The History of Anaesthesia

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Anaesthesia of today is the culmination of many earlier discoveries and events.

Surgical procedures are not a recent thing. Mankind has been carrying out operations for thousands of years. The skeletal remains of our earliest ancestors – the European Neolithic man – display evidence of possible surgery with surgical burr holes in the head. It is likely that such an event was to let out evil spirits.

Certainly, by the times of the Greeks and Romans, surgical procedures, albeit fairly minor, were taking place. In ancient India surgery was well advanced with the development of many surgical instruments and even plastic surgical procedures having been described. (The surgical reconstruction of an amputated nose by the use a rotational flap has been described.)

Around 900-1000 AD the Arabs in Andalusia were performing abdominal surgery. Islamic surgeons and physicians had described many operations and medical procedures including bladder stones and caesarean section. The Islamic practice of medicine was a thousand years ahead of western medicine and much of what was claimed as new was a rediscovery of ancient techniques lost to the West.

Toward Anaesthesia

Modern anaesthesia was not discovered until 1846, hence the control of surgical pain was poor and an ability to perform an operation was limited due to the patient's ability to tolerate pain and remain still. Early methods used to provide anaesthesia were use of the drugs:

- Opium (poppy)
- Mandrake (hyoscine)
- Alcohol
- Cannabis
- Cocaine.

Medical literature of the Middle Ages described an anaesthetic method called the soporific sponge. Albucasis (940-1013) and Ibn Zuhr (1091-1161) were surgeons in Islamic Spain who described the use of the sponge for surgery.

Heinrich von Pfolsprundt, a German military surgeon, gave the first European account of plastic surgery and the use of the soporific sponge in 1460.

The soporific sponge is a description of inhalational anaesthesia. The soporific sponge predates Christ and went under many names such as the Arabic sponge, or the Roman Sponge that was offered to those to be crucified. The sponges from different areas may have contained slightly varying components, the Roman sponge traditionally containing mandrake wine.

The history around the sponge is fascinating and may be the basis of the potion that Juliet is given in Shakespeare's Romeo and Juliet. (BMJ 1996; 313: 1630-1632 Narcosis and Nightshade)

The sponge continued to exist in the 1800s, revived by Dr M. Dauriol who recorded five cases in which he used the sponge for surgical procedures in 1847.

The sponges were soaked in plant extracts from opium, mandragora, hemlock, ivy, lettuce and daphne mezereum, all sources of scopolamine, morphine and atropine. The sponge was allowed to dry. Before surgery the sponge was soaked in hot water and applied to the nostrils. To wake the patient a sponge soaked in vinegar was applied to the face and under the nose. The actual effectiveness of the sponge has been questioned.

The use of the Arabic sponge may have helped develop surgery in ancient Islam.

Other methods to control pain were also used such as:

- The application of cold (packing a limb in ice)
- Pressure over nerves
- Pressure over the carotid artery
- Hypnotism and other psychological methods such as trance. The most famous practitioner, perhaps, was Anton Mesmer who introduced Europe to "mesmerism"
- Concussion
- Bloodletting (which probably worked through reducing consciousness).

Surgical procedures were largely superficial procedures such as amputations, particularly on the battlefield; the lancing of abscesses, and the excision of largely superficial tumours.

Elective surgery was performed infrequently. The records of the Massachusetts General Hospital from 1821 to 1846 show a total of only 333 cases. Surgery was a last ditch approach. (John T Sullivan in Surgery before Anesthesia in ASA newsletter Sept 1996 vol. 60 number 9 pg. 8-10)

However some procedures were quite large operations such as mastectomy (excision of the breast). There are vivid descriptions of this procedure performed with out anaesthesia. The English author Fanny Burney wrote to her sister in 1812 to describe her operation (a mastectomy)

> "When the dreadful steel was plunged into the breast, cutting through veins, arteries, flesh, nerves, I needed no injunction not to restrain my cries. I began a scream that lasted unintermittingly during the whole time of the incision, and I marvel that it rings not in my ears still ....I concluded the operation over. Oh no! Presently the terrible cutting was renewed and worse than ever... yet again it was not over, I then felt the knife rackling against the breast bone, scrapping it! This performed while I remained in utterly speechless torture....." The surgeon she described from her recollection of looking up at him at the end of the procedure was "...pale nearly as myself, his face streaked with blood and its expression depicting grief, apprehension and almost horror"
>
> *from ASA Newsletter Sept 1996 vol. 60 no 9.*

Speed of the surgeon was paramount. The faster the surgeon the less the time needed to endure the agony of surgery. The more renowned of the surgeons often got their medical students to clock the time for an amputation.

However it is not to say that had anaesthesia been available that types of surgery performed today would have existed. Complex procedures have required the development of antibiotics, antiseptics, drugs to maintain the blood pressure and the ability to give fluids and relace blood etc. Operations on the thorax required the development of muscle relaxants for example.

Where did western anaesthesia begin?
The starting events…

The early history

William Harvey (1578-1657) discovered the circulation of the blood and published his discovery in 1628. This discovery meant that an injection into the blood could carry a substance throughout the body. This was shown in 1665 when both Sir **Christopher Wren** (1633-1723) and **Robert Boyle** (1627-1691) injected opium into a dog, and **Sigismund Elshol**d (1628-88) induced unconsciousness in a dog by the injection of opium. This effect was again later discovered in 1840 when the lancet medical journal described the effects intravenous alcohol ether and opium in dogs.

(Christopher Wren was involved in the formation of the Royal Society of Anaesthetists. He was an assistant to an eminent anatomist; he later became the Gresham Professor of Astronomy in London in 1657, at the age of 25. He later became interested in architecture. He is responsible for such wonderful works of architecture as St Paul's in London. Many of the world great discoveries were made by men who had involvement in a variety of fields than stretched from science, social science to theology).

Joseph Priestly (1733-1804), who trained as a minister and became a schoolmaster, was the first to prepare oxygen. He noted that this gas was better at supporting combustion and respiration than air; he called it depholgisted air. (The phlogiston theory was that "phlogiston" was a part of all combustible materials and was liberated by their combustion and by an animal's respiration. Because this new gas allowed easy combustion it must contain less phlogiston. This type of quite erroneous science often coloured many discoveries and delayed further scientific work).

He had in fact discovered oxygen (1771). Priestly also isolated ammonia and nitrous oxide.

Valerius Cordus, possibly aided by **Paracelsus**, discovered ether, also known as sweet oil of vitriol, in 1540. Paracelsus noted that the salt, when eaten by chickens, caused them to sleep and wake without injury.

Its effects were also noted by Michael Faraday in 1818. Likewise Sir Humphrey Davy inhaled nitrous oxide to eliminate the pain of toothache in 1798 and suggested its use for analgesia in surgical procedures. Little note was taken of these suggestions. Both Nitrous oxide (laughing gas) and ether were relegated to drugs of abuse and/or entertainment (ether frolics). The mind altering effects of both drugs was well known but lost to medicine, the first anaesthesia agents being discovered more than 300 years (ether) and 70 years (nitrous oxide) before their medicinal use.

Around 1825 Henry Hickman carried out operations on animals using CO2 with freedom from pain and so established a platform for inhalational anaesthesia. This was the first use of inhalational anaesthesia, a development that was ignored by the scientific community of the time. Hickman died in 1830. Without his death anaesthesia may have developed more rapidly.

In experiments in the 20th century CO2 was also deliberately used to produce unconsciousness.

The start of anaesthesia

Horace Wells

Horace Wells, a dentist, saw the administration of nitrous oxide at a travelling show. The nitrous oxide administered by **Gardiner Quince Colton** (a travelling lecturer) was given to a chap who, under its influence, banged his shin but had no recall of the event. Wells thought that it could be used for pain control in dentistry and found it effective in that role. He gave an unsuccessful demonstration at the Mass General hospital in 1845 and was discredited when the patient complained of pain. He continued to use the method himself but gave it all away to tour the country with a troupe of performing canaries. In the end he wound up a chloroform addict and, following arrest for throwing acid at a prostitute, committed suicide in a New York jail by cutting his femoral artery. Nitrous oxide, like Wells, disappeared from the science until Colton reintroduced it in 1863.

Crawford Long

Crawford Long, in Jefferson Georgia, administered ether to a patient on 30 March 1842 for the excision of a cyst. Long was aware of the potential of ether through his own inhalation of the drug. He however did not publish his results and hence is not credited with the discovery of anaesthesia.

During the early 1840s laughing gas was the subject of much discussion and a number of demonstrations of its effects on volunteers. In January 1842, several of Long's friends induced him to let them have a nitrous oxide frolic. No nitrous oxide was available but Long offered sulphuric ether as a substitute, explaining to his friends that it was equally exhilarating and as safe as nitrous oxide. After observing that the young men who had inhaled the sulphuric ether did not experience pain, Dr Long decided to test its ability to produce insensitivity in his practice.

On March 30, 1842, Dr Long administered sulphuric ether to James Venable and removed a small tumour from his neck. This was the first recorded surgical procedure using inhalation anaesthesia. On June 6, he removed another tumour from Venable's neck and on July 3 amputated a boy's toe. By September, Long had performed eight operations using ether as the anaesthetic. This experience with ether was not published until December 1849, as a result of the controversy over W. T. G. Morton's claim to priority in its discovery. At that time Dr. Long described his first five operations using ether in a paper in the *Southern Medical and Surgical Journal* under the title "An Account of the First Use of Sulphuric Ether by Inhalation as an Anaesthetic in Surgical Operations".

Early experiments with ether were largely as part of sideshow demonstrations.

An impression of the first demonstration of ether.

W. T. G. Morton

W. T. G. Morton of Boston introduced anaesthesia as it is known today. Morton was a dentist that had prosthetic work as his specialty. At the suggestion of Charles T Jackson, a chemist and geologist, Wells applied liquid ether to tooth sockets to deaden the pain. He observed the effects the inhalation of the ether vapour had on his patients. On The 16th of October 1846 the first published general anaesthetic was administered. Ether was ether was administered from a glass flask. The flask had a breathing tube that was placed in the patient's mouth. Inhalational anaesthesia had begun.

The event took place in an operating theatre (called a theatre because of the tiered seating for the medical student audience) in the Massachusetts General Hospital, which is now preserved as the Ether Dome. The surgeon **Dr J.C Warren** removed a vascular tumour from the jaw of his patient **Gilbert Abbott**.

A re-enactment of the first anaesthetic

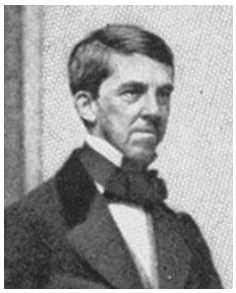
The news of this event was spread worldwide mostly by steamship. One ship, the wooden paddle steamer Acadia, spread the news to Canada, Scotland and England. The first anaesthetic given in Britain occurred on December 19th 1846. Anaesthesia was administered in Scotland on this same day. Ether had its first use in South Africa by 17 April 1847 and the first anaesthetics were given in Australia on 7 June 1847: one in Launceston and the other in Sydney.

The news of anaesthesia was brought to New Zealand by the ship Waterwitch. (Gwen Wilson One Grand Chain. The history of anaesthesia in Australia 1846-1962 vol 1. The Australian and New Zealand College of Anaesthetists 1995)

The first anaesthetic given in New Zealand was on September 26 1847. The ether was administered by **Mr Marriot** who had made the ether inhaler. The patient was a prisoner who had a tooth extracted while still in gaol. Wellington hospital saw the second anaesthetic which was given later that same day, this time to a Maori Chief who had a tumour removed from his back.

The first recorded anaesthetic given in Auckland was some six months later on 15 March 1848. The reason for the delay is not known.

Morton tried unsuccessfully to patent ether using the name “Letheon” and tried to disguise the nature of the drug he was using by adding various perfumes. He spent many years arguing with Jackson as to whom the credit for the introduction of anaesthesia belongs.



Oliver Wendell Holmes

Oliver Wendell Holmes, Professor of anatomy and physiology at Harvard Medical School, suggested the name anaesthesia for this new branch of medicine. (From the Greek word anaisthesia, ‘lack of sensation’)

John Snow a London physician used scientific principles in the administration of ether and devised inhalers in which the concentration could be controlled. Snow described some of the planes (stages) of anaesthesia; Snow is also famous for the removal of the Broad Street pump handle in 1854 believing that cholera was water borne and that the broad street well was a source of that contamination. This action terminated the third cholera epidemic in London.

John Snow

Snow gave chloroform to Queen Victoria for the birth of prince Leopold on April 7 1853. This event legitimised the use of analgesia and anaesthesia in obstetrics as until this time analgesia in childbirth was frowned upon because of the passage in the Bible:

> “I will greatly increase your pains in childbearing; with pain you will give birth to children”
>
> Genesis 3: 16-17

James Young Simpson

In 1847 James Young Simpson a physician of Edinburgh introduced chloroform as an alternative anaesthetic agent. He felt that chloroform had advantages over ether in that it had a faster induction, was more pleasant to breath and less was needed. Chloroform became the most popular agent in Britain, gaining wide support.

The third major personality in British anaesthesia was **Joseph Clover** who was a physician anaesthetist. He investigated the use of chloroform and developed inhalational equipment for its administration.

The administration of anaesthesia in Britain, which was the most advanced nation in the world at that time, was quite clearly in the hands of medical men. They researched the subject due to the work of the above three men. The American medical community were not as enthusiastic. There was a slow spread of the technique through the Americas: ether was given in Cuba on 10 March 1847, and in Mexico three months later. The process was something that the dentists were interested in, and it was largely left to the dentists to promote its use. As such it fell in to the control of the non-medical community.

In Britain, anaesthesia research introduced new drugs such as chloroform, a much more difficult and dangerous drug to administer than ether, which could virtually be given by anyone. This difference resulted in a situation today where in the US anaesthesia may still be administered by non-medical personal such as a nurse anaesthetist or a physician’s assistant.

A list of important dates

Other major developments in the history of anaesthesia are:

500 BC	Opium analgesia described by Hippocrates
1544	Ether synthesised
1596	South American arrow poison described
1628	Harvey describes the circulation
1665	First IV injection of opium into a dog
1776	Mesmer describes hypnosis
1772	N2O discovered
1796	Moore compresses nerves to produce local anaesthesia
1829	Cloquet uses hypnosis for mastectomy
1847	First veterinary treatment using anaesthesia 1847 Veterinary College London
1848	First anaesthetic death. Hannah Greener aged 15 died after chloroform administration (she had had a toenail removed)
1853	Invention of the hypodermic syringe and needle
1860	Cocaine isolated
1863	Popularisation of the use of N20
1867	Prof Lister introduces antiseptic surgery
1884	Demonstration of the local anaesthetic properties of cocaine on the cornea
1894	Harvey Cushing advocated the use of anaesthetic record charts
1898	August Bier introduced “spinal anaesthesia”
1917	Boyle’s anaesthetic machine, a N2O and O2 machine, first described
1920	Magill and Rowbotham developed endotracheal anaesthesia
1929	Fleming discovers that the mould Penicillium notatum inhibits bacteria
1930	The circle absorption system introduced by Brian Sword
1932	Association of anaesthetists of Great Britain and Ireland formed
1934	Thiopentone popularised Australian society of anaesthetists formed
1939-42	An ear oxygen meter developed and term oximeter coined
1940	Preparation of an active and concentrated form of penicillin described
1945	The American Society of Anaesthetists (ASA) formed
1942	Muscle relaxants introduced.
1952	Faculty of RACS formed Pin index system introduced
1951	Halothane synthesised
1973	Prototype pulse oximeter used clinically
1983	LMA use described
1984	Propofol in soya bean oil introduced
1987	First clinical use of desflurane

The development of the anaesthetic machine

The anaesthetic machine of today is based on the constant improvement and the addition of new and safety improving technologies.

The first anaesthetics were given not from a machine but from vaporisers or inhalers. Morton gave his ether through a simple inhaler. A breathing tube was placed in the patient's mouth and valves separated the inspired and expired gases.

The open drop technique involved using a folded handkerchief over the patient's face, leading to the development of masks. Millions of patients were anaesthetised with open masks. These masks were generally open mesh frames that were covered with cloth; ether or chloroform was dropped on to the cloth. Further development of these masks involved a lip to prevent spillage of liquid onto the patient eg a Schimmelbusch. What we call masks were called face pieces.

A Schimmelbusch mask

Anaesthetic machines were, and still are, either continuous flow or intermittent device machines. An intermittent device, also known as a demand device, only has a flow of gas with the patient's respiration. These devices were most commonly used in dentistry and obstetrics.

A Boyle's machine circa 1950s

The best-known continuous flow machine was the Boyle's machine. Until the development of the electronic machine all pneumatic machines worked on the basic principle of the Boyle's machine.

The original Boyle's machine was a device made up of two N20 cylinders and two O2 cylinders in a box with a water sight flow meter and an ether vaporiser. It had a pressure gauge on the cylinders and fine adjustment reducing valves. There was a spirit flame to prevent obstruction of the valves caused by freezing of water in the gas supplies. There was a cattlin bag, a three-way stopcock and a facemask.

A Boyle's vaporising bottle was later added to the flow meters and later again the flow meters were changed, via a few permutations, to fixed pressure rotameters. Much later, safety developments to the rotameters saw entry of oxygen as the last gas admitted to the back bar so that a leak in the other rotameters can not dilute the oxygen delivered, and the international oxygen knob was introduced with the oxygen knob set forward of all other knobs.

The oxygen flowmeter was later linked to the nitrous oxide flow meter such that no less that 25 percent oxygen could be delivered. An anti-hypoxic device for use whenever nitrous oxide is administered became a requirement of the ANZCA in January 2002.

The development of the machine saw the addition of new advances and safety devices.

Vaporisers developed from simple bubble through or flow over devices often using technology of other industries (the Goldman vaporiser little more than the bowl from a carburettor as used on a petrol engine) to devices that could guarantee a constant output over a given range of flow.

The use of ether, an explosive agent whose ignition caused many operating room deaths to both patients and staff, required the reduction of sources of ignition. Movable machines required anti static wheels, and the operating room antistatic floors.

The potential for loss of oxygen introduced the need for an oxygen warning device. Unlike earlier anaesthetics given via an open drop, the safety of room air was no longer available. The development of the oxygen warning device is instructive on how many developments occurred. An ideal failure device should be reliant solely on the gas the device is monitoring. One of the earliest and common devices was the Bosun alarm. As oxygen pressure falls a whistle sounds but the whistle is from the reduced pressure of oxygen opening a valve to N20. A light would also flash but the light required battery power and could easily fail. Earlier models even had a switch to turn the light off and a switch to turn off the N2O supply to the whistle.

The Ritchie whistle was developed in Dunedin in the late 60s. The Ritchie whistle operated on residual oxygen in the system and did not rely on a second gas to provide the alarm.

The Howison alarm also from Dunedin was a refinement of the Ritchie whistle. It cut off the nitrous oxide a whistle sounded and oxygen was supplied at a reduced rate from a reserve cylinder.

Pneumatic machines all have refinements of this type of system.

Further safety features

- The pin index system for cylinders has been an Australian standard since 1955
- The introduction of the ventilator alarm
- Patient safety valves in the circuit and machine
- Sleeved index and similar system for gas delivery to the machine
- Colour coding of cylinders and pipelines.