

Early history of wound treatment¹

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Introduction

Wounds cause pain, bleeding, disability and death. They have always been common and the problems associated with their treatment are as old as mankind and advances in the care of wounds have advanced the whole art of surgery. The history of surgery has been the history of wound therapy during the last four or five millenia and, despite the causes of the injury generally being obvious and the wound easily observed, it is only in the last two to three decades that the processes occurring in the wound and the factors influencing them have been understood.

The aim of wound treatment has always been to reduce the risks caused by the wound itself and to minimize potential complications. Pain, haemorrhage, loss of skin continuity and tissue substance in a wound have tested man's ingenuity throughout the ages.

It is difficult to find out how prehistoric man discovered the multitude of wound coverings, salves or ointments that were, in all probability, used. He probably observed that a covered wound bled less, or that pressure stilled a more serious haemorrhage. Certain plant extracts may have acted as styptics. Cold water, snow or ice or the application of herbs or clay may not only have soothed pain but hastened healing. It can only be assumed that the selection of these substances occurred by trial and error over a very considerable time. The result was that a number of effective topical treatments had become available by the time civilizations began to appear about six thousand years ago.

Prehistory

The first written records containing medical information date from about 2500 BC. Clay tablets from this time have been discovered in Mesopotamia and the first medical papyri from Egypt are probably some seven hundred years younger, though the Smith papyrus (from about 1650 BC) is thought to be a copy of a much older document. Apart from information gleaned from ancient civilizations, much has been learned about the practices of prehistoric peoples from the study of groups of primitive peoples today as well as from the legacy provided by folk medicine.

Bergmark (1967) cites the use of a number of plants in wound treatment and it seems possible that these may have been used for many thousands of years. Many plants have properties useful in wound therapy. Many are astringent (Bergmark 1967) and some 2500 have antimicrobial effects (Nickell 1959). The usefulness of many plants may have been suggested by their appearance: knot-grass (*Polygonia persicaria*) has leaves that appear bloodstained, while the perforated leaves of St John's wort (*Hypericum perforatum*) suggest a use on perforating wounds. Nickell (1959) showed that hypericum has antibacterial properties, as do oak-sap and oak-gall or the leaves of lady's mantle (*Alchemilla vulgaris*), which all contain the astringent tannin. The comfrey (*Symphytum officinale*) contains allantoin which, apart from being antibacterial, is said to be an excellent healing agent, promoting granulation tissue and being able to promote the healing of fractures (Bergmark 1967).

Many agents were discovered by primitive peoples in various parts of the world despite differences in climate and therefore in availability. Herbs could either be applied to the wound in a balsam or given as a draught. Leaves or grasses were often used as bandages, many being

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cooling and soothing. Poultices, cataplasms or ointments could be made from a wide variety of animal, vegetable or mineral substances (Table 1). It is generally thought that wounds, once they had been washed, were dressed directly. Suturing, though it did occur among the primitive peoples in South America, parts of Africa and in India – using the giant jaws of soldier ants according to Wheeler (1960) – was rare, and wounds were left open during treatment.

Some primitive peoples developed highly sophisticated surgical techniques. Some performed ritual amputations, though most abhorred the idea of mutilations except as punitive measures. The ancient Indians of the Peruvian Andes and the Masai in Africa are known to have performed trephinations, and such operations have been witnessed in recent times (Bishop 1962, Margetts 1967). The practice of surgery – and the responsibility for keeping and passing on knowledge of the medicinal properties of herbs, roots, animal products and minerals – was usually the province of a specially selected and trained medicine man or shaman who often enjoyed special powers within his tribe.

Thus, by the time ancient civilizations began to evolve, a large number of wound treatments had already been discovered and won widespread use: honey, animal fat and butter were common, as was the use of many herbs and barks. Many substances could be mixed – often into greasy mixtures – to guarantee effectiveness.

Wound treatment in ancient civilizations

Though many cultures were geographically separated, medical knowledge can be said to have developed in four main areas: Mesopotamia and the eastern Mediterranean; the Far East; India; and South America and Polynesia. There was certainly communication between Mesopotamia, Egypt, Greece and Rome and between Greece and India, through the conquests of Alexander the Great; thus Indian medicine may also have reached Rome. The origins of Chinese medicine extend back beyond history. The legendary emperors, Yu Hsiung (the Yellow Emperor who compiled the *Nei Ching*) and Shen Nung (the Red Emperor who compiled the first herbal, the *Pen-tsao*), were said to have lived about 2800–2600 BC. Surgery was held in low esteem in China while it attained great renown in India; if communication did occur between the two cultures no sign of it appears in Chinese surgery. It is thought that the high level of surgery attained by the Indians of the Peruvian Andes was transmitted to Polynesia by migrating South Americans.

In Mesopotamia, according to Majno (1975), wounds were washed with water or milk and were dressed with honey or resin, probably conifer, though myrrh and frankincense were also

Table 1. Topical wound treatments from ancient or primitive societies

Animal	Vegetable	Mineral
Bile	Bark	Alum
Blood	Dyes	Antimony
Butter	Fruit	Arsenic
Cobweb	Herbs	Clay
Cochineal	Honey	Copper salts
Egg-white	Leaves	Lead salts
Faeces	Oils	Mercury salts
Lard or grease	Resins	Potassium salts
Meat	Sap	Tar or pitch
Milk	Sugar	Zinc salts
	Turpentine	
	Wine or vinegar	

The best single modern reference is Majno (1975). Others include: Bergmark (1967), Bishop (1962), Forrest (1980), Hultkrantz (1962–63), Lyons & Petrucelli (1978), Renander (1962). Lyons & Petrucelli and Majno give references to suitable sources

used. Bandages could have been made of wool or linen but nothing is known of the ways in which bleeding was staunched. Akkadian medicine was a mixture of magic and empiricism. Its practitioners came from three vocations: the *baru*, or diviners, whose responsibility it was to establish the cause of the malady and make a diagnosis – not difficult in the case of a wound – and, most important, to divine the prognosis. The *ashipu* was a magician who could rid the patient of devils, while the *asu*, the priest-physician, assumed responsibility for prescribing or performing operations, though he too would also have made use of charms and incantations (Lyons 1978).

Wound treatment was no more scientific in Egypt. Neither culture had any knowledge of anatomy, despite the Egyptians' intricate embalming technique. Some ritual surgical procedures, such as circumcision, were performed in Egypt but surgery was otherwise primitive. Sorcery played a major part in all forms of treatment and diets and purges were also necessary. Surgeons in Egypt, like those in India, would never attempt to treat a hopeless case. The Egyptians appear to have learned that a closed wound heals faster than an open one. They invented the adhesive bandage by applying gum to linen strips and using these to draw wound edges together. Severe bleeding may have been treated with cautery.

The agents most used in Egypt were probably mixtures of honey and lard or honey and resin. The dearth of trees in Egypt made resins difficult to obtain but myrrh (from the *Balsamodendron myrrha* tree) was imported in large quantities. The reasons for the use of resins on wounds are unclear. Majno (1975) speculates that superstition may have played a part. Resins do not decay and it may have been thought that they would therefore prevent corruption in a wound. Further, resins are produced when a tree is injured and ooze from the wound to fill and seal it as they congeal. The fragrance of resins – particularly frankincense and myrrh – may have been a further inducement to their use in foul, malodorous sores.¹

The Egyptians also introduced a number of minerals into wound treatment. Green copper pigment obtained from malachite and chrysocolla was a coveted eye-shadow and came to be used on wounds, where it has powerful astringent and antiseptic properties. Mercury compounds are also antibacterial and were employed by the Egyptians. Most balsams and ointments were, however, based on magical mixtures of animal or vegetable ingredients, many of them unspeakably foul.

Greek medicine borrowed much from the older Egyptian, especially after the two cultures met in Alexandria from about 300 BC. The Greek historian Herodotus had visited Egypt in about 450 BC and reported on customs and practices there, but a medical tradition had existed in Greece since the time of Asklepios, approximately five hundred years earlier. The earliest Greek medical references are found in Homer's *Iliad* (from about 800 BC) and it seems that the Greek army had its own surgeons during the Trojan war. They had, however, not mastered the use of cautery or ligature in stopping bleeding, but chanted incantations after having washed and dressed the wound.

Hippocrates (460–377 BC) advanced medicine by describing diseases and their natural history. He suggested that contused wounds should be treated with salves in order to promote suppuration, remove necrotic material and reduce inflammation. He did not postulate that pus was necessary for healing, as would be suggested later. He preferred leaving wounds dry once they had been washed and he recommended the use of wine or vinegar for washing. Nature, he believed, would best heal the wound. Honey and oil as well as wine were among the most widely used ointments, though wool boiled in water or wine was considered a useful dressing.

Bandaging had become an art by the fifth century BC and surgeons knew that bandaging too tightly could cause gangrene. Hippocratic teaching warned against the overindulgent use of bandages. It further engrained the humoral theory of disease in the minds of physicians as well as philosophers. Imbalance in the body's humours (blood, phlegm, yellow or black bile)

¹ Recently a salve for minor cuts and abrasions has become available in Sweden that contains pine resin, bees wax, boric acid and milk fat, a recipe that the manufacturers claim is over 200 years old. Little do they suspect that similar mixtures have been in use for over 4000 years!

were considered to cause disease and the bad humour should be relieved if the illness was to be cured. Hippocrates considered that wounds were diseases and thus, by analogy, humoral imbalance prevented healing. Venesection was a common practice in the ancient world and was advocated in the treatment of wounds – including fresh ones – to remove the stagnated blood that was thought to accumulate around the wound. Thus a vessel near the wound would be opened to let this corrupt blood out. The remainder of the bad humours could be removed by purging, and the implementation of a strict diet would prevent the production of more bad humour. Even the strongest patient would have been severely taxed by this treatment, and one who had lost any quantity of blood must have been at great risk

Although Hippocrates advocated that the majority should be kept dry, most wounds were covered with a fat or oil-based ointment after being washed in wine or vinegar. They may or may not have been bandaged, depending on the type of wound. The Greeks introduced the use of verdigris as an antiseptic, which Majno (1975) showed to be more powerful than either malachite or chrysocollo. Clinical observation formed the basis of Hippocratic treatment but the people were not ready to leave anything to chance, and superstition and magic flourished, specially in the cult of Asklepios. More than two hundred temples to Asklepios were built throughout the Greek Empire to which the sick could turn should the treatment of the *iatros* not prove effective. The individual spent the night in the temple's *ábaton* and expected to be visited by the God – and cured – while he slept. Tame snakes played an apparently essential part in healing in these rites. As the individual settled down to await sleep and the visit of Asklepios the snakes would come and lick the afflicted part, eyes or sores – certainly increasing the mystic impression that the 'incubation', as the temple sleep was called, made on the individual.

From the time of Hippocrates until the fall of the Roman Empire in the fifth century AD the language of learning was to be Greek. The Romans had no medical tradition and no physicians until Greeks settled in Rome about 200 BC. Their armies had employed Greek wound surgeons despite an early mistrust of Greeks. By the second century BC Greek science had been accepted in Rome and, at the height of the Roman Empire at about this time, a number of authors felt that the remarkable growth in knowledge in all the sciences should be made available to a wider public than the Greek teachers reached. Little importance was attached to scientific writings in Latin until the arrival of the encyclopaedists. Three attempts – about a generation apart – were made to compile encyclopaedias in Latin. The first, of which only a few parts survive, was by Marcus Varro (flourished c.50 BC) about whom little is known. He is credited (Lyons 1978) with being the first to state the contagious theory of disease. After him came the second, and greatest, of the encyclopaedists, Aulus (perhaps Albinovarus) Cornelius Celsus (27 BC–AD 37). The eight books on medicine and surgery are all that remain intact of his encyclopaedia. Though Celsus is assumed not to have been a practising physician or surgeon, he must have had considerable first hand experience of medical and surgical practice to have been able to write his 'De Medicina' (written ?c. AD 50). Celsus wrote clearly on the care of wounds and was the first to define the four cardinal signs of inflammation (though not when discussing wounds): 'Notae vera inflammationis sunt quattuor; rubor et tumor cum calore et dolore'. He differentiated between wounds and chronic sores and realized that they required different management. He advocated the primary suture of fresh wounds and the surgical debridement of contused or contaminated wounds to convert them back to fresh wounds that could be sutured. He described a variety of different wounds and gave detailed descriptions of their treatment, classifying topical preparations according to their effects on the wound, naming styptics, astringents, escharotics, erodents and others. He also described the surgical instruments in use at the time and their use.

The third encyclopaedia in Latin was compiled – it is said in two years – by Celsus' contemporary Caius Pliny (the elder, 23–79). Pliny's 'Historia Naturalis' was an enormous work, containing – according to Pliny's boast – twenty thousand facts in its thirty-seven books. While 'De Medicina' appears to have been written by one with first hand experience of that which he describes, 'Historia Naturalis' was compiled exclusively from the works of

others. Despite this, 'De Medicina' vanished soon after its appearance¹ and 'Historia Naturalis' became a revered work in the Middle Ages.

Nearly one hundred years after Pliny's death in the eruption of Vesuvius that destroyed Pompeii, Claudius Galen (c.129–200) arrived in Rome from his native Pergamon where he had served four years as a surgeon to the gladiators. He soon achieved considerable renown in Rome and became physician to the Emperor Marcus Aurelius. Despite his considerable surgical experience in Pergamon he appears not to have practised surgery in Rome. He appreciated the fundamental importance of anatomy and physiology in medicine as well as the importance of scientific experimentation. He was limited by being able to observe only what was visible to the naked eye, and he was forced to explain a number of phenomena by philosophical and teleological arguments. So much of what he had written was accurate that even his hypotheses were universally accepted as fact and remained unchallenged until the Renaissance.

Galen relied heavily on medicines even though he had a morbid fear of being poisoned. He advocated polypharmacy but because of a deep mistrust for drug-sellers insisted on collecting all his raw materials himself; he even undertook a voyage to the Island of Lemnos with the sole purpose of collecting the famous red Lemnian clay that was used in dressing wounds. None of Galen's five hundred works reveals that his treatment of wounds differed from that of his contemporaries – cobwebs, writing ink and Lemnian clay were among his most favoured applications.

Graeco-Roman medicine reached its peak in the first two centuries after Christ. While Celsus' works disappeared, those of Galen gathered prestige and his precepts became unchallengeable. The unanimous acclaim of his successors over the ensuing thousand years helped to discourage or prevent the advance of new ideas until the Renaissance.

Into the Middle Ages

In the fourth century AD the cultural centre of the Mediterranean area shifted to Byzantium (Constantinople) and from there medical knowledge in the form of Galenic teaching spread to the Arabs by way of the exiled Nestorians, who translated Galen into Syriac when they found sanctuary in Jundi Shapur and thence into Arabic when the city was taken in 636. Graeco-Roman medicine and surgery were then passed on unchanged by the encyclopaedists Oribasius (325–403), Aetius of Amida (early 6th century), Alexander of Tralles (525–605) and Paulus Aegineta (607–690).

Paulus Aegineta's seven volume 'Epitome' summarized medical knowledge after Galen. It was the first work to include a separate section devoted to surgery. The 'Epitome' was taken up by the emerging Islamic medicine and the Arabs continued the Nestorian practice of hospital building as the Islamic Empire expanded in the ninth and tenth centuries. The principles of wound treatment thus remained as Galen had recommended, with one important difference: the Arabs, like the Jews, considered that the sick were unclean and abhorred physical contact with them. Physicians could practise without physical contact but surgeons could not, and thus no person of standing would choose to become a surgeon.

Paulus Aegineta's work sets forth the treatment of many kinds of wound as well as a variety of skin diseases. Each condition is described and remedies suggested. Adams (1844) in his annotated translation commented on Paulus' treatments and compared them with those of his predecessors. As Celsus had done, Paulus classified his applications according to their effects. Copper ore, Cimolian chalk, cold water, vinegar or wine were used as styptics. Myrrh, frankincense, egg-white, cooked honey, or a sponge or unscoured wool squeezed out in wine

¹ Within a century of its appearance, 'De Medicina' had faded into obscurity. Galen does not appear to have read it – possibly because it was written in Latin rather than the more erudite Greek. Not until 1426 was a manuscript found, but this was again lost. A further manuscript was found the next year and Celsus' renown spread. 'De Medicina' had the distinction of becoming the first book on medicine to be printed when it was published in Gutenberg in 1478. The acknowledgement of Celsus probably influenced Paracelsus (1490–1541) to adopt his eponym – indicating his stature alongside the Roman Master (even if Major (1965) cites other authorities that suggest that Paracelsus is only a transcription of his real name: von Hohenheim).

or vinegar acted as astringents; snails powdered in their shells were said to do the same, while verdigris, pine resin, turpentine, radish or raw honey would cleanse wounds (as would, it was thought, lizard dung or pigeon blood). Alum brine, chrysocolla, verdigris, red copper, ox bile or bitter almonds or their oil were erodents.

Adams also compares the treatment of haemorrhage: Celsus recommended filling the wound with dry pledgets or, if these were not adequate, pressing a moist sponge over them. If the bleeding still continued then the pledgets should be changed often and soaked in vinegar. A slight ooze from a small wound could be stilled by the application of cobwebs. When none of these measures was to any avail then the bleeding vessel should be identified and a ligature tied on either side of the puncture and the vessel divided. If this was technically impossible, and as a last resort, the wound should be cauterized. Galen specified that arterial bleeds should be treated by finger pressure on the vessels just firmly enough to stop the bleeding but not so hard as to cause pain. Deep-seated vessels should be caught on a little hook and twisted until flow was obstructed. If all this failed, then venous bleeds were to be treated by styptics and arterial ones by ligatures. Galen ridiculed the use of a tourniquet as he, and others, thought that squeezing the limb would just force more blood out of the wound; this theory had been expressed by Scribonius Largus more than a century earlier. Abul-Quasim al-Zahrawi (936–1013), whose name has been westernized to Albucasis, quoted four methods of stilling an arterial haemorrhage: cautery, division of the vessel, ligatures, or styptics applied on a compress tightly bound over the wound.

By the end of the tenth century, the dominant centre of Islamic medicine had moved from Bagdad to Cordoba, in Spain, and Albucasis was its most famous teacher. He was a surgeon who realized the importance of anatomy in surgery. His wound treatment was firmly rooted in Galen and he tried to encourage suppuration by the application of a variety of ointments. His importance lies in the fact that his teachings came to influence early European surgery. Islamic medicine made a number of important scientific contributions, the most significant of which were in the field of chemistry, where the Arabs discovered distillation and crystallization among other processes that would be necessary in the manufacture of medicines. They also founded the science of pharmacy.

European surgery in the Middle Ages

The first European medical school was founded at Salerno in the ninth century and through the survival of an enclave of Graeco-Roman surgery in Southern Italy it developed into a leading centre of surgical teaching by the eleventh century. It was here that the first medical curriculum was introduced and it also required medical practitioners to be licensed before being able to practise. However, the formalization of medical education did nothing to advance the science. The Church controlled much of the practice of medicine and forbade dissection as well as a number of surgical procedures, thus opening the way for barbers, charlatans or quacks to offer their services.

By the twelfth century the dominance in surgery had moved northwards to Bologna, where a school of surgery had been founded by Hugh de Lucca (c.1160–1257). His pupil, who may also have been his son, the cleric Theodoric (1205–1296?) compiled a 'Chirurgia' – assumed to be of the teachings of de Lucca – which was completed in 1267. In it Theodoric proposed that the common practice of promoting suppuration in a wound by probing, packing and dressing was contrary to Nature and prolonged the healing process. He advocated that wounds be kept dry.

Italian surgery spread to France toward the end of the thirteenth century with the help of Lanfranc (died 1315), who was a cleric who had studied in Bologna and was exiled from his native Milan. He fled to France and set up a surgical practice in Lyons and, later, in Paris (Zimmerman & Veith 1967). He did not subscribe to Theodoric's ideas on wound treatment, but reasserted the Galenic teachings and promotion of pus formation. At about the same time that Lanfranc moved to France a new centre of surgical teaching was developing at Montpellier, first under Maitre Henri de Mondeville (1260–1320), who was one of the few original thinkers of the Middle Ages. He questioned Galen's unassailability in his 'Cyrurgia',

written between 1306 and 1320, and pleaded that Galen could not have foreseen new discoveries and that these should be permitted to influence or modify older theories (see Zimmerman & Veith 1967). He, like Marcus Varro twelve hundred years earlier, believed that contagion caused wound infection and that the application of single agents to wounds was preferable to the polypharmacy generally adopted. Unfortunately de Mondeville's ideas were short-lived. His successor, Guy de Chauliac (1300–1368), once more reasserted Galen, and the maxim 'pus bonum et laudabile' was to hold sway for the next five hundred years. Zimmerman & Veith (1967) point out that de Chauliac's wound treatment was in many ways quite modern and they further plead that historians have treated de Chauliac unjustly. In his 'Cirurgia Magna' (written about 1363) he propounds his five principles of wound treatment: removal of foreign bodies, reapproximation of separated parts, the maintenance of their apposition, conservation of substance, and the treatment of complications.

The introduction of gunpowder into Europe at about this time started a violent controversy over the way in which gunshot wounds should be treated. This controversy lasted almost one hundred years and affected the whole practice of surgery. Cannon were first used in 1346 at the battle of Crecy, at which the English surgeon, John of Arderne (1307–1390), who had been trained at Montpellier, was present and where the English archers – in true Galenic style – were issued with small boxes of cobwebs to use to stop bleeding. Surgical teaching from Montpellier thus spread from France to England and even to the Low Countries, Germany and Scandinavia (Petrucci 1978). Mysticism increased and many of the lessons learned by Graeco-Roman surgeons were lost during the Middle Ages. Suturing became uncommon, though human hair was used occasionally. Cautery – a practice popular with the Arabs – became the standard treatment for wounds of all types and was not only used to still bleeding. Not until the practice of surgery became respectable once again – during the Renaissance – would many of the forgotten lessons be relearned.

Conclusion

A number of effective wound treatments had been discovered by prehistoric and primitive peoples alongside a body of magical or mythological therapies. Many of the agents commonly used, such as honey, butter, clay, bark, sap, and other plant extracts, have been shown to have useful pharmacological properties; others, such as urine, dung or blood, probably only had ritualistic significance. Magic and ritual dominated early civilizations and lack of knowledge of anatomy, often combined with an abhorrence of mutilation of the human body, hampered the evolution of the science of surgery.

By the fifth century BC diseases had come to be studied in their own right and attempts were made to influence their natural history, but no system developed in medicine until the great Roman encyclopaedist Celsus set down his surgical teaching in the first century AD. Primary and secondary suture of wounds were described and their care was made more rational, although a number of weird preparations were still recommended. Galen's teaching came to dominate medicine and surgery for fifteen hundred years and, indirectly, led to the decline of surgery from the seventh to the fourteenth century. The main culprit was however the Church, which had assumed responsibility for medical care. Ritual once again took over, and surgery was left to practitioners without formal training.

The belief that the formation of pus was necessary for healing led to the use of mixtures of irritating substances on wounds. Because physical contact with the sick was abhorrent to physicians in the Middle Ages cautery was substituted for sutures and wounds were no longer debrided. The rational use of topical preparations to achieve a desired effect became subjugated to the single aim of promoting suppuration. Wound treatment was, in effect, worse than it had been in prehistoric times.

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