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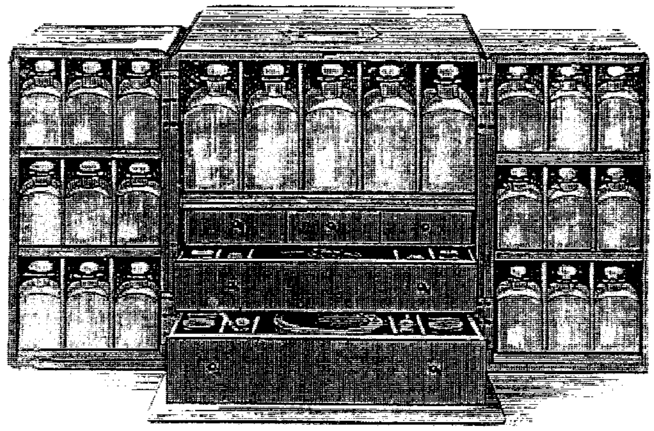
Historical Medical Equipment Society



Bulletin
No 6

July
1999

NEXT MEETING
Make a Note in Your Diary for the Meeting on Saturday 16th October, 1999 at the Royal London Hospital. Details will be sent out later.

Historical Medical Equipment Society

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EDITORIAL

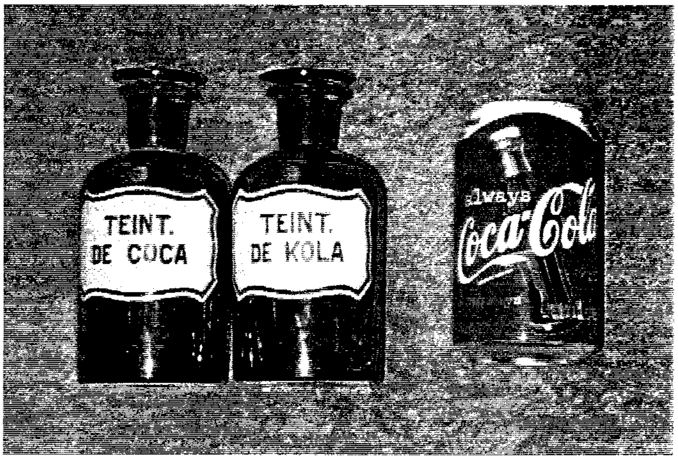
Your chairman, John Kirkup wrote the last editorial and seems to have had the magic touch, at least as far as articles are concerned because this time I have the greatest pleasure in saying that I have more than I need for one bulletin. Dave Peden, who handles the printing side at Philip Harris Medical, has said he will try to fit all I send in, by setting it in smaller type if necessary but it may still mean that one or two authors do not see their articles this time. Please however, rest assured that contributions are welcome from anybody and everybody and will be kept in rotation for the next Bulletin.

A good meeting was held at the Royal College of Surgeons on 8th May, attended by more than 20 members. A particularly interesting point was made by a non-medical member who said that there was no other society which catered for their interests, i.e. just a fascination with medical equipment without a medical background. He was joined by a couple of other non-medical members who said they really hope the society will continue. This is very pleasing. Perhaps we could hope that one of them might write an article about how he/she came to have such an interest?

The next meeting, advertised above, will be held on 16th October at the Royal London Hospital. Marios will be sending out notices nearer to the time with full details of speakers etc, but put the date in your diaries now so we can have a good turn-out, and please keep sending any news, articles or suggestions which are of interest. The first meeting for 2000 will be held in Bath on 6th May, so diaries can also be written in for that date.

Belinda Heathcote

Coca and kola drinks - the real thing? By Dr Marios Kyriazis



While certain old medical items have no great historical or monetary value they can nevertheless give us useful insight into past medical practices. This is true of a pair of pharmaceutical jars which was found in the collection of an elderly pharmacist from Cyprus who had originally purchased his equipment in France.
Both jars (pictured) are dated 1898, measure 14 cm X 6 cm and are made of brown glass. The jars still contained the original ingredients which had an odour strongly reminiscent of the modern Coca Cola drink, until 1995 when they were cleaned out.
Employees of a pharmaceutical journal and officials from The Coca Cola Company were amused to inspect these two jars and realise that modern products may not be as original as the manufacturers want us believe.

Coca

The Coca plant (erythroxylon coca) is native to Peru and

Bolivia. It has been used by the South Americans for hundreds if not thousands of years. Its active substance is cocaine, which in its natural form is buffered by the cocaine alkaloid (1).
Synthesized cocaine is a strong stimulant whereas natural cocaine is only a mild stimulant, elevates mood, clears the mind and it is reputed to be an aphrodisiac. Coca was used in order to tread gastric conditions such as dyspepsia, gastralgia and vomiting. If used externally it can reduce the symptoms of stomatitis and gengivitis (2). According to Indian beliefs it can also aid longevity and boost health in later life. It was taken in the form of tea and, during 1884 a certain Angelo Mariani produced coca wine which was "a brain tonic and a cure for all nervous conditions".
Coca leaves were officially listed in the British Pharmacopoeia of 1898. For a period, it was common practice to use coca in order to wean addicts off opium. Unfortunately, while this treatment was successful in reducing opium cravings, it caused cocaine addiction instead, and it was soon abandoned.

Kola

This is the eccipient of the kola nuts, native of West Africa. There are several types of kola nuts but the two main varieties are cola vera and cola acuminata. Its active ingredients are caffeine and the glucoside kolanin.

Kola nuts were used by Africans well before the 17th century, and were later exported to other parts of the world. The nuts were used in order to treat fatigue, to increase energy and generally as stimulants. Kola was still listed in the British Pharmacopeia of 1916 although this was not an official product (1).
Kola wine was a popular drink at the end of the last century and it was made by mixing one part kola and 10 parts sherry. At that time, other popular items containing kola were chocolate, wafers and certain proprietary soft drinks. The Coca Cola drink as we know it was first developed in 1886.

References:
1. Wyatt Squire. Companion to the British Pharmacopoeia 1916, JA Churchill, London.
2. Lemoine et Gerard. Formulaire, Consultation Medicales et Chirurgicales, 9th edition, Paris 1920.

THE TOURNIQUET IN SURGERY.

The early development of the tourniquet is bound up with the operation of amputation. Only since the Romans have various constricting devices been used to help control haemorrhage during amputation. Archigenes and Heliodorus, who practised in Rome at the time of Celsus, used narrow bands of cloth placed directly above and below the line of incision; each passed two or three times about the the limb and tied in a single knot. It was an advance on the practice of Hippocrates who advocated cutting through the dead limb at a joint.
For the next 1500 years no significant alteration appears to have to have been made. Ambroise Paré in the sixteenth century advocated tying "a strong or broad fillet like that with women usually bind up their hair withall" above the site of amputation. This helped to retain the maximum length of skin and muscle for the stump, controlled haemorrhage and reduced pain. The use of stick to twist the constricting bandage was known to William Fabry of Hilden (1516-1564), although Morell in the seige of Besancon (1674) is often given credit for this modification. In a work entitled "Currus Triumphalis e Terebintho" (1679), James Yonge of Plymouth gave an account of a similar contrivance which he had produced. Jean Louis Petit (1674-1750) descibed his invention of the screw tourniquet before the Academie Royal des Sciences in Paris in 1718. He was the first to use the name tourniquet, which is derived from the French " toumer", to turn. This was a definite advance because it did not require an assistant to hold it in place and It could be readily released. The tourniquet consisted of a strap which passed around the limb and to which the screw portion was attached. When the screw was turned pressure was brought to bear over the main vessel of the limb by a curved piece fixed to the screw. Various modifications fo Petit's apparatus remained in use until the latter part of the nineteenth century. During the Crimean War the British Army used a simple variety of strap and buckle tourniquet.
Lister, about 1864, was probably the first surgeon to use a bloodless field for operations other than amputations, He applied at first a Petit tourniquet and after its introduction an Esmarch Bandage as a tourniquet, following four minutes of elevation to empty the vessels of blood and used this technique for excision of tuberculous wrist joints.

The commonly used flat rubber bandage which was introduced by Johann Friedrich August von Esmarch, Professor of Surgery at Kiel, was first described by him in 1873. Esmarch used his bandage first to express blood from a limb prior to an amputation and then wound it around the limb proximally as a tourniquet.
Harvey Cushing introduced the pneumatic tourniquet to surgery of upper limbs in 1904. The idea of an inflatable cuff originated from the distensible armlet of the Riva-Rocci blood pressure apparatus. As this armlet could only be inflated slowly it allowed the limb to become engorged with blood before finally rendering it ischaemic, and this made dissection difficult. Cushing thus designed a rubber cuff which could quickly filled by connecting it to a large bicycle pump. As a refinement he suggested the insertion of a manometer in the tube connecting the tourniquet to the pump and a tank of compressed air to maintain the required pressure. He also used a pneumatic tourniquet as a constricting band about the head to prevent loss of blood while a skull flap was raised.

In modern operation theatres it is routine to use pneumatic tourniquets and Esmarch's bandages to exsanguinate the limb before application of the tourniquet.

Leslie Kleneman

3

DEVELOPMENT OF BLOOD PRESSURE INSTRUMENTS

N H NAQVI FRCA

The measurement of blood pressure is the most common clinical examination to diagnose, treat and prevent illness. In anaesthesia and intensive care medicine mandatory monitoring of blood pressure has been a success story being the major cause for significant improvements in the outcome. In today's medical practice blood pressure is monitored with the help of modem instruments, which provide accurate readings at bedside and in clinics. The historical evolution and development of these sophisticated devices is an interesting subject. My interest in collecting old blood pressure instruments brought me in touch with Prof. Blaufox, who is the Chairman of American Medical Collectors Association. Our mutual passion eventually resulted in a very fruitful conclusion, after 3 years of discussions and meetings we published a comprehensive illustrated history of non-invasive blood pressure instruments. We decided to end the book in the 1950s, and have not included the electronic and computer baseod devices, which in our view deserve separate treatment.

On the very first page it is argued that the origin of blood pressure measurement may be traced to the palpation of the pulse. This time tested examination has been practised for more than 4000 years. The earlier physicians were able to make some judgement of the arterial tension by palpation. This simple observation evolved into present day blood pressure instruments.

Estimating the force exerted on the arterial wall by trained fingers has been described in the writings and artefacts of Egyptians, Chinese and Greeks.

The translator of Edwin Smith papyrus, J H Breasted, has mentioned that the reference in this papyrus regarding counting with fingers or measuring the heart actually refers to counting the pulse. The following quote is further evidence that Egyptians were aware with the clinical significance of the pulse.

The heart speaks out of the vessels of every limb.

The priests of the Lion headed goddess Sekhmet were considered to be specialists in making diagnosis by palpation. Following inscription on the tomb of such a priest has been translated and says,

Powerful and clever in his art, who puts his hands on the sick and knows.

Looking at the Chinese contribution, we come across a famous medical text, which is attributed to the Yellow Emperor, and contains numerous references to the pulse, for example,

The pulse of a healthy heart should feel like continuous hammer blows.
A pulse like note from a string instrument.

He also observed, *Excess of salty flavour hardens the pulse.* This must be the earliest recognition of hardening the arterial wall, palpable by fingers. There are many more authoritative Chinese texts, which may well be the very first books written on the subject dedicated to the pulse only.

The Greeks had better understanding of human anatomy; they became masters in the examination of the pulse. Praxagora, a contemporary of Hypocrites was the first to write about the pulse, his pupil Herophilis was first to count the pulse using a water clock which was invented by his friend Ctesibius to time the speeches of the orators.

The overbearing authority of Galen cannot be matched; he wrote more on the pulse than any one before and after. Even today his I 8 books on the pulse are preserved, and some of the names he gave to various pulses are still used.

Arabs during the Middle Ages made significant contributions. Avicenna has recorded a correct definition of the pulse. He has also mentioned 50 named pulses in his massive writings.

The Arab decline placed the future development in the hands of Europeans. Nicolas of Cusa, a German Bishop suggested a unique concept that the volume of water escaping from a water clock while counting 100 pulses would vary in different clinical conditions and may be used to correlate with health or disease.

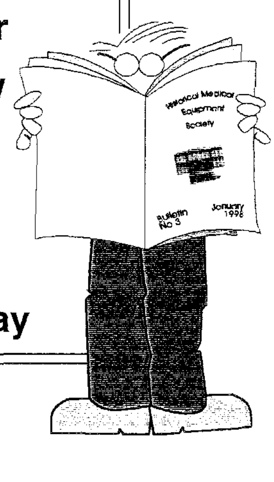
In 1555 a Polish physician Joseph Struthius wrote Art Sphygmica, and in this book a diagram of the pulse wave appeared for the first time. He also said ' *a pulsating artery supports or lifts heavier or lighter objects in proportion to the strength of its force.* The concept of measurement was introduced

Galileo synchronised his own pulse with the swinging lamp to overcome boredom during a dull lecture in Pisa Cathedral. At his suggestion in 1610 Santorio Santorio invented Pulsilogium, which could measure the pulse in linear units.

William Harvey is known to have counted the pulse using a pocket watch only capable of measuring time for a

REMEMBER!

Deadline for copy is now the end of November and the end of May



minimum of half-hour. Sir John Floyer, in 1707 invented a stopwatch to count the pulse in one minute.

Now we come to the real story, in 1711 the very first measurement of blood pressure was carried out by Stephen Hale in his famous experiment on a horse, although his work was not published till 1733.

It is surprising that Stephen Hale's pioneering work remained uncontested till 1828, when a Frenchman Poisuille, described the U-shaped glass tube filled with mercury, calling it Haemodynomometer. He used this tube to measure flow of fluids in tubes less than one mm in diameter and received a well-deserved gold medal from The French Medical Academy on his publication.

Poisuille's more important contribution was the mathematical derivation of the law which dictates the flow of fluids in tubes, this work was published in 1839. In the same year a German hydraulic engineer, Hagen independently reached same conclusion. Hagen's work remained unrecognised because he used Old Prussian units. The record was put right in 1925.

The equation known as Hagen-Poisuille Law, has been a source of inspiration in the design of blood pressure instruments.

The middle of the 19th century was a period of intense activity in Europe. In 1847 Karl Ludwig described his Kymograph, he also had the genius to connect Poisuille's Ushaped tube to the Kymograph, producing the earliest recordings of blood pressure on a smoked paper.

Invasive measurement of blood pressure in human was carried out in 1856 by a French surgeon Faivere, while he performed amputation of the limbs. This work was of great importance; it offered accurate average values of arterial pressure to those who were working on indirect methods.

The fist attempt to measure indirect blood pressure was by Herisson in 1834. He used a straight glass tube with markings; it was filled with mercury. The lower end was covered with thin leather to be placed over the radial artery. Harisson called this device Sphygmometer. No example survives in any museum; we know it by the diagram in the original publication. This simple device must be considered the original on which future instruments were designed.

In 1855 a German physiologist Karl Vierord introduced what he called a Sphygmograph. It was about 60 cm long, quite cumbersome and difficult instrument to use. There is no surviving example. Vierord himself was able to produce recordings from his instrument, which may be seen in his original publication.

EJ Marey, the famous French physiologist was disappointed with Vierord's instrument, so in 1860 he invented the famous Marey's Sphygmograph. In a BMJ Editorial of 1870, it was described as *'Exquisitely designed instrument of precision and remarkable beauty.* ' The definition was befitting, the manufacturer was the famous watchmaker Bruget of Paris.

Marey's Sphygmograph was extensively used in the UK by clinicians at bedsides and physiologists in their labs. There are many papers in all medical journals from 1865 onwards where data was collected on different waveforms; even diagnosis was made using this device. Many early users also made improvements and described a number of modifications. A bright medical student from Guy's hospital, whose name was Akber Mohamed, described the most important modification in 1870. He introduced an element of quantitative measurement, enhancing the respect of the Sphygmograph. Mohamed nearly described what we call essential hypertension. Unfortunately he died young.

Marey's Sphygmograph is in great demand by the medical collectors, in auctions it is sold for upto £2000.

The Sphygmograph remained the major preoccupation and focus of attention of the clinicians and physiologists. Probably it also contributed to separate cardiology as a speciality.

Marey continued his work, in his personal laboratory. He was also the inventor of cinematography, which he initially used to study human locomotion. He further devised the method to enclose the forearm in a watertight jacket; the pressure in the jacket could be adjusted by increasing or decreasing the height of the water reservoir, till the pulse disappeared at the wrist. The mercury column at this point represented the arterial pressure. The apparatus was cumbersome, difficult to use and never reached the floor of any French hospital. But all future investigators exploited the concept. Marey himself was able to produce excellent recordings on smoked paper using this method.

Another ten years passed when in 1880, Von Basch, professor of experimental pathology at Vienna, a skilful instrument maker, introduced a straight glass manometer. At its lower end was a double rubber bag, the inner bag was filled with mercury and outer with water. The bag was compressed against the radial artery, till the pulse disappeared when the pressure was noted.

Von Basch was also the inventor of the aneroid manometer, which he designed and made himself

A compact easy to carry, wholesome British contribution, typical example of Victorian engineering was described in 1878 by a Scottish physician whose name was Dudgeons, he practised Homeopathy in London. The Dudgeons Sphygmograph soon became the most popular device. Many modifications were introduced and these are frequently seen in medical antique fairs, costing upto £ 500.

James Mackenzie the Saintly cardiologist from Bumley introduced his ink Polygraph, which was seen in medical catalogues even in late 30's.

The first American contribution was by Holden, introduced in 1878. He also published a monograph on the subject. This instrument was not an innovation, only a minor modification of Marey's.

In 1880 another American introduced what he called Pond's Improved Sphygmograph. It was marketed in an aggressive manner without any clinical trials.

Potain was a cardiologist from Paris and had described Gallop Rhythm. He introduced a new and modern looking apparatus in 1888. It was a dial type or aneroid manometer with a small rubber bulb to be compressed by the observer over the radial artery, till the pulsations disappeared, and the pressure was read on the dial. The calibration on the dial was in centimetres of mercury not in millimeters. Towards the end of last century this was the most popular and widely used instrument in France and Germany.

A variety of pocket sphygmometers, similar to tyre-pressure gauge type devices, were in fashion, They were inaccurate pocket toys, of little clinical use. They do have a place in history only to be mentioned.

This brings us to the last decade of the last century. The developments in material technology primarily for the industry helped to improve medical instrumentation. The technology offered opportunity to mould rubber into tubes and bags and hand pumps rendering them less perishable.

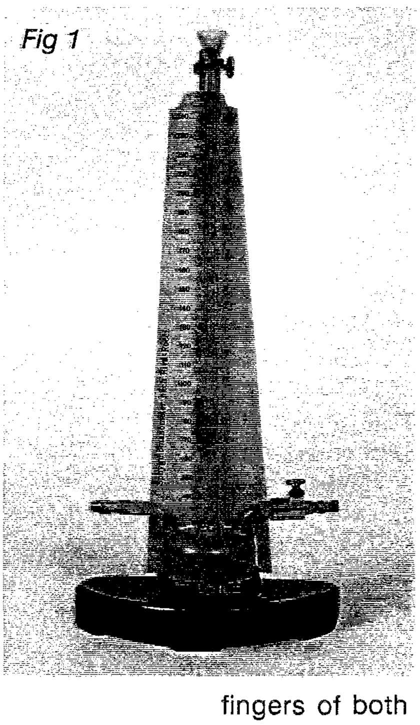


Fig 1

The opportunity was grasped by a shy, unassuming Italian professor. His name was Scipione Riva-Rocci. He published a long paper describing a rubber cuff, to obtain circular compression at the arm. The cuff was inflated by a hand rubber bulb and connected to a vertical glass tube filled with mercury as a manometer. With this simple apparatus Riva-Rocci started a revolution. During the last 100 years every doctor, nurse or health care worker has had to learn to use his method. Riva-Rocci published his classic paper in Dec. 1896, which has never been translated completely into English.

A few months after this paper appeared two physiologists from London Hospital jointly published a paper describing an arm cuff, similar to Riva-Rocci's and an aneroid manometer with bicycle pump for inflation.

They were Hill and Bernard, who deserved to be recognised as independent inventors along with Riva-Rocci.

In 1900 a German instrument maker marketed the very first Sphygmomanometer, but the name of the manufacturer does not appear on the instrument. (Fig 1)

The American Neurosurgeon, Harvey Cushing had introduced anaesthesia charts in 1895. After visiting Europe during the 1900, he took time to visit Riva-Rocci and learnt to use his new apparatus, which he introduced in America on his arrival in 1901. This was the start of recording the blood pressure readings and other parameters during anaesthesia.

Janeaway, professor at Johns Hopkins designed the first boxed sphygmomanometer, probably in 1901.

Another professor from Johns Hopkins, H W Cooks introduced another model in 1903. C J Martin, professor of medicine in Melbourne, was interested in blood pressure measurement, he wrote in the BMJ in 1904 describing his own device. H French was a London physician, who was responsible for introducing another simple instrument, which used a simple glass mercury reservoir, made in such a way that the mercury could not be spilled during movements and transportation.

German and French doctors and manufacturers were keen to use and improve the aneroid manometers, but American and British put their faith in mercury filled devices. The Germans used the principle of the Bourden tube; the French perfected the vacuum tube, which responds to pressure changes.

A French Professor Pachon introduced his device making use of vacuum tubes, it is still used in France in some form or other. Different makers marketed a large number of aneroid devices,- some of these do appear in medical antique fairs and surprise the collectors.

The laboratory-based doctors required an instrument, which could make reliable recordings for their research needs. The earliest recording instrument was described by two physiologists from Cambridge, Roy and Adami in 1890.This was never manufactured, it only exists in their published paper.

In l892 an Italian Professor Mosso, who was Riva-Rocci's tutor, had introduced a finger plathysmograph, utilising fingers of both hands to enhance the signal. It was capable making the pressure recordings in a waveform on a smoked paper on a revolving drum. In 1897 two British doctors travelled to Italy, used this apparatus and published a paper in the BMJ showing pressure changes during rest, mild exercise and severe exercise.

A Russian called Uskoff constructed a large and complicated device in 1910, which could make a paper record of the Blood Pressure.

Another Russian called Lavine made a compact recording blood pressure machine, this was smuggled out by another Professor called Pleash when he migrated to Germany and then to England. It was named after Pleash, though he never made such a claim.

All these devices were used to measure systolic pressure only. For the next important discovery in blood pressure measurement the medicine has to wait till a Russian doctor completed his war duties. It was Korotkoff who in 1905 described diastolic sounds. He presented his brief paper at the Imperial Academy of St. Petersburg to a hostile audience, but earned an MD. It is true to say that in blood pressure measurement there has been no intellectual progress or discovery since Korotkoff.

The news of Korotkoff sounds reached English doctors 5 years after in 1910, brought back by G Oliver while attending a medical conference in Germany. The next 10 - 15 years were of great turmoil in Europe due to the First World War. Only the American instruments makers were producing instruments, some had interesting vanity features.

As the demand for the blood pressure instruments increased the manufacturers responded by producing instruments without any consideration to quality or uniformity.

In I923 the American Bureau of Standard took the fist step towards standardisation. Using a special device they started testing sphygmomanometers, and issuing a certificate of performance. They published a major report in 1927, which established a uniform standard in America. Other manufacturers adopted it all over the world. One more important development was that the life insurance agencies commissioned epidemiological studies for actuarial decisions, and they dictated stringent control of the instruments.

William Baum used to work with life insurance in New York, he saw an opportunity, established his own industry, making Baummeters, which are still highly regarded and manufactured to this day.

In 1939 The American Heart Association and The Cardiac Society of Great Britain issued joint recommendations to adopt phase IV or muffling of Korotkoff sounds to indicate diastolic pressure. This was changed to phase V in 1951, in 1967 recommendation was to record both phases. In 1980 it was reversed to record phase V, but phase IV was retained for children and during pregnancy. This still stands today.

Von Racklinhauson's modified dry manometer made a reappearance and was popular among the anaesthetists in the 60's and 70's.

Towards the mid seventies electronic devices started appearing and computer controlled instruments were introduced in 1978.The manufacturers went mad during the 80's every one wanting to sell blood pressure machines. The computer controlled machine introduced in 1978 by Criticon, may be regarded as the parent of all modern devices.

As mentioned earlier the discussion has centred on non-invasive devices, which are mechanical types, the electronic, and computer based modern instruments have not been included in the discussion.

SURGICAL INSTRUMENTS OF PRE-ISLAMIC ANCIENT INDIA

Author: K.M.N. KUNZRU

INTRODUCTION

Ayurveda ("Knowledge" or "Science of Life") is a system of medicine and healing still practised in India. It was classified as an Accessory Veda (Upaveda) of the Hindu Vedas, the body of ancient knowledge and hymns. The last of the Vedas, Atharva Veda, was probably composed in the last millennium B.C.E. (Wujastyk pp 16 - 17).

During and after the lifetime of the Buddha, this knowledge was advanced and modified by the monks into later canons.

Surgery was an integral part of this system of medicine, but by the middle of the first millennium C.E. the practice was given up by the physicians of the higher, priest, caste, probably because of religious taboos and dogma. It was relegated to the artisan classes of lower caste, thus divaricating from the theoretical and "scientific" knowledge of the physicians.

SOURCES OF ANCIENT INDIAN SURGERY

No illustrations or even artifacts have so far been found to depict surgical operations or instruments from the first millenniums, C. E. and B.C.E. However, detailed accounts of surgical procedures, although concise, and description of surgical instruments used in these, are given in the "Three Greats" (Brihadtrayi) of Ayurveda - the compendia of Caraka (Carakasamhita) and Susruta (Susrutasamhita), and the work of Vagabhatta senior (the Astangahrdayam).

The first touches only briefly on surgery, being concerned mainly with physical diagnosis, pathology based on the three humours (tridosa) theory (common to all three works), and medical management by drugs (mainly plant-based) and regimen; and some incantations.

Susruta's work has the greatest detail on Surgery:

Surgical diagnosis (physical signs & symptoms), pathology (humoral theory, including blood as a fourth humour, in addition to wind, bile and mucus), and operative management, including instrumentation. Medical treatment, Toxicology, and Regimen to be observed as an adjunct, are also described. (Bhishagratna, Singhal, Atrideva). This work is dated in its greater part to the first millennium B.C.E. (Wujastyk, pp 104 - 105, Mukhopadhyaya - Introduction, Atrideva - Introduction). In the early to mid first millennium C.E., Nagarjuna revised the text and edited it, probably adding the last section, the Uttaratantra (Wujastyk, pp 104 - 105).

Vagabhatta, a later author, probably in mid-first millennium C.E., used Susruta's work as the basis of surgical knowledge, adding some detail, and included some more instrumentation.

I have been deliberately imprecise in dating these works because of controversy about their composition. The originals were written on perishable material, rescripted by scribes (Kayasthas) every sixth or seventh decade, possibly with some corruption of the text. The dating is based on philological and other analyses (Wujastyk, pp 40, 104, 105, 238). Some of these works might have had more than one author.

Later, medieval, commentators, like Dalhana in the 12th Century C.E. on Susruta, have been of some help in elucidating some of the perplexing text (Wujastyk p.19).

SUSRUTA'S SURGICAL OPERATIONS

It is impossible to list all the procedures in this vast text in the confines of this brief paper. A wide variety of surgical manoeuvres are described: Incision; Excision; Scraping (or thinly slicing); Removal of Missiles and Foreign Bodies; Probing; Catheterisation of the bladder;. Venesection; Thermal and Chemical Cauterisation; Wound repair by sutures, and more complicated plastic surgical procedures (including Rhinoplasty and Ear lobe reconstruction). Ants' mouth parts were used as staples to close skin and other wounds. The last section on Eye and Ear, Nose, Throat diseases includes description of Couching for Cataract of the Eye, pushing the lens away from the pupil.

Of necessity, Susruta and, later, Vagabhatta, describe a variety of instruments and accessories for these procedures, Susruta probably the model and source for Vagabhatta.

A pre-Susruta text describes catheterisation of the bladder using a hollow reed or lotus flower stem, combined with incantations, with mention of some sort of urethrotomy (Zysk II p.p. 70 - 71). Cauterisation of bleeding wounds is also described.

<u>SURGICAL INSTRUMENTS OF SUSRUTA</u>

Apart from classifying the instruments Susruta goes into some detail of their metallurgy and manufacture (including tempering of steel). His description of instruments makes it appear that he is quoting at times from pre-existing surgical literature. "One should use the experience of others in designing instruments" (S.S. 8/131). He also suggests using "logic" (Darsana) to deduce the design of the instrument (ibid.). The instruments were made of Iron or Steel (Ayasa) or similar metal, and "should handle well and be pleasing to behold" (S.S. 7/9 & 135). The sharps, except for the saw, "should have a smooth edge" (S.S. 818) and, for the rod instruments, a sharp point.
Some rods (Salaka) were made of higher metals, like gold, silver or bell metal (?bronze). Tubes made of lead are described, being easy to bend or contour (Mukhopadhyaya p.p. 63-64), to insufflate or instil medication in awkward cavities.
Lead plates to isolate growths for excision by moulding round them are also described (ibid.).

<u>CLASSIFICATION OF INSTRUMENTS</u>

Ancient Indians appear to have been keen classifiers. Both Susruta and Vagabhatta give a detailed classification of surgical instruments. The latter obviously used Susruta's work as his basis of classification.
Susruta and Vagabhatta classify instruments into Blunt (Yantra) and Sharp (Sastra).
Accessory blunt instruments (Upayantra) and sharps (Anusastra) are also described (Mukhopadhyaya p.p. 90 - 98).

Blunt instruments were used for various manoeuvres - 24 described by Susruta. The finger is classed as an accessory instrument used for squeezing or massaging out of splinters and pus; and as a probe. Extraction of impacted objects by holding them and moving them about is described (disimpaction of bone fragments or foreign bodies).

Filling of abscess cavities, and other natural cavities, by tubes using medicaments and irrigants are described, the tubes being contoured to reach awkward spaces. Similarly, use of tubes for drainage is also described. Tubes were also used to suck out poison from snake bites.
Elevation and depression of fractured bones (of the

skull and face), probing tracks to cavities (fistulae, natural orifices like nose and ear, the bladder and urethra) are manoeuvres described in the text.

Blunt instruments to spread tissues by retraction, and as guards are described (like lead plates to isolate growths).

Blunt instruments were classified into five groups:

1. Cruciform (Svastika)
2. Pincerlike (Sandamsa)
3. Flat, shaped like a "pick-lock" or "fish-palate" (Tala).
4. Tubes (Nadi)
5. Rods (Salaka)

1. Cruciform instruments had two handles crossing at an axle with a central pin (Kila) and with jaws shaped like and named after mouths of ferocious beasts and birds. (S.S.7/10). If the date of this work is accepted as mid 1st Millennium B.C.E., this is perhaps one of the earliest description of such an instrument.

The jaws varied in size and length from a small "Crocodile" forceps to a long "Heron Billed" (Kankamukha), "the most versatile" to the wide jawed "Lion jaw" (probably similar to the modem Ferguson's bone holding forceps). None have been described with a ratchet mechanism for locking the handles

2. "Pincer like" instruments are probably the wide round shouldered Backhaus towel clip like instrument. A dissecting forceps like instrument, with the blades fixed at one end with a rivet, is the second type; with sharp pointed ends, possibly like Mustarde's plastic surgical forceps. The description is limited in the text available.

3. Flat "picklock" like (Tala) instruments are described more like wide spatulate blades with a handle - "like the palate of a fish" (could it have been a curved blade?). These were probably used for bone fragment elevation.

4. Tubular: These have been discussed earlier, too. Use of these for irrigation, errhines in the nose, and fumigation with medicated smoke is described in the text. Specula for Ear, Nose, Throat, Vagina and Rectum come in this category.

5. Rods: (Salaka) These were used as bone elevators (e.g. nasal fractures), sinus probes, and as applicators of Collyria to the eyelids; the latter with specifically described rods made of material like ivory, gold, etc. to complement the medication being applied. (U.T. 18/62-63).

6. Accessory Blunts (Upayantra) Straps for restraint of patients (e.g. in lithotomy position for perineal lithotomy and ano-rectal procedures) are in this category.
An ingenious use of a strap to remove the impacted arrow with a broken shaft is described (Majno p. 272). The strap is tied to the shaft and the other end to a horse's bridle. On making the horse jerk its head the shaft was pulled out, probably causing significant trauma to tissue in immediate vicinity of the arrow track. An alternative method of tying the other end of the strap to a tree branch, bent down and held by an assistant, gave a similar result on the branch springing back on release (ibid.).

A fracture "bed" (Kapata) with peg like dowels to immobilise the limb with a reduced fracture (the dowels being strategically fixed in several holes in the board) is described (Mukhopadhyaya p.87; C.S. 4/3).

A large pestle for use as counterpressure in the axilla to reduce a dislocated shoulder (?with or without a fracture) is described, the technique being not too dissimilar to the Hippocratic method (C. S. 3/3 1).

A variety of bandages are listed with fairly detailed description of their use (S.S. 18/16-17, Mukhopadhyaya quoting Caraka IV/viii)

Containers for lotions, Animal Bladders as "disposable" containers for pus and body fluids, sieves etc. are all part of this group.

Caustics and cauteries (?of some types) are also included in this group (S.S. 7/15).

SHARP INSTRUMENTS

These are classified into categories as follows:

1. Knives (including bistoury-like knives).

2. Saws.

3. Awls.

4. Needles (for suturing).

5. "Scissors" (Sararimukha; named after an Indian Bird with a long bill).

6. "Axe shaped" (Kutharika).

7. Hooks.

8. Sharp Probes (Esani).

9. Trocar-like Instruments or Sharp Rods (Salaka).

10. Accessories (Anusastra).
These include the fingernail, thin slivers ("skin") of a bamboo as a knife for draining abscesses in children and those "who are afraid of ordinary knives" (S.S. 8/15 to 19). Accessories also include caustics and cauteries for cutting out growths by chemical or thermal burns, and leeches (in lieu of venesection). The latter have certainly made a come back in modern Reconstructive and Replantation Surgery in the limbs. Regarding the use of the fingernail as a "sharp" accessory instrument, Susruta gives clear instructions to surgeons to keep their nails clipped short! (S.S. 10/3).

It is beyond the scope of this paper to discuss individual instrument groups in detail but some do merit specific comment.

Group 1. A circular blade (Mandal a gra) is described for incising Pterygiums in the eye (U.T. 8/6) and lifting flaps (S.S. 8/4).

A "finger knife", like the distal phalanx of the finger, was used to incise pharyngeal "growths" (?abscess) and also as a cranial perforator in a dead fetus (Mukhopadhyaya p.p. 238 -239).

Group 3. Awls for perforating bones for drainage and for trephining for subungual haematoma, are described.

Group 5. Sararimukha A cutting instrument like scissors , with a pin axle (Kila) between two blades and handles, is described. The details in Susruta are not sufficient to say categorically that the cutting edges were bevelled (S.S. 8/7, and Mukhopadhyaya p. 250 quoting Vagabhatta). Another variety of "scissors"(??), Antarmukha, with short blades, is described by Vagabhatta (Mukhopadhyaya p.p. 250 - 251).

Group 6. Axe shaped instrument (Kutharika). This could be a small chisel like instrument with the axe shaped blade at the end of a handle. Its main use appears to have been for paring hard objects (like nails), and as a venesection instrument.

Group 9. A sharp rod like instrument (Salaka) is described for perforating the eye near the limbus for couching cataract (U.T. 17/82 to 85).

A Sharp Probe (Esani), with a cutting edge to cut the bridging tissue in Fistulae in ano, is described for multiple fistulae. This was done in stages (C.S. 8/5). This manoeuvre was reportedly condemned by later Buddhist doctors claiming that the Buddha himself had forbidden it (Zysk I, p.p. 114 - 115).
Despite the degree of sophistication of surgical armamentarium and the variety of procedures practised (presumably successfully), the practice of operative surgery declined by the latter half of the 1st Millennium C. E. for reasons beyond the scope of this paper. Vaidyas only practised medicine, surgical operations being left to the artisan classes. They continued to practice one or two procedures, like Cataract Couching and Rhinoplasty, as a family "trade", being passed from father to son by apprenticeship. These procedures were being performed by these groups of people well into the latter half of this century. I have myself seen patients who have had couching of cataract, unfortunately with an indifferent result.

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