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The Ancestors of Inhalational Anesthesia: The Soporific Sponges (XIth–XVIIth Centuries)

How a Universally Recommended Medical Technique Was Abruptly Discarded

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THE history of anesthesia is intimately linked to the history of surgery. The textbooks of the Hippocratic Collection, which are the oldest surviving books of Western medicine, describe a number of elaborate surgical techniques.[1] These procedures must have necessitated that the patient remained perfectly still, suggesting that restraints were probably used, and some degree of analgesia or partial alteration of consciousness. Methods available at the time to obtain adequate operating conditions included application of heat or cold, jugular vein compression,[2] and oral administration of alcoholic beverages or potions prepared from plants with sedative effects. Sedative substances inhaled at the time, but only in nonmedical situations, such as that of the Delphic priestess, who uttered her oracles while in a trance induced as a result of the inhalation of hallucinogenic vapors. Because of these nonmedical uses of inhalation, contemporary authors consider that inhalation for surgical purposes was first used during the XIXth century, in 1846[3].

However, inhalation methods were used in the Middle Ages in Europe.[4] The technique consisted of placement of a sponge soaked in juices of plants with hypnotic properties under the nose of the patient. The current article describes the changing composition of the soporific sponges during the centuries and the conflicting opinions about their effectiveness.

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The Abbeys (VIth–XIth Centuries)

At the councils held by the Roman Catholic Church in the VIth century, the bishops of the Western world were urged to attend diligently to their duties of hospitality and assistance. They were invited to set up *hospitalia* near their residences, offering beds for the crippled and the needy.[5] Little by little, *hospitalia* were created in rural parishes, along roads (most notably those traveled by pilgrims), near monasteries, or, sometimes, as in Saint Martin de Tours (France), near important shrines. Supported by the Carolingian kings, *hospitalia* became entirely the affair of the Church. The therapeutic activity that developed in *hospitalia* remained the only form of inpatient medical practice until at least the XIth century. To pass on their medical knowledge and to comply with the directives of the Aix-la-Chapelle Council (AD 817), which made the reading and copying of manuscripts a mandatory activity of all monastic orders, hospital monks created the first medieval textbooks of medical botany, pathology, and pharmacology. The Monte Cassino Abbey (Italy) was particularly active in this respect, as attested to by the *De innumeris morbis* and *De innumeris remedorium utilitatibus* (credited to Abbot Bertharius), and by the translations and compilations by Constantinus Africanus (circa 1015–1087).[5] One of these compilations contains the oldest soporific sponge formula known to date (see Appendix). The first sentence of this formula leaves no doubt that the sponge was used for surgery and that the substances it contained were administered by inhalation:

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This is a soporific preparation to be inhaled (*Id est somnificum-. . .soporati*), appropriate for those who are to have surgery (*his qui chirurgia curatur*), so that one can cut without causing pain (*aut sectionis dolorem non sentiant*).

The word *soporati* confirms that the aim of the procedure was actually inhalation, even if one cannot exclude that sponges acted through nasal absorption. Opium (*opiu thibaicu*), mandrake (*mandracore sucus*), hemlock (*cicute*), and henbane (*iusquiami secu*) were macerated in a certain quantity of water (*cum aqua sufficiente*) and used to soak a sponge (*spungie*), which was then dried in the sun (*infundis in calida*). When it was time to perform the operation, the sponge was soaked in hot water and applied while still damp to the nostrils of the patient (*naris adponis*) to induce loss of consciousness (*ut ad se ipsum rapiat spiritum, donec dormiat*). At the end of the operation, another sponge soaked (*altera spongia*) in hot vinegar (*aceto calefacto*) was used to wake the patient.[6,7]

Three arguments suggest that these soporific sponges were first developed by the Arabs.[8] First, many Arab medical texts were translated at Monte Cassino during this period. Second, Christians used alcoholic beverages widely as an anesthetic for the wounded. However, Muslims were prohibited by religion from drinking alcohol, a fact that may have prompted them to seek alternatives. Last, and most important, manuscripts from the School of Alexandria, dating from the same period as that of Monte Cassino, contain soporific sponge formulas that are virtually identical to those in the Monte Cassino manuscripts.[9] Therefore, there is strong evidence that, starting in the XIth century in Europe, a technique for surgical pain relief that relied on inhalation was used, taught, and made known by monks.

The School of Salerno (XIIth Century)

Until the XIth or XIIth century, however, medicine was taught only in monasteries, primarily by allowing young monks to accompany more experienced brothers as they cared for their patients. Later, by copying manuscripts, they captured this knowledge in a more reliable way and allowed it to reach beyond the geographic confines of their abbey. In the XIIth century, the School of Salerno was the first in Europe to teach medicine to laymen, using an ideological corpus that was circulated under the title *Articella* (Little Art).[10] This structured teaching gave the School of Salerno preeminence over the medical teaching offered by monasteries. Roger Frugardi, in *Practica Chirurgiae* (1170) and Nicolas Prepositus, the dean of the School of Salerno, in the *Antidotary* (1471)[11] both described a soporific sponge formula. This formula includes the ingredients used in the Monte Cassino formula, and lettuce seeds (*seminis lactuce*), poppy seed pods (*coconidii papaveris*), and juices of climbing ivy (*succi edere arborea*) and immature blackberries (*succi more immature rubis*). Fennel roots were introduced into the patient's nose to induce awakening after the operation.

Bologna (XIIIth–XIVth Centuries)

During the XIIIth century and until the middle of the XIVth century, three universities exercised a virtually monopolistic hold over the teaching of medicine in Europe: Bologna, Montpellier, and Paris.[10] Hugh of Lucca (1180-1252) was one of the famed practitioners from the School of Bologna. He used a soporific sponge formula, which was described by his pupil Theodoric (who died in 1298) in *Cyrurgia* (1264).[6,12] The title of the chapter describing the sponge (*De somniferis et sublimationibus*) indicates very clearly that the sponge was intended to induce sleep. Its formula was more complex than previous formulas, although the exact nature of some of its ingredients is controversial. In addition to the plants used by the School of Salerno, *succi mori sylvestris* (bramble berry juice), *seminis lapathii*, and *conidium* were added. The terms "*seminis lapathii*" and "*conidium*" illustrate the formidable challenges raised by the translation of medieval medical texts. It has been suggested that *lapathum* may be *lapacium* (burdock), polygonaceae (sorrel), chenopodiaceae (spinach), or even *Landolphia* or *Acocanthera,* two plants used by the Somali people to poison arrowheads and brought to Europe by the crusaders. As for *conidium* (or *coconidium*), another spelling may be *cocognidium,* a vulgar Latin word for *coccum-gnidium. Coccum* means "berry" and *gnidium* means "daphne," suggesting that *conidium* may be the daphne berry[13]. Fennel roots and vinegar were used to wake the patient. At the same time, Gilbertus Anglicus (1180-1250) suggested that blackberry and *lapathum* should be eliminated from the formula and that the vinegar-soaked sponge used to induce awakening should be rubbed against the patient's teeth.[8]

From Guy de Chauliac to Ambroise Paré (XIVth–XVIth Centuries)

The school of Bologna attracted students throughout Western Christendom. Soporific sponges are frequently

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mentioned in the writings of physicians trained in Bologna, with slight variations in the formula. The development of soporific sponges is attributed primarily to Guy de Chauliac (1300?–1368), a former student of the School of Bologna who was the physician of the popes in Avignon for more than 20 yr. His *Chirurgia magna* (or *Inventarium*), which he completed in 1363, occupied a place of prominence in the medical literature of the Middle Ages.[12,14] Treatise VI, doctrine I, chapter VIII provides a soporific sponge formula. It contained opium, black nightshade juice, henbane, mandrake, climbing ivy, hemlock, and lettuce. A sponge soaked in vinegar and fennel roots (inserted into the nose and ears) were used to wake the patient.[15]

The high quality of the work by Chauliac, its relatively wide circulation as a result of the recent invention of printing (more than 40 editions were printed in France), and its translation into many languages (Italian, English, Hebrew, Dutch, French, Spanish, and Provençal) made Chauliac's formula one of the most important in the history of soporific sponges: It was adopted by most European surgeons and used for more than 2 centuries[12]. During the XVIth century, Ambroise Paré (1509?–1590) used it, with a few changes:

> He (the patient) will be made to smell poppy flowers, henbane, water lilies, and mandrake crushed with vinegar, rose water, and camphor to obtain a mixture. Held long enough under the nose, to allow the smell to travel to the brain, they will induce sleep.

XVIIth and XVIIIth Centuries: Soporific Sponges Disappear

No mention of soporific sponges is found in medical and surgical texts written during the late XVIIth century or afterward. The reason is unclear. There are at least two possible explanations. First, soporific sponges were used outside the field of medicine for the practice of magic. In 1589, the renowned botanist John Baptista della Porta (1535–1615) wrote *Magiae Naturalis*, which contained a soporific apple formula derived from that of Chauliac.[16] However, Porta was suspected of dabbling in the occult and was blamed by Pope Paul V in 1578.[17] This must have had a negative effect on the reputation of soporific sponges. More generally, the political climate at this time, with the Roman Inquisition (1542) or the Index of Forbidden Books (1559), may have contributed to the disappearance of previously accepted medical techniques, especially when recommended by nonconformist minds such as Porta's. Second, soporific sponges may have been discarded because they were recognized as ineffective. This possibility will be discussed further on.

The XIXth Century: The Rebirth and Death of Soporific Sponges

Toward the middle of the XIXth century, the considerable popularity of anesthesia by inhalation (of nitrous oxide then ether) drew attention to the work of a physician from Toulouse, Dauriol. Dauriol was bold enough to anesthetize several patients with use of sponges soaked in henbane, nightshade, stramonium, hemlock, and lettuce. A piece of cloth soaked in vinegar was used to wake the patient. Dauriol's description of his experience with five patients was published in *The Lancet*.[18] The procedures consisted of amputation of a finger, removal of a tumor of an eyelid, repair of an anal fistula, removal of a breast tumor the size of a hen's egg, and amputation of three fingers. In all cases, the duration of the surgical procedure was extremely short. Dauriol explained that in his last case, in which the operation took longer, the anesthesia provided by the sponge was inadequate. After the discovery of ether, then of chloroform, soporific sponges were rapidly discarded, and to our knowledge have never been used since or studied in humans. During the XXth century, Baur, in 1924 [19] in Switzerland, and Infusino, in 1989 in Californis,[20] evaluated the effectiveness of soporific sponges in small rodents. Baur used the formula of Theodoric and Infusino used that of Chauliac. Neither was able to induce sleep in the study animals.

Did the Plants Used to Prepare Soporific Sponges Really Have Sedative Properties?

The four ingredients used in the earliest soporific sponge formulas were opium, hemlock, mandrake, and henbane. The sedative properties of opium, extracted from poppy seed pods, were already used in ancient Greece and Rome. It is therefore not surprising that opium was consistently included in the soporific sponges.[19] Hemlock was also known in ancient times: A drink of hemlock was used to carry out the death sentence passed on Socrates. The active ingredient in hemlock, conicine (or cicutine), is responsible for paralysis and loss of sensation.[21,22] Henbane and mandrake contain alkaloids (hyoscyamine, hyoscine, and scopolamine), which ability to cause parasympathetic system depression may have produced sedation. Mandrake was used in

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Egypt, Greece, and Rome. Its narcotic effects were probably potentiated by the superstition that surrounded it.[23,24] Henbane was recommended as an analgesic by Dioscorides (AD 1st century)[21]. However, before the use of soporific sponges, neither mandrake nor henbane was administered by inhalation.

Therefore, the soporific sponge formula used at Monte Cassino contained substances that have true sedative and analgesic properties. During the centuries other ingredients were added, such as poppy seed pods, lettuce, black nightshade, blackberry, bramble, climbing ivy, daphne, and the enigmatic *lapathum.* The level of opium, an essential ingredient in soporific sponge solutions, was probably increased by the addition of poppy seed pods.[8] The alkaloids found in lettuce and black nightshade, *i.e.*, hyoscyamine and solanine, respectively, depress the parasympathetic system and may thus have caused sedation.[21] Blackberry and bramble may have been chosen for their astringent properties, which may have decreased the production of oral and pharyngeal secretions. We have no satisfactory explanation to the use of ivy. Daphne may have been added to the formula simply to mask the unpleasant smell of some of the other ingredients, most notably hemlock. Finally, Dauriol added stramonium, which also depresses the parasympathetic system. Thus, all the soporific sponge formulas used from the XIth to the XVIIth century contained a mixture of plants with parasympathetic depressing properties (potentially responsible for sedation), opium (potentially responsible for analgesia), and hemlock (potentially responsible for paralysis).

Were Soporific Sponges Clinically Effective?

Several lines of evidence suggest that soporific sponges were effective, including the presence in the sponges of substances with sedative, analgesic, and perhaps muscle-relaxing effects, as described previously; accounts by physicians who used the sponges in their own practice; and the finding that soporific sponges remained in use for nearly 7 centuries. However, the sudden fall into disuse of soporific sponges in the late XVIIth century and the failure of modern investigators to find evidence of sleep-inducing effects seem to tell a very different story. Sponges may have been considered to be effective initially, and favorable accounts of their effects may have provided the impetus needed to drive their continued use during several centuries, despite a gradual loss of effectiveness over time, until finally opinion changed and soporific sponges were discarded. Fou arguments militate in favor of this hypothesis.

First, the concept of pain may have changed over th centuries: A level of analgesia and sedation considered t be acceptable in the XIth century may have been viewe as inadequate several centuries later; in the same way, i our modern medicine, the effectiveness of standard pos operative analgesia was recently reappraised and foun to be inadequate.[25] Also, early surgical procedures wer probably extremely short in duration and superficia because it was recommended that surgeons work *cito tuto et jucunde* (fast, unerringly, and without causin harm). Some surgical procedures lasted only a few sec onds (*e.g.*, repositioning of a dislocated joint, realigr ment of fractured bone fragments, or amputation) an could probably be performed even with a very limite degree of surgical pain relief. It is worth noting that th only failure reported by Dauriol was in a patient wh underwent an unusually long-duration surgical procedure

Second, the translation of ancient texts raises signif cant difficulties because of progressive changes in Lati grammar and vocabulary, the widespread use of abbre viations, and the frequent alteration of texts by copyin errors before printing was invented. In addition, accu rate identification of the plants used was difficult be cause no commonly admitted nomenclature was use before the XVIIIth century. The inaccuracies introduce by these factors may have been perpetuated and ampli fied over time as the texts were copied over and ove again. As a result, the composition of soporific spong preparations, and, consequently, their effectiveness may have changed gradually.

Third, the old manuscripts provide little or no infor mation about a number of practical aspects of soporific sponge preparation and use, such as the season durin which the plants were picked, the exact amounts used and the exact methods of administration (duration o exposure of the patient, type of breathing the patien was instructed to adopt, expected duration of the seda tive effects). This information was perhaps transmitte orally at the beginning of the development of soporific sponges, then forgotten or distorted.

Fourth, *scholasticism,* the doctrine used to teach med icine in the Middle Ages in Europe, may have foster the use of ineffective techniques.[10] Scholasticism em phasized logical argumentation and theoretical debat rather than experimental science. Teachers often quote the Hippocratic aphorism "experimenting is mislead ing." As a result of this philosophy, the empiric evalua tions that would have encouraged challenges to curren

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practice were not performed. These practices were often viewed as obviously valid simply because they existed. Soporific sponges may therefore have survived for centuries after they had lost part or all of their effectiveness. Together, these considerations suggest that soporific sponges were effective at first, then lost their effectiveness gradually before succumbing to the dual blow of their infamous use by magicians in the XVIIIth century and of the discovery during the XIXth century of modern anesthetics with more predictable effects.

Soporific sponges are the earliest example of a complex pharmaceutical formula capable of inducing anesthesia by inhalation. They probably had some measure of effectiveness, enough in any case to allow performance of the short-duration surgical procedures of the time. Perhaps during the centuries, imperfect transmission of the formulas resulted in a gradual loss of effectiveness. Such inaccuracies may have been perpetuated by the prevalent view at the time that it was useless and dangerous to challenge established practices. Yet, the history of soporific sponges stands as testimony to an early and compassionate desire to relieve pain and ease the surgical experience by means of inhaled agents, a cornerstone of modern anesthesiology.

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Appendix

Formula of the soporific sponge from the Monte Cassino abbey.[6]
Id est somnificum conveniens his qui chirurgia curatur, aut sectionis dolorem nonori sentiant soporati. Recipit hec : opiu thibaicu semis uncia, mandracore sucus ex foliis uncie octo, cicute his uiridis sucus, iusquiami secu uncie tres in unum cum aqua sufficiente, ut sucum faciat et ipsum sucum in spungie rude sicca redigis et diligenter sicca bis. Et dum uti uoleris ipsa spongia, ad hora infundis in calida et naris adponis et facit, ut ad se ipsum rapiat spiritum, donec dormiat. Et dum expergisci uolueris altera spongia aceto calefacto infusa naribus apponis et sompnum solues.

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