regurgitation

Apply ECG electrodes or precordial stethoscope

Inject d-tubocurarine (3mg/70kg body weight) intravenously

Give pre-determined dose of thiopental (150mg/70kg body weight) intravenously after about two minutes

Tilt the patient's head back with onset of unconsciousness and have assistant apply and maintain firm, continuous cricoid pressure

Inject suxamethonium intravenously100mg/70kg immediately after thiopentone

Allow respiration to cease spontaneously

Remove the mask whilst sustaining cricoid pressure, expose the larynx, and intubate the trachea rapidly; then inflate the cuff. Intubation should coincide with maximal relaxation, usually 30-60 seconds after intravenous injection of suxamethonium.

Release cricoid pressure, ventilate, switch to maintenance anaesthetic

Insert gastric tube if one is not already in place

Changes and controversies

There is currently no standard technique for rapid sequence induction, probably due to the controversy regarding some of the traditional components. Surveys of anaesthetists' practice have found great variation in technique.[11] As discussed above; the number of induction agents has increased since the RSI technique was first described. The current choice seems to depend firstly on the patient's clinical condition, followed by its effects on intubating conditions. Opioids were traditionally not included in the rapid sequence induction as the older opioids had a slow onset of action and long duration of action. Newer opioids are now available with a rapid onset and short duration of action. They can be very useful in attenuating the pressor response associated with laryngoscopy and intubation, and are regularly used as part of RSI by many anaesthetists. Some avoid using an opioid due to the risk of respiratory depression jeopardising patient safety if intubation fails.[11, 12] The traditional step of giving a small amount of non-depolarising neuromuscular blocker before suxamethonium is no longer routinely followed. Waiting two to three minutes between giving the non-depolarising neuromuscular blocker and suxamethonium was often too long in the emergency situation, it could result in pharyngeal weakness that was distressing to the patient, and it also increased the risk of aspiration prior to induction due to the loss of upper oesophageal sphincter tone and the inability to swallow.[12]

One of the most recent changes in the rapid sequence induction technique is the potential to use non-depolarising neuromuscular blockers instead of suxamethonium to achieve intubating conditions rapidly. Non-depolarising blockers have a long onset time, this can be overcome by increasing the dose, but this causes a prolonged block that can cause problems if the patient is difficult to intubate. For this reason they were traditionally not used in RSI. In 2008 Sugammadex, a modified gamma-cyclodextrin, was approved for use in Europe. Sugammadex is a selective relaxant-binding agent that binds to rocuronium and vecuronium and can rapidly reverse any depth of paralysis, enabling high-dose rocuronium to be used for rapid sequence induction.[13]

Cricoid pressure remains the most heated controversy in the RSI technique. There have been several reports of fatal regurgitation and aspiration despite cricoid pressure, and it has also been found to worsen laryngeal visualisation in some cases, making securing the airway more difficult and increasing the risk of aspiration. Advocates of cricoid pressure argue that the incorrect application of cricoid pressure is the cause of the reported problems, for example incorrect timing, the use of excessive force, or compression of the thyroid rather than the cricoid cartilage.[12] Although it is used routinely in the UK; this is not the case in other countries such as France and the USA.

Summary

The concept of the RSI gradually evolved following the work of Mendelson in 1946. The introduction into routine practice of suxamethonium and cricoid pressure were important milestones, but it wasn't until 1970 that the first standardised RSI technique was published. Today, the RSI remains a standard of care for inducing anaesthesia in patients with full stomachs. However, there have been several changes to the original technique, and controversy still surrounds some of the steps involved.

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EDWARD LAWRIE REVISITED

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Introduction

Previous writers have described Edward Lawrie's controversial opinions and his combative debating style.[1-3] This paper re-examines both his views and his polemical style, and attempts to relate them to the context of his own times.

Biographical Background

Edward Lawrie was educated at the Edinburgh Academy and at Edinburgh University from where he graduated in 1867. After a year's study in Paris he returned to Edinburgh in 1869 as house surgeon to James Syme but was soon dismissed from his post after he crossed swords with Professor James Spence. Masson *et al* see this episode as evidence of "*the personality defects so obvious in his later life*"[1] but Dudley and Simpson have argued that Lawrie was simply stating the facts as he saw them and that he was, at least in part, the unwitting pawn in a power struggle between Spence, who hoped to succeed Syme, and Syme who wanted to see Lister appointed as his successor.[4] Thereafter Lawrie worked briefly at the Manchester Children's Hospital in 1871 and then joined the Indian Medical Service in 1872.[1]

His appointment in 1874 as Resident Surgeon to the Calcutta Medical College Hospital was, by his own admission, due to a stroke of good fortune.[5] Here he became an enthusiastic exponent of antisepsis,[6] later describing himself in a letter to Lister in 1884 as one of his "*faithful followers and admirers*".[7] In 1879 he married the daughter of an important government official and was shortly after appointed to the chair of anatomy and surgery in Lahore.[1] From 1885 until he retired in 1901 he was Residency Surgeon at Hyderabad, "*the premier Indian native state, a post which is one of the most important medical appointments in India.*"[8] However, Masson *et al* noted that his military rank never rose beyond that decreed by his duration of service and that he received no reward or decoration after his twenty-nine years of service.[1]

On his return to England he practised not as a surgeon but as a consulting physician in London until 1908 when he retired to Hove. With the onset of war in 1914 he was appointed to the staff of the Indian Hospital in Brighton where he practised until his final illness and death the next year.[9]

Lawrie's Medical Interests: Anaesthesia

Lawrie is best remembered as the instigator of the Hyderabad Chloroform Commissions on chloroform.[10] As a disciple of James Syme he was a forceful proponent of the view that chloroform affected the breathing before it affected the heart and could therefore be given with perfect safety, so long as the breathing remained quiet and regular. He also believed that it was wrong for the chloroformist to watch the pulse because to do so distracted his attention from the breathing and, in any case, it was too late to take remedial action once the pulse had failed.[11]

The work of the first commission was undertaken by Lawrie and his colleagues in Hyderabad. Its conclusions were criticised in England, especially by the *Lancet*. Lawrie then arranged funding so that the experiments could be repeated and extended under the supervision of the *Lancet*'s nominated representative, the respected medical scientist Dr T Lauder Brunton FRS.[12] Brunton had believed that chloroform had a direct effect on the heart but changed his opinion while in Hyderabad. As a result he was to be drawn into acrimonious debate following publication of the Second Commission's report.

Because the Commission's results did not explain the fall in blood pressure during chloroform administration Lawrie commissioned two Cambridge physiologists, WH Gaskell and LE Shore, to perform further laboratory experiments using a cross-circulation technique (described later) which had been devised by Gaskell. The experiments did not confirm Lawrie's views and he claimed that all of them were flawed. He then arranged for the experiments to be performed in Hyderabad where different results, favourable to Lawrie's beliefs, were obtained.[13, 14] As will be described later, Lawrie then pursued what can only be described as a vendetta against Gaskell.

Despite much evidence to the contrary, Lawrie never accepted the concept of chloroform syncope which was later shown by Goodman Levy to result from ventricular fibrillation during light chloroform anaesthesia.[15] Levy's work was published at a time when Lawrie was still writing about chloroform but the latter never referred to Levy's findings. There was only one death attributable to chloroform in Lawrie's practice during his time in India (and Lawrie was in Bombay at the time)[16] but he was perhaps fortunate not to have had more after he introduced light or 'partial' chloroform anaesthesia for minor surgery, a procedure which he claimed was "*attended with absolutely no risk*."[17]

Lawrie was reluctant to accept the idea of delayed chloroform poisoning[18] but he was right to refute the existence of '*status lymphaticus*', a concept which was of course irrelevant to someone who denied the existence of chloroform syncope.[19]

Other contentious issues: Leprosy and Malaria

Lawrie believed that the bacillary theory of leprosy was "entirely destitute of foundation" because he had operated on hundreds of patients with leprosy and had never found bacilli in the affected nerves.[20]

More contentious were Lawrie's stridently expressed views on malaria where he claimed that Laveran's plasmodium was merely a degenerate white cell and that Manson's hypothesis, confirmed by Ross, of transmission by mosquitoes was wrong.[21, 22]

Lawrie's views on leprosy and malaria must be seen in the context of time and place. One of his papers on malaria[21] was prefaced by a vigorous attack on the *British Medical Journal* which had been vehemently critical of some aspects of medical practice in India. JM Cuningham, the most senior public health doctor in India, had been repeatedly criticised in the *Journal*'s editorials and in an article by the editor, Ernest Hart, who expressed '*astonishment*' at Cuningham's views on cholera.[23-26] A further article, written by the *Journal's* Calcutta correspondent and published just three months before Lawrie's paper, had spoken of "*the utter futility and outspoken ignorance*" of the views expressed on malaria by Lawrie himself at the recent Indian Medical Congress. The author wrote that the medical profession in India had been stupefied and ashamed by Lawrie's views.[27] Lawrie did not allude to the comments made about him. Instead he castigated the *Journal* for extolling those who supported Laveran's work,

> "*while senior men of the calibre of JM Cuningham, Bryden, Rice, Marston, DD Cunningham, Crombie, Sanders, and a host of others, whose names call up feelings of respect and admiration throughout the breadth and length of this land, have been as freely reprobated.*"[21]

What is significant here, apart from Lawrie's indignation at the *Journal*'s treatment of his colleagues, are the names of those whom he lists. With the exception of Crombie, probably all were prominent anticontagionists. The anticontagionist theories of what we now know as infectious diseases were based largely on climatic or miasmatic beliefs and held sway in the western world throughout most of the first half of the nineteenth century. By the later years of the century they had been largely discredited and replaced with contagionist theories which were increasingly based on the recognition of micro-organisms as the cause of much disease.

However in the Indian Medical Service [IMS] a small but influential group of senior doctors still held tenaciously to their anticontagionist beliefs, completely unable to adapt their views to the new thinking and its implications. The influence of these men had hindered medical advances in India. Thus cholera, a disease endemic in its ancient homeland in the Ganges delta, had been intensively studied over many decades by Anglo-Indian sanitarians and epidemiologists who had come to regard themselves as the repository of expertise on this illness; and yet, to their disbelief and chagrin, it was Koch, a German microbiologist, who established its bacterial origin.

Malaria, although by no means an exclusively Indian disease, had been the subject of intensive study by IMS doctors and was viewed by them as being very much their own preserve. Moreover it was the archetypal miasmatic disease. It was inconceivable to Lawrie and his ilk that malaria could be due to a microorganism. That the alleged micro-organism should have been discovered by an Italian, who was then lauded by Lawrie's fellow countrymen, was intolerable. Insult was added to injury when fellow members of the IMS like Ronald Ross "broke ranks" and joined those who Lawrie repeatedly described as "*the plasmodists*".[21, 28,29]

In the case of leprosy there was perhaps better reason for Lawrie's reluctance to accept a bacterial cause, because the very low rates of communicability in this illness allowed the persistence of anticontagionist views long after Hansen had discovered the causative bacillus.[30] In fact, support for non-contagion in leprosy actually grew after Hansen had discovered *Mycobacterium leprae* in 1873.[31]

Opium

When Lawrie gave evidence to the Royal Commission on Opium in 1894[32] he said that on his arrival in India in 1872, he had been strongly prejudiced against the use of opium, even for strictly medicinal purposes. However as a result of his experience in India he now considered it to be a safe and effective treatment in a variety of bowel complaints and as a prophylactic and therapeutic remedy in certain forms of malaria. As regards the non-medicinal, habitual use of opium he had seen no evidence that it harmed the physical or moral condition of its users. On the contrary, he considered that opium eating was beneficial in that it acted as a prophylactic against malaria, regulated the bowels and sleep, and kept the user contented and happy. These are certainly not opinions with which we could concur today. Masson and his colleagues described them as "*impulsive and unreasoned statements*".[2] However they described the Commission not as a Royal Commission but as a BMA Commission and so had probably read only the almost *verbatim* version of Lawrie's evidence which appeared in the *British Medical Journal*.[33] Had they read the Royal Commission's own report they would have seen that, although there were wide differences of opinion, Lawrie's views were corroborated by many of his medical colleagues and that, while they may seem extraordinary to us, they were not exceptional at the time.

Lawrie as a medical scientist

Although Lawrie held the chairs of physiology in Calcutta and of anatomy and surgery in Lahore, these were effectively honorary teaching appointments held in tandem with his clinical appointments and, even by the standards of the time, he had never received any training in scientific methodology. Even so, it is difficult to imagine anyone with a less scientific turn of mind. For example he wrote that before the Hyderabad Commission had started work, *"[T]he only reservation I made was that nothing the Commission could discover would persuade me that I could not give chloroform safely."*[34]

He made a habit of announcing his conclusions, without any supporting evidence, in telegrams to *The Times* newspaper[35,36], a practice which infuriated both medical journals and scientists,[37] especially when months then went by without any substantive publication. [38] He would describe having performed multiple experiments but would publish the results of only one or two, always ones which supported his conclusion,[39] and he would dismiss or ignore the results of other researchers when they conflicted with his own.[34,40]

Exasperated colleagues and journals pleaded unsuccessfully with him to provide more details of his experiments[41] and in a form in which they could be more readily understood.[42] Ross and other colleagues in the IMS had been greatly embarrassed by Lawrie's claims but Ross was initially extremely considerate in the manner in which he commented on Lawrie's errors.[43,44] Having then been subjected to much criticism by Lawrie, it is not surprising that he should have taken obvious pleasure in retaliating in kind when Lawrie's inexperience led him to confuse one protozoan with another.[45]

However the annoyances and occasional amusements caused by Lawrie's scientific ineptitudes were as nothing in comparison with the irritations and provocations engendered by his combative language.

Lawrie as a polemicist

Lawrie lived at a time when the language used in medical journals was immeasurably more robust, by several orders of magnitude, than that to which we are accustomed today. However I do not recall any other contributor who can begin to match Lawrie for such an intensive barrage of invective, much of it personal, and which was sustained for so long a time. Those holding views which differed from his own came to be seen as "*adversaries*" and "*opponents*" to whom he would issue "*challenges*".[46] He hoped that one of them would "*fight it out like a man to the end*" and if others were to "refuse to accept this challenge, judgement must go against them by default."[47,48] My handwritten notes of examples taken from the *British Medical Journal*, *Lancet* and *Indian Medical Gazette* extend to four sheets of A4 paper. Just a few must suffice as examples.

In reference to Camillo Golgi's work on malaria Patrick Manson had described Golgi as "*the talented Italian*" for which he was derided by Lawrie as "*that devoted* *worshipper of parasites and foreigners*".[21] Lawrie wrote of Ronald Ross's "*manifest ignorance*"[29] of his "*romantic verification of Manson's hypothesis*,[22] and of "*the sham science of malarial parasitology of which Dr McCallum and Dr Osler are the most recent exponents.*"[28]

Turning to anaesthetists, Buxton's method of monitoring patients during anaesthesia "*is impracticable, and its absurdity is only surpassed by the absurdity of the method...of Mr Lloyd.*[49] A suggestion made by Professor Scleich was "*clumsy, wasteful and impracticable.*"[50] There was generic criticism of "*those professional anaesthetists who 'funk' the heart*" and deaths in England as a result of anaesthesia were said to *"represent an appalling picture of the incapacity of the medical profession.*"[11]

Masson *et al* have suggested that these personal attacks were invariably started by Lawrie.[2] However Lawrie may have seen it differently. The '*plasmodists*', as he described Manson and his colleagues, were allied in his eyes to their supporter, the *British Medical Journal* which had been responsible for a sustained "*reign of terror*", to use Lawrie's own words, against the IMS; and when he wrote that it was "*criminal to watch the pulse*"[51] and that to do so amounted to "*homicide*"[52] he would have seen himself as echoing the language used by Jonathan Hutchinson and Augustus Waller. As far back as 1878, long before the Hyderabad Commissions, Hutchinson, who was himself no mean controversialist, had written that in most cases:

> *"...he should certainly regard himself criminally responsible if he placed any patient in danger of his life by the use of chloroform when ether was so efficacious and so very much safer.*"[53]

Nearly twenty years later Waller had, in Lawrie's presence, suggested that there were circumstances in which the use of chloroform "*should constitute a criminal offence*".[54] Hutchinson's words had not escaped the notice of Lawrie who was still in Calcutta at the time but who was already proselytising the views on chloroform of "*the wisest man I have ever known - the late Mr Syme.*"[55] Hutchinson, who was more circumspect than Lawrie in his choice of words, had not labelled those who used chloroform as criminals, having said only that he would regard himself as criminally responsible if he used this agent and the patient came to harm; but so far as Lawrie was concerned it would have been tantamount to calling his idol a criminal. In his mind the die had been cast and the lines of battle had been drawn; but how did Lawrie, who was more than just a mere polemicist, come to take such an extremely antagonistic attitude?

Lawrie's character

Other than what we can learn of Lawrie's character from the writings of himself and others, we are almost entirely indebted to Sykes who tracked down his granddaughter in South Africa and an old family friend in Scotland.[3] Not surprisingly they had more positive than negative comments on his character, though they did concede that he could be implacably opposed to those who disagreed with him, that he could be impetuous and that he was perhaps over-fond of gambling at the bridge table and on the horses. (**Tables I and II**)

Table I

Positive Characteristics

Contemporaries:
Granddaughter & Family Friend
Journals & Colleagues

Energetic
Zest for life, never bored
Wise
Hardworking, intolerant of laziness
Debonair, gay, witty
Hospitable, wide circle of friends
Cheerful
Loved by the young
Not bitter
Energetic, strenuous
Enthusiastic x 2
Zealous for truth x 2
Upright, respected
Fought for what he believed in
Virtues many, faults few
Popular with Indian poor
Tactful
Never mean or petty
Supportive of students
No hint of racism
No better house surgeon

Non-Contemporaries:
None(!)

Table II

Negative Characteristics

Contemporaries:
Granddaughter & Family Friend
Journals & Colleagues

Impetuous
Gambler
Implacably opposed to those who disagreed with him
Impatient
Dogmatic
Combative
Discourteous language x 2
Almost fanatical tendency
A public danger

Non-Contemporaries:
Impetuous, hot-headed,

Truculent, vituperative,
Arrogant, contemptuous,
Bitter, discourteous,
Zealot
Intransigent, obdurate,
Intolerant, Didactic,
Biased,
Unrepentant x 2

Both his contemporaries and especially those who have written about him in more recent years (chiefly Sykes, and Masson, Wilson and Hovell) have written of the many faults in his character, but it is very noticeable that a number of his contemporaries (chiefly Lauder Brunton and Buxton) had much to say about him that was praiseworthy, whereas the later authors could find absolutely nothing good to say of his character.

The comments in Tables I and II reveal two quite different men: the one who was wise and hardworking, debonair, cheerful and witty, tactful, loved by the young and with a wide circle of friends; the other discourteous, combative, contemptuous, dogmatic and intransigent.

Relevant to this dichotomy is a letter written to the *Lancet* in 1891 by James Wallace, the editor of the *Indian Medical Record*.[56] Wallace was another of Syme's disciples and appears to have been of a similar temperament to Lawrie because the editor of the *Lancet* wrote that he had censored some of Wallace's language which was "*more vigorous than polite*". Not surprisingly Wallace sided with Lawrie, claiming that the method advocated by Syme and Lawrie for the administration of chloroform was proven to be safe, while that used by those who criticised Lawrie "*is daily fraught with danger and death*". He went on to ask:

> "*Is it to be wondered at if such men [as Lawrie] finally reach a state of mind that compels them to feel that they are, like John of old, 'crying in the wilderness' to a stiff-necked generation, that there is no hope of the conversion of their opponents, and that they almost deserve to be called by hard names?*"[56]

The metaphor is apt. Lawrie expounded his views with religious fervour and with a Messianic conviction that he was right and that his opponents were wrong. We know that he was wrong to dismiss both a cardiac cause for sudden death due to chloroform and a plasmodial cause of malaria, but was he justified, at that time, in holding the beliefs which he did?

Could Lawrie's beliefs be justified?

Lawrie's boorish and truculent behaviour cannot be condoned, but were his beliefs in any way justifiable?

Mortality due to chloroform in India and Europe

In Britain and Europe in the 1880-90s there was a consensus that the mortality rate attributable to chloroform was of the order of 1:3000.[57,58] Some put the figure nearer 1:2000 to allow for the under-recording of deaths which was known to occur[59] and at St. Bartholomew's Hospital, where record keeping was excellent, rates as high as 1:1236[60] and 1:1587[61] were recorded. Some exceptionally good results were reported by military surgeons, with the French surgeon Baudens claiming 1:10,000 during the Crimean War and Hunter McGuire 1:15,000 in the American Civil War.[57] Claims of extreme safety with chloroform in Edinburgh have been demolished by Sykes[62,63] and in peacetime the military results were probably only matched in western countries by those of Joseph Clover. By 1871 he had given chloroform more than 7000 times[64] so may perhaps have given it 10,000 times by 1881 when ill-health forced his retirement, having had only one fatality.[65]

By contrast with results in Europe Lawrie's own record was quite exceptional. As already noted, only one death was ever attributed to chloroform in his department and that was at a time when Lawrie himself was absent in Bombay in 1899.[16] Ten years earlier he claimed that there had been no deaths in between 40,000 and 50,000 administrations when using the method which he advocated.[66] However this figure seems to have included an estimate of Syme's cases as well as his own.[67] He wrote later that he had given chloroform on 17,300 occasions in nine years[16] which would imply that he might have given it up to 50,000 times during his twenty-nine years in India. These imprecise figures indicate that there had been no systematic collection of data. Nevertheless it is an amazing record and all the more so because in many, perhaps the majority, of his cases the chloroform had been administered by medical students under the supervision of Lawrie who was performing the surgery.[67]

While no-one else could match Lawrie's figures, there was evidence that results in India were much better than in Europe. For example in an admittedly retrospective survey of results from several parts of India, Neve (another Edinburgh graduate) reported a death rate of 1:7920 (n=15843) during the previous two years and 1:26,136 in a much larger group (n=78,407) extending over 35 years.[68] Neve discussed why chloroform appeared to be so much safer in India than in Europe. He dismissed race, diet, alcohol and narcotic usage as possible explanations, concluding that the results were attributable to warmer ambient temperatures and better ventilation in operating rooms. In what Sykes described as a comprehensive literature search he discovered records of only five deaths under chloroform during a twenty five year period[3], possibly the same five cases which were recorded by Neve.

Four years before Neve's paper, Smyth had estimated that chloroform had been given 40,000 times over twenty years at the Madras General Hospital, during which time there had been only one unsubstantiated report of a death attributable to it.[69] In 1891 it was reported that Sir Joseph Fayrer, who had twenty years clinical experience in India and a further twenty years as President of the Medical Board at the India Office, "*knows of no death from chloroform in India, though its use is universal.*"[70] However Lawrie noted that Syme's method of giving chloroform, which had been almost universal during Fayrer's time in India, had since been largely replaced by "other principles, and several deaths have taken place." Lawrie knew of six deaths (one more than Neve and Sykes), of which five had occurred since 1879.[67] Irrespective of any debate over the manner in which chloroform killed, Lawrie undoubtedly saw the disparity between the results in Europe and those in India, and also the increase in deaths in India after Syme's method ceased to be universal there, as incontrovertible evidence in support of his case.

Although differences in climate and the ventilation of operating rooms may have influenced the results, and although there may also have been relevant differences in depth of anaesthesia and in the types of operation undertaken[71], the differences in mortality are so very striking that it is difficult not to have some sympathy with

Lawrie's case and with his frustration that anaesthetists in London were unwilling to give his method a fair trial.[72]

Lawrie's views on the cause of malaria

Lawrie was certainly not alone in his reluctance to accept plasmodia as the cause of malaria. Anticontagionists in India were particularly reluctant to accept Laveran's work. Not only was it incompatible with their aetiological theories but it also undermined the rationale for their measures to control malaria.[73] Moreover they could not accept the views of a foreigner like Laveran who had no experience of India's unique climate which they considered to play a critical role in the causation of malaria in India. Even in England there was persistent uncertainty about the role of plasmodia. In 1894 an editorial in the *Lancet* observed that "*we have not yet arrived at complete agreement regarding the true nature and cause of the scourge*"[74] and in 1896, the year in which Lawrie entered the fray, the *Lancet* was still circumspect, writing of "*the parasite which M. Laveran regards as the exciting cause of malarial fever.*"[75] There were several reasons for a delayed understanding of the role of plasmodia. Firstly Laveran's original description of his methodology and his drawings of the parasite had been unclear, so poor indeed that until 1894 even Ronald Ross thought that Laveran's work "*was unsound, or even a pretence.*"[76] Secondly, the most appropriate technique for visualising plasmodia remained uncertain until 1875[77,78] and, thirdly, it had proved impossible to grow plasmodia outside the body so there was no animal model of malaria.

No blame can therefore be attached to Lawrie for his scepticism about the role of plasmodia. What cannot be condoned, however, even though he was smarting under the criticism levelled by the *British Medical Journal* at anticontagionists in India, is his extraordinary arrogance in assuming that he and his colleagues in Hyderabad were competent to contradict the microscopical expertise of experienced laboratory malariologists. It was evident from the literature that special expertise was required and yet there is no evidence that Lawrie or his colleagues sought any additional training; and for this he was deservedly criticised.[42] Worse still was the scathing and sarcastic language which Lawrie employed to criticise his more experienced colleagues in Europe; but even worse was to follow.

Lawrie's vendetta against Gaskell and Shore: Cross-circulation experiments

As noted earlier, the cause of the fall in blood pressure during chloroform administration had not been addressed by the Hyderabad Commission's experiments. Those who considered that chloroform had a direct effect on the heart believed that this explained the fall in pressure. Lawrie and others who did not accept any direct effect on the heart attributed the fall in pressure to an indirect effect mediated via the vasomotor centre. Lawrie commissioned two highly respected Cambridge physiologists, WH Gaskell and LE Shore, to address this question [39,79] . Gaskell had devised a cross-circulation experiment whereby the brain of one animal was "fed" by the heart of another, the brain of the first animal having been isolated from its own circulation by ligation of the carotid and vertebral arteries. The effect of chloroform on the isolated brain could therefore be investigated in the "fed" animal while its effects on the heart would be apparent in the "feeder" animal. To Lawrie's evident surprise and irritation, Gaskell and Shore reported that chloroform had a direct effect on the heart[80]. They submitted their report to Lawrie because the work had been commissioned by him and funded by the Nizam's government. Lawrie promised to return the report with his comments but never did so, though he did send a copy to *The Lancet* whose editor believed that it had been sent to him for information but not for publication.[79] Lawrie claimed that publication was no longer necessary because he and his colleagues in Hyderabad had repeated the experiments and that "*no further controversy on the subject is possible*".[39,81] In contrast to the results of Gaskell and Shore, Lawrie reported that his results showed no direct effect of chloroform on the heart, as he had always predicted that they would. He wrote later that 53 experiments had been undertaken, of which only five were technically successful.[82] However he reported the details of only two, both of which supported his case.

In their report Gaskell and Shore had made some reasoned criticisms of the work of the Hyderabad Commission, to which Lawrie took exception, and he now set out to belittle their work, attacking physiologists in general and alleging that the cross-circulation experiments were "*devised for us unwittingly by Drs Gaskell and Shore*" who were "*new to chloroform research*" and who had underestimated the difficulties of their own "*excessively complicated*" experiments."[83] Gaskell and Shore responded that, on the basis of the limited information provided by Lawrie about his own experiments, they saw no reason to change their original opinion.[40] Lawrie then derided their "*exclusively scientific spirit*" and suggested that their "*purely physiological experiments...are evidently not biased by any desire to get practical results.*"[84] Lawrie's comments were particularly ironic as he had previously described Gaskell as one of "*the greatest physiologists in the world.*"[46]

Only one month after being subjected to these insults Gaskell and Shore agreed to undertake further cross-circulation experiments in Lawrie's presence while he was in England in 1894.[85] However there is no further mention of these experiments until seven years later when Lawrie published a letter from Gaskell in which he admitted that a vertebral artery had been imperfectly ligatured in one of the experiments.[82] Lawrie took this as proof that all of the Cambridge experiments had been fatally flawed and were therefore worthless. Why the impetuous Lawrie waited seven years before publishing Gaskell's letter is a mystery but he then continued to refer to it every few years.[13,14,86,87]

Royal Commission on Vivisection

In 1907, when criticising an editorial in the *British Medical Journal* on recent work in anaesthesia, Lawrie complained once again that the work of the Hyderabad Commission and the results of the Hyderabad cross-circulation experiments had been "*resolutely ignored*", unlike the experiments of Gaskell and Shore.[87] He concluded that the subject of anaesthesia should be subject to inquiry by the Royal Commission on Vivisection on the grounds, as he explained later, "*that until chloroform is given in the way that has been proved to be correct, vivisection cannot be carried out without pain.*"[88] In vivisection experiments chloroform was often given through a tracheostomy tube and Lawrie had previously argued that this interfered with natural respiration and therefore made the administration of chloroform unsafe.[89]

By this time the Royal Commission had been sitting for nearly a year and Lawrie would have known that Gaskell was one of the Commissioners.[90] The question therefore arises as to whether Lawrie was hoping simply to obtain further publicity for his views on chloroform or whether he was also looking for an opportunity to pursue his vendetta against Gaskell and Shore. When Lawrie was called to give evidence before the Commission in November 1907 he said that he had witnessed cross-circulation experiments in Gaskell's laboratory in 1894 where the entire experiment, including an extensive dissection of the neck, was performed with only a miniscule dose of morphia but no anaesthesia.[88] Lawrie said that he did not know at the time that it was illegal to carry out such experiments without anaesthesia but that he was told very soon afterwards. Although he did not initially mention Gaskell's name, one of the Commissioner's subsequently asked for clarification about the "*Cambridge experiments*" and Lawrie then referred to Gaskell. As a consequence of Lawrie's evidence Dr Shore was called to give evidence three weeks later. He insisted that chloroform had been given and that the animals were anaesthetised throughout the experiment. There the matter might have rested but Lawrie, irritated that his evidence had been contradicted, submitted a printed memorandum to each of the Commissioners and was therefore recalled to answer further questions in March 1908.[91] In his memorandum Lawrie had claimed that he had been told by Gaskell that no chloroform had been given to the dogs because that would have interfered with the experimental results. According to Lawrie, Gaskell had said that morphia had been given so that he could claim to have complied with the Act and thereby "*hoodwink the Inspector*". Lawrie alleged that the dogs had been in "*frightful agony*" and that he had thought it "*frightfully cruel*".

The Commissioners, whose membership included three eminent lawyers, then proceeded to discredit Lawrie's evidence. He was obliged to admit that Gaskell may not have used the word "*hoodwink*", as he had claimed in his memorandum, but insisted that it conveyed "*the precise meaning*" of what had been said. Later he was forced to concede that "*I do not say that the word was 'Inspector'*" even though he had also quoted Gaskell as using that particular word in his memorandum. Pressed to say how he knew that the dogs were in "*frightful agony*" he could only say that they were "*shivering*" and "*appeared to be in pain*". In his original evidence Lawrie had said that he had been told soon after he witnessed the cross-circulation experiments in 1894 that they had contravened the Act; but now, after being asked why he had waited fourteen years before making this allegation, he claimed to have learned only recently (but couldn't remember exactly when) that the law had been broken. As the questioning proceeded Lawrie became more evasive in his answers or hid behind an inability to remember. Although he had supervised cross-circulation experiments in Hyderabad he "*could not give an opinion*" on how long it would take to prepare the dogs for the experiment. The Commissioners expressed astonishment and disbelief at some of his answers. When Lawrie claimed that it would be more difficult to perform the experiments with chloroform than without (with the implication that chloroform had been omitted for that reason) the incredulous questioner asked if he desired to correct that answer. Lawrie finally conceded that the dissection of the neck vessels and the insertion of cannulae might be more difficult without chloroform.

When Shore was re-examined he again insisted that the animals had been given chloroform; that they had been insensible throughout with no evidence of pain or struggling; that it would have been impossible to perform the neck dissection on conscious animals and that the return of consciousness and any struggling would have ruined the recordings. Gaskell was called as a witness and confirmed that it would have been impossible to do the experiment if the dogs had been in pain. He pointed out that the chloroform bottles were connected to the tracheal tubes throughout the experiments and that Lawrie clearly had no conception of how the chloroform was being administered. He could not remember the details of his conversation with Lawrie in the laboratory but was adamant that he would never have said that he was intending to hoodwink the inspector who would not, in any case, have been deceived had he appeared in the laboratory. The evidence of Gaskell and Shore was corroborated by a laboratory assistant and another physiologist who had been present.

Considering how comprehensively Lawrie's claims had been demolished by the Commissioners themselves and by the evidence of the other witnesses, he was fortunate to escape with only a mild censure in the Commissioners concluding report which suggested that he may have been "*mistaken*" as to the suffering of the dogs and was "*altogether mistaken in his general contention*".[92]

The incident must have caused Gaskell considerable and prolonged embarrassment among his scientific colleagues and his fellow Commissioners. It led to questions in the House of Commons where one member suggested that Gaskell be removed from the Commission[93] and another questioned the terms of his vivisection license.[94] Gaskell was a genial and unassuming man who shunned publicity and who liked nothing better than to cultivate his large garden. According to FH Garrison "*every physiologist who has worked in the Cambridge [Physiology] Laboratory was his personal friend*" [95] and FN Langley wrote that the paper which he wrote with Shore on chloroform "was a useful piece of work, but it gave Gaskell the only enemy he ever made."[96]

Conclusion

By examining contemporary knowledge and beliefs this paper has shown how Lawrie was able to justify, at least in his own mind, his controversial opinions on chloroform, malaria and opium. So convinced was he that his opinions were correct that he thought it "*a reproach to British science and surgery that my work should be ignored*"[97] and he complained repeatedly that his work was "*resolutely ignored*"[87] and "*boycotted*"[19] by those whom he viewed as his "*adversaries*"[72] and "*opponents*".[51] None of this can excuse his discourteous and arrogant attitudes towards his colleagues. His vendetta against Gaskell was particularly reprehensible because it is simply not conceivable that he could have convinced himself of the truth of the allegations which he made. It is extraordinary that he could have become so bitter, antagonistic and probably also paranoid in his professional relationships while remaining cheerful, debonair, witty and hospitable towards his family and a wide circle of friends. After Lawrie's death, Lauder Brunton, a friend from his student days, wrote of "*his charming personal character*"[98] and even Dudley Buxton, so often maligned by Lawrie, wrote that:

> "*He fought with his gloves off because he believed he strove after the truth, and one honoured him for his very strenuousness in combat.*"[99]

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Homes associated with WTG Morton
His Birthplace, Waters-Morton Home, and Etherton Cottage *(Abstract)*

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Background: William Thomas Green Morton was born in Charlton, Massachusetts on August 9, 1819. We describe three homes closely associated with the life of Morton – the home where he was born, the home where his family moved when he was 8 years old, and the mansion he built in 1845 – Etherton Cottage.

Methods: Material from the public domain was examined for information for this study. In addition, consultations were obtained with staff at the Wellesley Historical Society, Charlton Historical Society, and the Public Library in the Town of Charlton.

Results: WTG Morton's father was a farmer, with no formal education. He lived modestly in the small home in which Morton was born. To enable the young Morton to attend school regularly, the family moved to a larger structure located closer to his school. This house is called the Waters-Morton Home, in memory of the Waters, who ran a successful tanning business in this location. In later years, Morton built a grand home in West Needham (now Wellesley), and named the mansion Etherton Cottage. He conducted experiments here, and the family lived here for at least 10 years. We provide information about the fate of that estate. Some of the structures associated with Morton have been captured in a set of 4 watercolor paintings by Leroy D. Vandam, M.D., chief anesthetist at Harvard Medical School's Peter Bent Brigham Hospital for a quarter century.

Conclusions: Homes associated with the life of the man most closely associated with the dissemination of the discovery of anesthesia can be visited in central and eastern Massachusetts. Watercolor renditions of these homes are on view at Wood Library-Museum of Anesthesiology, Park Ridge, Illinois.

HISTORY OF PORTSMOUTH ANAESTHETICS: 1950 TO 1966. *(Abstract)*

Dr Robert J Palmer Consultant Anaesthetist Portsmouth

Dr Philip Bromage, who went to McGill University, Montreal as chairman in the mid 50's, and Dr Brian Sandiford were prominent Consultants in the region in 1950. Their patch included Portsmouth, the Isle of Wight, Chichester, Midhurst and Worthing, and they drove around with a portable anaesthetic machine and cylinders in the boot of their car for domiciliary and nursing home anaesthetics. Dr Sandiford looked after the iron lungs used for the polio epidemic.

Dr Jim Hamer Hodges began as a trainee in Portsmouth in 1950. In 1954 he was appointed consultant anaesthetist in Portsmouth. He was interested in paediatric anaesthesia and in particular the intelligent cooperation of children (a video was presented made on his home cinecamera of his holding a pre-anaesthetic course with the children a day before their surgery, and of the surgery itself). He was also interested in obstetric anaesthesia and his landmark paper: *General anaesthesia for operative obstetrics…*[1] on the head up, thiopentone, succinylcholine, intubation, oxygen, nitrous oxide technique was published in the BJA in 1959. (A BOC video of his technique was shown). The video also demonstrated the anaesthetists' responsibility for resuscitation of the newborn, and the use of an anaesthetic record card. Another interest of his was muscle relaxants and he published extensively on these. Jim Hamer Hodges died under anaesthetic in 1961 at The Royal Hospital Portsmouth, aged 42, of tuberculous constrictive pericarditis, during the South Western obstetric and gynaecological society meeting in Portsmouth, at which, the day before, he had been a speaker.

In 1957 Dr Jeffrey Selwyn Crawford was a locum SHMO in anaesthetics in Portsmouth and Jim Hamer Hodges encouraged his interest in obstetrical anaesthesia. In 1967 Dr Selwyn Crawford's advice was sought about the provision of anaesthetic services for a new maternity hospital on the Queen Elizabeth campus in Birmingham. At that time he was deputy director of the research department of anaesthetics at The Royal College of Surgeons. He was subsequently persuaded to take up a post as full time consultant obstetric anaesthetist and he became nationally and internationally recognised in the field of obstetric anaesthesia.

He also ignited the interest in anaesthetics, in particular obstetrical anaesthesia, in Dr Mike Tunstall whom he first met in Ventnor on the Isle of Wight around 1956, where Dr Tunstall was a GP. In 1957 Mike became an anaesthetic registrar at Portsmouth under Jim Hamer Hodges, and was encouraged to participate in his obstetric anaesthetic research. Mike Tunstall went on to become a senior registrar on the Oxford, Portsmouth rotation and returned to Portsmouth in 1961. At this time nitrous oxide and oxygen were stored as a liquid and a gas respectively, and could only be given from four cumbersome cylinders (two plus two spares). Mike

Tunstall persuaded a sceptical BOC to try to mix the two in one cylinder, and this was successful producing Entonox which Mike first used clinically at The Royal Hospital, Portsmouth in 1961. Concerned about awareness when light anaesthesia with muscle relaxation came into fashion, Mike Tunstall devised the isolated forearm technique. Mike Tunstall also developed the first failed intubation drill. In 1962 he was appointed consultant anaesthetist in Aberdeen with the encouragement of Sir Dugald Baird, the professor of obstetrics and gynaecology.

Brief mention will also be made of The Royal Naval Hospital, Haslar, Dr Mike Glossop and the "Glossop tracheostomy tube" and Dr Alex Larson, who singlehandedly for many years ran the embryonic intensive care unit at The Royal Hospital, Portsmouth until a parliamentary question led to the appointment of two registrars, and possibly developed the second pain clinic in the country after Liverpool.

1.Hodges RJH et al. General anaesthesia for operative obstetrics with special reference to the use of thiopentone and suxamethonium. *British Journal of Anaesthesia* 1959 **31** 152-162

The full version may be found at www.bearmead.co.uk : item 8; History of Portsmouth Anaesthetics.

ANAESTHETIC CONSIDERATIONS FOR "THE BIG THREE" *(Abstract)*

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Winston S Churchill, Franklin D Roosevelt and Joseph Stalin all played crucial roles in the eventual victory of the Allies in World War II.

WS Churchill (1874-1965), British Prime Minister, had an episode of coronary insufficiency in December 1941 while visiting USA. By 1943 he was 68 years of age, portly, a drinker and smoker. In February of that year he suffered an attack of pneumonia. Also in 1943 it seems he underwent an operation by Surgeon TP Dunhill.

FD Roosevelt (1882-1945), President of USA, had permanent paralysis of his legs following poliomyelitis in 1921. By 1944 he was 61 years of age, a smoker with hypertension. In March of that year he required digitalization for congestive cardiac failure. In April-May of 1944 he developed acute cholecystitis with gall stones confirmed by abdominal x-ray, and surgical intervention was considered.

J Stalin (1878-1953), Leader of the Soviet Union, was a heavy smoker and drinker with arteriosclerosis and recurrent throat infections. Aged 62 years in 1941 he was afflicted with a severe throat abscess on 22nd June, the very day that Germany launched Operation Barbarossa. At this crucial time, Stalin could scarcely talk or swallow – an ENT specialist was called in.

Bearing in mind that an unsatisfactory outcome in each of these cases could have altered the course of world history, the anaesthetic problems are considered.

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Note: *a version of this paper was presented at the 8th ISHA in Sydney on 25 January 2013 – the full paper will be published in the Proceedings thereof.*

Was Robert Louis Stevenson's Novel Based on Horace Wells' Tragic Life?

(Abstract)

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Many sources suggest that Robert Louis Stevenson (RLS) may have been inspired to write his famous novel *Strange Case of Dr. Jekyll and Mr. Hyde* (SCJH) on the basis of the tragic life of the American dentist who introduced nitrous oxide into clinical use: Horace Wells. We investigate reports obtained from websites that are repositories of information related to gravesites; from the cemetery where Horace Wells is buried; from newspaper reports; and from books, to make a determination about whether or not such a correlation exists.

Horace Wells (1815-1848) lived his entire life in north-eastern USA, with his professional career being confined to Hartford, Connecticut and Boston, Massachusetts. The last few months of his short life were spent in New York City.

Scottish poet, novelist, and travel writer Robert Louis Stevenson (1850-1894) was born in Britain after Wells' death, and although he travelled to Europe, USA, and the South Pacific, there is no evidence to suggest that he spent any time in New England, or that he was familiar with Wells' life.

The novel, SCJH, explores and exposes the duality of man's nature, with the main character alternating between the kindly doctor and the offensive ruffian. There is an underlying tone of Victorian hypocrisy, whereby societal values inhibit and suppress inherent desires present in all individuals. The novel reveals actions that human nature may be capable of were anonymity to be assured. Stevenson's own life demonstrated some duality, as his upbringing and initial choice of studies finally gave way to his desire to become an author by means of rebellion against his family's desires and expectations.

There is evidence that the idea for SCJH's plot came to him during a dream and that he was quite upset with his wife when she woke him from these nightmarish visions. However, some days later, her editorial input was pivotal to changing his draft from a story to an allegory. In a matter of mere weeks after the dream, the masterful novel was written and brought to publication, expedited by RLS's grim financial situation.

In this report, we compile and analyse evidence from RLS's and Wells' lives, RLS' writings and writings of contemporaneous authors, as well as reports in newspapers, books and websites. The conclusion presents a reflection on whether sufficient evidence exists to suggest that SCJH was inspired by the tragic life of one of the pioneers of anaesthesia, Horace Wells.

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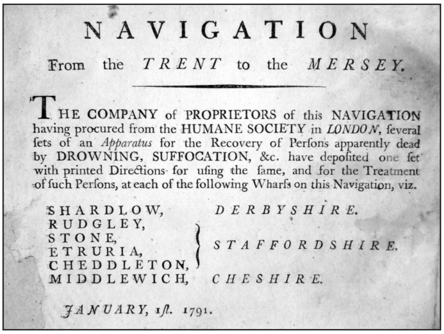
CANALS AND RESUSCITATION.

Dr Adrian Padfield: Past President, Retired Consultant Anaesthetist Sheffield

I've looked into the provision of (Royal) Humane Society apparatus by canal companies. This combines what could be described as *proto-anaesthesia* and my interest in canals. David Wilkinson in a paper at the 1987 [1] Second International Symposium on the History of Anaesthesia in London described the development of resuscitation in the United Kingdom. This starts with the experiments of Robert Hooke, secretary of the Royal Society, in 1667, who used bellows to ventilate animals' lungs via a tracheostomy. He noted that without ventilation the heart would stop but it restarted when ventilation was resumed. No one in the medical profession at the time seems to have taken up the idea. The eminent Quaker physician Dr John Fothergill published a pamphlet in 1744 and spoke at the Royal Society in 1745 referring to Dr William Tossach, a Scottish doctor who, in 1732, used mouth to mouth ventilation to resuscitate a miner overcome by fumes. Tossach published his account in Medical Essays and Observations in 1744 [2]. Other doctors are cited by Wilkinson as proposing methods of resuscitation. Generally speaking, however, artificial ventilation was not the primary method of attempting resuscitation. Warming the body and applying friction, and blowing tobacco smoke into the rectum were regarded as important for the drowned because it was thought they were only apparently dead or in a state of suspended animation. The use of tobacco smoke or a tobacco clyster or enema derived from the then prevalent idea of 'sympathy' (hence the sympathetic nervous system). This held that certain organs were in sympathy; the intestines and lungs were supposed to be in sympathy, so rectal stimulation would 'quicken' the lungs. In 1773, Dr Alexander Johnson reported that a society in the Netherlands had been set up in 1767 to revive people who fell into canals and apparently drowned. He suggested that a similar organisation should be started in Britain and he entitled it 'The General Institution'. However, Dr Thomas Cogan made a better translation of the Dutch Society's 'Memoirs' (1767 to 1773) and after meeting Dr William Hawes formed 'An Institution for affording immediate relief to persons apparently drowned'. It then became The Society for the Recovery of Persons apparently Drowned, and in 1776 'The Humane Society'.

Founded in April 1774, original leather bound books of 'Reports of the Royal Humane Society' are in the London Metropolitan Archives. These copies, annotated in black ink, may have belonged to Dr Thomas Cogan, one of the founders. I have worked my way through the half yearly reports which are quite repetitive. There are full reports of successful rescues in detail but usually only lists of the failures. From May 1775 the Reports contained the names of Humane Societies set up in other parts of the country often with descriptions of the first and subsequent meetings. Philanthropic members of the rising middle class became subscribers from a guinea (£1.05) upwards, as did the aristocracy who usually paid more. In 1785, George III granted royal patronage and in 1787 it became the Royal Humane Society. Based in London, the Society's first reports of rescues were from the Thames but soon published others from around the country. Surgeons were listed as Medical Assistants for Receiving Stations on rivers and canals. Apart from supplying the apparatus shown, the Society's income, subscriptions, were used to offer rewards from 2/6 (12.5p) to 4 guineas (£4.20: equal to £300 today perhaps?). Canny Cockneys soon realised there was money to be made and conditions for payments became more rigorous. In 1795 the Society published a volume of transactions, recording its activities from foundation to 1794. Up to then 2,572 cases had been investigated; 959 restored to life by Medical assistants, lives preserved by use of the Society's apparatus – 876, and unsuccessful cases: 747 (probably an underestimate).

From May 1775 there is mention in the Reports of the names of Humane Societies set up around the country. Several Navigations (= Canal companies) and rivers are included. In 1776, there are reports of rescues from canals: from the Falkirk canal on 29th September 1776 and on 31st December 1776 a seven year old child from the Birmingham canal. In 1777 a boy was rescued from the Leeds and Liverpool canal. On 16th July 1778 two people were resuscitated after falling into the River Avon in Bath. Only in the 1787 RHS Report is there specific mention of Inland Navigation in the Introduction but as detailed there had been activity before then. A recent acquisition of 115 items by the Railway and Canal Historical Society includes Notices by the Trent & Mersey Navigation.



NAVIGATION

From the *TRENT* to the *MERSEY.*

THE COMPANY of PROPRIETORS of this NAVIGATION having procured from the HUMANE SOCIETY in *LONDON*, ſeveral ſets of an *Apparatus* for the Recovery of Perſons apparently dead by DROWNING, SUFFOCATION, &c. have depoſited one ſet with printed Directions for uſing the ſame, and for the Treatment of ſuch Perſons, at each of the following Wharfs on this Navigation, viz.

SHARDLOW,	*DERBYSHIRE.*
RUDGLEY, STONE, ETRURIA, CHEDDLETON,	*STAFFORDSHIRE.*
MIDDLEWICH,	*CHESHIRE.*

JANUARY, 1st. 1791.

1. An early notice dated 1791, is self-explanatory but doesn't include instructions, just where the sets are.

By kind permission of the Railway and Canal Historical Society

In the 1794 RHS Report: *'Advice to the Proprietors of Canals intending to save the lives of those who are employed thereon, or others who may be drowned therein.'* This originally appeared in the Gentlemen's Magazine in June 1793. Several Navigations or Canal companies are included: the Forth & Clyde, Trent & Mersey, and Leeds & Liverpool. In 1795 a Humane Society was set up at least partly to oppose the canalisation of the rivers Wreake & Eye; to create the Melton Mowbray and Oakham canals

2. This superb example from the Bedford Museum dated 1807, shows the bottles of medications in situ.

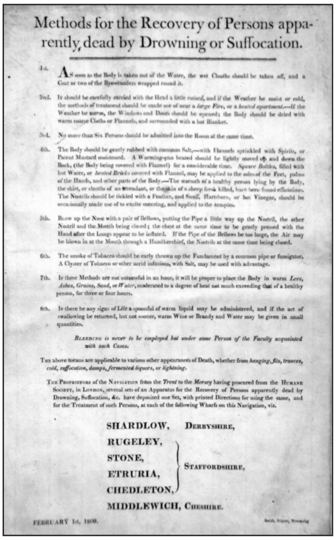
By kind permission of Bedford Museum

In the front is a combustion box with a tube at one end. Burning tobacco was put in the box and after insertion of the tube into the rectum and tobacco smoke was blown by the bellows attached to the other end.

3. Notice from the Proprietors of the Trent and Mersey Navigation.

By kind permission of the Railway and Canal Historical Society.

It has the instructions for the recovery of the apparently dead and repeats the wharf names where the apparatuses are kept. The 5th instruction is mouth to mouth respiration. It was deleted in 1812, because the resuscitator's breath was regarded as impure; perhaps also because of indelicacy and foul mouths. The idea (6th) of rectal insufflation of tobacco smoke and insertion of a tobacco clyster or enema was based on the 17 & 18th century theory of 'sympathy'. The dangers of tobacco were recognised and its use was forbidden in 1811.



Methods for the Recovery of Persons apparently dead by Drowning or Suffocation.

1st. As soon as the Body is taken out of the Water, the wet Cloaths should be taken off, and a Coat or two of the Bye-standers wrapped round it.

2nd. It should be carefully carried with the Head a little *raised*, and if the Weather be moist or cold, the methods of treatment should be made use of near a *large Fire*, or a *heated apartment*.—If the Weather be *warm*, the Windows and Doors should be opened; the Body should be dried with warm coarse Cloths or Flannels, and surrounded with a hot Blanket.

3rd. No more than Six Persons should be admitted into the Room at the same time.

4th. The Body should be gently rubbed with common Salt,—with Flannels sprinkled with Spirits, or Patent Mustard moistened. A Warming-pan heated should be lightly moved up and down the Back, (the Body being covered with Flannel) for a considerable time. *Square Bottles*, filled with hot Water, or *heated Bricks* covered with Flannel, may be applied to the soles of the Feet, palms of the Hands, and other parts of the Body.—The warmth of a healthy person lying by the Body, the shirt, or cloaths of an attendant, or the skin of a sheep fresh killed, have been found efficacious. The Nostrils should be tickled with a Feather, and Snuff, Hartshorn, or hot Vinegar, should be occasionally made use of to excite sneezing, and applied to the temples.

5th. Blow up the Nose with a pair of Bellows, putting the Pipe a little way up the Nostril, the other Nostril and the Mouth being closed; the chest at the same time to be gently pressed with the Hand after the Lungs appear to be inflated. If the Pipe of the Bellows be too large, the Air may be blown in at the Mouth through a Handkerchief, the Nostrils at the same time being closed.

6th. The smoke of Tobacco should be early thrown up the Fundament by a common pipe or fumigator. A Clyster of Tobacco or other acrid infusions, with Salt, may be used with advantage.

7th. If these Methods are not successful in an hour, it will be proper to place the Body in warm *Lees, Ashes, Grains, Sand*, or *Water*, moderated to a degree of heat not much exceeding that of a healthy person, for three or four hours.

8th. If there be any signs of Life a spoonful of warm liquid may be administered, and if the act of swallowing be returned, but not sooner, warm Wine or Brandy and Water may be given in small quantities.

Bleeding is never to be employed but under some Person of the Faculty acquainted with such Cases.

The above means are applicable to various other appearances of Death, whether from *hanging, fits, trances, cold, suffocation, damps, fermented liquors*, or *lightning*.

The Proprietors of the Navigation from the *Trent* to the *Mersey* having procured from the Humane Society, in London, several sets of an Apparatus for the Recovery of Persons apparently dead by Drowning, Suffocation, &c. have deposited one Set, with printed Directions for using the same, and for the Treatment of such Persons, at each of the following Wharfs on this Navigation, viz.

SHARDLOW, Derbyshire,
RUGELEY,
STONE,
ETRURIA,
CHEDLETON, Staffordshire,
MIDDLEWICH, Cheshire.

February 1st, 1809.

Leicestershire Record Office has a similar notice with a list of 9 instructions, I understand.

4. This set is from the Bath Royal Literary and Scientific Institution and with both bellows and a rubber bulb but no tobacco box. This suggests that it was after 1811 when the use of tobacco was deleted from the Instructions. It is interesting that Thomas Cogan one of the original founders of the RHS retired to Bath and founded the Bath Humane Society. It was recorded in the RHS Reports as meeting on 20th June 1805 but this probably wasn't the first meeting. The Kennet & Avon canal, as well as the Bristol Avon, runs through Bath.

By kind permission of the Bath Royal Literary and Scientific Institution.

There a number of resuscitation sets in the Science Museum. On the website they are all dated 1774 but perhaps this is a blanket figure relating to the date of the original foundation of the RHS. Certainly one of them does not have bellows, just a rubber bulb which was used for introducing fluids into the oesophagus.

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A cumulative index to Volumes 1-30 can be found in Volume 31 and to Volumes 31-35 in Volume 35

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