THE HISTORY OF ANAESTHESIA SOCIETY

Volume 10

Proceedings of the Meeting of 19th October 1991

SOUTHAMPTON

Volume 10. Errata

Dr D Zuck. *'Julius Jeffreys and the Physiology of Lung Volumes.'*

p55 para 2 line 1: 'design' should read 'diagram'
p58 line 5 should read ..'shows <u>no</u> recognition of..'

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PROCEEDINGS OF THE HISTORY OF ANAESTHESIA SOCIETY

Volume 10

PAPERS PRESENTED AT THE SOUTHAMPTON MEETING 19th OCTOBER 1991

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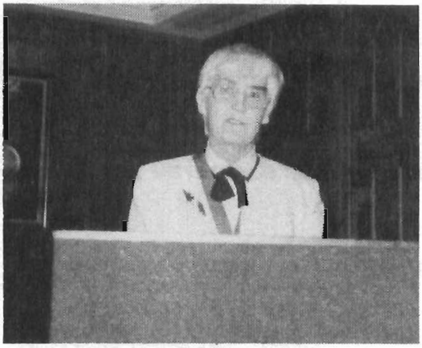

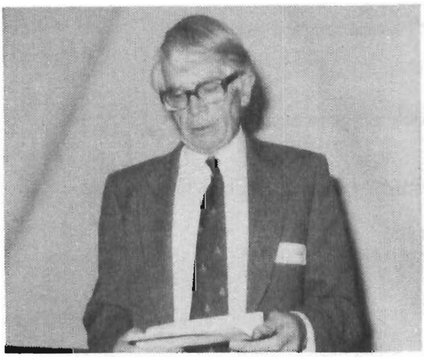

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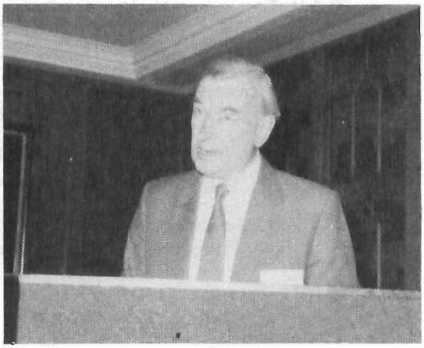

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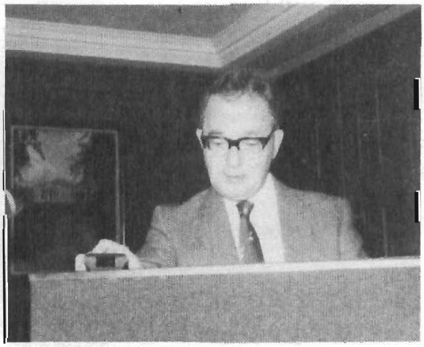

Dr D Zuck

PATRICK SHACKLETON AND THE DEVELOPMENT OF THE SHACKLETON DEPARTMENT OF ANAESTHETICS

Dr D J Pearce

Many of the senior members of the History of Anaesthesia Society will have their own happy recollections of Pat, as he was affectionately known to his friends and colleagues. It is difficult to provide a full account of his career but I hope to illustrate some of his work and initiatives, and to demonstrate how his influence continues to the present day.

The stimulus to the real development of the Department of Anaesthetics began with Dr Shackleton's appointment to Southampton in 1955 but there was a background in the preceding years which led to the great changes in anaesthesia in which he was so closely involved.

Medical services in Southampton prior to 1955

Before the War there were two large hospitals in Southampton, the Royal South Hants Hospital, a voluntary hospital established in 1838, and the Southampton Borough Hospital, built for the Board of Guardians in 1900 and

Dr Patrick Shackleton CBE

now named the Southampton General Hospital. There was also the Southampton Free Eye Hospital and a Children's Hospital. The isolation hospital was of lesser standing initially but became of great importance from the early 1950s onwards when it evolved into the Southampton Chest Hospital.

The anaesthetic staff were invariably general practitioners with an interest in anaesthesia. In 1938 4,838 operations were recorded at the Royal South Hants Hospital and from a report of 1939 it is interesting to note that the inpatient cost per week was £4-5s-2d. Audit was beginning, even then! Somewhat similar figures were recorded for the years 1939-1943 despite war-time conditions. From 1942 onwards an additional operating theatre and 73 beds were provided at Broadlands, the Romsey home of Lord and Lady Mountbatten and originally the home of Lord Palmerston.

The War years

With the onset of war Southampton's docks and industry were heavily bombed and much damage caused to civilian property, the Royal Pier, the docks and the main shopping areas. It must also be remembered that the Supermarine Spitfire factory was at Woolston, on the outskirts of Southampton, and this was a prime target. The town suffered 57 air-raids and 2,360 bombs and 31,000 incendiary bombs were dropped on the area; 633 civilians were killed and 922 seriously injured. The two main hospitals were organised to deal with the air-raid casualties and this system was maintained throughout the Normandy campaign when surgical teams from London assisted the Southampton surgeons and anaesthetists, each working 8 hourly shifts, in dealing with injured military personnel evacuated from France.

Special ambulances, many of them donated by charitable organisations and America, were developed to deal with the casualties. There was real fear that gas attacks would be made and the civilian population were issued with gas-masks and decontamination squads were formed. Foremost in the organisation of these services, working under the Medical Officer of Health, was Dr Murray Bigby who subsequently became a consultant anaesthetist at Southampton. With the successful conclusion of the War the nation returned to peace-time activities and the immense task of reconstructing the economy and the public services. Foremost was the introduction of the Health Service in 1948 and for us, as anaesthetists, the visionary move in establishing the Faculty of Anaesthetists.

Anaesthesia post-War

Similarly, in Southampton, a Medical Survey of Anaesthetic Services in 1948 reported that 'The present system is the part-time employment of a number of general practitioners on a sessional basis plus the services of two resident anaesthetists......The principle should be that a fully qualified anaesthetist is available. It is visualised that the services of six qualified anaesthetists are required.' And so, by 1954, with the appointment as consultants of many of the GP anaesthetists who had served so loyally during the War, the anaesthetic staff consisted of HCJ Ball, WLM Bigby, GG Havers, ES Machell, CB Picken and H Oakley White. Of these, Dr Eric Machell was the first, as it were, fully-trained anaesthetist to be appointed to the staff in 1952. This then was the situation of the early '50s and at that time Wessex or, as it was then named, the South West Metropolitan and Wessex Region, had a most brilliant medical administrator in the form of Dr John Revans, later Sir John Revans. He skilfully engineered the crucial medical appointments and developed the Regional strategies which were to lead to the formation of the present NHS services and the medical school.

Patrick Shackleton's early years

Foremost in his appointments was the invitation to Patrick Shackleton, then a consultant anaesthetist at Winchester, to become the Consultant in Administrative Charge of the Anaesthetic Department in Southampton in 1955. This invitation was accepted on the basis that he would be provided with an office and a full-time secretary, then unheard of demands for a non-teaching hospital. Pat rapidly established happy working relationships in Southampton - indeed, this facility was the hall-mark of his whole career.

Patrick Shackleton was educated at Charterhouse, Pembroke College Cambridge and St George's Hospital in London. Like many of his contemporaries his medical career began in his father's practice in Bushey, Hertfordshire, together with his life-long friend and most distinguished anaesthetist, Geoffrey Organe. In 1940 he joined the Emergency Medical Service as an anaesthetist in Sir Harold Gillies' Plastic and Burns Unit at Basingstoke. After the War he became an anaesthetist in Taplow and then was appointed a consultant in the Winchester Group in 1950, where he remained until he took up his new responsibilities in Southampton in 1955.

1955-64	Consultant in Administrative Charge, Department of Anaesthetics, Southampton.
1961	Frederick Hewitt Lecturer, Faculty of Anaesthetists.
1962	President, Section of Anaesthetics of the Royal Society of Medicine.
1964	Postgraduate Medical Education Adviser, Wessex Regional Hospital Board.
1966-67	Vice-Dean Faculty of Anaesthetists.
1968	President, Fourth World Congress of Anaesthesiologists.
1969	First Regional Post-Graduate Dean of Medical Studies, University of Southampton.
1970	John Snow Medal, Association of Anaesthetists of Great Britain and Ireland.
1977	Joint First Recipient of Faculty of Anaesthetists' Medal

Career Milestones of Patrick Shackleton

Developments in Southampton

First there were the developments in the then Regional Thoracic Unit at Southampton Chest Hospital. A second operating theatre was built and the facilities were greatly expanded for cardiac catheterisation and angiography. Many of the wards were in the grounds of the hospital and our junior colleagues will be horrified to learn that thoracotomy cases were returned in their beds to these wards immediately postoperatively! It was in this setting that the Australian surgeon, Mr Paul Chin and Dr Machell introduced surface hypothermia and then the extracorporeal heart-lung machine for intra-cardiac surgery.

Secondly, Dr Shackleton had an interest in tetanus and in 1958 a Tetanus and Respiratory Unit was opened, firstly as a three bedded unit converted from a medical side-ward and subsequently with the addition of a further side-ward. A team composed of physicians, nursing staff, physiotherapists and anaesthetists gained valuable experience in learning how to handle long-term intermittent positive pressure ventilation and airway problems often using, by present day standards, fairly basic and improvised equipment. Through Dr Shackleton's foresight this experience with tetanus and other causes of respiratory insufficiency undoubtedly paved the way for a better definition of Intensive Care and the purpose-built units which developed from 1966 onwards.

Thirdly, we turn to the development of post-graduate education in which Pat had the profoundest influence. The 1957 evening tutorials for the Primary FFA examination were gradually extended to full day-release courses for the whole Region. Professors Munday and Kercut, from the University, gave valuable assistance with physiology tutorials while Dr John Palfrey came down from St Thomas' Hospital every week to teach anatomy. Later, Dr Shackleton organised a small anatomy department adjacent to the pathology department and Professor Keene, a retired South African anatomist, was appointed. The anaesthetists undertook the pharmacology tutorials and an increasing amount of applied physiology. Later still, when the subjects for the Primary FFA were altered, Dr Percy Cliffe and Dr John Blackburn came down from Westminster Hospital to teach clinical measurement, physics and statistics. Nowadays, the anaesthetic staff in Southampton cover the majority of the subject material and the Courses provide an excellent foundation for trainees.

In 1964, with his wider appointment as the Regional Postgraduate Educational Adviser, Dr Shackleton gradually relinquished his clinical commitments. Postgraduate Medical Centres were then being developed throughout Wessex and were, very largely, the forerunners of other centres throughout the country.

In 1965 the first Final FFA day release course was organised under the capable supervision of Dr Malcom Yorsten and this has also continued to the present day. Despite the heavy clinical workload a feature of the courses has always been the enthusiasm and willingness of everyone in the Department to participate in this important work.

Dr Shackleton's efforts in postgraduate education, in conjunction with those of Dr John Revans, the pathologist Professor Michael Darmady, the

Vice-Chancellor of the University, Professor Mather and Professor Munday paved the way for a favourable response from the Todd report in 1968 which then led to the foundation of the Medical faculty in 1970.

From a departmental point of view much of the groundwork was completed with the appointment of Professor John Norman to the Chair of Anaesthetics in 1975.

Fourthly, throughout the time of these developments Patrick Shackleton was busy recruiting additional consultant anaesthetic staff who, as a team, would continue his work. Thus by 1965, the consultant staff had increased, and were WLM Bigby, JMB Burn, PJ Horsey, L Langdon, ES Machell, JM Manners, DJ Pearce, CB Picken, RPW Shackleton, MB Yorston and H Oakley White.

Peter Horsey and Malcolm Yorston, between them, undertook the whole of the neurosurgical anaesthesia when the new Regional Unit was opened in 1965. We also note the name of James Burn, prominent in the subsequent development of the regional Paediatric Unit and Day Case Surgery who, with his friend and colleague Laurence Langdon, transformed the Pain Clinic, started by Dr Harold Ball in the 1950s, into a full-blown service. Lastly, but by no means least, a significant arrival in that year was Dr John Manners whose contributions to cardiac anaesthesia have been immense.

Further hospital developments

Accompanying these changes, and from 1968 onwards, there were constant meetings to plan the new hospital building developments. The Regional Neurosurgical Unit was opened in 1965 and this was rapidly followed by other changes on the General Hospital site. The old frontage, including the Department of Anaesthetics' offices (previously the first Postgraduate Medical Centre) remained for some time during the site clearance for the new hospital. Out of this morass emerged the new Princess Anne Hospital for obstetrics and gynaecology and the new Southampton General Hospital, which includes the Regional Cardio-thoracic and Paediatric Units. Every modern facility is now available including the most sophisticated intensive care units, operating theatres, anaesthetic rooms and recovery units. Similar, but slower developments have taken place at the Royal South Hants Hospital. So by 1975 the anaesthetic staff had risen even further and consisted of the following consultant anaesthetists: P Appleton, JMB Burn, MM Crosse, AK Dewar, JC Edwards, PJ Horsey, L Langdon, ES Machell, JM Manners, TM Moles, J Norman, DJ Pearce, AC Wainwright, JH Winder and MB Yorston.

In 1968, in the planning stages, it was discovered that there was no Building Note for Anaesthetic Department accommodation in new hospitals. Under the auspices of the Association of Anaesthetists the Department was invited to produce a paper setting out the office requirements etc. and this, together with the engineering appendix, was subsequently published by the DHSS. With the introduction of the Medical Faculty and the help of the Dean, Professor Donald Acheson (later Sir Donald Acheson and the Chief Medical Officer) it was possible to plan a combined NHS and academic department.

This was formally opened and named, by Dr Shackleton's daughter, Mrs Desna Greenhow, on 9th December 1977, sadly seven months after her father's death. His photograph and bust are displayed at the entrance to the Department. The facilities include office accommodation for the secretarial, NHS and University staff, laboratories, a recently rearranged seminar room, a library and reading room complete with computers and a museum well set up by Dr James Burn and now looked after by Dr Paul Spargo. Many pieces of apparatus of historic interest are displayed, some donated by the earlier consultant staff together with other equipment used within the last 35 years. In the age in which nobody can function without disposable equipment we even see the intravenous cannulae originally used by Patrick Shackleton. The importance of maintaining these historical records so that each generation will remember the past, cannot be overemphasised.

Finally, Dr Shackleton's original team, like Topsy, has grown out of all proportion and it now consists of 23 consultants (including the Professor), 9 Senior registrars, 9 Registrars, 8 SHOs and 5 Clinical Assistants. Where will it all end one wonders. Who knows, but one thing is certain; if Pat Shackleton is looking down now he will have that benevolent but quizzical smile on his face and one can be sure that he will be well pleased that his initiatives have proved so fruitful.

DR ROBERT PATRICK WEBB SHACKLETON (1904-1977)

HIS INFLUENCE ON ANAESTHESIA IN THE BALKANS

Drs J Rupreht and D Soban

Most contemporary anaesthetists who do not remember the Second World War may be left unimpressed by the changes it brought to medicine. Advanced anaesthesia and plastic surgery in particular, were introduced into many parts of the world in the wake of the war. In several countries which until recently formed Yugoslavia, Dr P Shackleton played a key role in the introduction and teaching of anaesthesia. It has often been said that the development of contemporary anaesthesia has been related to that of plastic surgery. This was certainly the case in Yugoslavia when Sir Harold Gillies decided to send in plastic surgeons, and with them, as the anaesthetist, Dr Shackleton.

The events after the war which led to the development of anaesthesiology in Yugoslavia were described by Sir Harold during a ceremony at the University of Ljubljana, Slovenia, when in 1957, he was awarded an Honorary Doctorate. The following is part of an original transcript of the speech.[1]

> ...many of you remember that because of the first plastic and jaw work done by Battle and others at the No 1 Plastic Unit at Bari for wounded Yugoslav partisans, a move by your government was made to enable the work to continue after the war was over. In June 1944 UNRRA was requested to send a plastic surgery team to Yugoslavia to treat the large number of your soldiers wounded in the face or jaw, and I was selected by UNRRA to come over here and see what could be done.
>
> In those wonderful days when the war was over, not very good aeroplanes were available. But in Belgrade I duly arrived after a hectic night in Naples (in British headquarters)* and an even more exciting night in Bari where all Yugoslav wounded were displayed for my benefit. Negotiations in Belgrade were not all one-sided as (our Russian colleagues)* many friends were also anxious to help you. However, in those historic three days I made it quite clear that with our 10,000 war plastic cases in England our surgical teams were fully occupied and would not volunteer to leave their own wounded in favour of any other country's wounded, but, and there is a difference, if, I urged, your Yugoslav medical services have an ambition to learn what we can give of 'plastic surgery' for the people as well as for the wounded, then I am sure our surgeons will readily volunteer to come' (* crossed out by Gillies).

Early anaesthesia

Fortunately the negotiations in Belgrade had ended favourably. Plastic Unit No 1 arrived in there in 1945, well-equipped and with the aim of training a similar group of Yugoslavian doctors. The Unit worked in Belgrade for two years with some changes of personnel and was completely successful. The first Head of the Unit was Patrick Shackleton[2] who was not only the leader but had as well the difficult duty of transplanting the basics of sophisticated British anaesthesia into a rather primitive environment. By

1945 he had started endotracheal anaesthesia[3] and trained Kovacev, Cvetkovic and Jovanovic who were to become the first Yugoslavian physician anaesthetists.[4] In May 1946, when Shackleton left, Kovacev was already a trained anaesthetist in the Unit. Russell Davies, the British anaesthetist from Queen Victoria Hospital, East Grinstead, then came to Belgrade to continue Shackleton's work. He found one part of the latter's plan fulfilled, so he proceeded to the next problem: to persuade both the military and civilian medical authorities in Belgrade to recognise the importance of anaesthesia for the development of all surgical specialties and not only for plastic surgery. It took a few months to obtain satisfactory results and 'Kovacev, who was good pupil, became a good teacher too.'[5] Davies had also tried to effect the start of production of nitrous oxide in Yugoslavia, where until then only volatile anaesthetic drugs were available. At that time there was no nitrous oxide factory in all Europe south of London. Difficulties with this part of Davies' work in Belgrade deserve a separate story, with a happy ending in 1962 when the Slovenian pharmaceutical firm 'Lek' started an up-to-date plant near Ljubljana for manufacturing nitrous oxide for the needs of the whole country and later for export as well. After returning to England, Davies sent, in 1947, to his pupils in Belgrade, the first ampoules of curare.

Through the work of Patrick Shackleton and Russell Davies, Yugoslavia was, with Sweden, probably the first European continental country to introduce endotracheal anaesthesia, to use nitrous oxide and muscle relaxants and to have physician anaesthetists.[6]

The exceptional qualities of Dr Shackleton were displayed again before the anaesthetists of the whole world in 1968 when he was President of the IVth World Congress of Anaesthesiologists in London. The President collected Yugoslav participants in the middle of the Congress melee to have a meeting with Mrs Shackleton and Russell Davies. They were encouraged to describe how the specialty was prospering in their country.

Later contributions

Early in 1970, Drs Shackleton and Russell Davies started corresponding in order to prepare their contributions to the First Intersectional Meeting of Yugoslav anaesthetists which took place in Ljubljana in October 1970 - the 25th anniversary of anaesthesia in Yugoslavia. They were elected the first Honorary Members of the Yugoslav Society of Anaesthesia. Three years later, in 1973, they both took part in the IIIrd Congress in Opatija, Croatia, where they were awarded the Bettini medal.

This was Shackleton's last visit to a Yugoslav country which he loved very much. In a letter of 2nd May 1977, Russell Davies sent to Slovenia the sad news of Patrick Shackleton's death together with some memories of the last months of life of his old friend: 'Yugoslavia and its anaesthetists he often thought about, and his experiences in your country were always happy ones for him.'

Over the years, Dr Shackleton eagerly corresponded with his pupils in all parts of Yugoslavia, even to the extent of keeping them in an active group by mentioning what others were doing.[7] Although he may rightly be called 'father of anaesthesia' in the Balkans, he preferred to call himself a grandfather. When he died in 1977, he was fortunately spared knowing about the wars that fourteen years later would be suffered by his Yugoslav pupils and by the differing countries of the Balkans he loved so much.

Appendix, a transcription of a letter from Dr P Shackleton to Dr D Soban

8 St James Terrace,
Winchester.

March 7th 1975

My dear Darinka,

Oh dear! No, I had no letter from you in the New Year - I had written to you in the Autumn sometime. I have not been well since December, having a strange painful condition of muscles - matter of my shoulders and arms, which has defied treatment until just recently when they put me on Steroids. It is very painful at night and I sleep most irregularly. However, the last week it is improving and I can write again, which I have not been able to do for weeks.

Russell lives in Winchester now and I see him from time to time, though he is more often away at a cottage he has in Cornwall. He retired in October which makes another one of us on the shelf.

I had a word on the telephone the other day with Antic from Belgrade who is over here for a month or two for special studies of some sort. I had, incidentally, a letter which I have written to him in October returned by the post office so there is something wrong with the European mails. I had to send it again and the second time he received it.

As I didn't have your letter please send me your news when you have time to write again. It isn't only you who has deep roots - I always keep a great interest in my grandchildren and only wish that I could spend a long visit round them all in the Spring. But I know I can't so must rely on letters.

I had a wonderful letter from Ljubo, sending me the......for the Bettini medal and honorary membership of the Society, and a most warming and cheering covering letter. These are very treasured possessions.

I am off this afternoon to the heart Hospital in Southampton to have my pacemaker checked and to see that all is well. In fact all is well and I am the most efficient clockwork mouse in existence.

Dear Darinka, take care of yourself and I do hope you are happier and feeling less frustrated. You deserve to find tranquillity and I hope that you have. In looking for your last letter, in case I had made a mistake, I found your letter of last Spring with the primrose still in it. I expect they are in flower again.

With love, dear Granddaughter,

Patrick

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HOW THEY BROUGHT THE GOOD NEWS TO SOUTHAMPTON

A.J.Norman and Professor J Norman

Sykes[1] gave one of the best accounts of how the news of anaesthesia came from Boston to the United Kingdom. It is interesting to discover how soon the first anaesthetics were given in the town of Southampton. The Royal South Hants Infirmary was built by public subscription and opened in 1844 at a cost of £5,080 14s 6d. It had an operating theatre on the upper floor reached by a narrow winding staircase.[2]

Sadly, full records of the hospital's activities are not available. However two local papers - the 'Hampshire Advertiser' and the 'Hampshire Independent' carried extensive accounts of what was happening. This paper compares the reports in these weekly papers with the news appearing in 'The Lancet' at the beginning of 1847.

2 January 1847

'The Lancet' carried the report by Dr Boott and the accounts from Boston from the Bigelows describing the introduction of ether. It also contains the letter from Robert Liston recounting his first two cases. The 'Hampshire Independent' records the following:

> 'Successful use of the vapour of ether
>
> We have been informed that two operations have been performed by Mr Liston, at the University College Hospital, on Saturday last, while the patients were under the stupefying influence of the vapour of ether'.

It also records that Mr Robinson, the dentist, had written to the 'Morning Chronicle' giving details of several operations where he had already used ether.

9 January 1847

'The Lancet' carried more accounts of the use of ether and Dr Boott's rebuttal of the claim for a patent for it. It also carried a letter from a Dr Collyer of Jersey submitting a claim to using ether in Boston in 1843. Nothing more was heard of this. The 'Hampshire Independent' carried reports of successful painless operations at Bristol General Infirmary on December 31st. How did the news get there so quickly?

16 January 1847

'The Lancet' carried details of Squire's and Hooper's vaporizers for inhaling ether and a leader stating that 'the inhalation of sulphuric ether vapour for a few minutes...is vastly superior to all measures previously described'. The 'Independent' carried more accounts of success in the metropolis.

23 January 1847

In the 'The Lancet' John Snow makes his first appearance with a description of the composition of saturated mixtures of ether and air at various temperatures and a forecast of a better vaporizer. The 'Independent' carried a general commendation of the importance of the new discovery.

30 January 1847

John Snow described his apparatus which incorporated a large surface area to vaporize the ether, a water bath to a act as a heat sink and a low resistance breathing attachment in 'The Lancet'. The 'Hampshire Independent' carried two accounts. The first, while commending the use of ether to provide pain relief, notes some comments in the 'Journal des Debats' which warn that mixtures of ether vapour and air can explode. It also includes this item. 'Now, if it be considered that the vapour-laden air inspired by the patient about to be operated on is precisely this explosive mixture - that during the operation the surgeon is surrounded by lighted candles - and that the attendants pass backwards and forwards with lamps in their hands - an idea may be formed of the fate that awaits the patient, if the fire should unhappily reach the air which he is inhaling.'

The second report is briefer: '

> Inhalation of ether. - We understand that a successful operation has been performed in our town under the influence of ether, by Mr Edwin Hearne MB of Bernard Street. The subject was a mechanic from the Dockyard at Portsmouth, and applied with a swollen face, to have a tooth extracted.' Thus again, the first operation was a dental extraction.

6 February 1847

'The Lancet', among many reports, carried a letter referring to Hickman's work in 1824 and noted that Hickman's widow was still alive and living in Hertfordshire. Both local papers carried accounts of the first operation under ether carried out at the Royal South Hants Infirmary. This account is from the 'Advertiser'.

> 'Operations without pain - During the past week two severe operations have been performed at our Infirmary, whilst the patients were inhaling the vapour of ether, and with complete success. The first patient was the engineer of the 'Forth' steamer, who, whilst oiling the engines, had his forearm crushed between the crank and the iron grating above it. The injury occurred off Plymouth on Friday, and he was admitted to the Infirmary the same evening. Not only the two bones were broken, but the flesh and skin were much torn, so that amputation of the limb was immediately necessary. After inhaling the vapour of ether for two or three minutes, the arm was rapidly amputated above the elbow, and the man evinced no pain whatsoever, although previously on examining the limb he had shown himself extremely susceptible to pain. He was quite sensible during the inhalation, and the next day said that he had felt a sensation like 'needles and pins' when the arm was being cut off, but that the most

pain he suffered was in walking up to the operating theatre, from jarring the limb.'

So much for the winding staircase! The vaporizer used was Hooper's as described in 'The Lancet'. As with so many of the early operations, the inhalation produced analgesia but not anaesthesia. Sadly, the patient died four days later. At the inquest death was ascribed to blood loss, shock and the delay in procuring surgical treatment. Perhaps septicaemia also played a part.

The 'Forth' was one of the West India Company's steamers carrying the mails to and from the West Indies and Central America. It would seem she arrived at Southampton on January 29th with the injured engineer. We are not sure when she left but she carried not only the mails but also 58 passengers. Both local papers continued to carry further accounts of the successful uses of ether both in the town and elsewhere throughout the next month.

Comment

We were surprised at the wealth of detail printed in the local weekly press about ether and its introduction. Perhaps we should not have been. To have to undergo an operation without analgesia must have been a terrifying ordeal for any patient. The news of ether's success must have spread to patients in the wards and to the public like wildfire. Not surprisingly the general press took up the stories. It is one of the genuine revolutions in medical care and it is pleasant to record it being used in the provinces within a month of its introduction in London.

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HARVEY CUSHING, HIS CONTRIBUTION TO ANAESTHESIA

Dr G B Smith

Harvey Cushing was born in Cleveland,Ohio on April 8th 1869, the son of a doctor. After graduating from the Central High School in 1887, he entered Yale College and distinguished himself in both academia and athletics, obtaining a BA degree in 1891. Despite pleas for him to stay on at Yale, he decided to follow in his brother's footsteps and entered Harvard Medical School in September 1891. He qualified as a doctor on June 26th 1895.

Early experience with anaesthesia

As a Harvard medical student, Cushing administered ether to patients undergoing surgery on many occasions, and it is probable that his early experiences prompted him to try to improve the patient's lot. At that time it was common practice for untrained and inexperienced medical students to be asked to anaesthetise patients; furthermore, the surgeon generally insisted on a depth of anaesthesia so profound that there was little margin for error. Describing his first experience of administering ether, Cushing recalled that he had been summoned from his seat in the surgical amphitheatre and sent into a side-room where, under the direction of an orderly, he proceeded to 'etherize' the patient, an elderly man, as best he could. After repeated urgent calls from the impatient surgeon the patient was wheeled into the amphitheatre. As the operation started, 'there was a sudden gush of fluid from the patient's mouth most of which was inhaled...' It is not surprising to learn that the patient died.

It was during his second year as a medical student that Cushing gave that fateful anaesthetic. Following this, he and a colleague, Ernest Amory Codman, resolved that they would improve their technique of administering ether. Cushing suggested that '...in order to make a game of the task before us we made a wager of a dinner as to who could learn to give the best anesthesia.' They were both determined to become good etherizers and to this end devised the first anaesthetic charts. These 'ether charts' were introduced in 1894 and allowed both the anaesthetist and the surgeon to follow the condition of the patient by recording pulse, respiration and temperature during the operation. Cushing stated that '...careful anesthesia and record taking was undoubtedly a step toward improvement in what had been a very casual administration of a dangerous drug.' The idea for the 'ether charts' came from Codman's chief, F B Harrington.[1] Codman was almost certainly the first to use one but it is clear that Cushing was equally involved early in their introduction. This was the first recorded use of an anaesthetic chart.

Later career and local anaesthesia

Following his internship at Massachussetts General Hospital, Cushing moved to the Johns Hopkins Hospital in Baltimore where he became assistant resident to the Professor of Surgery, William S Halsted. Anaesthetic practice in Baltimore was similar to that in Boston where medical students were called on to administer anaesthesia using ether cones made from newspaper, or via ether sponges. Cushing found it impossible to change this practice and after a number of anaesthetic deaths in Baltimore in 1897, he began to use cocaine as a local anaesthetic. In fact, his chief, Halsted, had investigated the anaesthetic effect of cocaine and had also overcome a serious habituation to the drug. Several of Halsted's assistants had died of cocaine abuse.

The use of cocaine for nerve blocks was re-introduced by Cushing. He became adept at performing brachial plexus blocks for amputations and practised both inguinal and femoral hernia field blocks. He later published his observations in several papers.[2-4] One on the use of cocaine for hernia and thyroid operations,[2] makes it clear that Cushing appreciated the risks attendant in anaesthesia for the elderly, for those with cardio-respiratory disease and in cases with a full stomach. Cushing also refers to the use of a few inhalations of chloroform, not enough to produce loss of consciousness, used as an adjunct to the local technique.[3] In 1902, he suggested that the process of blocking nerve trunks be termed 'regional' in contradistinction to 'local'anaesthesia, thereby coining the phrase used to this day.[4] During regional anaesthesia he insisted on an assistant in place of the anaesthetist; the assistant offered 'timely encouragement' to the patient.

European research

Two years earlier, in July 1900, Cushing had spent many months travelling in Europe. Whilst in Berne, Switzerland, and under the direction of Theodore Kocher, he researched the influence of brain pressure on circulation and respiration. His experiments led to the finding that an increase in intracranial pressure was associated with a reflex increase in arterial blood pressure - later this became known as the Cushing Reflex. At the same time, Professor Hugo Kronecker assigned Cushing a problem in nerve-muscle physiology involving the perfusion of the hind-leg vessel of frogs. Here, Cushing learnt a great deal about nerve physiology and discovered that frog muscle was 'poisoned' when exposed to sodium chloride alone. Both calcium chloride and potassium were required to be added to the perfusate in order to maintain normal muscle contractility.[5] On his return to America, Cushing used this information in the production of an eponymous salt-containing solution for intravenous therapy, although its use was later mysteriously abandoned.

Shortly after completing his work in Berne, Cushing travelled to Pavia, Italy. Whilst visiting the Ospidale St Matteo he found that a simple home-made adaptation of Scipione Riva-Rocci's blood pressure apparatus was in daily routine use by the bedside of every patient. He quickly sketched a diagram of the apparatus and upon his return to Baltimore in September 1901, Cushing almost immediately developed a new anaesthesia chart and insisted that blood pressure should be recorded during all major operations. Soon he published a paper in which he showed that the application of cocaine to nerves could prevent the shock often associated with limb amputation;[4] the publication contained many examples of intra-operative blood pressure charts. Furthermore, on January 19th 1903 he presented a paper to a special meeting at the Boston Medical Library entitled 'The clinical value of blood pressure observation'. The text of this lecture was subsequently published[6] and as a direct result of Cushing's presentation, the Harvard Medical School distributed a circular to all members of the Department of Surgery requesting that a committee be formed to consider the importance of blood pressure determinations. After many meetings of the committee, and in good surgical tradition, it was eventually decided that '..the skilled finger was of much greater value clinically than any pneumatic instrument.' Despite this decision and probably due in part to the publication of George Crile's monograph:'Blood pressure in surgery', clinicians throughout the country began to record intra-operative blood pressure.

Cushing's anaesthetists

On Cushing's return to Baltimore, he remained concerned about the administration of ether by medical students and soon began to employ a full-time physician anaesthetist, Dr S Griffith Davis. Private patients paid for his service; for public patients, Cushing paid Davis out of his own pocket. There is little doubt therefore, that one of Cushing's major accomplishments was recognition of the need for a physician-anaesthetist. In a paper on neurosurgical techniques he wrote '..regardless of the drug to be employed, it is essential that it be administered by an expert..'.[7] Cushing frequently complimented Griffith Davis on his skill and care[6] and commented that a degree of increased safety was due to his use of an early form of precordial stethoscope termed the phonendoscope.[7] Its use arose out of work undertaken in Cushing's physiology laboratory in which Cushing and his students were producing experimental heart valve lesions in dogs.

In 1912, Cushing was appointed Surgeon-in-Chief to the newly opened Peter Bent Brigham Hospital in Boston and as Moseley Professor of Surgery at Harvard. There, he continued to employ the services of a regular anaesthetist, Dr Walter Boothby. Boothby had previously investigated the effect of administering carbon dioxide during anaesthesia, was co-inventor with Frederick Cotton of the Boothby-Cotton nitrous oxide-oxygen apparatus, and also described, again with Cotton, the technique of nitrous oxide-oxygen anaesthesia using intra-tracheal insufflation. Cushing invited Boothby to become Supervisor of Anaesthesia and Director of the Respiratory Laboratory, but in 1916 Boothby left to establish a metabolic laboratory at the Mayo Clinic. He was replaced by Gertrude Gerrard, the first nurse anaesthetist at the hospital. She was part of Cushing's mobile surgical team, based in France, during the First World War.

On Cushing's return to private practice at Harvard, he continued to excel in the practice of neurosurgery. On November 5th 1932, he performed his last craniotomy and shortly afterwards, retired from Harvard. He took up the non-clinical post of Sterling Professor of Neurology at Yale, a position that he held until he died of a coronary thrombosis on October 7th 1939 aged 70 years.

In summary, Harvey Cushing made considerable contributions to the specialty of anaesthesia. He was involved in the introduction of the first anaesthesia records, the intra-operative monitoring of blood pressure, pre-cordial auscultation of heart beat and respiration, the use of cocaine for what he termed 'regional anaesthesia', and the introduction of an intravenous fluid which bears his name. He was one of the first surgeons who required the presence of a dedicated physician-anaesthetist during his operations. In view of his numerous other talents, it is not surprising that in 1988, the U.S.Postal Service released a commemorative stamp of Harvey Cushing.

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ANAESTHESIA AND THE ROYAL NAVY 1847 TO 1856*

Surgeon Lieutenant Commander P A Glew RN

The early history of anaesthesia in the Royal Navy is a mix of individual endeavour and delayed official sanction. Even after its introduction into the Navy, much operative surgery continued to be carried out without anaesthesia. This would seem barbaric unless we consider the state of civilian practice at the time and in fact find it to be the norm. It is only following the experiences of the Crimean War and the debates that it engendered that anaesthesia regained the position it originally held and was used for all operations.

Conveniently the first decade of Naval anaesthesia can be divided into three periods. The first, 1847-1852, was characterised by the efforts of individuals. The second, 1852-1854, follows the official introduction of anaesthesia but highlights its limited use. The third and final period, 1854-1857, corresponds with the Crimean War and the central question of anaesthesia and the severely injured patient.

Individuals: 1847-1852 - Thomas Spencer Wells

For much of his early Naval career, Spencer Wells worked mainly in the Royal Naval Hospital of Malta. First as an additional Assistant-Surgeon on board the receiving ship HMS Ceylon and then, in 1843, as an Assistant-Surgeon to the flag ship of the Mediterranean Fleet, HMS Hibernia. It was during this time that Spencer Wells gave the first 'Naval' anaesthetic, for a dental extraction. Ether was given by a Hooper inhaler and the date was March 6 1847.[1]

Over the next few months Spencer Wells gave 106 anaesthetics for a range of operations, mostly dental extractions but also amputations, lithotrity, excision of tumours, division of fistulae and drainage of sinuses. Wells used the Hooper inhaler in 73 cases but regarded only 15 of those as a complete success; in the remaining cases he used an ether-soaked sponge with considerable success. His experiences led him to recommend that the sponge 'must be preferred to apparatus by the practical surgeon'.[2]

An account of one of his original cases was published separately on 16 July 1847, because rather than being an operative case it was a description of the medical use of ether. A fatal case of hydrophobia followed the bite of a cat. He attempted to treat the patient, a woman, with large doses of belladonna and used inhalations of ether to control her convulsions. Unfortunately the patient was unable to tolerate the smell of the ether and its use had to be abandoned.[3]

June of 1848 brought the Paris insurrection and found Spencer Wells, who had by now left HMS Hibernia, there to report on the treatment of the wounded for Sir William Burnett the Director-General of the Medical Department of the Navy. The report contains a paragraph on the use of chloroform commenting that there had been several deaths attributed to it,

*A preliminary version of this paper was presented at a recent Society of Naval Anaesthetists Meeting, May 1990 one of which Spencer Wells had witnessed.[4] In the Bradshaw Lecture of 1890,[5] given to the Royal College of Surgeons, Spencer Wells said 'I was from the first afraid of it [chloroform]' quoting both his experiences in Paris and in the Samaritan Hospital, London, to which he was appointed in 1854, whilst still being on the Navy List. In fact he was so anxious about chloroform that from 1867 all his patients were anaesthetised with methylene bichloride.

Spencer Wells' last account of his use of chloroform appeared in 1851; this was not for operative surgery but for the relief of the symptoms of respiratory disease. Spencer Wells, while on half pay from the Navy travelled extensively with the Marquis of Northampton in both Italy and Egypt. It was at the suggestion of the Marquis that Spencer Wells tried the inhalation of chloroform, to alleviate that gentleman's severe cough and dyspnoea. It proved to be so successful that throughout the remainder of the Marquis's life, only 7 months, Spencer Wells frequently administered chloroform to him 'with great alleviation of his suffering, without any ill effects being observed'.[6] The final paragraph of this account is the report of his experiences of the use of the inhalation of the anaesthetic in 2 cases of asthma. Whilst this is not by any means the first use of anaesthetic agents to treat respiratory illnesses his prediction that this would prove to be a 'valuable palliative remedy in such cases' shows remarkable insight.

Although Spencer Wells has no further part to play in Naval anaesthesia he does reappear, but this time as a surgeon when he was appointed to the civilian hospital at Rankeni, during the Crimean War in 1855 whilst continuing to receive half pay from the Navy. He was unable to take up a Naval appointment in the previous autumn because he had punctured his finger at a post-mortem examination. This together with what was seen as preferential treatment throughout all of his Naval career caused some comment in the medical press.[7]

HMS Columbine

At the end of 1847 chloroform was introduced into clinical practice by Sir James Young Simpson[8] and it has been suggested that its first use in the Navy, albeit on board a ship, the sloop HMS Columbine, rapidly followed.[9]

The commanding officer of the vessel Commander C D Hay (later Admiral Dalrymple-Hay) obtained both chloroform and the technique for its use from Simpson. He then travelled over land to join his ship which was part of the East Indies Fleet. Once Columbine's Medical Officers, Dr John Campbell and Dr Danual J Duigan had studied the technique of its use, a 'volunteer' from amongst the officers was found, the Captain's Clerk Mr Benifold who was suffering from toothache consented to be placed under the influence of chloroform for the extraction of the tooth. This was duly carried out in front of a petty officer from each mess who were invited to witness the event. Mr Benifold recovered satisfactorily even though five rotten teeth and not one were removed. The exact date of this is unknown although the year was reported to be 1847.

In an effort to provide a more accurate date it is worth examining the account in greater detail. Commander Hay took up his appointment in HMS

Columbine from 6th December 1847[10] which means that the event could have only taken place after that date. Of the other main characters Dr Campbell was already a member of the crew[11] so this does not help us in narrowing down the date. Unfortunately, looking at the other two main protagonists more closely reveals some difficulties with the account. Dr Duigan was an Assistant-Surgeon in the Royal Navy but was appointed to HMS Hibernia[10] with Spencer Wells; he had been since 1846 and was destined to remain there until 1849.[12] A possible answer to this problem is to suggest that as the Columbine sailed to the East Indies it could have called in to Gibraltar at the same time as the Hibernia, thus allowing Dr Campbell and Dr Duigan to be in the same place at the same time. This suggestion has some attraction because as an immediate contemporary of Spencer Wells, Duigan could have gained some insight into his use of anaesthesia.

Fitting the final protagonist into the story has proved to be impossible. Although a Benifold does appear in the Navy list as a purser, he remained on half pay without an appointment during this period.[10] Since the Navy list is purely a list of officers, the only possible explanations are either Benifold was not an officer, or that he was a civilian.

We are left with an account of an event we are only able to say may have occurred in the closing weeks of December 1847. But more problematically it has not been possible to absolutely place all the participants together using contemporary sources. So, interesting as this account is, we cannot place complete reliance on it.

The Dreadnought Seamans Hospital

This hospital, though not traditionally regarded as a Royal Naval hospital did treat Naval sailors. A Hospital report of 1853 noted that the total of Royal Naval seamen treated in Dreadnought up to that date was 3,100.[13]

In July of 1850 a seaman who was to undergo a testicular operation died without warning before the first incision,[14] adding Dreadnought's name to the growing list of hospitals that had reported fatalities associated with chloroform anaesthesia. The identity of the patient is unknown although it is likely to have been a Merchant seaman simply because their numbers treated there far exceeded those of Naval seamen.

Official sanction, 1852-1854: a Scale of Medicines

The anaesthetic events cited so far were very much the exception and relied on a few enterprising individuals obtaining their own supply of volatile anaesthetic agents. The rest of the Navy had to wait until 1852 before they were supplied with chloroform.

All medicines supplied to all Naval ships and hospitals were (and to this day still are) derived from a set list of approved medical stores, a Scale of Medicines. The Scale then in force had remained unchanged since its introduction in 1782.[15] To bring the Scale of Medicines up to date Sir William Burnett issued a new Scale which came into force on 1st April 1852 and contained 'many medicines that were in common use in private medical practice in England'.[25] Although it has proved impossible to trace a copy of this document it must have included chloroform. This contention is supported by Circular h88 issued two years later at the beginning of the Crimean War instructing all Naval hospitals to supply all ships bound for the Crimea with double the quantity of chloroform they normally carried.[16] Since no new scale of stores had been introduced since 1852 we can conclude that that one must have included chloroform.

The Naval hospitals

It is disappointing to find that the introduction of anaesthesia into Naval hospitals appears to have caused very little, if any comment. It is generally held that the first use of anaesthesia occurred in 1852 at the Royal Naval Hospital Haslar[17] where, at the instigation of Sir John Richardson, a patient had a circumferential amputation of a limb. Unfortunately no contemporary records of this event could be found so the date, the exact nature of the operation and even the names of the main characters are unknown. No other reports of the early usage of anaesthesia in the other Naval hospitals were identified.

Perhaps an explanation as to why the introduction of anaesthesia in the hospitals seems to have passed almost unnoticed can be found in the limited amount of operative surgery carried out. In 1869 when the first records are available, only 15 operations were performed in Haslar and these were all of a trivial nature.[18] This surprising state of affairs is better understood when we consider that almost all patients were admitted into Naval Hospitals during peacetime because of medical rather than surgical problems. The majority of the surgery carried out was as a result of injuries sustained on board ship and consequently was performed there by the attendant Medical Officer, almost invariably without anaesthesia. A point well-illustrated by the experience of Dr Graham the Surgeon of HMS Bellerophon who amputated the arm of a seaman without anaesthesia, at the shoulder, because of injuries he received when a cannon exploded. The patient died some time later of tetanus.[19] Even if chloroform was available, the failure to use it in acutely injured patients was for the time, in no way unusual. It was only after the Crimean War that things changed.

So with such minimal requirement for anaesthesia in Naval Hospitals it is not surprising that so little comment was made. That is not to say that the Medical Officers in the Hospitals were ignorant of the use of chloroform. A Naval Surgeon, Alexander M'kechnie, in February 1853, successfully gave chloroform to a patient with tetanus under the care of Dr Lowes of Gosport.[20] M'kechnie was appointed to Haslar at the time.[21] In the other main naval hospital at Plymouth, we find a year later, a suggestion to use chloroform over a prolonged period of time to allow a patient to tolerate the application of compression pads to treat a popliteal aneurysm. The suggestion was not taken up.[22]

Charles Dean Steele and HMS Arethusa

Following its official introduction into the Navy the use of chloroform at sea was not slow in coming. On 12 August 1852 Charles Deane Steele, the Surgeon of HMS Arethusa, removed some loose cartilage from the elbow joint of a seaman whilst that ship was at sea. He performed a similar operation on a second case some months later but did not publish an account of the event until the following year.[23] Although in both cases he used chloroform the noteworthy thing about them as far as Steele was concerned, was the close proximity of two cases of an unusual delayed complication of injury.

In sharp contrast to these two cases, Steele, on 20th October 1853 amputated the left leg of a seaman who had been wounded in the thigh by the discharge of a gun. He again performed the operation aboard HMS Arethusa, but this time no anaesthesia was used.[24] Because of their close proximity, these two events perfectly highlight the practice of avoiding anaesthesia in injured patients.

The Crimean War

The Crimean War commenced on 4 October 1853 when Turkey declared war on Russia, but it was not until 28 March 1854 that Britain and France entered the fray. Over the next 31 months only four major battles were fought, Alma, Balaclava, Inkerman and finally the taking of Redan and Malakoff by the Allies which concluded the siege of Sebastopol which the battle of Alma had begun. Secondary operations against the Russians were carried out in the Baltic. An armistice was signed on 14 March 1856 which finished a war, glamorised by Tennyson in his poem 'The Charge of the Light Brigade' but which was in reality one of trench and siege warfare, where the troops were more exposed to the ravages of disease than to the effects of weapons of war.[25]

Medically, this war was more noted for the outbreak of cholera and the appalling shortage of even the most basic of medicines, than for any advances in treatment of the wounded. To quote a doctor from the East in 1855 '..our practical medicine and surgery have been almost as bad as perhaps our cookery has been described to be. We have spoken of chloroform and the excision of joints and improvements of modern surgery, but we fear that the ultimate returns will show that we have gone backwards rather than forwards'.[26] However, the conduct of anaesthesia in this war added great weight in favour of the argument that chloroform can be safely used in all cases no matter how ill the patient.

Anaesthesia for trauma?

The central dilemma faced by all doctors of the age, particularly those who were to see action in the Crimea, was whether chloroform in severely injured patients would result in large numbers of deaths under its influence.

From the very outset, anaesthesia had been used in injured patients both in the main London teaching hospitals[27,28] and in small provincial ones.[29] But it is clear that the initial enthusiasm was soon tainted by the growing list of deaths attributed to anaesthesia.

A few voices were raised in defence of anaesthesia; a Dr Hearne of Southampton remarked that..[ether] 'by the prevention of shock or loss of nervous energy which pain alone must occasion, with consequent saving of strength is of incalculable service to patients submitting to long and protracted operations and often of itself sufficient to turn the scale in favour of the patient'.[30] But as the years wore on we find both increasing criticism of chloroform[31] and its avoidance in severely ill patients,[32] and by 1854 we find the situation that anaesthesia was relegated to use in only routine cases and patients with minor injuries.

The case against anaesthesia is probably best put by prominent doctors of the day. The Principal Medical Officer of the Army, Dr John Hall, in his advice to medical officers bound for the Crimea in 1854 said: 'The smart of the knife is a powerful stimulant and it is much better to hear a man bawl lustily than to see him sink silently into the grave'.[1] Dr Hall was not an isolated voice, his opinion was supported by Dr Andrew Smith the Director General of the Army Medical Corps who in 1855, when before the Sebastopol Committee said: '..in the case where a man having received a gunshot wound which rendered immediate amputation necessary, the depressing effects of chloroform would render recovery of the man less probable than that of a man who underwent the operation without chloroform'.[33]

The problem was also addressed by the President of the Royal College of Surgeons of England, Mr Guthrie, in his pamphlet to the Hospital Brigade. He advised that chloroform should be given for minor operations, amputations of the upper extremity and those below the knee. But for amputations above the knee 'the administration of chloroform, when there is much prostration, is doubtful and must be attended to and observed with great care. The question of whether it should or should not be administered in such cases being undecided.'[34] It is interesting to note that before the Sebastopol Committee it was stated that Dr Hall's advice against chloroform was countenanced by a suggestion of Mr Guthrie.[33] As for the Navy, no similar advice was offered, in fact no official advice on the use of chloroform was offered at all save that it should be available when the ship was cleared for action.[35]

What was appreciated was that chloroform could be either a 'blessed balm or a deadly poison according to the knowledge and experience of the hand applying it. Is it to be a "non-professional assistant", some old pensioner, or some druggist's boy?'[36] And this highlights the Navy's most pressing problem of the day, the shortage of manpower. Because of poor pay and conditions the Navy had been unable to attract a sufficient number of doctors into the Service.[37] The situation was so serious that many ships were dispatched to the East without their full complement of medical officers.[38,39] In an already depleted service things only got worse with many doctors dying during the Crimean cholera epidemic.

Supplies

As mundane as this subject may seem, its importance cannot be over-estimated. The state of supplies affected fundamentally how medicine and surgery were practised during the war.

Chloroform was supplied to both the Army and the Navy when they were dispatched to the East. From contemporary accounts we know that 180lbs[40] of the anaesthetic were provided for the Army, although it has been suggested that the figure should be 240lbs.[1] From Circular h88, issued by Burnett, all ships were provided with double the normal quantity of chloroform.[16]

Despite these preparations we soon come across complaints about lack of chloroform. Following the battle of Alma we find that 'The supply of chloroform was most limited. One surgeon was borrowing from another's small pannier stock - originally only 8oz, when he could ill spare the loan'.[41]

Things were no better in the Navy. After the Naval bombardment of Sebastopol in October 1854 many 'primary amputations were required and performed...with involuntary obedience to Dr Hall's scientific opinion issued to the Army with reference to chloroform and which anaesthetic in homeopathic quantities is now included in the Naval medical chest.' The anonymous author goes on to call for a revision of the Scale of Medicines supplied to the Navy, a call which was not taken up. Examining the Scale of 1861 we find that the amount of chloroform supplied to each ship was on average 1oz per 50 men.[42]

The shortage of chloroform was mirrored by equal shortages of many essential drugs including opium.[43] This was true in both services but the Army's situation was compounded by severe shortages of many of the basic necessities of life including food, cooking utensils and even candles. As the war progressed the supply situation improved[26] but by this time the major battles had been fought.

Surgery and chloroform

During the war many Naval medical officers were employed ashore with the Naval brigade[44] with the Army on land, where to their surprise they found many soldiers suffering from scurvy[45] and this was also seen on board the ships used to transport battle casualties back to the Army hospitals at Scutari.[46] So to just consider the naval experience of chloroform in the war is to see only part of the picture. The whole can only be viewed if the Army's practice is included as well.

Despite the caution with which many senior officers treated chloroform we find that right from the outset it was used. An Army surgeon, disregarding Dr Hall's advice, used chloroform when he amputated the left leg of a wounded Dragoon. But 'the man had lost a large quantity of blood before he could reach the surgeon and gradually sank after the amputation.'[31]

Following the battle of Alma we have evidence from a Naval assistant-surgeon that chloroform was used in all operations he performed or assisted at, even though he was aware of the doubts expressed about its safety, and commented that 'Chloroform was used with perfect success in every case.'[47] This experience seems to be borne out in the Army as well, even in the face of a shortage of the drug, but it certainly was not universal. We can be in little doubt that the Army surgeon who said 'they [the soldiers] laugh at pain and scarcely submit to die'[48] was unlikely to have used anaesthesia for his operations.

The shortage of Army doctors meant that Naval medical officers were transferred to the ships used to transport the casualties back to the military hospital at Scutari. In one incident, after Alma, a medical officer was transferred from HMS Niger and together with two other doctors, looked after 650 wounded officers and men. He wrote: 'I assure you we were working day and night, not even time to sit down to dinner. Nothing but cutting off arms and legs all day long. I had more operations during that time than any London surgeon in a twelvemonth. We could not operate fast enough to save all the wounded on board. I had one amputation of the shoulder joint and as for thighs and legs, I left off counting them.'[46] At no point does the author mention using chloroform and it is very unlikely that it was used at all both because of the number of cases and because these transports were not supplied with additional stores to cope with the patients they had to carry.

October 1854 brings us to the only Naval engagement of the war, the shelling of Sebastopol. With it we have a graphic account of the treatment of casualties on board HMS Agamemnon and we find that chloroform was used, although not for all cases. '..in one case it was not called for, the patient bearing his suffering with heroic coolness. We had so much smoke and heated atmosphere from our lamps and candles and the smoke occasionally after gunpowder that we did not deem it advisable to employ it until after the action was nearly over and we were dealing with the minor cases.' It was used in redressing an amputation stump because the patient was 'very irritable and loud in his outcries'.[49] On other ships during this engagement operations continued to be carried out without chloroform not because of the desire to avoid its use but because of the scarcity of it.

As the year drew to a close we find an Army surgeon writing from the heights before Sebastopol that 'Chloroform was generally used in every serious operation and in my experience its effects are most favourable'.[50] This attitude was not isolated and in the medical correspondence from the East we find both the admission that to deny patients with gun-shot wounds chloroform was an error[51] and laying the blame for the mistake at Dr Hall's feet.[52] As for the patients we find that they were not nearly so reticent about its use 'many of the poor fellows were cunning enough to ask for chloroform'.[53]

By the middle of 1855 chloroform's position was firmly established and it was used in all patients no matter how shocked they were; on occasion the patient died, but even then it was held that 'the chloroform enabled the man to bear the operation better than he would have done without it.' But perhaps the most telling comments were made by Dr George Pyemont Smith in his report to 'The Lancet' on 'Military Medical Practice in the East'. 'The celebrated manifesto of Dr Hall against chloroform had not much attention paid to it at Scutari. I had been accustomed to the use of chloroform, but certainly had never seen it given to the extent that it was employed there. An operation was never commenced before the patient was fully under the influence of chloroform. Where a patient without injury to health or life be brought into this state,(and I must acknowledge that I did not see or hear of anyone dying under the influence of chloroform, and this extreme action did not prove so injurious as I expected) it affords great facilities to the inexperienced operator, and prevents any necessity for hurrying an operation. Generally speaking, at Scutari the patient was, by means of chloroform, brought into the condition of a dead body, and then it was not an operation but a dissection that was performed.'[54]

Although Smith's experiences were solely of the Army there is no evidence to suggest that in the Navy things were any different.

It is interesting to compare the slow British adoption of chloroform with that of the other two main protagonists. The French used chloroform for all their patients.[55] As for the Russians, the surrender of Bomarsundand which had been taken by the Royal Marines, revealed that 'in various parts of the fort [there were] bottles of chloroform which appeared to have been lately used; they were generally in those quarters where our shell and shot had done most damage. I heard afterwards from one of their medical men that they perform every operation with chloroform, no matter how trivial it might be'.[56]

Following Smith's account of military surgery in the Crimea, the war continued for another year during which only one further battle was fought on land. The attention of the doctors turned away from the treatment of gun-shot wounds to cases of cholera, typhoid and other infective illnesses.

Aftermath

The civilian debate over the use of chloroform continued throughout the war. Guthrie entered the fray in April 1855 with a lecture delivered to the Royal College of Surgeons of England on 'Military Surgery in the Crimea'. In the lecture Guthrie quotes Snow directly. 'Chloroform may be given with safety and advantage to every patient....in a condition to undergo a surgical operation. A state of great depression from injury or disease does not contraindicate the use of chloroform. This agent acts as a stimulant in the first instance, increasing the strength of the pulse and enabling the patient in a state of exhaustion to go through an operation much better than if he were conscious. From these and other considerations, I am of the opinion that accidents from chloroform are to be prevented by care in its administration and not by the selection or rejection of cases for its employment.' Guthrie then returns to the advice he offered to the Army Medical Department at the beginning of the war[34] and reiterates his opinion that 'Chloroform might be used with advantage in all cases of injury requiring amputation save one, and in that one, experience was wanting to decide the point.... but as I believe nothing in surgery until fairly tried and found to answer, I refrain for the present, from expressing any opinion, save that the trials should be made with caution'.[57] The exception he was referring to was amputation at the thigh. It is likely that by the time that Guthrie was giving this lecture his caution had been superseded by practical experience in the East.

Snow entered the debate himself later in the year and again expressed the opinion that chloroform was safe for all operations. Surprisingly, in view of all the evidence coming from the East that this was so, there was still dissent from this view, not least in the Army. Many senior officers strongly supported Hall in his directive against chloroform.[58] But despite this it was clear that the use of anaesthesia in all patients, civilian and military, was here to stay. As for the Navy, there is no evidence that a similar debate took place at all.

The final word must go to the first Naval Anaesthetist, Spencer Wells, who in the Hunterian Oration of 1883 said:'The use of anaesthetics and latterly antiseptics, in spite of much larger numbers of wounded after modern battles, have greatly lowered the death rate'.[59]

Acknowledgement

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THE 'MAGILL ATTACHMENT'

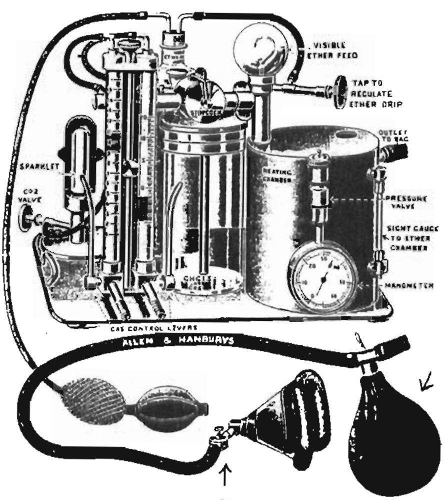
Dr O P Dinnick

Although Magill never published a paper devoted to the device which, in his words[1] 'is sometimes known as the Magill attachment', he did in fact describe some of its features.

Nomenclature

Several other names for this device are confusing and should be obsolete, such as open, semi-open or semi-closed breathing system or - worse - 'Magill's Circuit' - for the gas does not go round and round, and the attachment is best described in terms of the International Standards Organisation vocabulary. Thus, it is an assembly of three breathing attachments , a reservoir bag on a mount (which is attached to the common gas outlet of an anaesthetic machine), a breathing tube and an adjustable pressure limiting (APL) valve next to the patient connecting port. The bag is surrounded by a net and the bag mount contains a tap, which, when open,

Addenda—*continued*



11748

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11748 **Nitrous Oxide - Oxygen - Ether - Chloroform - Carbon Dioxide Apparatus, Magill's,** portable, latest model, consisting of dry flow meters for regulating the supply of nitrous oxide and oxygen, chloroform bottle with control stopcock, carbon-dioxide fitting for use with "Sparklet" bulbs, ether drip feed complete with

Figure 1. From Allen & Hanburys' catalogue 1931. The arrows indicate the only two features of the breathing system mentioned by Magill.[5]

permits the assembly to function as a partial rebreathing system - type 'A' in Mapleson's classification. When the tap is closed, the assembly is not a breathing system but simply a tube to supply gas for insufflation anaesthesia. (Although many published illustrations show the attachment fitted to an angle-piece and face mask, these two components are not an integral part of it).

Early usage

In 1967, Magill claimed[2] that the attachment was devised for his famous case of 1920 when he used a single wide bore tracheal tube for a 1¼ hour nitrous oxide and oxygen anaesthetic.

Although the breathing system which he used on that occasion was functionally similar, but not identical, to later versions, structurally it was very different and was described in his joint paper[3] with Rowbotham in the following year:- 'A Phillips airway or pharyngeal tube with angle piece and wide tubing can be attached to a Bath [sic] three-way stopcock and gas bag after removal of the face piece, and nitrous, oxygen and ether given with rebreathing. In one or two cases, we have passed a stout rubber tube through the glottis by direct vision and connected it with the wide bore tube and gas bag with satisfactory results.'

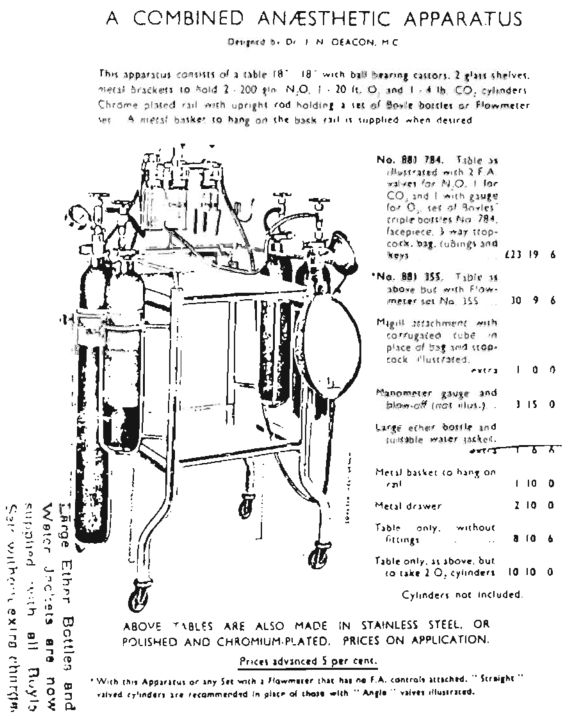
An earlier paragraph implied that this improvised breathing system may have been supplied with gas from a Shipway apparatus. The length of the wide bore tubing was not mentioned but it must have been long enough for the contemporary 2 or 3 gallon bag to be well away from the surgical field.

The relatively large dead space in the tube between the patient and the expiratory valve in the stopcock meant that there would have been a fair amount of re-breathing but this was considered physiologically and economically advantageous at that time. Similar breathing systems - though with the APL valve nearer the patient - had been used for some years in the USA but had not then been introduced into this country. In his important 1928 paper on 'Endotracheal Anaesthesia'[4] Magill did not describe any new breathing system for use with the single tube inhalational technique but merely referred to the method described in his 1921 joint paper with Rowbotham which has just been quoted.

However, two years later in his famous address[5] in Winnipeg he wrote:- 'I use any efficient apparatus which may be available in the hospital but as bulk and portability are considerable factors in the conditions under which anaesthetists work in England, I find a small continuous flow apparatus of my own design to be most useful. It is provided with a half gallon bag of thin texture close to the machine and a delicate spring valve next to the patient. This valve is connected by a metal elbow to the tube in the trachea. I endeavour to interfere as little as possible with the normal respiratory mechanism of the patient. Low pressure is used as a routine but ample high pressure is immediately available in case of emergency.' He did not mention the tap on the bag mount. Neither did he say anything about the net on that occasion but many years later[2] he explained that 'it only came into action if positive pressure was required in an emergency.'

Magill's machine with his new breathing system was illustrated in Allen and Hanbury's 1931 catalogue but this system differed from later versions firstly because the bag mount was not fixed directly on to the machine and secondly in its breathing tube. The latter was described as a 'large bore rubber tube' but, in fact, it appears to be relatively narrow in comparison with the APL valve and with the machine outlet, as well as being ribbed like a garden hose. This is less surprising in the light of Hewer's statement[6] in the following year that 'until recently these pipes were made of heavy armoured piping but a light and unkinkable concertina pattern is now available'. He referred to a short paper by Rowbotham[7] who, in October 1931 had described 'Extremely flexible tubing...of great use e.g....between any form of endotracheal intubation and the anaesthetic supply.'

This red corrugated tubing, which remained in general use for the next 25 years was made by Siebe Gorman and was supplied by Allen and Hanburys (presumably only after their 1931 catalogue had gone to press!) and by Charles King Ltd. As the Magill attachment is always portrayed with the new corrugated tubing, 1931 must be the first year in which it could have been made.



A COMBINED ANÆSTHETIC APPARATUS

Designed by Dr. I. N. DEACON, M.C.

This apparatus consists of a table 18" × 18" with ball bearing castors, 2 glass shelves, metal brackets to hold 2 - 200 gln. N_2O, 1 - 20 ft. O_2 and 1 - 4 lb. CO_2 cylinders. Chrome plated rail with upright rod holding a set of Boyle bottles or Flowmeter set. A metal basket to hang on the back rail is supplied when desired.

	£	s.	d.
No. 881 784. Table as illustrated with 2 F.A. valves for N_2O, 1 for CO_2 and 1 with gauge for O_2, set of Boyles' triple bottles No. 784, facepiece, 3 way stopcock, bag, tubings and keys	£23	19	6
*No. 881 355. Table as above but with Flowmeter set No. 355	30	9	6
Magill attachment with corrugated tube in place of bag and stopcock illustrated. extra	1	0	0
Manometer gauge and blow-off (not illus.)	3	15	0
Large ether bottle and suitable water jacket. extra	~~1~~	~~6~~	~~6~~
Metal basket to hang on rail	1	10	0
Metal drawer	2	10	0
Table only, without fittings	8	10	6
Table only, as above, but to take 2 O_2 cylinders	10	10	0

Cylinders not included.

Large Ether Bottles and Water Jackets are now supplied with all Boyle's Sets without extra charge.

ABOVE TABLES ARE ALSO MADE IN STAINLESS STEEL, OR POLISHED AND CHROMIUM-PLATED. PRICES ON APPLICATION.

Prices advanced 5 per cent.

* With this Apparatus or any Set with a Flowmeter that has no F.A. controls attached, "Straight" valved cylinders are recommended in place of those with "Angle" valves illustrated.

Figure 2. From Coxeter's catalogue. Probably 1931.

Charles King's influence

It was almost certainly Charles King who gave the attachment its eponym and in 1932 he made the first Magill machine with a wide bore outlet to which that device could be fitted. However, Magill did not describe this machine in the medical press and it was as part of a more widely used machine that the attachment became known, namely the Boyle apparatus made by King's parent company Coxeter.

When the attachment was first marketed can only be ascertained from the catalogues of these two companies - and these I have not seen - with the exception of one undated page of a Coxeter catalogue which portrays a machine with no reducing valves, water bubble flowmeters, two Boyle bottles with 'plungers' and a Cattlin bag with a three-way stopcock.

The 'plungers' were first added in 1930[8] so while the machine itself is a 1930 design, the illustration could be of a later date as reducing valves were not fitted until '1931-33'.[9] However, that date can be deduced from the printed list of available extras which, though it does not mention reducing valves, includes a more expensive flowmeter set - which must be of the dry bobbin type, for these became available in 1931[8] - and Coxeter dry flowmeters were listed in a Mayer and Phelps catalogue of that year.
As it is unlikely that Coxeter would make their flowmeter available to another firm before advertising it themselves, the date of this page of their catalogue is probably also 1931, especially as it lists another extra 'Magill attachment with corrugated tube in place of a bag and stop cock as illustrated, extra £1'.

The other interesting feature of this illustration is that it is headed 'A Combined Anaesthetic Apparatus designed by Dr J N Deacon MC.'

John Deacon

John Nissen Deacon was a remarkable man who qualified at the London Hospital in 1913, joined the RAMC and was awarded the Military Cross. After the war he returned to London where he held ENT and anaesthetic appointments and then worked for a time in Tangier. In 1927 he became medical superintendent and ENT surgeon to the small Redhill Hospital and supervised its growth into the 600 bed Edgware General Hospital. He made many contributions to hospital design and devised several pieces of equipment including an intermittent flow machine for giving carbon dioxide in oxygen as treatment of postoperative 'chests' or for coal gas poisoning.[10] He had many interests outside medicine - including archaeology, genealogy and heraldry as well as music, opera and ballet. He died in 1959.[11,12]

His important contribution to anaesthesia - like most good ideas, was devastatingly simple and was to fit the Coxeter Boyle machine on top of an instrument trolley with the cylinders on the latter's side. He named it the 'Redhill Anaesthetic Trolley'. Nissen-Deacon received no lasting credit for his important contribution which set the pattern for hospital anaesthetic machines which remained substantially unchanged for fifty years as Charles King re-named his apparatus as the 'Boyle Anaesthetic Table' and with one exception, Deacon's name never again appeared in relation to it.

That exception was in the legend to the first published picture in the anaesthetic literature to illustrate the Magill Attachment and it appeared in the 1937 (2nd) edition of Hewer's 'Recent Advances'.[13] It shows the attachment as part of a Deacon Machine with dry flowmeters and reducing valves and was entitled 'Continuous flow gas-oxygen machine combined with anaesthetic trolley (Nissen-Deacon)'.

Hewer did not mention Deacon in the text of his book - neither did he mention Magill in relation to the attachment - and the assumption must be that the device was by then widely known and no longer a 'recent advance'.

Indeed, there were remarkably few references to the attachment in the pre-war anaesthetic literature. Apart from an indirect allusion to it as 'the Magill bag and outlet valve' by Challis in 1933,[14] the first textual reference to 'Magill's attachment' that I could find was in a paper by Noel Gillespie in January 1939[15] while the first mention of it in a textbook was by Minnitt as the 'Magill re-breathing attachment' in 1940[16] but neither author said anything about the date of its origin.

The first reference from the New World was in 1941 - again by Gillespie - who wrote in his book[17] that 'Magill's attachment is commonly used in Great Britain' for the endotracheal technique. And not only for that technique, as it became the most widely used breathing system in this country until the advent of muscle relaxants heralded its decline in popularity.

As the years went by, the attachment acquired a larger bag and lost its net and tap. But for a while the immobile tap handle was retained so that over it could be looped the bottom of the bag and thus reduce the latter's effective capacity. But that was long ago and today, 60 years from its birth, the Magill attachment is no longer widely known by that name for, as did the Deacon anaesthetic apparatus - it has acquired a new eponym - 'Mapleson A'.

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CLANDESTINE MEDICAL EDUCATION IN POLAND 1939-1945

Dr Aileen K Adams

Many British anaesthetists attended the European Congress of Anaesthesiology held in Warsaw in 1990. This was a highly successful occasion and all were very impressed by the way our Polish colleagues under the chairmanship of Professor Z K Rondio had organised this Congress in the midst of the political upheaval which was taking place at the time. The movement for freedom from communist rule and Soviet domination was in full swing, and up to the start of the Congress the organisers were uncertain about whether there would be some oppressive move, either by government authority or by military might from outside Poland, which would make it impossible for the Congress to take place. The organisation therefore was to some extent an act of faith, but happily their faith was justified. All was well, the political though not the economic situation had stabilised, the Congress went ahead and was a wonderfully enjoyable occasion.

Poland and universities

Political instability is not new to Poland, its history has been one of turbulence, revolution and conspiracy, and at various times it has been partitioned amongst other countries of Europe. It is quite remarkable that Polish culture has survived at all. This culture is long established, the Jagiellian University of Krakow having been founded in 1364, and is still in existence. Scientists studying in these universities have ranged from Copernicus to Madame Curie, artists from Chopin to Joseph Conrad. In 1939 there were seven universities with 900 professors and 48,000 students.

About a hundred years ago Poland was suffering one of its periodic partitions, in this case between Prussia, Russia and Austria, and could hardly be said to exist except as an intellectual spirit. But for the Poles this was enough. It was not until after the First World War that Poland emerged as an independent modern state, although even then it showed little stability, with governments forming and dissolving with great rapidity. It is therefore not surprising that in 1939 Nazi Germany was able to move in fairly easily and occupy Poland as part of its campaign to expand eastwards and gain additional lebensraum for its own citizens. But what was living space for Germans soon turned into death space for Poles, and, although the Western Allies promptly went to war with Germany, there began one of the most evil and oppressive of the regimes to which even Poland had been subjected.

Shortly after I returned from the Warsaw Congress I read that the College of Medicine of South Africa had admitted to Honorary Fellowship Professor Witold Rudowski, Professor of Surgery in Warsaw and Director of the Research Institute of Haematology and Blood Transfusion, and described as a man well-known and honoured internationally.[1] I read his citation with increasing interest as it unfolded a story which was new to me, namely, that there had existed in Warsaw during the Second World war a clandestine medical school which continued to train doctors in spite of all the efforts of the Nazis to suppress it.

Scotland's Polish Medical School

The existence of the Polish Medical School in Scotland is well-known.[2] It was set up within the University of Edinburgh in 1941 by agreement between the university authorities and the exiled Polish government in London, with the object of training doctors for the Polish Armed Forces who served alongside our own Allied Forces. It was both a Polish academic institution with its own staff, and an integral part of Edinburgh University which supplied some of the professors where no Polish counterparts were available. It existed for eight years and graduated 227 doctors. Sadly, due to the political and military situation in Poland at the ending of the war, only 20 of these graduates were able to return to Poland. About 100 remained in the United Kingdom, the remainder dispersing to North America or Third World countries. The Golden Jubilee of the School was celebrated in 1991 by a reunion in Edinburgh. There is a small Museum in the Erskine Library of Edinburgh University which houses a collection of memorabilia including pictures, sculptures, medals and graphic works.

Much less well-known though, is how the Poles ensured the continuity of medical education in Poland itself during the Nazi occupation, when the occupying forces made a determined and ruthless effort to extinguish all traces of Polish culture and higher education.[3,4] On November 6th 1939 after entering Warsaw victoriously the Nazi Governor-General Hans Frank declared 'The Poles are a slave people and do not need education. From now on there will be no higher education in Poland.' Forthwith all universities and polytechnic schools were closed down as part of this policy. For a time it seemed likely to be successful for hundreds of university teachers were sent to the Sachsenhausen concentration camp where few survived.

The Poles however were determined that their culture should survive and conceived the idea of continuing university teaching in secret as part of their resistance campaign, a proposal that was encouraged by the Polish government in exile in England, and an idea which seems to have been immediately accepted and which spread with almost mystical fervour. It is worth noting that Poland was alone amongst the countries occupied by the Nazis in that not one group emerged to form a focus for collaboration with the occupying powers. The Poles are proud of this distinction, but it is one for which they paid a high price, because it meant that the Nazis initiated an extremely harsh regime where any illegal underground activity was punished savagely when it was detected.

Polish Medical School in Warsaw

Professor Witowski has described how clandestine higher education was carried out in medicine.[5] He was himself a student in the underground school, qualifying in 1943, and he went on to become one of its teachers throughout the war. In the early years teaching was carried out in a haphazard fashion, lectures and tutorials being given as and when possible. Most of the staff were professors from Warsaw and Poznan Medical schools, and by 1943 a Medical School had been re-established in complete secrecy in Warsaw, and over 400 students had been enrolled. One thing played into the hands of these early teachers, namely the appalling conditions in the Jewish ghetto in Warsaw where an epidemic of typhus fever raged and by 1940 had killed about 25,000 people. As a result of this, and the fear of its spreading to the German population, the Nazis had agree to establish a school of hygiene to to train sanitary workers and disinfection teams. Although the level of training was very low, this served the underground medical school as a convenient cover for continuing to train doctors under the pretence that they were training health workers. Unfortunately it did not last long, as the Nazis suspected what was happening, wondering why the Poles claimed it took two to three years to train people to clean drains and wash kitchens! Two years later they closed the school and imprisoned its director. However in this time it had been possible to raise the standard of teaching in microbiology and other basic sciences almost to university level.

In spite of this setback teaching continued and as it became better organised it was extended, so that at one time there were four separate schools in existence in Warsaw alone. Students took an oath of secrecy, lectures were given to small groups meeting in private homes or factories, and often they used assumed names, whilst the schedules were changed frequently to avoid detection. That the Nazis were intent on stopping any form of intellectual activity seems to have been obvious from the start. From time to time physicians were arrested and sentenced to death for what were described, amongst other crimes, as 'illegal undergraduate activities against the Third Reich'. Because the students and lecturers had to earn a living doing other jobs, teaching took place only in the afternoons, and it was impossible to meet in the evenings because of the dusk-to-dawn curfew when no-one dared to go out. There were almost no books, so mimeographed lecture notes were guarded carefully and circulated widely. Conditions were desperately uncomfortable, often rooms were unheated and only lit by candles, whilst cold, malnutrition and the shortages of fuel, clothing and drugs took their toll of both teachers and the taught. Nevertheless they managed to carry out in addition some research activities, particularly into the fields of epidemiology and the effects of starvation and cold. The school in the Warsaw ghetto came to a terrible end when the Nazis totally destroyed the ghetto in 1942, and it is estimated that only about 10% of the students and doctors survived the holocaust.

Clinical training was obviously very difficult to organise and many ruses were employed - for example, students worked as laboratory assistants, stretcher-bearers, nurses, barbers and even under the guise of patients' visitors in order to receive teaching. It seems likely that the patients knew what was going on, but they too contributed to the conspiracy of silence. Staff and students had to be seen to hold a job, but other illegal activities were fitted in, such as distributing subversive literature and carrying out acts of sabotage. In spite of all this, the clinical course was compressed from three years into two by dint of sheer hard work and determination, and no doubt a sense of loyalty and comradeship. At the same time there was an insistence on maintaining standards at a high level, and regular examinations had to be taken.

Discovery by the occupying Nazis meant severe reprisals, and sometimes teaching had to be suspended until new ways of meeting could be devised. Finally, the uprising in Warsaw in 1944 ushered in such an orgy of destruction and terrorism that medical training could not be sustained in that city, though it continued throughout the rest of the war in Poznan, Krakow, Kielce and Czestochova. The shared experiences of secrecy and danger brought unique bonds of friendship, as well as a strong sense of discipline and solidarity.

What were the results of all this effort and suffering? Certainly the scale of activity in the underground universities far exceeded anything that the Polish government in exile had expected. In Warsaw alone some 4000 students studied medicine under 500 teachers, and although the drop-out rate was high for reasons already mentioned, nevertheless 2,000 graduated as doctors. After the war was ended all of these were required to retake their examinations to confirm that their standard was good enough, and almost all passed. A number of doctoral theses were published reporting the results of the research done during the period of underground practice.

Poland suffered appalling loss of life during the war, with about 6 million dead, including 5,050 doctors, 7,300 pharmacists, and 2,500 dentists, as well as suffering huge material losses. Nevertheless when the medical schools reopened after the war no fewer than 120 teachers were found from amongst the survivors to become professors, sufficient to reopen 11 schools, whilst others provided the nucleus of the post-war medical profession. There were of course more intangible results, in that it brought hope for the future into an otherwise dreadful reality. Once again the Polish people showed their strength and tenacity, and their determination that not even the most oppressive of regimes could silence for long their ancient traditions of learning. Just as they rebuilt their devastated cities, so they rebuilt their destroyed institutions, and the results have been clear to see by those who have visited their country since then.

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Ether Hill

Dr D D C Howat

I shall confess at once that this is an account of a pursuit in which the chase was more intriguing than the kill - a state of affairs no doubt very familiar to some - but it has a rather unusual ending.

Just over two years ago, when walking on Chobham Common in North West Surrey, I noticed on my map a feature called 'Ether Hill'. Struck by the name, I went to have a look at it. I found an eminence some 50 metres above sea-level, though not more than 30 metres above the surrounding country. It is covered with trees, mostly fir, pine and beech, and the soil is sandy. It is open to the public and adjoins a recreation ground called Ottershaw Memorial Fields and covers about six hectares. It is situated in the grounds of Potters Park Farm, which later became part of the Queenwood Estate and was previously part of Ottershaw Park.

Local historians

However, it was more than a year before I began to make some enquiries about the name. I went to the public library in the nearby town of Addlestone, whence I was directed to the small museum at Chertsey, about two miles to the north. There, the curator and her staff had not heard of Ether Hill and the local history curator, who had arrived from Wales only three weeks previously, confessed total ignorance of the area. Three old maps, dated 1729, 1819 and 1830 were produced, but did not name the hill. The next map, one of the early large-scale Ordnance Survey ones, dated 1871, showed Ether Hill by name.

The curator gave me the names and addresses of two local residents, both considered to have a profound knowledge of the history of the area. In reply to my letters to them, both gentlemen wrote that the hill was marked as 'Heather Hills' or 'Hill' in some of the older maps. One of them, Mr Stratton, a retired surgeon who has published a history of Ottershaw, pointed out that heather still grows there (although I did not see any on my visits to Ether Hill) and also that a family called Heather had lived nearby in the early 18th century and might have given rise to the name.

Mr Pardoe, who is the director of the Chertsey Museum, made another interesting comment. At the turn of the 9th and 10th centuries, marauding Danes had sacked the important Abbey of Chertsey and put to death the Abbot, the priest and 90 monks. Nothing now remains of the Abbey except a small blocked-up, ivy-covered gateway and a few stones. According to Mr Pardoe, the earliest reference to the hill is in the Abbey Cartularies, where it is referred to as 'le Gallewes'. The Abbots had powers, normally reserved to the Crown, of making judgements in criminal cases. Presumably a gallows, on which malefactors were hanged, was sited on the hill as a warning to passers-by of the fate of evil-doers. Mr Pardoe suggested that the Danes might have hanged the priest there: his name was **Ethor.** He hastened to add that history does not depend on conjecture.

Local maps

In Guildford, the County Archivist referred me to the Surrey Local Studies Library. There I saw a succession of old maps dating from 1579, but none of them referred to the hill. The scale of many of them was too small. In 1768, a map of Surrey by John Roques, the scale 2 inches to the mile, shows 'Heather's Hill', but a later map dated 1793 and a first series Ordnance Survey map dated 1811 do not show it. However a map of 1823 (republished in 1829) by Charles and John Greenwood shows 'Hather's Hill'. In 1819, the Ottershaw Park Estate was broken up and a large-scale map showing the various lots for sale, prepared about 1817, does not show the hill.

A visit to the Ordnance Survey Headquarters in Southampton revealed two 1" maps dated 1816 and 1863. I also went to the British Library, where they have the earliest Ordnance Survey map of North West Surrey, dated 1806-7. Although Potters Park is shown on these maps and the 1806 map shows a rough shading of the hill, it is not named.

I hoped to discover some old records which might give me a clue to the origin of the hill's name in the Surrey Record Office in Kingston-upon-Thames. Although I looked through many books on Surrey, including the standard 'Victoria History of Surrey' and 'The Place-Names of Surrey', I could find no mention of it. However, I did find a map dated 1832 which gives the name 'Hather's Hill'. A later, undated map, which is interesting in that it shows turnpike roads, toll bars and early railways, gives it the same name. According to 'A Regional Survey of the Railways of Great Britain', the Chertsey Branch of the South Western Railway was opened in 1848.

On the same map are the Wandsworth Common to Crystal Palace Railway, which was opened in 1856 and its Norwood extension, which was opened in October 1857. The Epsom to Leatherhead Railway, which was opened in February 1859 is not. The date of the map is therefore about 1858. The 1871 Ordnance Survey map, scale 25" to the mile is the first to show 'Ether Hill', as all succeeding maps do to the present day.

Why Ether Hill?

Why did the name change from Hather's Hill to Ether Hill in the thirteen years between 1858 and 1871? Was Ether merely a corruption of Heather? The park keeper of the Ottershaw Memorial Fields, a man in his fifties, told me he had always lived in the area and known it as Ether Hill with a long E. Perhaps a Sapper officer detailed to survey the area asked a local: 'Tell me, my man, what is the name of that hill?' and misinterpreted the reply in a Surrey accent 'That be 'Eather Hill, sir'.

But there is another, to my mind more appealing explanation.

The park keeper also told me that the hill had been purchased by the Runnymede District Council from the Borthwick Trust, which had owned the estate. A lady in the legal department of the Council Offices in Addlestone confirmed the purchase, which was made in 1988, and gave me the name and address of the member of the family with whom the Council had dealt.

I wrote to Sir John Borthwick, now living in New York, and received this reply:

'Dear Dr Howat,

In the 1920's and 1930's, there lived in Accommodation Road a Miss Leicester-Pethryn and I believe my father bought Queenwood from her parents. I understand that these late Victorian/Edwardian people had two passions in life - fresh air and Wordsworth. Apparently they sat on a summer's eve on a hill which they had planted with fir trees and recited the works of Wordsworth to each other. If you would read Laoda Mia you will come across "...and ampler ether, a diviner air and fields invested with purpureal gleams..." According to the elderly lady who lived at Childown House they could find no better name for the hill than Ether Hill.

Yours sincerely, John Borthwick.'

Although I was deprived of the hoped-for odour of di-ethyl ether, I find this explanation most attractive.

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FROM LUBECK TO LONDON VIA HANGZHOU: THE 40 YEAR WANDERINGS OF AN ANAESTHETIC MACHINE

Dr D J Wilkinson

Anaesthetic apparatus has always been an item which could easily be exported from one country of design and manufacture to another. All countries have benefited from this distribution of new technology and each country's own anaesthetic techniques are usually the result of a distillation of their own inventiveness combined with these external flavours.

Early apparatus

Initially, anaesthetic apparatus was small, light and therefore easily transportable, not only from place to place, but also from country to country. Some of the early glass vaporisers may have been a little fragile but the metal masks and inhalers of the 19th century spread around the world as the news of anaesthesia spread. Museums of anaesthetic apparatus abroad are full of British equipment, and scenes of anaesthesia, captured on the first photographs, often show familiar inhalers about to be used, or actually in use. There are countless Clover's inhalers, Junker's chloroform bottles and wire frame masks like the Schimmelbusch so depicted.

When apparatus was introduced that utilised nitrous oxide and oxygen as carrier gases in the early part of the 20th century, then the size of anaesthetic equipment increased dramatically. No longer could the nomadic anaesthetist simply carry a small bag with a few 'bits and pieces' around with him. The early Boyle's machines were often described as 'portable' but required considerable strength to so do, especially if three or four full cylinders were attached. Once the next stage had evolved where the machine was incorporated in the anaesthetic table, as made by Deacon in Edgware in the early 1940's, then simple transport or exportation became much more difficult.

It was not only the British manufacturers who believed that big was beautiful, American and German apparatus was becoming equally complex. The Heidbrink Kinetometer, Foregger's Aquameter and Connell's apparatus were all increasing in size and weight. Drager too were not being left out as they incorporated closed circuit systems and ventilators into their machines. In England in the 50's and 60's anaesthetic machines were grafted onto the huge ventilators then in vogue so that the giant Cape's, Barnet's and Blease machines became common sights. Other manufacturers in Europe soon followed this trend and Engstrom machines began to appear in the UK. All these large heavy pieces of equipment tended to stay in the country of manufacture and few were exported to other countries.

Problems in exportation

Third world countries are usually eager to find out about the latest techniques and see the latest equipment on offer. Many companies that manufacture this type of apparatus take advantage of this and sell apparatus that is not only overpriced but is also totally unsuitable for that underdeveloped country. Once sold there is little chance of servicing, calibration or replacement of defective parts, so that hospitals in Africa and Asia are littered with a variety of apparatus which cannot be used and for which hard earned currency has been wasted.

China has become the new frontier for exportation of apparatus, but this has not been the first export drive in this field. A recent lecture tour of North East China confirmed that 'modern western' anaesthetic machines were of only limited use and their own Shanghai-built closed circuit apparatus was both safe and effective for all forms of surgery. The rooms full of European, American and Japanese machines which were 'being evaluated', i.e. were useless to them, were a sad indictment of current sales techniques which care nothing for the end user in the long term.

The diving bell

The receipt of a letter from a friend in Hong Kong which revealed the discovery of an ancient anaesthetic apparatus in a hospital in southern China proved to be the start of a long struggle with Chinese bureaucracy. It was described as looking like a diving-bell with a clock on top, and with a variety of small cylinders hanging from its sides; but perhaps of most importance, it was not in use, and was lying covered in dust in a corner of the operating suite at present.

The Anaesthetic Department in the Hangzhou hospital were happy to let the machine go, but wished to have something in return, especially if their old machine was considered valuable. John Warren, then Managing Director of Tricomed Hong Kong, was able to offer a substantial discount on a new anaesthetic machine especially adapted for the Chinese environment and negotiations began for the exportation of what was now considered to be an ancient artifact.

The new Tricomed machine was delivered to the hospital and once it had been demonstrated and proved serviceable then the 'diving-bell' could be removed. Some two years after its original sighting this specially crated apparatus came out of China by rail to Hong Kong. This large package was then transferred to the docks and sent by sea to the UK and eventually appeared at St Bartholomew's Hospital where its size and the Chinese lettering on its side caused considerable interest.

Identification

It took over an hour of concerted effort with tyre levers, hammers and crowbars to unveil the machine but this was eventually managed. The apparatus (shown in Figure 1) was easily identified as a Drager apparatus, but which one? Fortunately, the Chief Engineer, now retired, of Drager, had published a history of their equipment and there, to my delight, was the Chinese machine.[1] I wrote to Joseph Haupt, the engineer, for further information and this he gladly provided.

Manufactured in 1950, it was a Modell G machine, first demonstrated at the International Congress of Thoracic Surgery in Rome that year. Herr Haupt had designed the apparatus himself for the American market, where its multiple gas combinations were in favour, with machines like the Heidbrink, Foregger and McKesson selling well. Their were no records available as to the number made or their subsequent deployment but some original advertising leaflets still remained.

It was sold for 3,300DM as a basic machine, with extra costs if helium and cyclopropane attachments were needed. Despite its bulk it was described as a compact apparatus which could utilise any combination of two to five gases. It was fitted with two cylinders of nitrous oxide and oxygen with optional carbon dioxide, helium and cyclopropane. The 1-2 litre cylinders made of steel were attached via American yoke connectors which were not

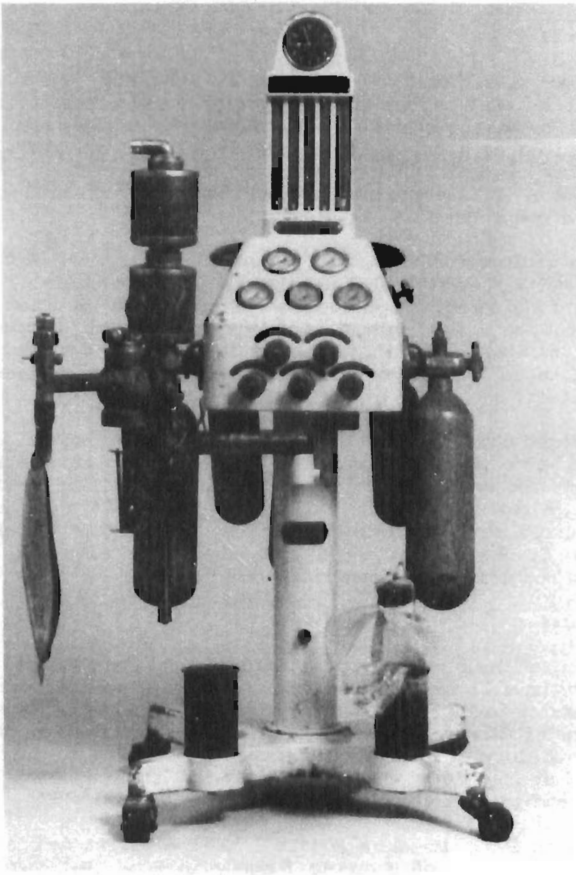

Figure 1
Drager Modell G anaesthetic apparatus of 1950

permitted in Germany as they were all identical, so that inadvertent incorrect connections could be made. Haupt's text refers to many minor incidents occurring during the 1950's until pin-indexing was introduced!

The clock on the Rotameter block 'made time-checks easier for the anaesthetist', while the closed circuit was a modification from the earlier Modell F apparatus. The apparatus is said to have been received with some scepticism initially but later proved popular because of 'its solid and functional design'. Some two years later, in 1952, Drager brought out their Romulus recirculating apparatus, which, although similar in function, was of very different design.

Travels

It is the travelling that this machine has undergone that I find so extraordinary. Made in Lubeck in Germany some time around 1950, it was transported, presumably by rail and sea, half way round the world to Hangzhou in southern China, used for an unknown length of time with unknown results and then abandoned. It was then rediscovered and re-exported by rail and sea again back to England, only a few hundred miles from its birth-place. Drager themselves, only have one such machine in their collection and were pleased to hear of the rescue of this apparatus.

The other strange concept is the apparatus itself, of giant size and weight, yet deliberately designed for export, not for the home market, as was the usual practice.

One may only speculate as to what else is lying in corridors, rooms and cupboards in hospitals all over the Third World which is useless to the present owners yet might be of great value to collectors of such equipment. It is a shame that other modern manufacturers cannot adopt a 'new lamps for old' policy to rescue these vital parts of our anaesthetic heritage.

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THE DEVELOPMENT OF ACUPUNCTURE

Dr T P Nash

Acupuncture was first described in Western literature by the Dutch physician Willem ten Rhyne in 1683.[1] He coined the word acupuncture from the Latin 'acus' (sharp) and 'punctura' (puncture). It refers to the practice of inserting sharp needles into the body to treat pain and disease, and was particularly developed by the Chinese within their traditional system of medicine.

Western medicine

Western medicine has developed from our own traditional medicine, which has evolved alongside Western science. Empedocles (born 492 BC) postulated that there were four basic elements (unchanging substances) and two forces - attraction and repulsion (poetically love and hate). The four elements were earth, air, fire and water.

Empedocles, indeed, founded a school of medicine that stressed the importance of air, both inside and outside the body. The Pythagorean school, led by Alcmaion of Croton, taught that health was due to a balance of forces within the body, with the brain as the centre of sensations, and that there were sensory, animal and 'vegetative' functions. Other schools stressed the value of gymnastics and diet and were interested in psychosomatic medicine.

Hippocrates (born about 460 BC) expanded Empedocles' elemental theory; it was to be accompanied by four qualities: dryness, dampness, heat and cold. The body also contained four humours: blood, black bile, yellow bile and phlegm. In a healthy person these four qualities were in balance. An excess of one or two would lead to some bodily disorder. These imbalances were corrected by bleeding and cupping, which were also used - with scarification, cauterisation, blistering fluids, moxa, and trepanation - to produce pain, irritation and inflammation to combat the chronic pain of headache, backache, sciatica, gout and toothache.

Galen, in the second century AD, extended this doctrine to include the four temperaments: sanguine (warm and pleasant), phlegmatic (slow-moving, apathetic), melancholic (sad, depressed) and choleric (hot-tempered, quick to react). This classification survived in medicine until the 17th century.

Indian science

It is interesting to consider Indian atomic theory, which was more complex and subtle than the Greek. It imported their four element theory and added a fifth heavenly essence. The formation of bodies in the natural world was described in an atomic context. Each of the four elements had its own class of atoms - all indivisible and indestructible. Dissimilar atoms could not combine, only two similar ones in the presence of a third.
The Indian philosophy also proposed a theory of impetus to account for the continuing motion of a body, a very definite forerunner of what was developed mathematically in the West during the scientific revolution.[2]

Chinese medicine

The Chinese never developed an atomic theory, which went against the view of the natural universe as an organism operating according to the interplay of right and natural behaviour. The founder of all Chinese scientific thought, Tsou Yen (Zou Yan) consolidated the Chinese elemental theory that originated at least as early as 350-270 BC. This stated that there were five basic elements which were active principles, not substances, and were associated with organs of the body: water (associated organs - kidney and bladder), metal (lung and large intestine), wood (liver and gall bladder), fire (heart and small intestine), earth (spleen and stomach) and two fundamental forces, the yin and the yang. Yin was associated with clouds and rain, with the female principle, with what was inside, cool and dark. Yang was coupled with the idea of heat and warmth, sunshine and maleness. They could not be found separately as each was the essential counterpart of the other. In every situation one took preference over the other (or one was dominant and the other recessive, as in current genetic theory). The organs associated with the elements were not necessarily the anatomical organs of today, but more what they stood for. Our own language has vestiges of similar meanings - to lose heart, vent spleen, have guts, show gall. These 'organs' formed the basis of the acupuncture meridians. The elements were considered to form a cycle of 'mutual conquest', with wood conquering earth (a wooden spade can dig it up), metal conquering wood (it can cut it and carve it), fire conquering metal (it can melt it), water conquering fire (it can extinguish it) and earth conquering water (by damming it).

Acupuncture originates far back in Chinese history, with records of the practice on bone etchings dating from 1600 BC.[3] The first written documentation dates from about 600 BC. It was a practical method of stimulating the natural responses of the body to disease and was used in both human and veterinary medicine. There was a belief in the close link between men and earthly things (the microcosm) and the universe at large (the macrocosm) echoing their view of the entire universe as an organism. The original acupuncture points bore a specific relationship to the points of the compass and the arrangement of the heavens. It was considered that there was a 'vital spirit' or 'air' which moved within living things, and this motion was facilitated by the implantation of needles. This 'vital spirit' led to the theory of a 'pneumatic' circulation powered by the lungs. A second circulation was considered to exist concerning blood, which was thought to carry a vital 'juice' and was powered by the heart. This theory preceded that proposed by Harvey by 1600 years.

The Chinese physician, with two circulations to consider, put great store by pulse diagnosis. But they also were interested in the general medical state of the patient, the smell of their breath, the cleanliness and colour of the tongue and the beating of the heart. Moxibustion, the burning of wormwood close to, or on the skin at specific points, was also used in harmony with acupuncture, massage, exercise therapy and the use of drugs.

Hospitals were also invented by the Chinese, and increased in number with the arrival of Buddhism. Indeed, the Chinese had quarantine regulations as early as 400 AD.

By 1550, the scientific knowledge in China was far superior to that of the West. Then the West experienced the scientific revolution to produce the era of powerful modern science. This did not occur in China as there was a close association between science and the state bureaucracy, originally defined by Confucius many centuries before. It is also possible that the lack of an atomic theory played its part.

Western medicine was introduced to China in 1822 and at this time the rulers ordered the suspension of the teaching of acupuncture. Further attempts to abolish traditional Chinese medicine were made in 1914 and 1929 as it was deemed to be unscientific. In 1944, Mao Tse Tung appreciated that to cope with the 1.5 million people of the Shensi-Kansu-Ningsia border region, one million of whom were illiterate and mainly under the influence of superstition and the 2,000 practitioners of witchcraft, he could not rely solely on modern medicine. It was economically important to unite modern and traditional medical knowledge and practice.[4]

Acupuncture was first used to provide analgesia for surgery (an appendicectomy) in 1958.[5] A success rate of 90% was claimed, although many of these patients phonated and experienced discomfort during surgery. There was a very strict selection limiting the use of acupuncture to 6-10% of surgical cases. The patients underwent considerable psychological preparation and were premedicated with narcotics. There was no consistency or logic in the points selected, and it was used especially for thyroid, cranial and thoracic surgery.

Transcutaneous electrical nerve stimulation

Other methods of stimulation-produced analgesia have also existed. Scribonius Largus, in 46 BC, described the use of the electric torpedo ray by the Romans for gout and headache. The electric catfish, illustrated in a bas relief in Egypt from 2750 BC, was known as the 'releaser of many' or the 'shaker'. The electric eel from South America was studied by Baron Friedrich von Humboldt in 1800. He stood on one and experienced the development of a painful numbness up to his knees which left him with a violent pain in his knees and the rest of his joints for the remainder of the day. He prophesied that 'the discoveries that will be made on the electromotive apparatus of these fish will extend to all phenomena of muscular motion subject to volition. It will perhaps be found that in most animals every contraction of a muscle fibre is preceded by a discharge from the nerve to the muscle.' He also predicted that electricity is the source of life and movement in all living things.[6]

The Leyden jar had been invented in 1745-6, and this led to the development of various magneto-electric electroanaesthetic equipment. John Wesley used his electrostatic machine to treat 'rheumaticky pains' in a patient 'made helpless like an infant'. After the second shock he felt some change, after the third he was able to raise himself, and after two more he rose and walked about the room, and before noon he was quite well.[7] Althaus described the application of his apparatus to peripheral nerves in England in 1858. At the same time, Francis in Philadelphia was producing dental analgesia for extractions. Oliver in Buffalo and Garratt in Boston were similarly producing dental analgesia and developing its use at other sites. Garratt, in particular, used it for dental neuralgias, hyperalgesia, tic douloureux, toothache and jaw ache. Oliver used it also for amputations of limbs and for childbirth.[8] The Cataphoresis machine of 1925 can be seen in the Charles King Collection at the Association of Anaesthetists, which again was used for dental analgesia.*

Such apparatus is again in vogue - with the modern H-wave and Ultracalm machines.

Modern stimulation-produced analgesia

Acupuncture and transcutaneous electrical nerve stimulation (TENS) for analgesia is now considered in the light of the type of stimulus used. Conventional TENS is a high frequency, low intensity stimulus; with acupuncture, and indeed acupuncture-like TENS, a low frequency, high intensity stimulus. The low intensity stimulus is considered to activate large muscle (Type 1) and large skin (A beta) fibres, possibly through interneurones with gamma-amino-butyric acid receptors, to produce gating with segmental inhibition. The analgesia is often of rapid onset and short duration, and tolerance can develop from continuous therapy. Low frequency, high intensity stimulation (acupuncture) is considered to act by stimulating small muscle afferents (type III, A delta fibres) to produce both segmental and supra-segmental inhibition via endorphinergic and serotoninergic pathways. The analgesia produced has slow onset and long duration, and the thirty minute treatments do not produce tolerance.

What of acupuncture and disease? Electro-acupuncture has been shown to markedly enhance motor and sensory nerve regeneration. Electro-magnetic fields are used to stimulate bone growth and regeneration. Acupuncture-like stimulation of the sciatic nerve has been shown to lower blood pressure for prolonged periods in hypertensive rats. Nausea can also be treated.[9]

Acupuncture can produce a generalised increase in temperature and microcirculation which can promote healing of chronic ulceration, probably due to the release of vaso-active intestinal peptide. Acupuncture also affects the pituitary-hypothalamic system, thereby releasing endorphins. Perhaps more importantly, ACTH is also released, and may be responsible for its effects in treating arthritis and asthma.[10]

Conclusion

Traditional medicine developed with great similarities across the world, but particularly survived the scientific revolution in China. The old science was based on observation. Our new science of strict measurement is slowly discovering modern explanations for the effects of traditional treatment on disease, and modern explanations for the observed phenomena of millenia.

*This Cataphoresis apparatus was on loan for an exhibition between 1989 and 1991 on analgesia and anaesthesia for dentistry and has now been returned to the museum of the British Dental Association in Wimpole Street, London.

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JULIUS JEFFREYS AND THE PHYSIOLOGY OF LUNG VOLUMES

Dr D Zuck

Julius Jeffreys invented the principle of the heat and moisture exchanger, and also the volute humidifier on which John Snow based his first ether vaporiser.[1] In 1843 Jeffreys published a book entitled 'Views on the Statics of the Human Chest',[2] in which he appeared to have made three fundamental contributions to the understanding of lung volumes for which he nowadays receives no credit at all. It is generally accepted that the study of lung volumes had originated with John Hutchinson, who demonstrated his spirometer, and published his first reports, in 1844.[3] Hutchinson's last work on this subject was published in 1846,[4] after which nothing of an original nature was done in this field for almost one hundred years. So it was a great surprise to find that Jeffreys had apparently anticipated some of Hutchinson's work and that he demonstrated a far greater understanding of its physiological implications.

All are familiar with the modern design that appears in the physiology textbooks to illustrate the relationship between the various lung volumes. But this dates back only to 1950, when a meeting of respiratory physiologists was held at which it was agreed to standardise the nomenclature.[5] Those who learned physiology before then will remember that what are now called the inspiratory and expiratory reserve volumes, were known as the complementary and supplementary volumes, or occasionally complemental and supplemental. Here was Jeffreys giving what appeared to be the first coherent account of lung volumes, complete with his own nomenclature, which remained in use for over one hundred years.

The early researchers

The seventeenth century Italian mechanistic physiologist Borelli is credited with being the first to attempt to measure what is now called tidal volume. His work was published posthumously in 1680. The English physician James Jurin repeated and refined his method, and also demonstrated 'that there is more air in the lungs that can be expelled by an ordinary expiration'.

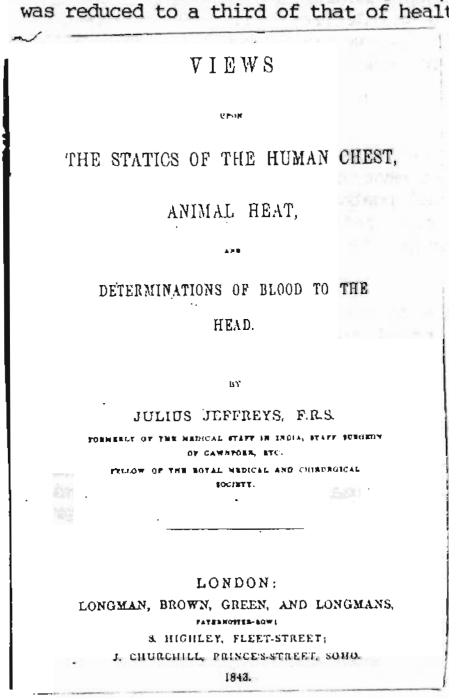
Stephen Hales measured the dead space of a calf's lungs by filling the air passages with water, and he also tried to measure the total pulmonary capacity by inflating the lungs under water and measuring the volume displaced.[6] He also recognised the existence of the residual volume.

Late 18th century and early 19th century views

The person generally and erroneously credited with initiating the study of lung volumes is Edmund Goodwyn.[7] Goodwyn measured the residual volume in several cadavers, by collapsing the lungs and filling the pleural cavities with water. He showed that even after a complete expiration the lungs contained a considerable volume of air. To measure the volume of an ordinary inspiration he devised an apparatus in which air drawn from a closed metal container was replaced by water drawn into it through a tube; the water was then weighed and the volume calculated. So Goodwyn had measured the residual volume, the tidal volume and was aware that a larger volume than tidal could be inspired. Most writers credit him with being the first to describe and measure the residual volume but Hales had recognised it before this. Goodwyn's treatise had a practical purpose, resuscitation from asphyxial death, and attracted a lot of notice.

The work that became accepted as a standard was published by Robert Menzies in 1790.[8] He used an allantoid, a large membranous container of known volume, to measure the tidal air. He breathed into it via a valved connector until it was full, and calculated the tidal volume by dividing the known volume of the container by the number of breaths. He checked his results by a plethysmographic method, immersing a man in a hogshead of water up to his chin. He may have been the first to use this technique. Although little known today, Menzies' work was widely accepted, and quoted in the physiology textbooks as the most accurate available, for the next forty years.

A quite different method of measuring lung volume was used by Humphry Davy.[9] The method that he invented, breathing an inert gas, hydrogen, and calculating the lung volume from the percentage and quantity that remains in them, is in the principle still in use today. Allen and Pepys during 1808-09,[10,11] showed that successive samples taken during a single exhalation contained different proportions of oxygen, nitrogen and carbon dioxide, so establishing the difference between dead space and alveolar air. They then went on to a remarkable study of nitrogen washout. Thackrah[12] measured the vital capacity of flax workers, and showed that it was reduced to a third of that of healthy persons.


VIEWS

UPON

THE STATICS OF THE HUMAN CHEST,

ANIMAL HEAT,

AND

DETERMINATIONS OF BLOOD TO THE

HEAD.

BY

JULIUS JEFFREYS, F.R.S.

FORMERLY OF THE MEDICAL STAFF IN INDIA, STAFF SURGEON OF CAWNPORE, ETC.

FELLOW OF THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY.

LONDON:

LONGMAN, BROWN, GREEN, AND LONGMANS,

PATERNOSTER-ROW;

S. HIGHLEY, FLEET-STREET;

J. CHURCHILL, PRINCE'S-STREET, SOHO.

1843.

So what was the approach to this subject at the beginning of the 1840's? The most highly regarded physiology textbook was Bostock's 'Elementary System', first published in 1826. This devoted 14 pages to the subject of lung volumes, much of it a review of previous work, taken largely from the 'Essay on Respiration' that he had published in 1804. Bostock discussed the average bulk of a single inspiration, which we now call the tidal volume, and showed that he was aware also of the residual volume, the expiratory and inspiratory reserve volumes, and described them only as observational phenomena, but he did suggest further lines of research.

Bostock's book was gradually replaced by the more modern textbook written by William Carpenter, 'Principles of Human Physiology', the first edition of which was published in 1842. Carpenter's whole discussion of lung volumes is 22 lines long. It is mainly concerned with listing the discrepancies between the various attempts to measure the volume of what he calls the ordinary respiratory movement.

Jeffreys' contribution

Jeffreys' book (Fig 1) was published in the following year, 1843, but had been in preparation for some time, because it was to have been the introduction to the series of papers on 'Artificial Climates' that he had been persuaded to published separately in the 'London Medical Gazette'.[13] He begins by explaining that people have hitherto studied the contents of the chest, liquid or blood and gaseous, separately, and have obtained only a partial view of their importance. By the term 'statics' he intends to denote a comprehensive study, encompassing the relations and proportions that these contents bear to each other. Since statics is the accepted term for the balance of pressures and the maintenance of the condition of things, which is his subject, that is the word he has chosen.

He continues: 'Every time a person yawns or sighs an experiment is unconsciously made, and a curious and important fact declares itself, inviting further attention... . every person may,.... make the following experiment. At the moment when he has completed an act of inspiration... he may, (instead of breathing out) force himself to continue to inspire air, when he will find that his chest can take in, before it is distended, a quantity of air very much larger than that of an ordinary breath.'
'Again, after an act of expiration, at the moment when he would instinctively inspire he may, instead.... continue to breathe out for a great length of time....(and) .... if it has not occurred to him to make the experiment before, he will find to his surprise, that when he supposed his chest to be empty, it still contained a vast quantity of air.'

He continues that the mechanism of the chest is such 'that there is still a considerable quantity of air which cannot by any effort be expelled. This is the quantity which remains in the body after death. To these several quantities we have to add the space occupied by the air of ordinary respiration... . We have then before our view four distinct quantities which it is necessary we should distinguish by certain terms of reference.'

'Commencing with... the air which we cannot expel... we may call this by a term which has been employed by others - the residual air. Then we have, on the top of this, the large bulk, which we can expel after an ordinary out-breathing; this may be named the supplementary air, it being the quantity filling the chest below the region of respiration. Upon this comes the ever-fluctuating air of respiration, which, in its influent state, may be known as 'the fresh breath' and in its effluent state as 'the stale breath'. (Later he uses the expression 'tidal or respired' air, and appears to have been the first to do so.) Over and above all this we have the capability of the chest to receive, when the fresh breath is already in, the occasional quantity which enters with a yawn or a sigh, and which may be termed the complementary air.'

He goes on to review the values arrived at for these volumes by earlier researchers, and mentions his own researches which, he says, involved numerous trials, carefully made, with an apparatus constructed to insure accuracy, but about which he gives no information at all. The one volume he omits, and shows recognition of, is the dead space, and this was to lead him rather astray.

Volume measurements

He gives the following as being in his opinion the best values, derived from his own and the researches of others

	Cubic inches	cc equivalent (16.4 cc/cubic inch)
Residual air	120	1970
Supplementary air	130	2130
The breath	26	425
Complementary air	100	1640

He next points out that Bostock has already expressed surprise that the volume 'which I have ventured to name the supplementary air', has been overlooked by a number of writers, including the great Liebig, all of whom regard the total volume of the chest as being made up of the residual air and the air of respiration. But since during normal breathing the lungs contain both the residual and the supplementary air, he proposes that these two volumes be called the resident air. Nowadays, of course, we call this the FRC.

'Now,' he continues, (and here he begins to go astray in two directions) 'because physiologists have always concerned themselves with the tidal volume only, they have assumed that it is this air only that enters the alveoli at each breath and effects changes on the blood gases. But there is no way known to physics whereby fresh air introduced through the throat can shoulder aside the gases already present in the lungs, and enter the alveoli. The fresh air of each breath must gradually mix with the resident air, descending further and further into the lungs.

Similarly, the stale air will gradually ascend and be exhaled. The advantage of such an arrangement is that the alveolar gases reach a state of homeostasis, and can exchange smoothly with the blood during all stages of the respiratory cycle. In contrast, the current view implies that gaseous exchange with the blood will be constantly fluctuating, being maximal during inspiration and minimal at the end of expiration. To be efficient this would require a tidal flow of blood through the pulmonary vessels to match the varying supply of oxygenous air. But we know that there is no sudden ebbing and flowing of blood thorough the lungs to correspond with the extreme ebbing and flowing of the breath. So now we may surely perceive the beauty of the arrangement which lodges a large quantity of resident air in the chest.'

At this point he embroils himself in the sort of circular argument that he was occasionally prone to, by following a mistaken premise to its logical conclusion. 'If fresh air is much diluted before it reaches the depths of the lungs, it follows that the concentration of gases is much different at that level. We know that exhaled air contains about 5% carbon dioxide; therefore in the alveoli it must contain more, perhaps 10% - and hence only 10% oxygen, since the nitrogen percentage is invariable. Now our first instinct is to reject the idea that the air in the alveoli, which after all is where gaseous interchange with the blood is taking place, can be so stale, but logically it must be so. Since it is so, the Creator must have had a good reason for making this arrangement, and the reason can only be that a higher content of oxygen than 10% would be harmful to the delicate lining of the lungs; and this is why the Creator had provided the resident volume, to dilute the atmospheric air to a safe level.

He continues with a discussion of the functions of the various volumes. 'The resident air is important because, as we have just seen, it dilutes the tidal air, diluting also any irritants that it might contain, and allowing also for warming and humidification. Then he points out that normal breathing takes place at a certain position in the range of total lung volume, and asks why this is so, whether it varies from time to time in the same individual, and whether it occupies the same locality in all persons. For example, we could breathe only on our residual air, and we can do so voluntarily for a brief period. But this would exclude the diluting effect of the supplementary volume, and also would cause the pulmonary vessels to become convoluted and compressed, so that the circulation would become obstructed, as in the fetal lung.

The reason why we do not normally breathe with a full chest, at the top of the complementary volume, is that our demand for air fluctuates, as during exercise or coughing, or when we are drowsy and need to yawn. Also, both complementary and supplementary spaces may be required during speech, and are essential for the art of oratory and for the playing of wind instruments.'

As regards variations in the location of the tidal volume in the range of total lung capacity, he points out that the chief muscles of the trunk arise from the chest wall, and the larger their base, the greater their power, so that if we wish to make a considerable effort, we take a deep breath first, and retain all or most of it. It follows that people who are accustomed to heavy work or strenuous exercise tend to be deep or broad-chested, with a larger volume of supplementary air, and a greater potential capacity for complementary air. He concludes that he is quite sure, from his experiments and observations, that the location of ordinary breathing in the range of total lung capacity, varies between persons, and in the same person in different circumstances. In general, both in health and disease, he thinks it is an advantage to have a large volume of resident air, and he suggests exercises to this end. Some of this theory is verified by current understanding of lung physiology.[14]

Conversely, Jeffreys continues, sedentary workers tend to have a smaller resident volume, especially those who sit doubled over at their work. He mentions the work of Thackrah, and his own visit to Sheffield to study the effects of stone and steel dust on the lungs of the cutlery grinders. He is scathing also about the effects on young women of tight lacing, whose folly nearly reduces the figure to that of an insect, and whose countenances betray the state of the lungs.

It is surprising that Jeffreys didn't make the simple comparison of the volume of the anatomical dead space, which had already been estimated by others, with the tidal volume, and so demonstrated to himself that more than half of each breath must indeed enter the alveoli. Also he had disregarded both that the chest expands during inspiration and the anatomy of the tracheo-bronchial tree, and instead visualised successive tidal volumes diffusing into the lungs from the apex downwards. He probably knew nothing about velocity profiles in fluid flow, first described during the early 1840's by Hagen and Poiseulle, which to some extent determine mixing and the tidal component of alveolar ventilation. Nevertheless he seems to have been the first to demonstrate an appreciation of the importance of perfusion matching ventilation, something that was not seriously taken up again until at least the 1930's, if not later.

Jeffreys' influence

Publication of Jeffreys' book brought an attack from a Dr Calvert Holland, already well-known for his argumentative approach to life, alleging that Jeffreys had plagiarised the idea of the pulmonary mixing of air from one of his own writings. Jeffreys replied politely but entertainingly, saying that he had been quite unacquainted with Holland's book and pointing out, quite correctly, that in any case there was no similarity at all between what Holland had suggested, and his own thesis.

Even Hutchinson, in the following year, 1844, in his first accounts of spirometry,[3] said that he had confined himself to determining 'what quantity of air we are able to expel from the lungs by the greatest voluntary effort we are capable of exercising. Owing to the various terms given to designate the different divisions of respiration, I have found it difficult to separate this division from the chaos of physical experiments hitherto made upon the lungs ... I have used the term "capacity" to signify the quantity of air which an individual can force out of his chest by the greatest voluntary expiration, after the greatest voluntary inspiration.'

Hutchinson was only interested in using what he called 'capacity', and the maximum attainable intrathoracic pressure as measured by a sustained expiration into a mercury manometer, as indicators of lung disease.[4] He knew that the capacity varied considerably in the healthy, and he was able to show a direct relationship between capacity and height. It was his ability to predict accurately the capacity of any healthy individual, and to confirm it with his spirometer, that made such a great impression on his first audiences.

But by 1846 Hutchinson also was describing the lung volumes, and denominating them residual, reserve, breathing, and complemental air, the last three comprising what he now called the vital capacity. Surely it is a little too much of a coincidence that he was now adopting both Jeffreys' approach, and with a slight modification, part of his terminology.

The eclipse of all earlier work, including Jeffreys' contribution, is due mainly to Kirke's 'Handbook of Physiology'. First published in 1848, it ran through about twenty editions, eventually becoming Halliburton's, and was still available in the 1940's, so it must have influenced several generations, both of students and of textbook writers. Kirkes gave a brief account of Hutchinson's work 'from whom nearly all our information on this subject is derived....' and this was repeated not very much changed until after 1900. Even as late as 1924 Halliburton was giving the volumes in both cc's and cubic inches.

For the best part of a century the treatment of lung volumes in the textbooks was dominated by Hutchinson's account of his work, and virtually everyone reproduced at least one of his illustrations. But all the many physiology textbooks that I have looked at that were published between the 1870's and 1950 had also adopted Jeffreys' terminology, or with a variation of the suffix, without any attribution. The OED attributes the first use of the word 'supplementary' in this context to Dunglison's 'Medical Lexicon' of 1857, and of 'complementary' and 'tidal air' to Huxley's 'Physiology' of 1857. As we have seen, all of these are incorrect.

Summing up, Jeffreys appears to have been the first to give a clear and coherent account of the lung volumes, the first to attach an accepted nomenclature to them, and he was the first to think seriously about their possible functions and significance in the mechanics of respiration, and the first to draw attention to the importance of perfusion matching ventilation. It is fair to say that no other work on the subject of lung volumes stands out as a comparable landmark.

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