VICTORY OVER PAIN

A History of Anesthesia

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In the chronology of our subject, no event is recorded for the year 1883, but it was the natal year of two men who were destined to make important contributions to the conquest of pain. For permission to dedicate his book to these masters of modern anesthesia, the author is grateful to Dr. Arthur Ernest Guedel, of the University of Southern California School of Medicine, and to Dr. Ralph Milton Waters, of the University of Wisconsin School of Medicine.

The Saturday afternoon visits of the publisher Henry Schuman, accompanied by his associate, Lewis F. Thompson—delightfully prolonged on occasion to the early hours of the morning—invariably aroused the hormonic tides of authorship.

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HALF-TONE PLATES

Introduction

THE AUTHOR began an earlier book (*The Story of Medicine*, 1931) with the line: "The first cry of pain through the primitive jungle was the first call for a physician."

The present volume is devoted exclusively to pain and its conquest. When Simpson, one of the foremost fighters against pain, was created a baronet in 1866, he adopted as his coat-of-arms the rod of Aesculapius with the words *Victo dolore*. The translation of that motto, *Victory Over Pain*, serves as the title of this book.

The first operations performed with sharpened stones and pointed flints in the shade of rock-shelters or under forest trees, have no recorded history, but we know what uninvited guest was present. Surgery learned many lessons through the ages, but never was it able to banish Pain. The screams of the patient which rang in the hairy ears of the Stone Age surgeon were heard in the classic period by the disciples of Hippocrates, and the undiminished cries echoed down the corridors of modern hospitals. All who sought release from disease at the point of the knife were first compelled to pay homage to Pain.

One hundred years ago, a vapor in the operating-room of the Massachusetts General Hospital blotted out suffering from surgery. It was the most beneficent change in the history of surgery, and has since been hailed as America's greatest gift to mankind.

In every branch of the healing art, Europe had long been the mentor of America. We studied in Edinburgh, or took postgraduate courses in Vienna; for texts we reprinted British books or translated them from French and German. With anesthesia the situation was reversed. The academic gown fell from the venerable European shoulders, and the old schoolmaster became the eager pupil: America taught Europe the alphabet of anesthesia.

This book, written on the eve of the centennial of merciful surgery, relates the long struggle of science against suffering, unsuccessful for ages and seemingly no nearer the goal—until the unexpected achievement. The revelation of anesthesia is a chapter in the life of science where it merges with the history of humanity: as such it should be part of the general education of the present generation.

V.R.

EARLY DEVELOPMENTS

ONE

Drugs and Dreams

NATURE GIVES pain to Life for its protection. Pain is the instinctive cry at the onset of injury and disease. Pain rings a sleepless alarm, warning all living creatures of danger. Pain saves the organism by informing it in time of disordered conditions. Pain is the cruel but life-saving guardian of protoplasm. The absence of pain in the early stages of cancer, for example, is one of the darkest tragedies of the human race.

From primitive times man sought the separation of pain from the advancing knife. To the surgeon, pain was the barrier he was forced to penetrate before his terrible instrument became the healing knife. The pain of the patient often denied access to his body; the sick often preferred to die rather than submit to an operation.

When the surgeon of the Stone Age, using a flint knife, made a hole in the vault of the skull to permit the demon to escape, was the patient fully conscious during the operation? Did the medicine-man choke the patient, causing partial suffocation? Was there a sudden kick in the solar plexus? Did the surgeon's assistant stun the patient with a blow on the head, or deliver a knock-out punch on the jaw? There is no evidence that these procedures were used, but if they were they could hardly have been a solution, for man began to look about him for more soothing methods.

Man early sought his pain-relievers from his surroundings—from the herbs that grew out of the earth. The reputed joy-bringing, sorrow-easing power of nepenthes (from the Greek *ne*, negation, and *penthos*, sorrow or pain) and helenium (the tears of Helen of Troy) belongs to the myths of medicine, but even in the infancy of the healing art our ancestors found actual, useful anodynes.

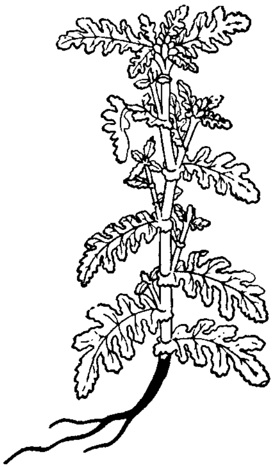
In the *Odyssey*, Homer exhibits the medical knowledge of the beauteous Helen: "Straightway she cast into the wine of which they were drinking a drug to quiet all pain and strife, and bring forgetfulness of every ill. . . . Such cunning drugs had the daughter of Zeus, drugs of healing, which Polydamna, the wife of Thon, had given her, a woman of Egypt." Some scholars have contended that nepenthes was no actual drug, but that Homer was referring to the charm of Helen's conversation.

The plant helenium, described by Pliny, harks back to the Homeric nepenthes: "The helenium is said to have had its origin in the tears of Helen, and hence it is that the kind grown in the island of Helena is so highly esteemed." Pliny does not forget so interesting a remedy, and returns to the subject, saying that taken in wine, the helenium is believed to have "a similar effect to the nepenthes, which has been so much vaunted by Homer, as producing forgetfulness of all sorrow."

The mythographer Apollodorus regarded Melampus as "the first to devise the cure by means of drugs and purifications." Melampus, a shepherd, saved the lives of some young serpents and took care of them. One day when

Melampus was asleep, the serpents in gratitude cleansed his ears with their tongues. Melampus awoke in fright, but found he could now understand the language of the birds and foretell the future.

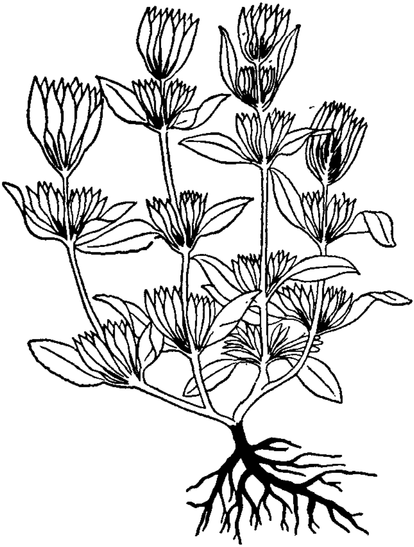
Among the remedies introduced into medicine by Melampus were iron rust in wine, the original *vinum ferri*, and black hellebore, *helleborus niger*, with which he healed the madness of the daughters of Proteus, king of Argos. Black hellebore was the dominant purgative of antiquity, frequently prescribed for that purpose by Hippocrates, the father of medicine, in the fifth century B.C.



Hellebore

The sedative property of hellebore was noted about one hundred years later by Theophrastus, who stated in his *Enquiry into Plants* that the cautions of druggists and herb-diggers about the proper methods of cutting and gathering plants are sometimes of practical value. "The properties of [some] plants are hurtful; they take hold, it is said, like fire and burn; for hellebore too soon makes the head heavy, and men cannot go on digging it up for long; wherefore they first eat garlic and take a draught of neat wine therewith."

Dittany (*dictamnus*), another popular herb, grew on the mountains Dicte and Ida on the island of Crete, and took its name from the former. According to Aristotle, in his *History of Animals:* "Wild goats in Crete, when wounded by arrows, are said to go in search of dittany, which is supposed to have the property of ejecting arrows from the body."



Dittany

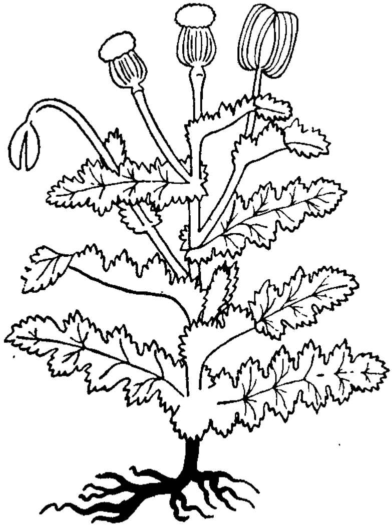
When Aeneas was wounded, Venus administered dittany. As told by Virgil in the *Aeneid:*

Hereupon Venus, smitten by her son's cruel pain, with a mother's care plucks from Cretan Ida a dittany stalk, clothed with downy leaves and purple flower; not unknown is that herb to wild goats, when winged arrows have lodged in their flank. This Venus bore down, her face veiled in dim mist; this she steeps with secret healing in the river-water poured into bright-brimming ewer, and sprinkles ambrosia's healthful juices and fragrant panacea.

Virgil then relates the result of the celestial anesthetic:

With that water aged Iapyx laved the wound, unwitting; and suddenly, of a truth, all pain fled from the body, all blood was staunched deep in the wound. And now, following his hand, without constraint, the arrow fell out, and newborn strength returned, as of yore.

Wine was man's early intoxicant: it enabled him to escape from reality, liberated him from sorrow, and permitted him to dream of pleasure and grandeur. Wine was also man's early anodyne: in all ages it was known that in the narcosis of drunkenness surgical operations could be performed without consciousness of pain. The story of Noah and his vineyard – "And Noah awoke from his wine"– and the "wine-colored sea" of Homer attest the popularity of wine in remote days.



Opium

From *narkē*, the Greek word for "stupor," has stemmed our word narcotics, meaning drugs which induce sleep and lessen sensibility. In his great herbal, Dioscorides, the famous Greek physician of the first century A.D., who served for a time in the army of Nero, wrote of opium as "a pain-easer and a sleep-causer." From ancient until modern times the dried milky juice of the capsule of the white- or scarlet-flowered poppy, from which opium is derived, has been the most important of narcotics.

Lucian, too, speaks of the poppy and associates it with sleep. In his *True History* he comes to the Isle of Dreams, and there finds the City of Sleep "round about environed with a wood, the trees whereof are exceeding high poppies and mandragoras, in which infinite numbers of owls do nestle. As one enters the city, on the right is the temple of Night. On the left is the palace of Sleep."

Of all the roots nourished at the breast of Mother Earth, none was so mysterious as the mandragora (mandrake). The man-like form of the outspread, two-legged root was awe-inspiring. It grew beneath the gallows, feeding on the flesh of felons: its pain-easing, sensation-destroying death-

Dioscorides receiving a root of the mandrake from the Goddess of Discovery

wine (Wine of the Condemned) was given on a sponge to those about to be tortured and hanged.

People believed that when the mandrake was uprooted, it uttered such unearthly shrieks that those who heard the sounds perished. Therefore the herb-gatherer securely tied a dog to the mandrake and walked off. The dog, making frantic efforts to join his master, pulled the mandrake out of the ground. At that moment the herb-gatherer blew a mighty blast on the horn to drown out the terrible cry of the mandrake. When the unprotected dog died, it was considered safe to handle the plant.

In Greece, mandragora was popularly recognized as a narcotic. The earliest reference in Greek literature is found in the *Enquiry into Plants* of Theophrastus:

> The leaf of mandrake, they say, is useful for wounds, and the root for erysipelas, when scraped and steeped in vinegar, and also for gout, for sleeplessness, and for love potions.

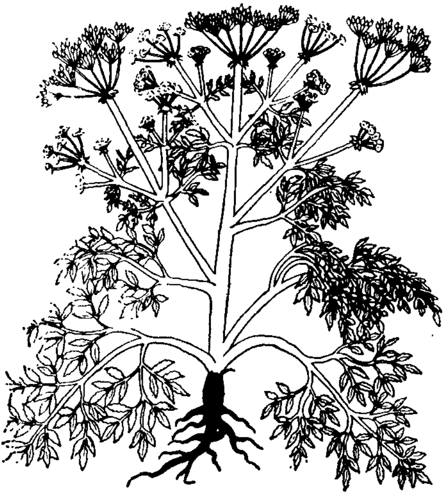
Demosthenes, who lived at the same time as Theophrastus, knew his audience would understand his meaning when he exclaimed that the Athenians could not be awakened, for they were like men who had drunk mandragora. In the materia medica of Dioscorides, mandragora is recommended for the production of anesthesia.

The mystic mandrake was thus one of the earliest of anesthetics.

The herbalists of ancient times also experimented with hemlock. They discovered that the poison in the leaves was not constant. Its pain-relieving power varied according to the weather and the climate, the conditions under which it was grown, and the age at which it was collected. The leaves might be shining green in color, and the odor languorous and heavy, and yet be lacking in narcotic power. The Greeks learned to gather the hemlock when the flowers fade, for then the narcotic is strongest.

The Athenians considered hemlock a very satisfactory state poison. It was immortalized in the execution of Socrates, movingly described by Plato in the *Phaedo*—perhaps the most wonderful death-scene in history. After describing the last hours of Socrates among his friends, Plato tells how the executioner entered the cell, carrying a cup of hemlock. When Socrates beheld him, he said: "It is well, my friend; but what is proper to do with it? for you are knowing in these affairs."

The executioner explained: "You have nothing else to do but when you have drunk it to walk about, till a heaviness takes place in your legs, and afterwards lie down; this is the manner in which you should act." He extended the cup to Socrates who received it with cheerfulness and calmly drained its contents.



Hemlock

For a time Socrates walked around talking with his friends, but soon his legs were heavy, and he lay down. At intervals the executioner touched the lower part of his body. Then he violently pressed the foot of Socrates, and asked if he felt anything. Socrates said he did not. The executioner pressed the thighs of Socrates, and moved his hands steadily upward to indicate the parts that were already devoid of feeling.

In Plato's words: "And Socrates also touched himself, and said that when the poison reached his heart, he should then leave us. But now his lower belly was almost cold;

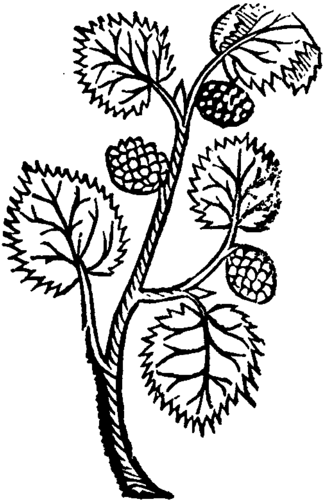
when uncovering himself (for he was covered) he said (which were his last words), 'Crito, we owe a cock to Aesculapius.' " When Crito said he would pay the debt, and asked his master if he had any other commands, there was no reply.

In the Roman era, Pliny, the encyclopedist, referred to hemlock with reluctance: "Hemlock, too, is a poisonous plant, rendered odious by the use made of it by the Athenian people, as an instrument of capital punishment: still, however, as it is employed for many useful purposes, it must not be omitted." He mentions its use as a poultice to allay pains in the eyes, and says the leaves have a soothing effect on every variety of pain.

Henbane

Pliny refused to describe its internal administration: "As to those cases in which it is recommended to take it internally as a remedy, I shall, for my own part, decline to mention them."

Varieties of the leaves, seeds, flowers and tops of henbane (hyoscyamus) were part of the early materia medica. The name hyoscyamus (swine-bean) indicates that it was thought good for hogs, while henbane plainly indicates that it was considered poison for fowls. The medical authors of the first century A.D. knew the plant was a narcotic. Celsus wrote: "Beneficial for . . . composing the mind itself is saffron ointment with orris applied to the head. If in spite of this patients are wakeful, some endeavor to induce sleep by draughts of decoction of poppy or hyoscyamus; others put mandrake apples under the pillow; others smear the forehead with cardamomum balsam or sycamine tears."

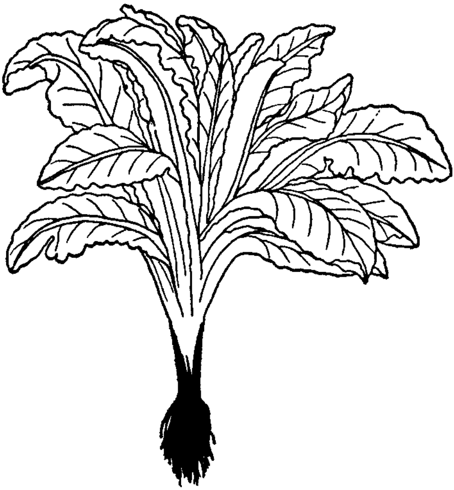


Mulberry

Dioscorides, who pointed out that henbane grows by the sea and amidst the rubbish of buildings, called attention to its pain-relieving qualities: "First of all the juice and that which is made of the dry seed, is prepared for lotions to take away pain, and for the sharp and hot rhume, and for ear pains and griefs about the matrix."

The mulberry-tree (*morus*), also called sycaminus or sycamine-tree is also mentioned as a soporific by these authors. Celsus wrote: "For producing sleep the following are good: poppy, lettuce, and mostly the summer kinds, in which the stalk is very milky, the mulberry, the leek."

The garden lettuce, gathered when young and tender to give the world its salad, contains a bitter milky juice, *lactucarium,* whose sedative power was known in ancient times. Its soporific action was recognized by the writers of fables ("after the death of Adonis, Venus threw herself on a bed of lettuces, to lull her grief and repress her desires"), and by the classic and medieval physicians. Galen shunned the strong narcotic drugs, but enthusiastically recommended lettuce for its calming effect. He relates that in his old age he could not sleep when his mind was overexcited by study, but when he ate liberally of lettuce a soothing slumber overtook him.



Lettuce

The twining hop-plant, *humulus lupulus,* celebrated in the beautiful line, "A land of hops and poppy-mingled corn," is usually thought of in connection with the brewing of beer. But narcotic properties were early ascribed to hops. It was observed that the air of warehouses in which large quantities of hops were stored grew heavy-laden, and those who inhaled the air for any length of time were overcome by drowsiness and sleep. The hop-pillow became a popular sedative for restlessness and sleeplessness, and was prescribed for George III in his period of insanity.

Our forefathers learned by experience what could be expected of these drugs, but many secrets eluded them. The basic or active substances of plants were unknown to them, and they did not realize that it was the alkaloids hidden in the drugs which really produced the results. They could not regulate the dosage of their remedies, and they did not know why portions of the most powerful plants, if they are inert, can be swallowed with impunity.

The Greek physicians found that mandragora was truly a sleep-producing drug; but they did not know that its potency was dependent on its alkaloids (atropine, hyoscine, scopolamine), nor could they map the blocking of the nerve pathways of pain. They knew it was not the brilliant foliage, but the juice exuding from slits in the cortex of its capsule, that gave the opium poppy its narcotic force. But the alkaloids of poppy (morphine, codeine, and others) were not isolated for centuries.

Hops

With the material available they wooed sleep and fought pain. If hemlock and mandrake have disappeared from our materia medica, and if we have hypnotics surer than lettuce, numerous preparations of opium and the extract and tincture of henbane still retain their places in our pharmacopoeia. With hope and valiant hands our forefathers mixed their drugs to give their patients pleasant dreams and to produce anesthesia in surgery.

TWO

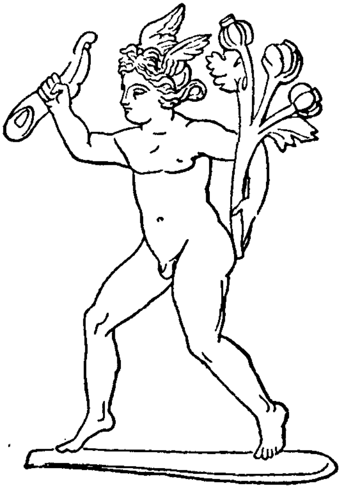
Control of Pain in Antiquity

ANTIQUITY SAW the dawn of anesthesia, but it was a strange dawn with twilight shadows. The Greeks were wonderful theoreticians, but poor mechanics. If they did not develop a technique for their administration, they nevertheless appreciated the principle of pain-controlling drugs.

They told of Lethe, the silent stream of Oblivion, slowly flowing in the lower world. Before souls passed to Elysium, they drank the waters of Lethe to forget earthly sorrow. But the pathways of pain remained open during life, and the ancients endeavored to bring the draught of forgetfulness to the patient beneath the knife.

The Greeks worshiped Hypnos, the god of sleep, the fatherless child of night and the twin brother of death. In works of art, Hypnos and Thanatos are depicted as slumbering together or as holding inverted torches in their unconscious hands. Statues to Hypnos were erected in the healing shrines of Aesculapius, the god of medicine. Hypnos was the father of Morpheus, the god of dreams. The Romans deified Hypnos as Somnus.

Hypnos was the most welcome of gods in sorrow and sickness, and especially during the pain of operative surgery. It was then, however, that Hypnos slept and did not hear the prayer of the sufferer. The Greeks had various devices and drugs to summon Hypnos. They realized, as the younger nations were subsequently to learn for themselves, the mystery and the mercy of sleep.



Hypnos

The epics of Homer demonstrate how early in their development the Greeks were interested in pain-controlling drugs. In the *Iliad* Homer tell us that when the warrior Eurypylus is struck by an arrow, Patroclus leads him to his hut, where the skins of oxen are put upon the ground for the wounded man.

There Patroclus made him lie at length, and with a knife cut from his thigh the sharp-piercing arrow, and from the wound washed the black blood with warm water, and upon it cast a bitter root, when he had rubbed it between his hands, a root that slayeth pain, which stayed all his pangs; and the wound waxed dry, and the blood ceased.

According to tradition, the lyric poet Pindar in the fifth century B.C. was so close to the Delphic Apollo that city-destroying tyrants twice spared his house and his descendants. In one of his *Pythian Odes*, Pindar breathes the prayer that the Centaur Chiron "were reigning still in Pelion's glen, as in the olden days when he reared Aesculapius, the gentle craftsman who drove pain from the limbs he healed."

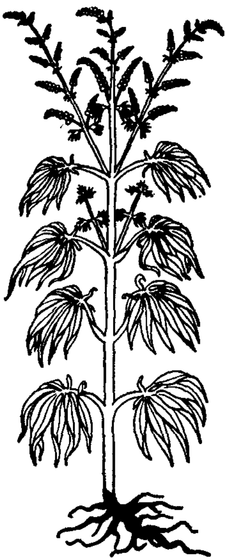
The word which Pindar uses is *nodynia*, meaning *ease from pain;* it is an older and more convenient term than anesthesia, and might well have become the accepted expression for insensibility to pain. In one of his *Nemean Odes*, Pindar sings in honor of the swift feet of Deinias of Aegina, who won a double race, proclaiming that "toil is made painless (*nodynon*) by the spell of song."

The intoxicating power of the plant *cannabis indica*, popularly called Indian hemp and hashish, was known to the ancient world. Herodotus, the historian of the fifth century B.C., has left a famous description of the baths of the Scythians: "The Scythians then take the seed of this hemp and, creeping under the rugs, they throw it on the red-hot stones; and, being so thrown, it smoulders and sends forth so much steam that no Greek vapor-bath could surpass it. The Scythians howl for joy in the vapor-bath." It seems that the father of history did not stay for the end of the performance, as he says nothing of the sleep-producing or narcotic properties of hemp.

The works on Hindu medicine, attributed to Susruta and Charaka, mention the native hemp of India as a remedy. The plant was endowed with such epithets as leaf of delusion, exciter of desire, increaser of pleasure, cementer of friendship, the laughter-mover, causer of the reeling gait.

The stage of excitement was followed by the stage of sleep and insensibility to pain. Inhalation of the fumes of burning hashish produced a crude and early form of anesthesia.

The first use of the term *anesthesia*, or at least the first found in Greek literature, occurs in Plato. In discussing why God placed dense flesh over certain bones and little flesh over other bones, Plato says in the *Timaeus:*



Hashish

> At the junctions of the bones, except where reason revealed some necessity for its existence, He made but little flesh to grow, lest by hindering the flexions it should make the bodies unwieldy, because stiff in movement, or else through its size and density, when thickly massed together, it should produce anesthesia, owing to the rigidity. . . .

The ancients knew that compressing the carotid arteries, the principal arteries of the neck, causes loss of consciousness. The Greek word *carotid* means drowsiness, and carotid artery means the artery of sleep. Pressure on the jugular veins of the neck—the cut-throat veins—likewise causes insensibility. In a passage in his *History of Animals,* Aristotle says of the jugular veins: "If these veins are pressed externally, men, though not actually choked, become insensible, shut their eyes, and fall flat on the ground."

The father of pastoral poetry, Theocritus, in the third century B.C., has a passage in his *Idylls* which demonstrates the Greek interest in assuaging the pangs of childbirth: "On the island of Cos the daughter of Antigone cried aloud in the oppression of pain to the Girdle-Looser; Lucina, friend of women in travail, stood by to comfort her, and shed insensibility to pain over her limbs, and thus a beloved son in the likeness of his father was born." Theocritus, like the poet Pindar before him, uses the expression *nodynia* to denote immunity to pain.

In one of his *Georgic* poems on agriculture, the farm-born Virgil has a beautiful phrase about the power of the poppy: *Lethaeo perfusa papavera somno* ("poppies steeped in Lethe's slumber").

In the *Aeneid* Virgil relates how Cerberus, the dreaded three-headed dog which guarded the entrance to Hades, was put to sleep by a drug:

> To Cerberus, on whose necks bristled the snakes, the seer flung a bait mixed in honey and drugged meal. Opening his triple throat in ravenous hunger, Cerberus catches it when thrown, then relaxes and sinks to earth, succumbs to sleep and stretches his bulk all over the cave.

The Roman poet Ovid also recognized the narcotic properties of opium. In the *Fasti,* he wrote: "Her calm brow wreathed with poppies, Night drew on, and in her train brought darkling dreams." Elsewhere Ovid states clearly: "There are drugs which induce deep slumber, and steep the vanquished eyes in Lethean night." These exquisite words unfold the essence of anesthesia.

Sleep-inducing drugs are described as anodynes by Celsus in the first century A.D., whose encyclopedia is, with the exception of the writings bearing the name of Hippocrates, the oldest medical classic extant. Celsus has the following passage in his *De Medicina:*

Pills are also numerous, and are made for various purposes. Those which relieve pain through sleep are called anodynes; unless there is overwhelming necessity, it is improper to use them; for they are composed of medicaments which are very active and alien to the stomach. There is one, however, which actually promotes digestion; it is composed of poppy-tears and galbanum (4 grms. each), myrrh, castory, and pepper (8 grms. each). . . . Another, worse for the stomach, but more soporific, consists of mandragora (1 grm.), celery seed and hyoscyamus seed (16 grms. each), which are rubbed up after soaking in wine.

Pliny not only recommended the anesthetic efficacy of mandragora but claimed that the mere smell of its juice would put some people to sleep:

Administered in doses proportioned to the strength of the patient, the juice of mandragora has a narcotic effect; a middling dose being one cyathus [1½ ounces]. It is given, too, for injuries inflicted by serpents, and before incisions or punctures are made in the body, in order to ensure insensibility to the pain. Indeed, for this last purpose, with some persons, the odor of it is quite sufficient to induce sleep.

The last statement is to be doubted unless the ancient mandrake was more powerful than its modern descendant.

In his description of mandragora, Dioscorides uses the word anesthesia perhaps for the first time in its medical sense: "One cyathus [1½ ounces] of the wine of mandragora is given to those who cannot sleep, and such as are in grievous pains, and those to be cut or cauterized, when it is wished to produce anesthesia." Three times in this same passage Dioscorides points out that when physicians are about to cut or burn a patient, they give him the wine of mandragora to cause insensibility. Dioscorides was familiar also with the term local anesthesia, for in his brief description of the Memphitic stone of Egypt, he says: "It is reported that when the Memphis stone is smeared upon the parts of the body to be cut or burnt, it brings about a local anesthesia without danger."

Although the Greek poets specified pain-relieving drugs and physicians were familiar with sleep-producing drugs, it must not be assumed that operations in those days were performed under anesthesia. The sensibilities of patients may have been blunted by wine, hemp, or the poppy, but the administration of pain-controlling drugs was too uncertain to become an accepted part of surgical procedure.

The surgical books of Hippocrates are among the finest manifestations of Greek genius, but they do not mention the relief of operative pain. Galen, the most celebrated physician after Hippocrates, expressly states, "I abhor more than anybody carotic drugs," meaning drugs which produce stupor or heavy sleep.

What was done to a patient about to undergo an operation? It was the custom then, as for centuries afterward, to bind the patient to the table with ropes or straps. His screams were disregarded, but if he struggled too violently, assistants grasped his arms and legs. Brave patients scorned such measures as effeminate, and would not permit themselves to be tied down. An operation in the second century B.C. on the Roman general Marius was later described by the biographer Plutarch:

There is testimony both to the temperance of Marius, and also to his fortitude, of which his behavior under a surgical operation is proof. He was afflicted in both legs, as it would appear, with varicose veins, and as he disliked the deformity, he resolved to put himself into the physician's hands. Refusing to be bound, he presented to him one leg, and then, without a motion or a groan, but with a steadfast countenance and in silence, endured incredible pain under the knife. When, however, the physician was proceeding to treat the other leg, Marius would suffer him no further, declaring that he saw the cure to be not worth the pain.

Evidence has already been presented of Greek knowledge of anesthesia, but it was employed more by the poets and dramatists in their works than by the medical men in their practice. The Greek medical writings contain no record of a single operation under anesthesia.

THREE

Anodynes in the Orient

AN ANCIENT Chinese legend relates that the fairy Chang Sang gave Pien Ch'iao a wise book and a package of herbs. The fairy instructed him to read the book and to taste the herbs every day. Pien Ch'iao did as he was told, and in a month he became so skilled a physician that he was able to see through the human body and to note the diseases of the internal organs. He did not reveal his power for fear it would frighten people. He pretended to diagnose ailments by feeling the pulse, and thus became the founder of pulse-lore.

Once a patient from Lu and a patient from Chao came to Pien Ch'iao for treatment. The doctor examined them and found that the patient from Lu had a strong will but a weak mind, whereas the patient from Chao had a weak will but a strong mind. Thereupon, Pien Ch'iao gave them a narcotic wine so powerful that they remained insensible for three days. While they were in this state, he opened their chests, removed and exchanged their hearts. He revived the sleeping patients, and they were cured. The interesting feature of this legend is its anticipation of the great modern medical developments: X-rays and anesthesia.

The historical medicine of China begins in the Han dynasty. Hua T'o, who lived in the third century A.D., urged the practice of calisthenics to improve health:

> The body needs exercise, only it must not be to the point of exhaustion, for exercise expels the bad air in the system, promotes free movement of the blood, and prevents sickness. The used doorstep never rots, and it is the same with the body. That is why the ancients practiced the bear's neck, the fowl's twist, swaying the body, and moving the joints to prevent old age. I have a system of exercise called the frolics of the five animals, which are the tiger, the deer, the bear, the monkey, and the bird. It removes disease, strengthens the legs, and ensures health. If one feels out of sorts, one should practice one of these frolics. It will produce sweating, give a feeling of lightness to the body, and increase appetite.

Hua T'o is a unique figure in Chinese annals, for he introduced surgery into China. Until he began his work the Confucian doctrine that the human body was too sacred to be mutilated had prevented the development of surgery in China, but Hua T'o was so skilful a surgeon that temples were erected to him and he was worshiped as the god of surgery.

Hua T'o's fame spread to western lands for his knowledge of anesthesia. He is credited with the discovery of an effervescent powder which when dissolved in wine produced complete insensibility. This powder enabled Hua T'o to open any portion of the body, and to inspect, wash, cut, and remove a diseased organ, and suture the wound without the patient's knowledge. But Hua T'o did not leave to posterity the formula for his soporific powder.

The Sanskrit epic, *Rāmāyana*, ascribed to the poet Valmiki, of the third century B.C., contains the injunction:

"The wounded in battle should be quickly picked up, carried into a tent, the bleeding stayed, and upon the wounds should be dropped an anodyne oil with the juice of healing herbs."

In the tenth century A.D., Firdousi of Khurasan wrote the *Shāhnāma*, or Book of Kings, in which he refers to anesthesia in the caesarean birth of Rustum, the Persian Hercules.

The griffen, who had nurtured Zal on Elbruz, had given him, at parting, some of her feathers, and directed him to burn one whenever he was in extreme distress. He did so now and his kind nurse appeared. She told him it was necessary to make an incision in the side of Rondabah and gave him some intoxicating drugs, which when administered to the princess, would make her insensible to pain. Zal did as he was directed and the giant child was cut from the side of his mother, who was soon restored to perfect health.

The Arabian Nights contain some delightful allusions to soporific drugs. For example, there is this use of henbane:

Presently he filled a cresset with firewood, on which he strewed powdered henbane, and lighting it, went round about the tent with it till the smoke entered the nostrils of the guards, and they all fell asleep, drowned by the drug.

Ibn Sina, known to the western world as Avicenna, was the dominant figure of the Arabian school of medicine. His *Canon of Medicine* codified all available medical knowledge; translated into Latin, it became the authoritative medical textbook of Europe for six centuries. In Islam it is still considered infallible. Avicenna enumerated the agents which alleviate pain:

There are three groups of agents which alleviate pain: 1) those contrary to the cause of pain, which remove the pain. Examples: fennel; linseed made into a poultice and applied over the painful place. 2) those counteracting the acrimony of the humors, soothing, inducing sleep, or dulling the sensitive faculties and lessening their activity. Examples: inebriants; milk; oil; sweet water. 3) those infrigidating and dulling the sensation in the painful parts. Examples: all narcotics and somniferous drugs. The first of the three is the most certain.

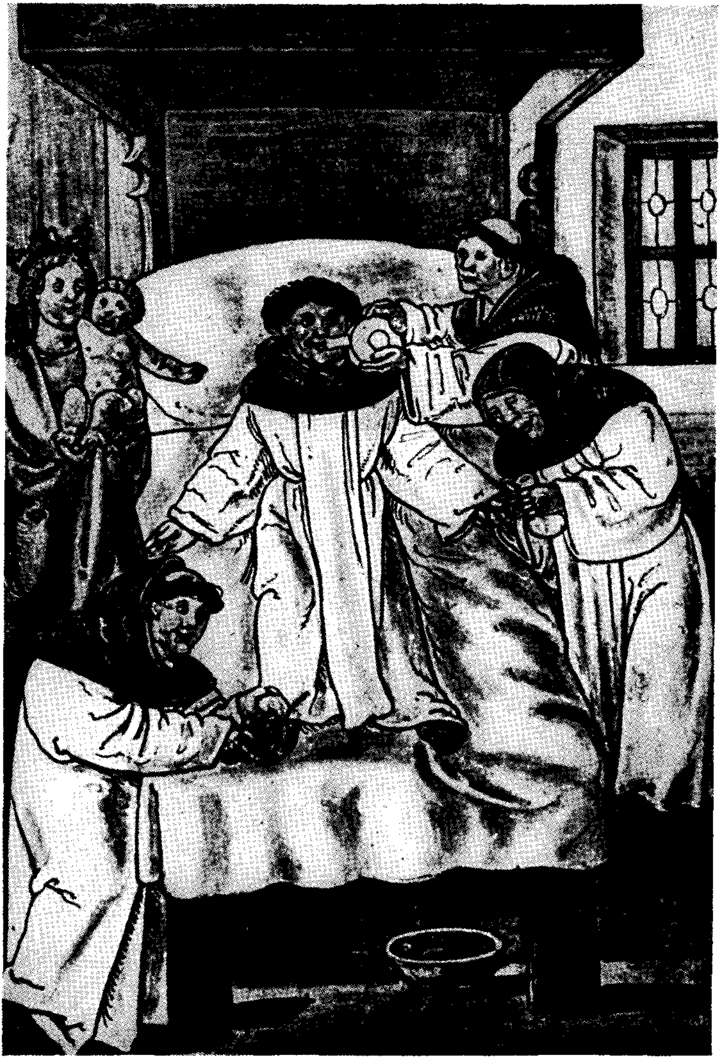
Avicenna also recommends opium, henbane, and mandrake:

If it is desirable to get a person unconscious quickly, without his being harmed, add sweet-smelling moss or aloes-wood to the wine. If it is desirable to procure a deeply unconscious state, so as to enable the pain to be borne, which is involved in painful applications to a member, place darnel-water into the wine; or administer fumitory, opium, hyoscyamus (half dram dose of each); nutmeg, crude aloes-wood (4 grains of each). Add this to the wine, and take as much as is necessary for the purpose. Or boil black hyoscyamus in water, with mandragora bark, until it becomes red, and then add this to the wine.

Avicenna discussed fifteen types of pain: boring, compressing, corrosive, dull, fatigue, heavy, incisive, irritant, itching, pricking, relaxing, stabbing, tearing, tension and throbbing. His discourse on the relief of pain is subtle, and if his remedies proved ineffective, the learned Avicenna tempered them with philosophy.

In the vast brotherhood of pain, there is neither East nor West: with opium and mandrake and hashish and henbane, the Oriental healer, like his Occidental colleague, sought to bring to his operative patients the balm of merciful sleep.

John Arderne (From a fifteenth century manuscript in the British Museum)



Early use of alcoholic fumes for anesthesia (From Schilling's *Swiss Chronicle*, 1513)

FOUR

Narcotics in the Middle Ages

THE FIRST medieval reference to anesthesia is to be found in the fourth century, in the writings of Hilary, a zealous convert to the Christian religion who was elected bishop of his native city of Poitiers. In his treatise on the *Trinity*, St. Hilary plainly distinguishes between anesthesia due to disease and anesthesia resulting from drugs:

The nature of our bodies is such, that when endued with life and feeling by conjunction with a sentient soul, they become something more than inert, insensate matter. They feel when touched, suffer when pricked, shiver with cold, feel pleasure in warmth, waste with hunger and grow fat with food. By a certain transfusion of the soul, which supports and penetrates them, they feel pleasure or pain according to the surrounding circumstances. Where the body is pricked or pierced, it is the soul which pervades it that is conscious, and suffers pain.

For instance a flesh wound is felt even to the bone, while the fingers feel nothing when we cut the nails which protrude from the flesh. And if through some disease a limb becomes withered, it loses the feeling of living flesh: it can be cut or burnt, it feels no pain whatever, because the soul is no longer mingled with it.

Also when through some grave necessity part of the body must be cut away, the soul can be lulled to sleep by drugs, which overcome the pain and produce in the mind a death-like forgetfulness of its power of sense. Then limbs can be cut off without pain: the flesh is dead to all feeling, and does not heed the deep thrust of the knife, because the soul within it is asleep.

Hilary does not describe the drugs which lull the soul to sleep, but for the next few centuries the emphasis was still on mandragora. Thus Apuleius, a fifth century compiler of Greek botanico-medical material, published in his popular herbal a passage on mandragora:

If any one eat it he will die immediately, unless he be treated with butter and honey, and vomit quickly. Further, if any one is to have a limb mutilated, burnt, or sawn, he may drink half an ounce with wine, and whilst he sleeps the member may be cut off without any pain or sense.

The *spongia somnifera*, or sleeping sponge, a sea-sponge saturated with the mixed juices of soporific plants, introduced in the ninth century, was the major anesthetic of the Middle Ages. Its fumes were inhaled by the patient before an operation and were supposed to render him unconscious to surgical pain.

Hugh of Lucca, the leading surgeon of his day, prepared the sleeping sponge which was the basic prescription for medieval doctors. It is given by Theodoric of Cervia, the son of Hugh, in the *Cyrurgia,* the great surgical work of the thirteenth century:

Take of opium, of the juice of the unripe mulberry, of hyoscyamus, of the juice of hemlock, of the juice of the leaves of mandragora, of the juice of the wood-ivy, of the juice of the forest mulberry, of the seeds of lettuce, of the seeds of the dock, which has large round apples, and of the water hemlock—each an ounce; mix all these in a brazen vessel, and then place in it a new sponge; let the whole boil, as long as the sun lasts on the dog-days, until the sponge consumes it all, and it is boiled away in it.

As oft as there shall be need of it, place this sponge in hot water for an hour, and let it be applied to the nostrils of him who is to be operated on, until he has fallen asleep, and so let the surgery be performed. This being finished, in order to awaken him, apply another sponge, dipped in vinegar, frequently to the nose, or throw the juice of the root of fenugreek into the nostrils; shortly he awakes.

But Theodoric seems to have doubted the power of the sleeping sponge to produce narcosis, for he bound his surgical patients. In the operation for hernia, for example, he advised that the patient be tied with three bands: one around his ankles; one encompassing his thighs; and one across his chest, securing both the arms and hands.

Guy de Chauliac, whose *Great Surgery* became the standard treatise on the subject in the later Middle Ages, continued to urge the use of narcotic inhalation in the fourteenth century. But John Arderne of Newark-on-Trent, the originator of the operation for fistula in ano (a type of ulcer near the rectum), proposed another formula. Arderne described himself as *chirurgus inter medicos,* "surgeon among physicians," and to judge from his statements, and especially from the fees he collected, his practice was limited to the nobility, wealthy landowners and higher clergy.

Arderne gave the following prescription for producing anesthesia:

An ointment with which if any man be anointed he shall suffer cutting in any part of his body without feeling or aching. Take the juice of henbane, mandragora, hemlock, lettuce, black and white poppy, and the seeds of all these aforesaid herbs, if they may be had, in equal quantities; of Theban poppies and of poppy meconium one or two drachms with sufficient lard.

Braize them all together and thoroughly in a mortar and afterwards boil them well and let them cool. And if the ointment be not thick enough add a little white wax and then preserve it for use. And when you wish to use it anoint the forehead, the pulses, the temples, the armpits, the palms of the hands and the soles of the feet and immediately the patient will sleep so soundly that he will not feel any cutting.

Arderne also used opium or henbane in wine, but the chief difficulty with all these anesthetics was that they made the patient sleep too profoundly. He added the following caution: "And know that it is well to tweak the nose, to pinch the cheeks or to pluck the beard of such a sleeper to quicken his spirits lest he sleep too deeply."

For post-operative treatment, John Arderne suggested:

And know that it is good to give him afterwards castoreum [the odorous secretion of the perineal glands of the beaver, used as a nerve stimulant], for castoreum chafeth and most comforteth the chilled sinews and relieveth the paralysis. And also give him things that comfort the brain such as castor, musk, nutmegs, roses, nunufar, myrtle and sumace.

As the Middle Ages drew to a close, what had been written by the medical men about narcotics began to seep down into general literature. Boccaccio, who survived the Black Death of 1348, and Chaucer in the fourteenth century described the use of narcotics. Chaucer paid brief tribute to opium in the *Knight's Tale:*

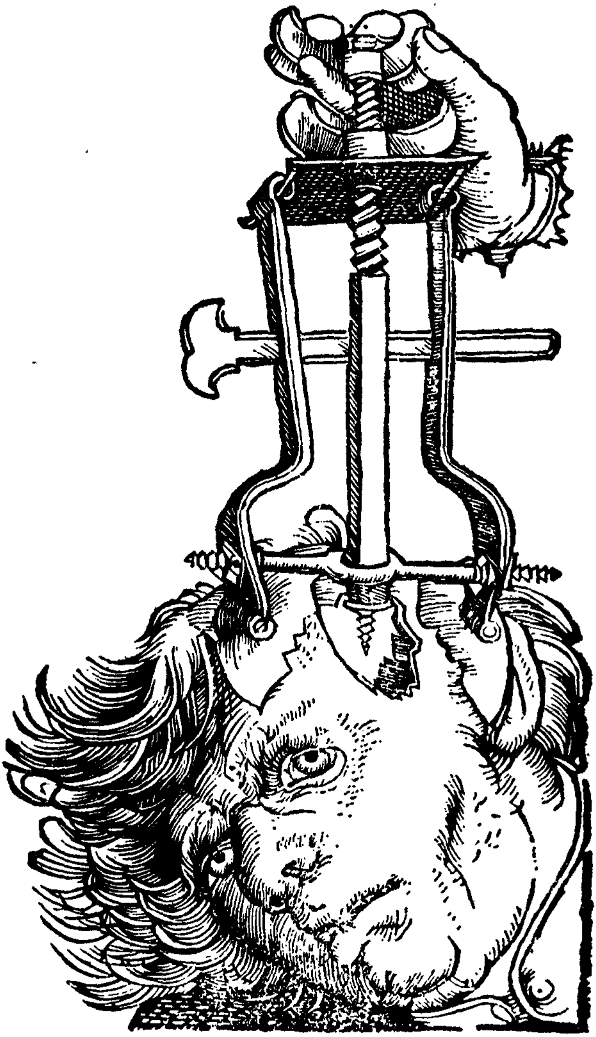
Of a clarre, made of a certain wine,
With Narcotikes and Opie of Thebes fine,
That all the night through that men wold him shake
The gailer slept, he mighte not awake.

In the *Decameron,* Boccaccio mentions the soporific draught prepared by the leech of Salerno, Mazzeo della Montagna:

It happened that there came to the attention of the physician a patient with a gangrenous leg, and when the master had made an examination he told the relatives that unless a decayed bone in the leg were removed either the entire leg would have to be amputated or the patient would die; moreover, if the bone were removed, the patient might recover, but he refused to undertake the case except as if the man were already dead. To this the relatives agreed and surrendered the patient to him.

The doctor was of the opinion that without an opiate the man could not endure the pain and would not permit the operation, and since the affair was set for the evening, he distilled that morning a type of water after his own composition which had the faculty of bringing to the person who drank it sleep for as long a time as was deemed necessary to complete the operation.

Actually the thousand years of the Middle Ages contributed little to man's search for effective anesthesia. As the active principles of drugs (alkaloids) were unknown, it was necessary to use the crude drugs themselves. Their action was uncertain, for there was no way of standardizing the dosage and apparently identical samples of opium, mandrake, or hemlock might differ markedly in narcotic power. Plant juices are not volatile, and since they do not vaporize or diffuse in the air, results are unobtainable by inhalation. The narcotics could be effective only if taken internally, but



Trephining without an anesthetic (From Brunschwig's *Book of Wound Surgery*, 1497) this procedure was too dangerous to become popular. Consequently, it is not surprising to find a recent experimenter characterizing these medieval narcotics as unable to "make even a guinea pig nod." In practice, the safest and most convenient anesthetic of the period was drugged wine: not enough drug to be poisonous, but plenty of wine.

The mental activity of the age was directed toward the salvation of the soul, and the weight of theological doctrine was overwhelmingly on the side of pain: pain came on earth with the Fall of Man and must be endured by the body vile until Judgment Day.

FIVE

The Renaissance

ETHER, THE first modern anesthetic, was discovered in the sixteenth century. But for more than three hundred years, its anesthetic properties were unknown, despite the fact that the search for pain-relievers never ceased.

The first to describe the synthesis of ether from sulfuric acid and alcohol was Valerius Cordus, who in his brief span of twenty-nine years, gave Europe its first Pharmacopoeia, inaugurated the systematic study of botany, and was a pioneer in the transition from alchemy to chemistry. Cordus gave the earliest known account of the synthesis of *oleum dulci vitrioli* (diethyl oxide) from the distillation of "very biting wine," or alcohol, and "sour oil of vitriol," or sulfuric acid. The exactness of Cordus' method marks him as a modern in chemical procedures. He found that ether was highly volatile and that it was an excellent solvent for many substances. Since it was the treatment of disease which first of all interested him, he noted that ether "may be used in pleurisy, peripneumonia, and hacking cough to draw from the lungs pus and mucus." These observations are of great relevance, because it is possible that from the use of ether for these conditions stemmed the discovery of its anesthetic powers in the early nineteenth century. Cordus died in

1544, but his "sweet vitriol" was not called "ether" until 1730, when Frobenius of Germany so named it.

A passage by Paracelsus, the celebrated Swiss physician of the Renaissance and a contemporary of Cordus, is as puzzling as everything else connected with this remarkable man. If Paracelsus was referring to the ether of Valerius Cordus, it is strange that he described so vanishing a substance as "stable." However, the paradoxical Paracelsus, as on so many other occasions, came near the truth, and therefore this passage, despite its obscurities, is worthy of quotation:

> The following should be noted here with regard to this sulfur, that of all things extracted from vitriol it is most remarkable because it is stable. And besides, it has associated with it such a sweetness that it is taken even by chickens, and they fall asleep from it for a while but awaken later without harm. On this sulfur no other judgment should be passed than that in diseases which need to be treated with anodynes it quiets all suffering without any harm, and relieves all pain, and quenches all fevers, and prevents complications in all illnesses.

The tradition of the soporific sponge of the Middle Ages persisted in the Renaissance. It was largely Guy de Chauliac's surgical writings and his great reputation that were responsible for its continued use. Hugh of Lucca's formula was used, with some variations, throughout Europe until the end of the sixteenth century. In Germany, Hans von Gersdorff, a great military surgeon, had his patients suck the sponge for several minutes; in Italy, Giambattista della Porta disguised the odor by adding musk, but the formula remained substantially unchanged.

In England, William Turner published his magnificent

The first picture ever made of an amputation (From von Gersdorff's *Field-Book of Wound Surgery*, 1517) herbal, which marked the start of the science of botany there. In it he gave a prescription for a potion containing mandragora root and said that:

If they drink this drink, they shall feel no pain, but they shall fall into a forgetful and a sleepish drowsiness. The apples, if a man smell of them, will make him sleep, and also if they be eaten. And so doth the juice that is strained out of them. But they that smell too much of the apples, become dumb.

Perhaps the first known reference in an English medical book to an anesthetic agent used in surgery was made by William Bullein. In his *Bulwarke of Defence againste all Sicknes,* in 1562, he wrote:

The juice of this herbe pressed forthe, and kepte in a close earthen vessel, accordyng to arte: this bryngeth slepe, it casteth men into a trauns on a depe tirrible dreame, untill he be cutte of the stone.

In Arthur Brooke's *Tragicall Historye of Romeus and Iulieit,* which preceded Shakespeare's version, Friar Laurence described to Juliet a soporific potion:

It doth in halfe an howre / astonne the taker so,
And mastreth all his sences, that / he feeleth weale nor woe:
And so it burieth up / the sprite and living breath,
That even the skilfull leche would say, / that he is slayne by death.
One vertue more it hath / as meruelous as this;
The taker, by receiving it, / at all not greeved is;
But painlesse as a man / that thinketh nought at all,
Into a swete and quiet slepe / immediately doth fall;
From which, (according to / the quantitie he taketh)
Longer or shorter is the time / before the sleper waketh;
And thence (theffect once wrought) / agayne it doth restore
Him that receaved unto the state / wherein he was before.

In describing a similar scene, Shakespeare revealed a profound knowledge of the effect of anesthesia. Friar Laurence tells Juliet what will happen when she drinks the potion:

> Take thou this vial, being then in bed
> And this distilling liquor drink thou off;
> When presently through all thy veins shall run
> A cold and drowsy humour, for no pulse
> Shall keep his native progress, but surcease:
> No warmth, no breath, shall testify thou livest;
> The roses in thy lips and cheeks shall fade
> To paly ashes, thy eyes' windows fall,
> Like death, when he shuts up the day of life;
> Each part, depriv'd of supple government,
> Shall, stiff and stark and cold, appear like death:
> And in this borrow'd likeness of shrunk death
> Thou shalt continue two and forty hours,
> And then awake as from a pleasant sleep.

Shakespeare elsewhere makes references to poppy, mandragora, and "drowsy syrups," and his contemporary, Christopher Marlowe, speaks of "poppy and cold mandrake juice."

Legal records of the time show that prisoners often took narcotics in order not to feel the torture of their punishment or disclose their secrets in their pain.

But uncertainty of the potency and action of the narcotic drugs rendered their application dangerous and by the end of the sixteenth century such anesthetics had largely fallen into disuse. The patients themselves mistrusted the drugs because of the danger of fatal outcome. Moreover, magicians and sorcerers used the same drugs and recipes for their potions and magic apples, and their use was therefore discredited by regular physicians.

As the drugs began to be discarded, physicians turned to an ancient method of producing anesthesia—by pressure applied to a nerve trunk or artery. As early as 1543, Ambroise Paré, one of the great surgical figures of all time adopted the pressure method for inducing anesthesia. The Spanish physician Valverde reported his observation of this procedure:

The carotids or *soporales*, that is, sleep-producing arteries, are so named because when they are pressed upon or closed in any way we soon go to sleep. This experiment I saw performed by Realdo Colombo in 1544 in Pisa on a young man in the presence of a number of gentlemen, with no less fear on their part than amusement on ours, we giving them to understand that it was done by sorcery.

This reversion to an old procedure, with no significant modifications, is in a sense typical of the poverty of Renaissance thought in the field of anesthesia. Despite its manifold contributions in other sciences, the Renaissance has a disappointing record in the relief of pain.

Seventeenth and Eighteenth Centuries

So DISCREDITED had narcotic drugs become by the middle of the seventeenth century that when Nicolas Bailly, a barber-surgeon of Troyes, administered a narcotic potion to a patient before an operation, the venture aroused widespread condemnation. Bailly was arrested and fined for practicing witchcraft. The stupefaction of patients by administration of herbal remedies was then forbidden in France under heavy penalty.

Refrigeration anesthesia was introduced by Marco Aurelio Severino of Naples in the middle of the seventeenth century, but the method did not come into widespread use until the Russians used it extensively in the Finnish campaign of 1939-40. Thomas Bartholinus in his book, *The Medical Use of Snow*, described Severino's method:

Before employing the cautery on wounds in various parts of the body, apply snow to dull the sensation. . . . To avoid gangrene Severinus had us apply the medication in narrow parallel lines; after a quarter of an hour the feeling would be deadened and the part could be cut without pain.

A new method, intravenous anesthesia, was made possible in the seventeenth century by William Harvey's demonstration of the circulation of the blood. Interestingly enough, it was not a physician who suggested the method, but Sir Christopher Wren, the famous architect of St. Paul's Cathedral in London, who was at that time professor of astronomy at Oxford. Wren's interest was in discovering a new therapeutic procedure; his experiments are discussed later, in the chapter on intravenous anesthesia.

But about the same time Johannes Sigmund Elsholtz, physician-in-ordinary to the Elector of Brandenburg, made the first methodical efforts to use the intravenous method in obtaining anesthesia by injecting a solution of an opiate.

The value of intravenous treatment was vigorously debated by all the great physicians of the period. By the end of the seventeenth century, however, this method was largely discarded because of the uncertain results obtained.

Opium was still occasionally used. Hermann Boerhaave, the renowned Dutch physician and scientist of the seventeenth century, is said by his pupil van Swieten to have used opium as an anesthetic. He prescribed both the inhalation of the vapor and the internal administration of the powder. In 1781, Sassard, a Parisian surgeon, described the action of opium and recommended that the drug be administered before operations.

The great increase in chemical investigations toward the end of the eighteenth century led to the discovery of many new gases. Indeed, the rise of modern inhalation anesthesia may be traced to the widespread interest in these gaseous elements and their effects on respiration. In 1771, Joseph

Priestley in England and Carl Wilhelm Scheele in Sweden independently discovered oxygen. The following year Priestley discovered nitrous oxide. However, it remained for Antoine Lavoisier and his wife, applying quantitative methods in chemistry for the first time, to determine the true nature of oxygen and to realize its great significance. Oxygen and the phenomena of oxidation in the living body are of the greatest importance to anesthesia. The way was now prepared for the determination of the anesthetic and analgesic properties of nitrous oxide by Humphry Davy, whose suggestion in 1800 for its use in surgery to relieve pain went unheeded.

In 1784 there emerged in England a new advocate of anesthesia in amputation by compression of nerves; James Moore described an apparatus designed to produce complete insensibility of various nerves within a half-hour. Moore's method was evaluated by Benjamin Bell, author of a standard textbook on surgery in the eighteenth century. "All that this instrument seems to require in order to render it perfect, is the power of compressing the nerves of a limb without affecting the veins." Bell thought that the veins would burst if they were compressed too long, and that Moore's suggestion of opening a vein would weaken the patient by loss of blood.

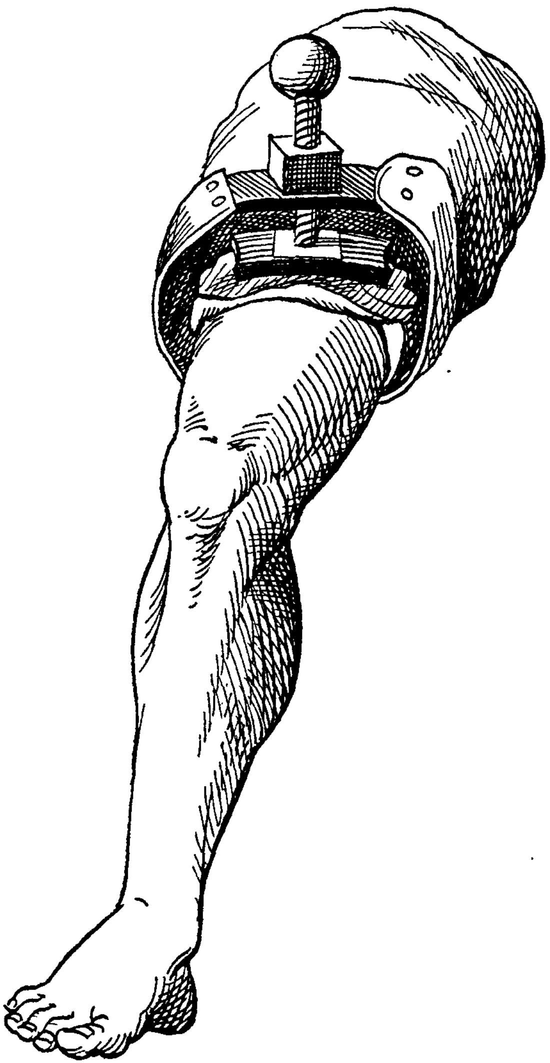
Eighteenth century knowledge and attitudes toward anesthesia are summed up by Bell, in his *System of Surgery:*

The pain induced by operation may be lessened in different ways: By diminishing the sensibility of the system; and by compressing the nerves that supply the parts upon which the operation is to be performed. . . .

As opiates are apt to induce sickness and vomiting, I seldom

The healing-master treating varicose veins (Bettman Archive)

A drawing by Rowlandson of an amputation without anesthesia



Clamp used for compression anesthesia

venture on giving them before an operation, unless the patient has previously been in the habit of using them. . . .

It has long been known, that the sensibility of any part may not only be lessened, but even altogether suspended, by compressing the nerves that supply it: And accordingly, in amputating limbs, patients frequently desire the tourniquet to be firmly screwed, from finding that it tends to diminish the pain of operation.

The effect of this, however, is . . . inconsiderable.

The search for a successful anesthetic continued fruitlessly. Having abandoned the soporific drugs of previous centuries, physicians relied largely on whiskey, gin and rum, or on mechanical devices for producing local anesthesia, which were as painful as the operation itself. In practice, the reduction of pain depended upon the speed of the surgeon.

ON THE THRESHOLD

SEVEN

Humphry Davy

(1778–1829)

Cornwall is England's west; it is bounded in the east by Devonshire, on the south by the English Channel, on the north by the Atlantic Ocean. It is a county of contrasts, with wind-whipped moorlands and mighty rocks, and a soft climate where palms and myrtles flourish. Motor busses rush by sand dunes where prehistoric monuments have fallen, children play near the tin mines where the ancient Phoenicians worked, and fish still come in countless numbers to the waiting drift-nets.

To enter Cornwall is to step back into the enchanted land of nursery days and fairy tales. The visitor to Cornwall ("I love thee, Cornwall, and will ever") does not forget such places as: Polperro, a fishing village within a ravine; Dozmare Pool, into whose waters the wounded King Arthur cast his sword, Excalibur; Falmouth ("O, Falmouth is a fine town with ships in the bay"); Mullion Cove, once a favorite hideout of smugglers; Asparagus Island, with the cave known as Devil's Throat; St. Ives ("As I was going to St. Ives"); St. Michael's Mount, whose earliest inhabitant was the Giant Gormoran, finally slain by Jack-the-Giant-Killer; the seaport of Penzance, with floating docks in the harbor, and the old wishing-well near the village flanked by monoliths and cromlechs; Land's End, whose lighthouses, looking through sea-mist and storm, have saved generations of sailors.

Passing through Penzance, the scientist Davies Gilbert saw a young apprentice idly swinging back and forth on the half-gate of the house of his master, the surgeon-apothecary, John Bingham Borlase. Gilbert engaged the lad in conversation, learned his name was Humphry Davy, and found there existed a sentimental tie between them: both had been educated in the grammar school of Penzance. Presumably, they did not converse in Cornish, for in the neighboring village of Mousehole, famous for its large cavern, was the tomb of the fish-seller, Dolly Pentreath, reputed to be the last person who could speak the Cornish language.

No one could ask questions of Humphry Davy, even while he was swinging on a gate, without realizing the precociousness of the lad. He had transformed an empty garret into a chemical laboratory, from whose terrifying explosions the youthful experimenter escaped unharmed, though his sisters complained that his corrosives ruined their best dresses. Gilbert was so impressed by the apprentice's grasp of the principles of science, that he invited him to his house and offered him the use of his library.

At Clifton, near Bristol, the physician Thomas Beddoes had established the Pneumatic Institution in 1798 for the treatment of disease by inhalation. Beddoes was an interesting but ill-fated character; his versatility was his enemy. His class in chemistry at Oxford appears to have been the largest assembled in the University since the thirteenth century, but his sympathy with the French Revolution made his resignation expedient.

Beddoes deserves credit for discovering the merit of the forgotten John Mayow, who was on the trail of oxygen and the true nature of respiration a century ahead of his time. There could be no objection to the rehabilitation of a neglected genius who had long been dead. But Beddoes had a knack of offending the influential and the powerful. On one occasion he wrote a florid poem, ostensibly on the conquests of Alexander, the real purpose of which was to denounce British aggression in India.

The plans (or dreams) of Beddoes for the welfare of mankind caused the poet Coleridge to hold him in the highest esteem and tenderest affection. And the poet Southey declared: "From Beddoes I hoped for more good to the human race than any other individual."

Beddoes had good friends: Wedgwood contributed a thousand pounds to the Pneumatic Institution, and so eminent an engineer as James Watt, father of the steam engine, constructed the apparatus. Beddoes now had everything except an assistant; but Gilbert asserted he knew the best assistant in the world. He recommended Borlase's apprentice, Humphry Davy, then nineteen years of age, and brilliant in experimentation.

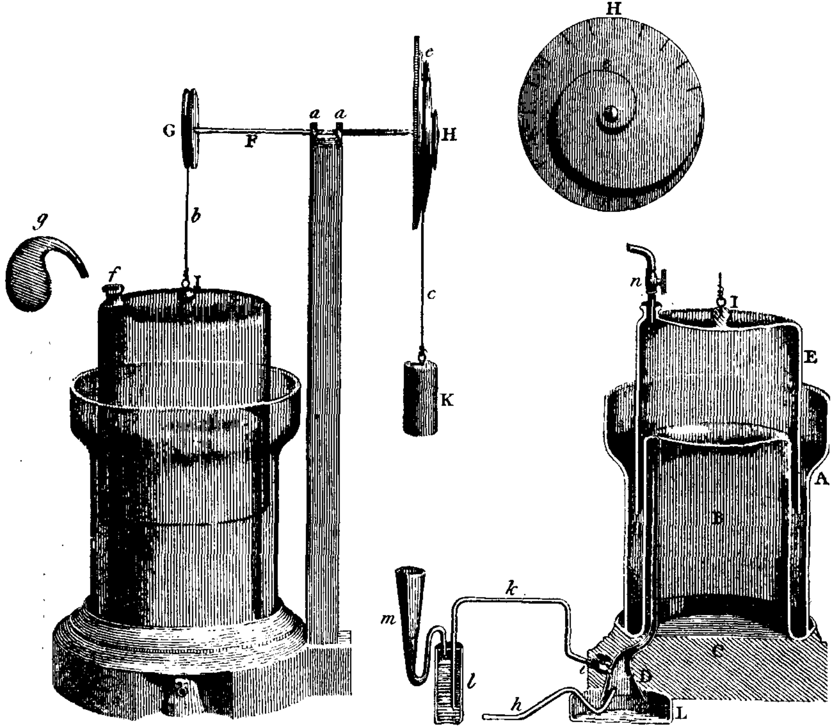
Humphry Davy was not free to enter the Pneumatic Institution immediately, for he was bound to Borlase. It therefore became necessary for Gilbert, who perhaps knew something of politics, for he had served as high sheriff of Cornwall, to carry on diplomatic negotiations with Davy's master. Science triumphed: Borlase lost an apprentice who was training to be a country doctor, and Beddoes gained an experimenter in the inhalation of gases.

The activity of young Davy as superintendent of the Pneumatic Institution was phenomenal. The gases he condensed and tested, the apparatus he devised as occasion demanded, the old hypotheses he threw overboard in the light of his experiments, revealed a new master of chemistry.

Samuel Latham Mitchill, the arbiter of science in colonial America, who richly deserved both his appellations of "a living encyclopedia" and "a chaos of knowledge," had definite views on two gases isolated by Joseph Priestley: oxygen and nitrous oxide. According to Mitchill, oxygen was the giver of life, while nitrous oxide was the destroyer of life. Upon this conviction he built his theory of medicine, and sent it to Beddoes for confirmation. It thus became Davy's problem to test this theory.

In the manner of Erasmus Darwin's *Botanic Garden,* Mitchill expressed his views in verse. Mitchill was one of the worst rhymesters on record, but we are here concerned with the physics, not the poetry, of his *Doctrine of Septon.* Nitrous oxide, in his view, was the diabolic septon, plotting its attacks upon the human organism, bringing fevers into the world, causing serpigo, cancer, scurvy and leprosy; its monstrous progress could be halted only by the interposition of the celestial alkalis.

Davy read Mitchill's theory that nitrous oxide was the principle of contagion, the satanic septon capable of producing the most terrible disasters when inhaled by animals or respired by plants in the minutest quantities, or even when applied externally. Others accepted, without ques-



Sir Humphry Davy's gas machine

Sir Humphry Davy (From a portrait by Sir Thomas Lawrence in the possession of the Royal Society) tion, the conclusions of so learned a savant as Samuel Latham Mitchill, but Davy insisted on testing them by experiment.

Davy first breathed nitrous oxide on a day in spring. He lived. What then did the fantastic theory mean? Was the American doctor honestly mistaken, or was he perpetrating a sardonic jest on his followers? Nitrous oxide was anything but the Mitchillian demon of universal dissolution. Its inhalation produced not disease but euphoria and mirth. Sweetish in taste and pleasant of odor, nitrous oxide gas was the so-called "laughing gas."

Davy wrote on April 17, 1799, to the famous scientific editor, William Nicholson: "I have this day made a discovery which, if you please, you may announce in your *Physical Journal*, namely, that the nitrous phosoxyd, or gaseous oxyd of azote [nitrous oxide] is respirable when perfectly freed from nitrous gas."

After proving by testing it upon himself, that nitrous oxide could be inhaled without destroying life, Davy undertook the following experiment upon a cat:

A stout and healthy young cat, of four or five months old, was introduced into a large jar of nitrous oxide. For ten or twelve moments he remained perfectly quiet, and then began to make violent motions, throwing himself round the jar in every direction. In two minutes he appeared quite exhausted, and sunk quietly to the bottom of the jar. On applying my hand to the thorax, I found that the heart beat with extreme violence; on feeling about the neck, I could distinctly perceive a strong and quick pulsation of the carotids. In about three minutes the animal revived, and panted very much; but still continued to lie on his side.

As the cat recovered from the effects of the nitrous oxide, Davy administered the gas to kittens, dogs, rabbits, guinea-pigs, mice, hens, and goldfinches. Those animals which died from the nitrous oxide were post-mortemed and carefully studied.

To ascertain the effects of the gas on man, Davy administered it to several individuals, some of whom reacted unfavorably. It was a physiological irony that Priestley, the discoverer of nitrous oxide, could never enjoy its effects, for breathing the gas caused him such throbbing of the arteries that he had to stop inhaling it.

Those to whom Davy gave nitrous oxide included the physician Robert Kinglake, an authority in his day on gout; Peter Mark Roget, then just out of medical school, and now chiefly remembered as the compiler of the widely used *Thesaurus;* and the poets Southey and Coleridge. Most of the experimenters testified that the gas produced a delicious sensation of warmth and joy.

Davy observed:

From the strong inclination of those who have been pleasantly affected by the gas to respire it again, it is evident that the pleasure produced is not lost, but that it mingles with the mass of feelings, and becomes intellectual pleasure, or hope. The desire of some individuals acquainted with the pleasures of nitrous oxide for the gas has been so strong as to induce them to breathe with eagerness, the air remaining in the bags after the respiration of others.

Of all the experiments which Davy made with the gas, the most interesting were those conducted on himself. He recorded:

I have often felt very great pleasure when breathing it alone, in darkness and in silence, occupied only by ideal existence. . . . Whenever I have breathed the gas after excitement from moral or physical causes, the delight has been often intense and sublime.

On a May night, Davy walked for an hour amidst the scenery of the Avon, by moonlight. Entering the laboratory with uplifted soul, he breathed six quarts of newly prepared nitrous oxide. The experimenter thus reported the result:

The thrilling was very rapidly produced. The pleasurable sensation was at first local, and perceived in the lips and about the cheeks. It gradually, however, diffused itself over the whole body, and in the middle of the experiment was so intense and pure as to absorb existence. At this moment, and not before, I lost consciousness; it was, however, quickly restored, and I endeavoured to make a bystander acquainted with the pleasure I experienced by laughing and stamping.

Laughing gas and loss of consciousness: in the darkness a door was opening which was to lead to the conquest of pain.

Davy wrote a volume on his experiments, and there was nothing cumbersome about the book except its title: *Researches, Chemical and Philosophical; Chiefly Concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and Its Respiration* (1800). It is usually referred to by its shorter title, *Researches on Nitrous Oxide*, and remains one of the classics of chemistry.

Humphry Davy could not be detained long on the lower rungs of the ladder of fame: Borlase had released him from his indenture so that he could go to Beddoes, and before the expiration of his contract with the Pneumatic Institution, Beddoes permitted him to advance to the Royal Institution. The young man was able to write to his mother, January 31, 1801: "You will all, I dare say, be glad to see me getting amongst the *Royalists*, but I will accept of no appointment except upon the sacred terms of *independence*."

With the departure of Davy, the Pneumatic Institution collapsed. Beddoes did not have the heart to continue alone, and he knew he could not find another Davy. On his deathbed, Beddoes wrote to his former assistant, describing himself as "one who has scattered abroad the *avena fatua* of knowledge, from which neither branch, nor blossom, nor fruit has resulted."

The Pneumatic Institution was regarded as a failure. But posterity knows it otherwise: it was the forerunner of the modern application of chemistry to medicine, and of the inhalation therapy of today. The barren oats of Thomas Beddoes have nourished generations that have forgotten his name. The Pneumatic Institution also served as the training ship of Humphry Davy, preparing him for the cruise of discovery to the outposts of science.

Sir Humphry Davy's great work was to place electricity in the service of chemistry. With a powerful voltaic battery in his hands, he became a pathfinder in the unexplored field of electro-chemistry, discovering element after element. It was reported that when he first saw the minute globules of potassium breaking through the crust of potash and bursting into flame, he could not contain his joy, but danced around the room in ecstasy; and it was some time before he was sufficiently calm to continue his experiments. Turning his genius to a practical field, he invented for the miners of the world the safety-lamp, known everywhere as the Davy lamp.

In his maturity Davy looked back with disdain on his nitrous oxide researches, expressing regret that these youthful dreams had ever been published. He regarded the time spent on this work as "misemployed," and never knew that within its pages he had left for posterity one of the most pregnant passages in the history of medical progress. It is this work alone which gives Humphry Davy his high place in anesthesia; and it is, of course, the only one of his works which particularly concerns us here. Had Davy written nothing else, had he died in his twenty-first year, his fame would still be secure.

Toward the end of his first book, on page 556, Davy wrote:

> As nitrous oxide in its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place.

No surgeon of the age picked up these words in which Humphry Davy gave the secret of anesthesia to mankind.

EIGHT

Henry Hill Hickman

(1800–1830)

On January 27, 1800, the year that Humphry Davy's book on nitrous oxide appeared, a boy was born in the unmapped village of Lady Halton; three days later the child was baptized in Bromfield Church as Henry Hill Hickman. At this point, biographical information ceases for twenty years. The next view of Hickman is as a member of the Royal College of Surgeons of London, and of the Royal Medical Society of Edinburgh. The youthful country doctor celebrated his majority by marrying Eliza Hannah Gardner in 1821. They became the parents of three daughters and one son.

The parish of Hickman's birth is in Shropshire, the English county on the Welsh border. Hickman did not venture far from his birthplace. He practiced in Ludlow and Shiffnal, hamlets in Shropshire; and in Tenbury, a little town in the neighboring county of Worcester, where his wife had been born. Hickman lived a simple life among his own people, for he belonged to an old Shropshire family which had for decades tilled its share of the Shropshire soil.

The memorials of Hickman are few: the mortar and pestle with which he pounded drugs; the brass plate, with his name on it, from the door of his surgery; a card, "At home every Tuesday from 10 o'clock until 4, for the purpose of giving advice *gratis* to the poor and laboring people"; some letters and pictures; a manuscript; a pamphlet; and a flowered-silk waistcoat worn by the handsome young doctor.

When Hickman began to practice his profession, surgery and suffering were inseparable; the screams of the patient accompanied every movement of the scalpel, the chisel, the saw and the clamp. Protest against operative pain was heard in the cradle of the human race, and down through the ages the cries had not ceased. To the weeping, bleeding patient who was being cut, the modern knives of steel were not less cruel than the primitive knives of stone and flint. Surgery was as painful at Guy's Hospital under the famous Sir Astley Cooper as it had been under Antyllus and Heliodorus in the days of the old Roman Empire. There had been practically no progress in the conquest of pain.

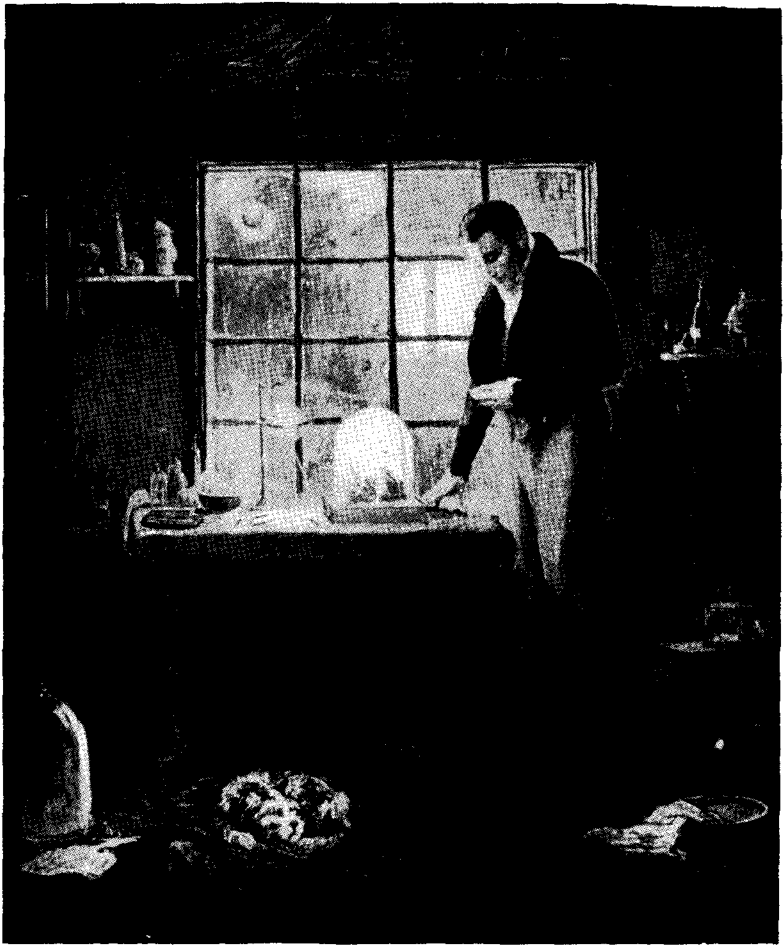
Pneumatic medicine, or the treatment of disease by the inhalation of gases, had been in vogue since Beddoes established his Pneumatic Institution in 1798. The victim of asthma sat in a pneumatic cabinet, inhaling oxygen and hydrogen and diluted chlorine; as the consumptive was believed to suffer from excess of oxygen in his lungs, he was put to inhaling carbonic acid gas, or was told to breathe the foul air of stables to counteract the oxygen poison. During the reign of pneumatic medicine, the new vapors which arose in the crucibles of chemistry were applied by physicians to the treatment of respiratory and pulmonary maladies.

Hickman alone among his contemporaries had the idea to introduce into the lungs sufficient vapor to pass into the blood-stream and affect the nervous system, causing that sleep from which pain is absent. The patient would live, but under the influence of the vapor would not appear to live: it would be a state of "suspended animation." Such theories must be proved by experiment; Hickman's first subject was a puppy.

He set a month-old puppy on a piece of wood surrounded by water. Then he placed a glass cover over the little animal. In ten minutes the puppy became uneasy because it was deprived of air; in twelve minutes, the puppy breathed with difficulty; in seventeen minutes, the respiration ceased. A minute later, Hickman cut off one of the puppy's ears. There was no bleeding and the puppy showed no sign of pain. The animal survived to become the subject of further operations.

Hickman's first experiment with the puppy was unwise, as first experiments often are. The puppy sank into unconsciousness because it was asphyxiated—suffocated from lack of air. Such practices could never become a part of rational medicine. Hickman worked without guidance, and it was necessary for him to teach himself. After the puppy lost its other ear and tail in the service of science, Hickman experimented upon a mouse, an adult dog, a rabbit, a kitten.

In some of his later experiments, Hickman brought about insensibility to pain by having the animal breathe carbon dioxide, a gas that was first isolated from the air by van Helmont in the seventeenth century. The carbon dioxide was introduced through a tube placed under the edge of the glass cover. It was the first time that unconsciousness was deliberately produced by the inhalation of a gas. This con-



Henry Hill Hickman experimenting with anesthesia on animals (From an oil painting in the Wellcome Historical Medical Museum)

stitutes the induction of anesthesia; its purpose was to make the patient sleep through the ordeal of surgery. Hickman mutilated a puppy and other animals to free mankind from its primitive dread of operative pain.

As the result of a few simple experiments, Hickman could make incisions in the body of an animal and remove its ears or its legs or its tail without the infliction of pain. The extension of this principle to the human patient would liberate surgery from the demon of pain; the knife that had long been followed with moving eyes of terror would become unseen and unfelt.

Hickman had got hold of a great secret—a secret of such an order that it must not be confined to a village doctor. Gas carried in its vapor a mercy which must extend to the operating theaters of London and Edinburgh, and ultimately to all the world. Hickman never had the chance to use the gas on a human subject, but renowned surgeons of the metropolis would be able to do more than he. Nevertheless, the country doctor of Shropshire had spread the blanket of sleep over the horrors of surgery, and had changed the ruthless knife into a magic blade that cut without pain.

But it was all useless unless others would listen and believe. Hickman had no laboratory with associates and assistants. No man of science had seen his experiments. These experiments must be checked by impartial observers. They must be discussed in medical journals and reported in the transactions of learned societies. The goal of Hickman's desire was recognition by the Royal Society, symbol of the most advanced and progressive scientific thought.

The most important man in the kingdom, from Hickman's viewpoint, was Davy. But Davy was no longer easy to meet. Davy was now a baronet, and above all he was the husband of a haughty heiress. It was Lady Davy who once made a venerable professor in Edinburgh lace her boot in the streets, and she treated Michael Faraday as a servant. Under her tutelage, "Carver Davy's boy" forgot his humble origin, and learned to arch his eyebrows. His colleagues noted with dismay that in his reception-room Sir Humphry was a lofty gentleman. It is true that in his laboratory Davy took off his mask and became a scientist again; but how could an unknown rustic gain access to Davy's laboratory?

At this juncture, Hickman became acquainted with a Fellow of the Royal Society. His name was Thomas Andrew Knight and he lived in Downton Castle on his family estate of ten thousand acres. Knight was the famous horticulturist of his time who raised new varieties of vegetables and fruits; the term *Knightia* still survives in botany. Hickman did not know Knight well, for he thought he was "one of the presidents of the Royal Society." Knight was president of the Horticultural Society, but never of the Royal Society.

Knight loved to throw open the hospitality and solitude of Downton Castle to Davy, who came when he could spare the time. There was a professional tie between the friends, since Davy for several years lectured on *The Elements of Agricultural Chemistry*, and dedicated the last edition of this book to Knight. To the eager Hickman, the intimacy of Knight and Davy was exciting; through Knight he might reach Davy.

Hickman sent a letter to Knight, dated Ludlow, February 21, 1824. It was a four-page letter: two pages of reflections and two pages on his experiments. From a number of experiments, seven were selected, each reported in as few words as possible. The letter is the first separate document on anesthesia. Hickman was twenty-four when he wrote to Knight:

There is not an individual who does not shudder at the idea of an operation, however skilful the surgeon or urgent the case, knowing the great pain that the patient must endure, and I have frequently lamented, when performing my own duties as a surgeon that something has not been thought of whereby the fears may be tranquilised and suffering relieved.

In the summer of 1824, Hickman wrote a pamphlet entitled: *A letter on suspended animation, containing experiments showing that it may be safely employed during operations of animals, with the view of ascertaining its probable utility in surgical operations on the human subject, addressed to T. A. Knight, Esq., of Downton Castle, Herefordshire, one of the presidents of the Royal Society.* Hickman's pamphlet was the first separate publication on anesthesia.

The pamphlet was printed at Ironbridge in Shropshire, a town on the Severn named after the bridge which crosses that river, a one-span iron bridge, the first of its kind. But Hickman gave his residence as Shiffnal. The name was significant, for Shiffnal was the birthplace of Thomas Beddoes. Beddoes had died prematurely, but surely some of his disciples in the Royal Society would be interested in a work dealing with new experiments in inhalation.

Who was the president of the Royal Society when Hickman's pamphlet was published? The president was a former assistant of Beddoes, Sir Humphry Davy. Knight was the friend of both Davy and Hickman, and Davy was the leading authority on inhalation. It seemed like a happy omen. It needed only a word from Davy to make young Hickman famous, and to reawaken interest in the inhalation of gases. But that word never came. Hickman was completely ignored by the Royal Society.

In all England not one voice was raised in encouragement of Hickman. He held in his gifted young hands the principle of anesthesia by inhalation. And he offered his discovery freely to his profession and his country. But he was rejected by his contemporaries, or noticed only to be condemned. Bewildered and hurt, yet convinced he was right, Hickman determined to go abroad. Perhaps France would accept what England refused. "To His Most Christian Majesty Charles X King of France," Hickman addressed the following letter in April 1828:

> In addressing Your Majesty upon a scientific subject of great importance to mankind, I feel a properly humble, but a firm confidence in Your Majesty's universally known disposition to countenance valuable discoveries;—this relieves me from all apprehension of being considered presumptuous.
>
> Permit me, Sire, to state that I am a British Physician, Member of the Royal College of Surgeons, London, who has visited Paris in part for the purpose of bringing to completion a discovery, to which I have been led by a course of observations and experiments on Suspended Animation.
>
> This object has engaged my practical attention during several years:—It appears demonstrable that the hitherto most agonising, dangerous and delicate surgical operations, may now be performed, with perfect safety, and exemption from pain, on brute animals in a state of suspended animation. Hence it is to be strongly inferred, by analogy, that the same salutary effects

may be produced on the human frame, when rendered insensible by means of the introduction of certain gases into the lungs:—I have discovered a number of facts connected with this important subject; and I wish to bestow them on society.

Paris, the great Metropolis of Continental Europe, is the place above all others, where the profound studies of Humanity are, with the utmost facility, carried to their highest extent and perfection; and, Sire, I feel confident that I do not say too much, with a due regard for the scientific distinctions of my own Country, in avowing that these facilities, nowhere else to be found, and their most admirable results, have deservedly conferred on Your Majesty's Chief City, and its illustrious Schools of Practical Philosophy, the eminent title of the Centre of Science to the Civilised World.

Presuming thus, Sire, to attract Your Majesty's thoughts to this interesting subject, I have resorted to the French Capital for the completion of my discovery, hoping to have the honour of placing it under Your Majesty's Royal and gracious auspices. In this manner I would pay to Your Majesty's Kingly and paternal Zeal in the promotion of every branch of useful knowledge that tributary homage which I am sure, Sire, it would be unjust, on a suitable occasion, to withhold from an Exemplary Monarch, who is surrounded by the wise and the Learned, the philanthropic, and celebrated in all the Arts and Sciences, which benefit, ameliorate, ornament and dignify the condition of mankind.

It is upon purposes of this nature, Sire, that Your Majesty daily deigns and delights to smile with enlightened, constant and the most effectual and condescending encouragement. Your Majesty invites the Philosophical from all Lands and they are certain of protection.

It must have occurred to Your Majesty's magnanimous mind, that our species rise in the scale of moral and intellectual greatness, in proportion as our efforts are directed to the diminution of the sum of human misery, and physical evil. This was the elevated and virtuous aim of the Sages, and the best of Kings of Antiquity; and this grand purpose is yet more conspicuous in modern times:—

Under this grave and powerful impression, I have ventured on the liberty of praying Your Majesty to be pleased, by an express intimation, or command, on the subject, to permit me to develop my ideas on operations in a state of suspended animation, in the presence of Your Majesty's Medical and Surgical schools, that I may have the benefit of their eminent and assembled talent, and emulous cooperation.

It is also my desire, at a fit opportunity, to solicit the honour of presenting to Your Majesty, in person, if Your Majesty will condescend to receive it, a Book containing an account of my discovery which, as far as I know or can learn, has entirely originated with myself; and should my labours meet with the approbation of Charles the Tenth, I shall ever enjoy the grateful satisfaction of believing that I have devoted myself to my profession to a distinguished and to a happy end.

With the hope that Providence may continue Your Majesty's invaluable Health, and prosper Your Illustrious Reign, I have the Honour to be, Sire, with profound Respect, Your Majesty's

Most Obedient and Most Humble Servant,

H. Hickman

Paris, Hôtel des Ambassadeurs,

1828. 11, Rue Notre Dame des Victoires

The restored Bourbon, Charles X, was as obtuse a monarch as ever occupied a throne. His was a seventeenth-century mind living in the nineteenth. Believing that he could turn back the tide of the Revolution, he abolished the freedoms of the press and assembly. He was anachronistic enough to attempt to revive the King's Touch for the cure of disease. Destiny, in the shape of the suppliant Hickman, gave Charles X his one opportunity to render his reign illustrious in the annals of science.

Hickman's letter to Charles X was passed to the minister of the Royal Palace who forwarded it to the Academy of Medicine, which appointed a committee to consider the matter. Countless discoveries in the history of medicine have perished in the laps of committees of academies. The committee deliberating in Paris read the proposition of a British doctor that insensibility can be produced by the methodical introduction of certain gases into the lungs. But only one member, Dominique-Jean Larrey, surgeon-in-chief to the *Grande Armée* of Napoleon, was of the opinion that the work deserved the attention of surgeons. He was outvoted by the intrenched majority of short-sighted academicians. Long afterward, the secretary of the committee explained: "This affair went no further."

Hickman waited in Paris for an answer that never came. He returned to England in defeat, and no more is heard of him during his life, which ended prematurely. Innovators and discoverers have learned from history that the silence of official committees is a frequent fate of the pioneer.

Hickman, baptized in Bromfield Church, was buried in the churchyard there thirty years later, on April 5, 1830. In the year of his death, the offensive reign of Charles X ended in overthrow and abdication. With the exception of his brief and futile journey to Paris, Hickman had never been far from home. For years the grass grew over his forgotten grave. Surgery made little progress, for it knew no way to conquer pain. Beneath the slab at Bromfield lay hidden the secret of anesthesia.

Nearly a hundred years after Hickman's death, in 1928, two American men of science, eminent in anesthesia, published in the *Journal of Pharmacology and Experimental Therapeutics* the result of an authoritative study entitled, "The Anesthetic Value of Carbon Dioxide." They had repeated the work of the pioneer, and found he was right.

The Hickman Centenary Exhibition was held at the Wellcome Historical Medical Museum of London. The chemical manufacturer and archeologist, Sir Henry Wellcome, founder and director of the Museum, in his study of the triumph over pain, had become the votary of Hickman. The Museum issued a beautiful souvenir in 1930, an elaborately illustrated brochure which is a good source of information on Hickman and confirms his place in the history of anesthesia.

In that year, a memorial to Hickman was dedicated in Bromfield Church. It reads: "This tablet is placed here at the initiative of the Section of Anaesthetics of the Royal Society of Medicine as a centenary tribute to the memory of the earliest known pioneer of anaesthesia by inhalation. A.D. 1930." Unrecognized in his lifetime, Henry Hill Hickman waited in Bromfield churchyard a century until Anesthesia claimed him as her apostle.

NINE

Mesmerism in Anesthesia

ONE OF THE stranger historical bypaths on the road to modern pain control is mesmerism. For a long time doctors have realized that an unknown but invaluable kernel of truth lies hidden in the accounts of hypnotic cures—hidden beneath dross of spiritualism, quackery and supernatural notions. While hypnosis probably goes back to the infancy of the human race, it has been connected with religious practices for the greater part of its history. Medical interest in it got its primary impetus from the work of Franz Anton Mesmer (1734-1815).

Mesmer lived affluently in Vienna, as a gentleman of means. He followed the latest developments in the arts and sciences with keen interest, took an intelligent part in discussions on abstract philosophy with his many learned friends, and was a genial, hearty host, richly endowed with health and personality. He counted Mozart among his closest friends, and music played a vital part in his life and work.

Through his association with Pater Hell, a Jesuit and professor of astronomy at the University of Vienna, Mesmer became converted to the theory that the lodestone was useful in the treatment of certain ailments. The action of the magnet was indeed intriguing and mystifying: what made it behave as it did? Wherein lay its drawing power? It was an absorbing puzzle that a small sliver of the substance could serve dependably as a guide to mariners. Might it not attract other things than bits of iron? Might it not, for instance, attract human maladies? Mesmer, believing illness to be a pernicious interruption of the rhythmic tide and flow in the human organism, a disturbance of the harmony therein, could also believe that the magnet might set up such a flux and reflux as would dispel the disturbing influences. In the body there was a "magnetic fluid" that Mesmer called "animal magnetism," by means of which ailments could be cured.

After considerable experimentation, Mesmer applied his theories to the curing of human ills. These cures covered the greatest variety of ailments, from stomach-ache to paralysis, from ear-ache to blindness. Word of his miraculous cures spread. The council of the Augsburg Academy, in a report issued in 1776, said: "What Dr. Mesmer has achieved in the way of curing the most diverse maladies leads us to suppose that he has discovered one of nature's mysterious motive energies." He was made a member of the Academy of Science of Electoral Bavaria. "It is undeniable," read the citation, "that the activities of so outstanding a personality who has won to fame by special and incontrovertible experiments and whose erudition and discoveries are as unexpected as they are useful must add lustre to our institution. . . ."

But not so the medical profession in Vienna. It withheld recognition, theories he attempted to demonstrate were controverted, the efficacy of his cures denied, and his magnetic doctrines laughed to scorn.

Mesmer left Vienna for Paris in 1778. There he went ahead with his experiments and reported some amazing results. The mood of Paris was singularly receptive to sensational novelties. The French Revolution was in the offing. It was the day of Cagliostro, of magic potions and talismans, of Mme. Bontemps who read the futures of noble ladies in coffee dregs, of clairvoyants and swindlers. The rich flocked to Mesmer for a new thrill, the poor for miracles.

In Paris, too, animal magnetism created a storm of controversy, leading even to duels between its supporters and opponents. Said Baron Dupotet: "It is impossible to convey the sensation which Mesmer's experiments created in Paris. No theological controversy in the earlier ages of the church ever was conducted with greater bitterness."

Then came the famous report of 1784 discrediting Mesmer's claims and concluding that there was nothing to prove the existence of his animal magnetic fluid. The report was made by a royal commission of the Faculty of Medicine and seconded by another commission of the Académie des Sciences, the first consisting of the principal physicians of Paris, the second of eminent men like Benjamin Franklin, Lavoisier, and Bailly. As a result, Mesmer's reputation was gravely injured and the public lost interest in his theories.

In the 1830's, however, there was a popular revival of interest in mesmerism and its direct outgrowth, hypnotism, and physicians in many European countries used it as a therapeutic agent. But it is the use of mesmerism for surgical anesthesia with which we are concerned, and behind this development lies a fascinating but neglected chapter in the medical history of the nineteenth century.

Mesmerism in surgery was an integral aspect of the mesmeric movement. The first use of mesmerism as a form of anesthesia in surgery occurred on April 12, 1829, when Jules Cloquet, a French surgeon, removed the breast of a patient in mesmeric sleep. John Elliotson, who was later to become the leading exponent of the mesmeric movement, became interested in mesmerism in the same year, through the influence of an Irishman named Chenevix. After practicing mesmerism in Paris, Chenevix visited London and gave several demonstrations of mesmeric phenomena. Elliotson made arrangements for him to experiment at St. Thomas's Hospital, and he observed the results with keen interest.

It was not until 1837, however, that Elliotson became an enthusiastic convert to the cult. Early that year Dupotet, a Frenchman who had long practiced mesmerism in France, came to London to propagate the doctrine of animal magnetism. It was Dupotet's experiments which became the instrument of Elliotson's conversion.

John Elliotson is a figure of considerable interest in medical history. He was the first Professor of the Practice of Medicine at the new University of London, and Senior Physician at the newly founded College Hospital attached to the University. This was the scene of those activities which brought professional ostracism and notoriety upon Elliotson and at the same time made him the leader of the mesmeric movement in England.

By 1837 Elliotson had secured a reputation as one of the ablest physicians of London. His active and inquisitive mind was receptive to new ideas. His progressive attitude in medicine is clearly revealed in his passionate advocacy of the stethoscope, a new instrument regarded with suspicion by conservatives in the medical profession. The lengths to which medical conservatism has sometimes been carried may be illustrated by the attempts to invalidate Elliotson's testimony in a court of law because of his use of the stethoscope.

A man of strong character, who felt it his duty to fight for his convictions whatever the consequences, Elliotson soon found himself embroiled in a bitter controversy with his colleagues over the practice of mesmerism. His demonstrations, which aroused great public interest and were attended by such famous persons as Charles Dickens, Thomas Moore, and members of the nobility, were attacked as "humbug." And by the end of 1838, his opponents had become so strong that the Council of University College passed a resolution forbidding the further practice of mesmerism within the hospital. As a result, Elliotson promptly resigned.

Immediately he bent all his energies to what he conceived to be his mission—to demonstrate the truth of mesmerism. His experiments were continued at his home and his séances attracted the public as before. In order to present his cause favorably and to build up in the minds of his followers an appropriate image of the opposition, Elliotson needed a medium of expression, a forum for the presentation of his views. This he obtained in 1843 when he and his sympathizers started a journal entitled *The Zoist: A Journal of Cerebral Physiology and Mesmerism, and their Applications to Human Welfare.*

The Zoist concerned itself not only with mesmerism and phrenology, but also with social problems such as housing, crime, and education, on which its editors took a very progressive position. But its primary purpose, as the prospectus in the first number stated, was to proclaim the merits of mesmerism:

> The science of MESMERISM is a new physiological truth of *incalculable* value and importance. . . . Already has it established its claim to be considered a most potent remedy in the cure of disease; already enabled the knife of the operator to traverse and divide the living fibre unfelt by the patient. If such are the results of its infancy, what may not its maturity bring forth?

In the course of its twelve-year history, *The Zoist* reported numerous operations performed painlessly during mesmeric trance. Elliotson, seeking ammunition to confound his conservative enemies, busily collected similar reports from every possible source. Some were found in American journals, notably a "Case of Excision of a Wen, without pain, in the Mesmeric State," taken from the *Illinois Telegraph and Review*, August 19, 1843, and the removal of a tumor from the shoulder, taken from the *Missouri Republican*, February 21, 1843.

According to Elliotson, the first surgical procedure performed under mesmerism in England was the insertion of a seton in the neck of Elizabeth O'Key in 1838. The first *major* operation in England on a patient in a mesmeric state was performed four years later by Ward, who amputated a leg at the thigh. Painless surgery under mesmeric trance was also claimed in a variety of other types of cases, including venesection, dental extractions, excision of tumors, and childbirth.

Mesmerism in surgery apparently aroused less animosity in American medical circles than in Britain. Some of the leading members of the profession were willing at least to attend operations and study the phenomena of mesmerism. For example, Valentine Mott, a New Yorker whose great work in surgery nearly spanned the nineteenth century, watched A. Sidney Doane remove a tumor from the neck. Other interested observers on this occasion were J. Kearney Rodgers and John W. Francis. The removal of a tumor from the neck of an elderly doctor was performed at Cleveland Medical College by Ackley, assisted by Delamater, Kirkland, and others. A breast was amputated by L. A. Dugas of the Medical College of Georgia. The removal of a polyp from the nose was reported in the *Boston Medical and Surgical Journal.*

It is apparently to these accounts that Crawford Long referred when he wrote in 1849: "At the time I was experimenting with ether there were physicians high in authority, and of justly distinguished character, who were the advocates of mesmerism, and recommended the induction of the *mesmeric state* as adequate to prevent pain in surgical operations."

The most significant accomplishment in the application of mesmerism for surgical anesthesia was that of James Esdaile, an ardent follower of Elliotson. While in charge of the Native Hospital at Hooghly, India, Esdaile performed a remarkable series of mesmeric operations. His first attempt was undertaken on April 4, 1845. The following January, he reported that he had successfully performed 73 "painless surgical operations" with the aid of mesmerism. These included amputations of the arm and breast, removal of tumors, hydrocele and cataract, and tooth extractions.

But ten months after the publication of Esdaile's 1846 report in *The Zoist*, the discovery of ether anesthesia was announced to the world. *The Zoist* itself, in fact, carried a glowing account of the use of ether anesthesia in Boston, written by an American observer. Though the mesmerists later became increasingly hostile to ether and chloroform, their initial reaction was generally favorable. "If this plan," said Elliotson, "produces insensibility to pain in more instances than mesmerism, and quite as innocently and easily as when mesmerism succeeds, it will indeed be a blessing, and none will hail it more joyously than we mesmerists, who have no other object than the good of mankind. . . ." The mesmerists, however, took credit for providing the inspiration that led to the search for a chemical anesthetic: "To mesmerism and mesmerisers all this is really owing. The idea of proving insensibility for operations had through mesmerism laid such hold on men that the trial of inhaling ether was made. . . ."

In fact, Esdaile himself made such a trial of the use of ether in the hospital in Calcutta which had been placed at his disposal. He concluded that:

> By cautious and graduated doses, and with a knowledge of the best antidotes, I think it extremely probable that this power will soon become a safe means of procuring insensibility, for the most formidable surgical operations even.
>
> All mesmerists . . . will rejoice at having been the means of bringing to light one truth more, especially as it will free them from the drudgery required to induce mesmeric insensibility to pain. . . .

Nevertheless, Esdaile retained his faith in the superiority of mesmerism and continued to practice it until he left India in 1851. In those six years since his first attempt, he had

Mesmer practicing animal magnetism (From Holländer's *Die Karikatur und Satire in der Medizin*, 1921) performed a total of several thousand operations, about 300 of which were major. But his conclusions on ether show that he recognized the basic weakness of mesmeric anesthesia in surgery: that it was less efficient than ether or chloroform. The margin of uncertainty in producing anesthesia was greater with mesmerism, since not every person requiring a surgical operation could be successfully mesmerized. Mesmerism could not be used in emergencies because the process was laborious and time-consuming. Finally, the advocates of mesmerism were interested in its surgical application chiefly for propaganda purposes, as a way of demonstrating the existence of mesmeric force. It is therefore not surprising that with the appearance of more efficient chemical anesthetics, mesmerism's influence in surgery waned, although its medical use persisted.

An interesting variation in mesmeric theory is represented by James Braid, an Edinburgh surgeon who practiced at Manchester for most of his life. Braid became interested in mesmerism in 1841, but he did not accept the theory of animal magnetism. In his *Neurypnology, or the Rationale of Nervous Sleep,* he attributed mesmeric phenomena to suggestion and substituted the term hypnotism to describe the process. Despite his interest, Braid performed few operations on mesmerized patients, limiting his efforts chiefly to dental extractions, incision of abscesses, and the like. In view of his theoretical position, it is not to be wondered at that the few references to him in *The Zoist* are rather hostile in nature.

The exclusion of the practice of mesmerism from the regular hospitals made it necessary for the medical mesmerists to have their own institutions. The first steps to establish such an institution were taken in 1846, but it was not until March 1850 that the London Mesmeric Infirmary was finally established at No. 9, Bedford Street, Bedford Square. Other mesmeric institutes were founded at Bristol, Exeter, and Dublin. At the Exeter Mesmeric Institute, J. B. Parker reported that he had "performed upwards of two hundred surgical operations without the patients feeling pain, whilst under the influence of mesmerism, including twenty most painful operations on the eye. . . ."

Mesmerism in surgery became a lost cause with the advent of ether and chloroform. But its practitioners performed a useful purpose in preventing pain at least with patients who were sufficiently suggestible to respond. Thus mesmerism, when successful, can legitimately claim credit as a forerunner of anesthesia. Moreover, the advocates of its use in surgery attracted attention to the possibility of painless operations and thus helped to prepare the way for an acceptance of chemical anesthetics.

TEN

Before the Discovery

IN ORDER to grasp the tremendous significance of the introduction of anesthesia, our modern attitude of taking it for granted must be abandoned, and an attempt to visualize the conditions which existed in operating-rooms before its introduction must be made.

The spectacle cannot be regarded without emotion. The patients were few in number, for the fear of pain was a deterrent equally as strong as the fear of possible accidents or of fatal errors by the surgeon. Many preferred to die rather than endure the exquisite agony which was in store for them. Once brought to the table, they responded to the ordeal in various ways. Some struggled and screamed without remission, begging the surgeon to leave off or to make haste; some, usually the feeblest, fell into a trance-like state, which favored the progress of the operation but gave little promise of survival; some bravely made no sign of suffering at all. Some cursed, some prayed, few wept or fainted. Sir Benjamin Ward Richardson wrote:

> I asked a man once after an amputation if he felt faint during the operation. His reply was very curious and characteristic. "Did I feel faint? What a question to ask! Did I feel faint? Why of course I didn't. Neither would you if you had the same reason to keep you from fainting. It was a good deal too bad for that."

For all patients the experience meant severe nervous shock, followed by a long period of depression, conditions which interfered seriously with the healing of operative wounds and greatly protracted convalescence. Richardson said: "I have heard many express that if they had known beforehand what the suffering was, and the effects subsequently endured, they would rather have faced death than such a fearful struggle for continued existence."

While we are naturally stirred to pity for the patients of the days before anesthesia, we must remember that for surgeons also operating was frequently no less a terrifying ordeal. Surgeons did not control pain on the operating-table because they could not. Surgeons did not necessarily grow callous to the suffering they were powerless to prevent. The man in the gown was not insensitive to the agony he inflicted. Whether the victim was a pauper or a prince, a stranger or a member of the surgeon's family, or the surgeon himself—for surgeons were human, and the wielders of the knife also went under the knife—Pain dominated the scene.

As students, surgeons had to learn to harden themselves to the spectacle of pain—a difficult lesson indeed. It is told of Sir James Young Simpson that "after seeing the terrible agony of a poor Highland woman under amputation of the breast, he left the class-room and went to the Parliament House to seek work as a writer's clerk." William Cheselden, famous eighteenth century English surgeon, perhaps the most rapid of all preanesthetic operators, so swift of hand that he could incise the bladder and remove the stone in fifty-four seconds, confessed that he tossed without sleep on the night before an important operation. John Abernethy, surgical successor to the all-around John Hunter, whose blunt speech and insulting manners covered a generous heart, vomited when emerging from the torture-chamber of the operating theater.

A humane man cannot inflict pain without himself sharing it in good measure; there was always the chance, too, that the agonized writhing of the patient might lead to some fatal slip. Valentine Mott wrote:

How often, when operating in some deep, dark wound, along the course of some great vein, with thin walls, alternately distended and flaccid with the vital current—how often have I dreaded that some unfortunate struggle of the patient would deviate the knife a little from its proper course, and that I, who fain would be the deliverer, should involuntarily become the executioner, seeing my patient perish in my hands by the most appalling form of death.

For the development of surgery as a science, pain was ever an insuperable barrier. Time was at a premium for the operator; ideally, he must have accurate anatomical knowledge, coolness and presence of mind, and not least, great manual dexterity. Sir Thomas Clifford Allbutt, whose span of life extended to recent times, recalled the slapdash surgery of his childhood: "When I was a boy, surgeons operating on the quick were pitted one against the other like runners on time. He was the best surgeon, both for patient and onlooker, who broke the three-minute record in an amputation or a lithotomy."

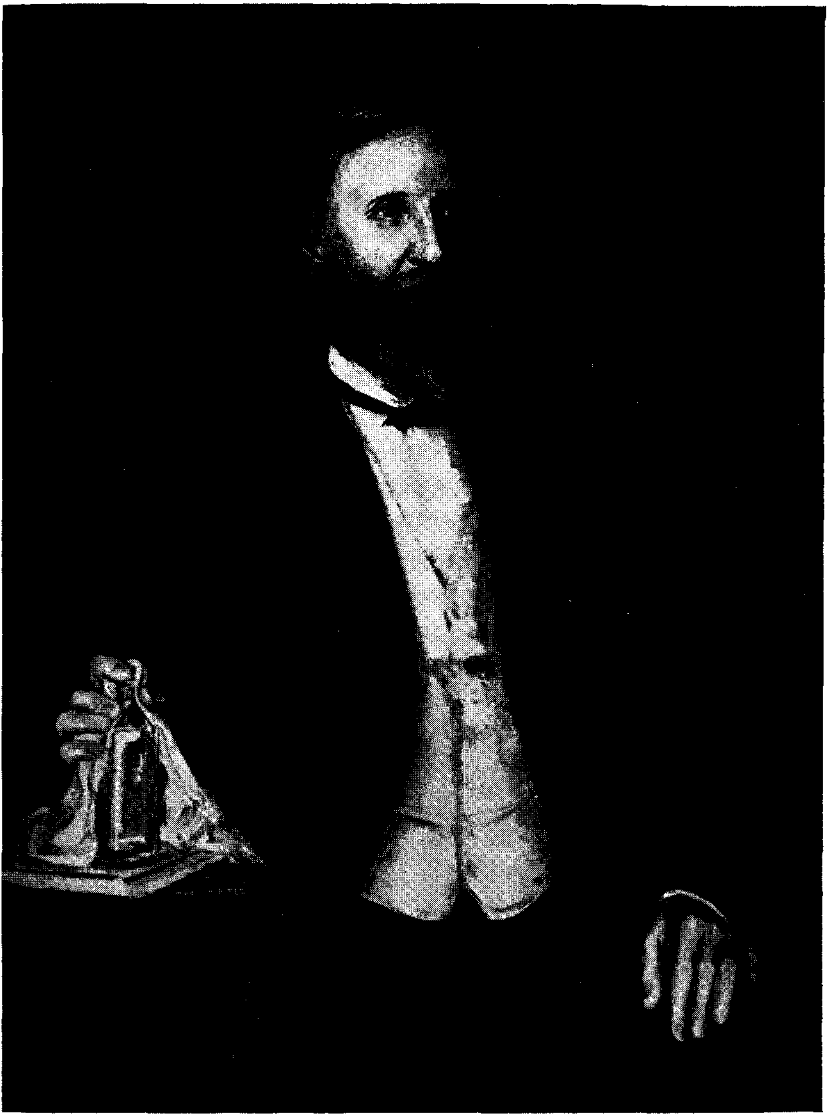
Operations were few in number and limited in kind, partly because of the patients' fear, partly because surgeons themselves considered the knife their last resort. During the five years preceding the introduction of anesthesia, only 184 operations—three per month—were performed at the Massachusetts General Hospital; these were chiefly confined to the surface of the body, including excision of tumors, amputation of limbs and breasts, various plastic operations, and herniotomy.

These conditions were typical. In 1844-45, the British surgeon Robert Liston operated in "five cases of lithotomy, four of herniotomy, and one of perineal section for laceration of the urethra" and in several cases of phimosis, fistula in ano, and extravasation of urine; he excised tumors in 22 cases, including a large ovarian tumor; he performed ten amputations, one excision of a joint, one ligation for aneurysm of the femoral artery, three subcutaneous and a number of plastic operations.

This was a limited program, surely, for one of the most popular and skilful surgeons of the day, yet, save for a few established operations, Liston had no precedent for invading the three internal cavities. Trephining of the skull is a practice older than history; drainage for empyema is mentioned by Hippocrates; lithotomy, herniotomy, the removal of cysts, and reparatory measures in cases of traumatism were the sole accepted excuses for entry into the abdominal cavity. Surgical diagnosis was severely hampered, since the barbarity of an exploratory incision was unthinkable. Great operations were planned and executed upon cadavers, but pain clearly forbade their use in actual practice, for the probability of the patient's succumbing was too great.

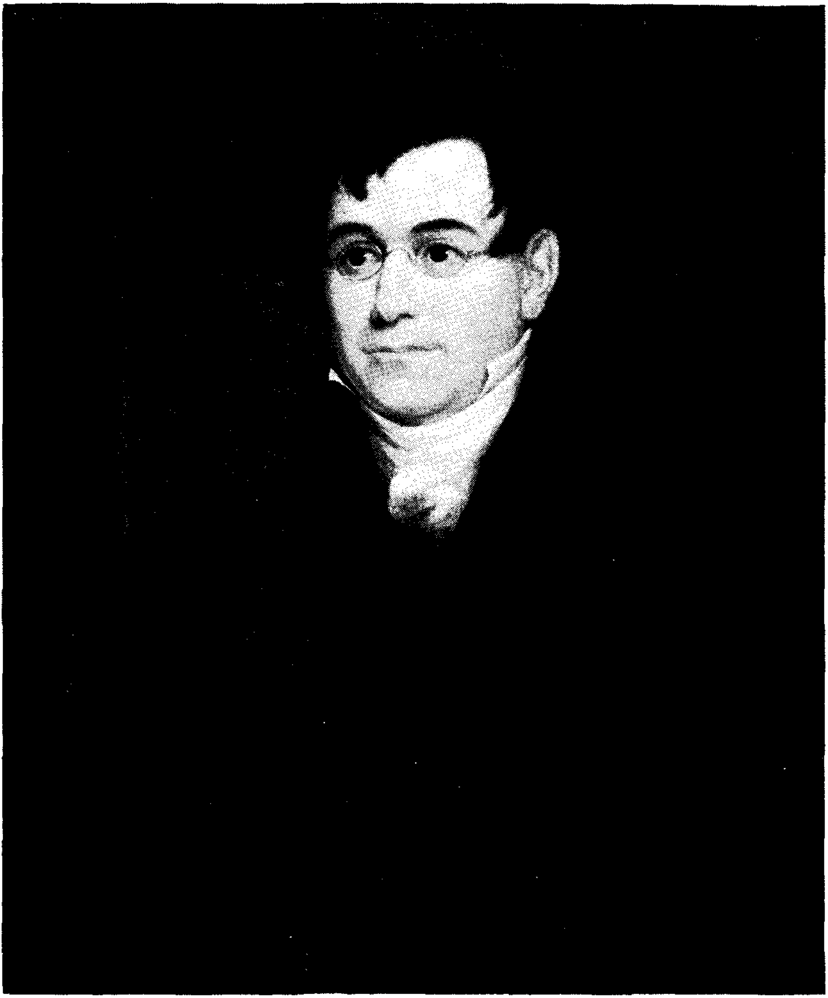
As stated by Benjamin Travers, of St. Thomas's Hospital of London: "Pain in excess exhausts the principle of life." And Guillaume Dupuytren, of the Hôtel-Dieu of Paris, the ablest French surgeon of his time, thus summed up the surgery of his age: "Pain kills like hemorrhage."

THE DISCOVERY



Crawford Williamson Long (From a portrait by Richard Lahey)

Horace Wells (From a print in the Clendening Library)



Charles Thomas Jackson (Reproduced from the original painting by Samuel F. B. Morse in the collection of Dr. Lawrence Reynolds)

William Thomas Green Morton (From a print in the Clendening Library)

ELEVEN

Crawford Williamson Long

(1815–1878)

DESPITE PURITAN opposition, the nomadic circus early became a feature of American life. Among the traveling showmen of the 1830's, none was more picturesque than a tall lad in a frock coat and a high hat, advertising himself—at the tender age of eighteen—as "Doctor Coult of New York, London and Calcutta." Actually, he was Samuel Colt of Hartford, Connecticut, and his formal education was limited to an unfinished course in a preparatory school. Young Sam Colt was going around the country, giving exhibitions of nitrous oxide (laughing gas) to obtain the cash he needed to patent his revolver—the revolver which bears his name and brought him fame and fortune.

In 1832, he set out with a home-made apparatus for a tour of the towns neighboring his father's home in Ware, Massachusetts; he carried his laboratory after him on a handcart. At street corners, in the center of the public squares on a typical New England market day, Sam would set up his apparatus. After demonstrating the effects of laughing gas on his own hardy person, he would invite his spectators to try it for themselves. While these innocent volunteers amused their own neighbors, Sam would circulate in the crowd and take up a collection.

Sam made as much as ten dollars a day in this homely manner. It is not surprising that a year or two later, when he needed money for the Canadian patents on his weapon, he bethought himself of laughing gas as a quick source of ready funds. At this time he lived in Cincinnati, where he was part owner of the Penny Museum. His showmanship had grown with his still tender years, and he hired six Indians to appear in a gas-inspired comedy.

The place was crowded with curious citizens on the evening of the first performance. The audience was obviously uneasy over the effect the peculiar gas might produce on the savage redskins. A number of the gallants had cautiously armed themselves with stout canes. And not a few carried more deadly weapons belted at their waists.

But nobody, least of all Sam Colt, was prepared for what actually did happen. The inventor of the revolver administered the gas to his six red Indians—who promptly fell sound asleep with not so much as a preliminary whoop or a drunken giggle. Sam knew very well that his customers had not paid their admission to see Indians taking a nap. He saved the day by administering the gas to a blacksmith who obliged by furiously chasing Sam about the stage. He finally careened into the seated Indians who woke to find themselves on the floor.

The audience applauded what they thought had been a planned act. But Sam Colt could find no answer to the puzzle, and he knew his show had come close to a fiasco. He abandoned his laughing gas demonstrations.

It is very curious to see how this acutely alert New England lad, so alive to new ideas, had failed to notice the extraordinary fact that he had produced complete anesthesia.

The scene now shifts to the sleepy southern town of Jefferson, Georgia, a typical ante-bellum agricultural community. Even before Samuel Colt had given his Cincinnati demonstration of the effects of nitrous oxide, the boys and girls of many small towns were familiar with laughing gas as an excitant. There was scarcely a gathering of young people which did not wind up with one of these frolics. Old-fashioned quiltings were popular—young folks would attend for the fun of dancing and a mild indulgence in nitrous oxide.

The town physician of Jefferson was one Crawford Williamson Long, who had four students in his office. Long's students were familiar with the effects of nitrous oxide from the parties they had attended. No doubt they had also seen the itinerant lecturers who traveled the country, expounding the marvels of chemistry and generally winding up with a demonstration of the exhilarating properties of laughing gas.

Long was only twenty-seven years of age, his pupils between nineteen and twenty-one. The doctor entered into the sports of his students heartily, without neglecting in the least his duties as their teacher. On one occasion, when Long's boys were discussing the amazing antics of people under the influence of the gas, they asked him to make them some. In those easy-going times, the town physician was also the local druggist-chemist, and the request was a natural one. This occasion is best described in Long's own account of those momentous years:

In the month of December, 1841, or January, 1842, the subject of the inhalation of nitrous oxide was introduced in a company of young men assembled at night in this village (Jefferson) and several persons present desired me to prepare some for their use. I informed them that I had no apparatus for preparing or preserving the gas, but that I had a medicine (sulfuric ether) which would produce equally exhilarating effects; that I had inhaled it myself, and considered it as safe as the nitrous oxide. One of the company stated, that he had inhaled ether while at school, and was then willing to inhale it. The company were all anxious to witness its effects. I gave it first to the gentleman who had previously inhaled it, then inhaled it myself, and afterwards gave it to all persons present. They were so much pleased with the exhilarating effects of ether, that they afterwards inhaled it frequently, and induced others to do so, and its inhalation soon became quite fashionable in this country, and in fact extended from this place through several counties in this part of Georgia.

Thus it was that Long helped to inaugurate the ether frolics that became common in that section. Many were held in his own office, with odd effects that did not escape the doctor's attention.

He himself became furiously excited on several occasions after inhaling the vapor and could not control his movements. When he emerged from the ether intoxication, as he called it, he would find that his arms and hands were severely bruised. Yet he had not been conscious of feeling any pain. He saw that his friends, while etherized, often fell to the floor with a thud that should have hurt them badly. When he questioned them, they agreed uniformly that they had not felt the least effect.

Among Long's patients was a young man named James

M. Venable who had two tumors on the back of his neck. Venable was a local resident who was fond of ether and, like many other of the villagers, accustomed to inhaling it.

It was about James M. Venable that the first use of ether and the first instance of complete anesthesia induced by it was recorded; and it was Long who administered it and performed the excision of the tumorous growth on March 30, 1842. But strange to relate, Long appeared to have been utterly unaware of the significance of this great event, and did nothing to announce his discovery. Years later, after ether anesthesia had been universally recognized through the efforts of other men, he came forward to claim recognition for its first use.

Was he endowed with too little ambition or too little scientific awareness? Or was it inertia which kept him from appreciating the epochal importance of the act performed by his own hands, and making it known to mankind? Whatever the answers, Long's first use of ether was of importance to no one except the four or five patients upon whom he used it, and for four years longer ether remained unknown and unavailable to the world whose pain it might have eased.

Does the ancestry or environment of Long throw any light on the subject? He was the son of James Long, descendant of Scotch-Irish pioneers who had settled some half-century earlier in Madison County, Georgia. James Long was an influential and prosperous citizen. He acquired extensive plantations. He was important in business and banking circles. He was so well versed in law that he was frequently consulted by bench and bar. Crawford's mother was also a person of marked intelligence and force.

Born into the old South's cotton aristocracy, Crawford Williamson Long first saw the light of day in Danielsville, Georgia, November 1, 1815.

He gave early evidence of precocity and intelligence. At the age of five, he accidentally struck the hand of his little sister with an ax and nearly severed three fingers. Instead of running in panic, as most children would have done, he pushed the bleeding fingers back into place while his mother bandaged them in position, coating the fingers with sugar to prevent infection. The effect must have been distinctly antiseptic for the wounds healed perfectly, with no deformity whatever. It is hard to imagine that this interesting episode turned the child's thoughts toward the career he was later to pursue, but even as a small boy, Crawford showed marked evidence of resourcefulness.

At the local academy, founded by his cultured father, Long showed himself a good student, graduating at the age of fourteen. He was admitted to Franklin College in Athens, later to become the University of Georgia. Here his roommate was Alexander Stephens, destined to become Georgia's most distinguished man and a powerful figure in the Confederacy.

Long graduated from Franklin College before his twentieth birthday, in 1835, and stood second in his class. Returning to his home in Danielsville, he told his father of his wish to study medicine. The elder Long thought a year of seasoning as a teacher would do the boy no harm, and shortly afterward Crawford Long became principal of the town academy.

With an energy that contrasts oddly with what can only be called his later apathy, Long even then read medicine under his preceptor, George R. Grant. When his year was over, he started across mountain trails for the distant province of Transylvania, now Kentucky, and entered Transylvania Medical College at Lexington, then an outstanding institution.

Benjamin Winslow Dudley, then Professor of Surgery at Transylvania, was distinguishing himself as a lithotomist, and in the nearby town of Danville had lived the great Ephraim McDowell, the first to remove an ovarian tumor successfully. The acclaim accorded these men might have been expected to spur a young man to emulation. But in view of Long's later failure to announce his use of ether, their example seems not to have made a deep impression.

In 1837, Long transferred to the University of Pennsylvania where he remained for two years and took his medical degree. Every evidence again seems to point to the young Long as a person of more than average abilities. He went from Philadelphia to New York where he spent the next eighteen months devoting himself chiefly to surgery, gaining the reputation of an unusually skilful operator.

But family fortunes turned in 1841 because of crop failures. Crawford's father was no longer able to supplement his son's earnings, and Crawford returned to Jefferson where he obtained the practice of his old preceptor, who moved to greener pastures.

Here Long, at the age of twenty-seven, settled comfortably into the harness of a country doctor. In 1842, he married well, winning the hand of no less a beauty than Caroline Swain, niece of Governor David Lowry Swain of North Carolina.

It was in this same year, on March 30, 1842, that Long was responsible for ether's first use in a surgical operation. The best account of what happened is probably Long's own. In the heated controversy that later involved his name—debates reached even the floor of Congress—the authenticity of the facts he subsequently related was never questioned. They may be accepted as absolutely authoritative.

> The first patient to whom I administered ether, was Mr. James M. Venable, who then resided within two miles of Jefferson. . . . Mr. Venable consulted me on several occasions in regard to the propriety of removing two small tumors situated on the back of his neck, but would postpone from time to time having the operation performed, from dread of pain. At length I mentioned to him the fact of my receiving bruises while under the influence of the vapor of ether without suffering, and as I knew him to be fond of, and accustomed to inhale ether, I suggested the probability that the operation might be performed without pain, and proposed operating on him while under its influence. He consented to have one tumor removed, and the operation was performed the same evening.
>
> The ether was given to Mr. Venable on a towel; and when fully under the influence, I [*sic*] extirpated the tumor. It was encysted, and about a half inch in diameter. The patient continued to inhale ether during the time of the operation; and when informed it was over, seemed incredulous, until the tumor was shown him.
>
> He gave no evidence of suffering during the operation, and assured me, when it was over, that he did not suffer the slightest degree of pain from its performance.

After this tremendously significant event, there is absolutely nothing to indicate that Long was aware of its far-reaching importance; seven years were to elapse before he announced that he was fully cognizant of its implications. In his ledger occurs the simple entry: "James Venable, 1842. Ether and excising tumor, $2.00."

In his own behalf Long said:

> I was anxious, before making my publication, to try etherization in a sufficient number of cases to fully satisfy my mind that anesthesia was produced by the ether, and was not the effect of the imagination, or owing to any peculiar insusceptibility to pain in the person experimented upon. . . . I determined to wait . . . to see whether any surgeon would present a claim to having used ether by inhalation in surgical operations prior to the time it was used by me.

By delaying publication Long lost the honor he might have won. From him cannot be withheld the credit of prior experiment and discovery; but to him cannot be granted the credit for influencing the historical development of anesthesia or giving it to the world.

In 1850, Long moved to Athens, Georgia, because of the superior educational opportunities the city offered his children. Photographs reveal that his home was ample, surrounded by a large, tree-bowered garden. He was a successful man in the last days before the outbreak of the war between the states for he had suddenly acquired a large surgical practice.

With the advent of civil conflict, Long joined the Confederate Army and was given charge of a hospital on the campus of the university at Athens. During his flight before the oncoming Union forces in 1864, he carried with him a glass jar containing a roll of papers—"my proofs of the discovery of ether anesthesia."

In 1867, the Surgeon General in Washington appointed him to a post attending the sick among the Union troops which occupied Athens. But his fortunes, hard-hit as they were by the debacle that swept the economy of the entire South before it, continued to decline.

Ten years later, struggling with the difficulties of bad times, and a heavy but unremunerative practice, Long was still in harness. Attending a woman in labor, he administered ether. When his patient was fully anesthetized, he delivered the child. At the very moment he handed the baby to a nurse, he had an apoplectic stroke and fell unconscious. He was carried into another room and died a few hours later; the date was June 16, 1878.

Long was sixty-two years of age when death took him. His life, which might have been bright with accomplishment, was ill-starred with disappointment and final poverty. But he died practicing his profession. Most fitting was his last act—the use of ether to relieve the pains of childbirth.

TWELVE

Horace Wells

(1815–1848)

THE TIME is 1844. The period in the history of our country is now called "federal" by the antique dealers and old-print merchants. They identify the grace of furniture and picture frames, gardens and architecture, with the first long, deep breathing-spell a young nation was permitted between intervals of revolution and foreign and civil war.

The federal period was lively with discoveries in science, and fruitful in art and literature. Even entertainment frequently held a serious note beneath outer trappings designed to amuse. It is not startling to find that a favorite diversion was the lecture on the marvels of chemistry, ending with demonstrations of the effect of laughing gas.

The street-corner professors, the tent-show exhibitors of chemical wonders, doubtless attracted their audiences in the fashion so typically Yankee which we still know in the carnivals of today.

HUR-RY, HUR-RY, HUR-RY! SEE the great exhibition of the gas that MAKES you laugh! FEEL the pleasurable sensations that rouse the risibilities. This MARVELOUS VAPOR excites every fiber of the body to ACTION and sharpens all the faculties of the MIND. STEP RIGHT UP, GET YOUR TICKETS HERE! YE-E-E-S, this gas induces EXHILARATION, causes uproarious outbursts of UNCONTROLLABLE MIRTH. YOU, TOO, can enjoy the delights of INTOXICATION without any of its DEGRADING AFTER EFFECTS! Better than drinking fermented liquors. THRILLING sensations, SUBLIME emotions, EXQUISITE pleasure! FEEL lighter than the ATMOSPHERE. Float away into the AIR! HEY, buy your ticket and go inside! HEY, show ready to start in a few moments. ONLY a quarter to gain admission! Twenty-five cents, the fourth part of a dollar! STEP RIGHT UP! Don't be afraid to take your lady, Sir. This is a gentlemanly exhibition! You don't have to WAIT!

One of these showmen, though his lecture was given in the respectable theaters and halls of the larger towns, was Gardner Quincy Colton. A New England boy born February 7, 1814, tenth son and twelfth child of Walter and Thankful Colton, he was to play a large rôle in the events that led step by painful step to the final acceptance of anesthesia.

Gardner Colton received a scanty education. At the age of sixteen, he was apprenticed to a chair-maker at five dollars a year. This trade brought him to the great metropolis of New York as a journeyman maker of cane seats. An older brother had meanwhile prospered, and aided Gardner to study medicine under Dr. Willard Parker. But his funds did not permit him to continue long enough to qualify for a degree. It was during these studies, however, that he learned of the properties and effects of nitrous oxide.

Colton's wits were sharpened by years of hand-to-mouth existence. It occurred to him to dignify the catch-penny demonstrations of the itinerant workers of chemical wonders. He proposed to friends that they furnish the money for leasing a hall where, posing as "Professor" Colton, he would give a frock-coated exhibition of chemical marvels and induce the audience to try nitrous oxide after he had described its amusing effects.

To the astonishment of Colton's friends, the lecture was a resounding success. A large audience paid the amazing total of $535 to witness the performance. Fortune beckoned: Gardner Colton made arrangements to repeat his success in other cities.

On December 10, 1844, he gave his show in Hartford, Connecticut. The occasion is famous today for the presence there of Horace Wells.

Colton's own account of what happened vividly brings to life this colorful, historic figure. Although other witnesses of this interesting and important occasion will be needed to round out fully our description of it, the warm and generous Colton has richly earned his opportunity to speak:

On the 10th of December, 1844, I gave an exhibition of laughing gas in the city of Hartford, Connecticut. After a brief lecture on the properties and effects of the gas, I invited a dozen or fifteen gentlemen to come upon the stage, who would like to inhale it. Among those who came forward was Dr. Horace Wells, a dentist of Hartford, and a young man by the name of Cooley.

Cooley inhaled the gas, and while under its influence ran against some wooden settees on the stage and bruised his legs badly. On taking his seat next to Dr. Wells, the latter said to him, "You must have hurt yourself." "No." Then he began to feel some pain, and was astonished to find his legs bloody; he said he felt no pain till the effects of the gas had passed off.

At the close of the exhibition, Dr. Wells came to me, and said, "Why cannot a man have a tooth extracted under the gas, and not feel it?"

I replied I did not know.

Dr. Wells then said he believed it could be done, and would try it on himself, if I would bring a bag of gas to his office. The next day—11th of December, 1844—I went to his office with a bag of gas.

It is very important for our story to note that Colton always gave credit to Horace Wells for suggesting the first practical use of nitrous oxide. Indeed, we owe Colton's account of what occurred during the last weeks of the year 1844 to his desire to contradict the story of Mrs. William T. G. Morton in *McClure's Magazine*. When Colton took up his pen in behalf of Horace Wells, he was an old man near death.

It would seem a pity to let Colton disappear from these pages without some brief account of the rest of his interesting life.

After instructing Wells in the making of nitrous oxide, Colton went off on what he called his "exhibition business." He is next heard of in 1847, when he was lecturing on the telegraph for its inventor, Samuel F. B. Morse. Colton gave further proof of his versatility in this same year when he devised an electric motor which he exhibited in Pittsburgh. Though the idea of using electricity as a means of traction was by no means new—Thomas Davenport had patented an electric railway motor in 1837—there is reason to believe that Colton's invention was not derived from it. Colton never sought a patent. The model is on exhibit to this day at the Smithsonian Institution.

In February of 1849, quick fortune sent up its call from

California. Colton joined his brother in the gold fields, and when his luck proved unremarkable there, he practiced medicine for a few months. Later he was appointed Justice of the Peace in San Francisco by Governor Riley.

Colton amassed a small fortune from his diverse activities in California. But on his return to the East, he speedily lost it in bad investments. For a while he supported himself reporting sermons for the *Boston Transcript*.

In 1860, with the outbreak of the Civil War, he sought to regain his former prosperity by publishing a series of war maps. This latest venture evidently did not provide the security Colton had spent his life seeking. In 1863, we find him once again lecturing on nitrous oxide, which had long since been supplanted by ether and chloroform. Among his auditors at a New Haven, Connecticut, demonstration was J. H. Smith, a dentist. Together, Smith and Colton extracted 1,785 teeth in twenty-three days, using the almost forgotten nitrous oxide.

Here at last, Colton found the key to a future without worry. He moved to New York where he established, with John Allen, the Colton Dental Association. This organization had for its sole object the painless extraction of teeth under nitrous oxide. It prospered exceedingly. In 1866, branch offices were opened in Philadelphia, Baltimore, St. Louis, Cincinnati, Boston and Brooklyn. It has been estimated that Colton administered nitrous oxide at least 25,000 times without a fatality! He died at the age of eighty-four in Rotterdam, Holland.

Colton's long and evidently happy life offers sharp contrast to that of young Horace Wells, upon whom Colton's demonstration of laughing gas had such a profound effect in 1844.

For when Wells made his wonderful discovery that the extraction of teeth could be freed from pain, the event brought stark tragedy to himself and his entire family. His widow later declared that the discovery "has been to her family an unspeakable evil." It cost the life of her husband and substituted domestic conflict for what had been a lucrative professional life and a happy home.

His wife's comment that he had made a spectacle of himself at Colton's lecture is interesting. Although she was deeply devoted to her handsome, red-haired, blue-eyed husband, she did not seem too sympathetic with his life as a man of science. He was, in spite of his comparative youth, one of the most distinguished dentists of his time. His obsession with anesthesia appeared only to distress her.

One can see her at Union Hall, the night Colton gave his epochal demonstration, hiding her face behind the wings of her bonnet when Horace answered Colton's call for volunteers. Her husband's participation scarcely enhanced his professional dignity. It was, in fact, the first of a series of incidents that led both to anesthesia's universal acceptance and Wells's untimely end.

Wells was born January 21, 1815, at Hartford, Vermont. His parents were intelligent, wealthy for that region, and very indulgent. The boy was bright, and they made certain that he lacked for no comforts or advantages which they were able to give him.

He attended the select school of his locality until he was thirteen. Later he was sent to the academies at Amherst, Massachusetts, and Walpole, New Hampshire, where he was accounted a promising youth. He showed evidence of a deeply religious inclination, and for a while considered the ministry as a career.

But his mind was a restless and inquisitive one. He had a strong mechanical and inventive bent which led him to construct several machines that were subsequently patented. Characteristically, he lost interest in their development once he had finished them, and sought other outlets for his wide talents.

In the year 1834, when he was nineteen, he began the study of dentistry in Boston. Dental colleges had not yet been established but Wells received the best education possible at the time. He read under preceptors and acquired clinical experience in the office of the best practitioners.

Wells's ingenuity continued to manifest itself in the invention and construction of his dental instruments. His dexterity was marked, and his judgment evidently sound. He quickly made a place for himself in a city widely celebrated for the skill of its dental surgeons.

He, too, soon accepted students. Among them was John Mankey Riggs, of Hartford, after whom Riggs' disease (alveolar pyorrhea) was later to be named, and William T. G. Morton, of Boston. Both of these pupils figure prominently in our story. It was Riggs who earned the honor of extracting the first tooth without pain, performing the operation at Wells's request.

Although Riggs was instrumental in aiding Wells's experiment, it is greatly to his honor that, like Gardner Colton, he always gave full credit for the discovery to Wells.

For a long time, the sensitive Horace Wells had been deeply concerned about the pain that he inevitably caused in performing oral surgery. The night he was present at Colton's demonstration, seeing Sam Cooley's bloody shins which should have had him literally hopping with anguish, he instantly concluded that nitrous oxide was something that might make his dental chair less terrible to his patients.

After addressing himself to Colton, and obtaining the "professor's" adherence to his plan for a trial of laughing gas the next morning, Wells took his wife home and then sought out his old student, Riggs.

Far into the night they argued heatedly about the danger of giving sufficient gas to make a patient insensible to the wrenching of a tooth from the live bone. They scarcely dared submit the first comer to the experiment they wished to undertake. It had been whispered about that persons had succumbed to an excess of nitrous oxide. Then, too, lengthy explanations would be necessary. Time was short. Colton's program called for moving on to other cities.

It happened that Wells had a troublesome wisdom tooth; he decided to submit to the operation himself if Riggs would perform it.

Early the next morning, Wells called for Colton. The "professor" brought with him a supply of the gas in a rubber container equipped with tubing and a wooden spigot. With one of Colton's brothers, who was making the tour with the "professor," they proceeded to Wells's office. There Riggs awaited them, as well as Cooley, whose battered legs of the night before had set Wells on the path he was now following.

Wells seated himself in his own operating chair. He took into his mouth the rubber tube that Colton handed him, and the lecturer opened the spigot. Riggs waited until Colton, who gave a little more of the gas than he usually administered at his demonstrations, signified that Wells was apparently "under." Riggs picked up his forceps. Firmly, while casting an anxious eye on the strangely quiescent Wells, he gripped the root, rocking it to break it loose, and pulled. He held the bloody molar in the air while Wells did not even stir in his seat. There was no sign of any reaction whatever. Colton, Riggs, and Cooley exchanged glances. There was no doubt in their keen Yankee minds that they were in the presence of something of transcending significance.

Tranquilly, Wells regained consciousness. Riggs showed him the tooth, still gripped in the forceps. Wells exclaimed, "It is the greatest discovery ever made; I did not feel it so much as the prick of a pin!"

That was the first tooth ever drawn under the influence of total anesthesia, or at any rate, the first reliably recorded instance of it. Wells and Riggs were intensely excited. Wells promptly obtained Colton's agreement to show him all he knew about the preparation of nitrous oxide and the laboratory apparatus that would be needed.

Colton thought that it would be necessary for Wells to go to Boston to get the things he required. Wells evidently dropped everything to begin work with the least possible delay. Colton later wrote that soon after he left Hartford, he read a newspaper account of Wells extracting teeth without pain.

Years after the great event, when attempts were made to minimize Wells's priority in pioneering anesthesia, Riggs stated that he and Wells turned all their attention to "the extraction of teeth by means of this agent, and continued to devote ourselves to this for several weeks almost exclusively."

Wells then plunged energetically into the search for ways and means of bringing his results before the public at the earliest moment possible.

Colton's demonstration had taken place December 10, 1844. On the very next day Wells had made the first experiment—with himself as guinea-pig. After assembling the materials that were needed to manufacture the gas, Wells instantly sought a score of opportunities to employ it. The entire period of discovery, manufacture, and further testing could not have been more than a fortnight in duration. Early in January, Wells presented himself at Boston to his old student, William T. G. Morton. He told Morton the exciting news.

An acquaintance of both Morton and Wells was the eminent chemist and geologist Charles T. Jackson, who had once rented Morton an office when he first struck out for himself. Morton and Wells had both consulted him a few years earlier for his opinion of a solder the latter had created for the construction of dental plates. Morton, who knew Wells's quality, was inclined to take the idea very seriously, but Jackson pooh-poohed it. Major surgical operations without pain! Utterly preposterous!

This was the reaction of a man who was to have an important influence upon the final acceptance of anesthesia, a man who was also to become one of the embittered claimants to its discovery.

Jackson doubtless considered that the findings of a dentist could scarcely be worthy of his own serious attention.

But Morton had connections at the Massachusetts General Hospital and Wells persuaded him to help obtain a hearing. Colton's account of this portion of Wells's trials is unusually interesting.

"At length," Colton wrote in his defense of Wells, "he went to Cambridge College, and the elder Dr. Warren, at the close of his lecture on surgery, said to the class, 'There is a gentleman here who pretends he has got something which will destroy pain in a surgical operation. He wants to address you. If any of you would like to hear him, you can do so.'"

Colton declared that a member of the class who had been present gave him these words of Warren.

John Collins Warren, the outstanding surgeon of his day, is given the credit for allowing his name and position to be used as sponsor for the first demonstration of anesthesia, not by nitrous oxide, but by ether. This took place a year and a half after Wells sought to prove the *fact* that anesthesia was possible. The recognition of the fact of anesthesia was very probably postponed by the manner in which Warren's students received Wells. Perhaps the fault was that of Warren himself.

"There is a gentleman here who pretends. . . . If any of you would like to hear him, you can do so."

Wells made a few brief statements to his audience—Morton was present but Jackson was not—and then, as some accounts have it, he asked for a volunteer on whom to demonstrate. He administered the gas to his patient, applied his instrument, and proceeded to extract the tooth. Whether he had not waited long enough for the vapor to take effect, had given an inadequate quantity of gas, or whether the patient moaned even though anesthesia was complete, will remain a mystery.

At the last moment, just as Wells drew the tooth, the boy in the chair made a sharp outcry. The students jeered, hissed and shouted "Humbug!" Wells was driven from the hospital amphitheater a dejected figure, his head bowed, his eyes unseeing.

The patient himself declared later that he had felt no pain, but Wells himself was convinced that he had failed. Wells's admission is not to be construed as a concession that nitrous oxide was powerless to render a patient insensible. He merely believed that he had taken the bag away too soon, that he had given too little gas.

Although he returned to Hartford dismayed at his luckless inability to persuade the doctors that surgical operations could be performed painlessly, he still believed in the discovery he had fathered, since he continued to administer nitrous oxide to his own patients. Bishop Brownell, his two daughters, and some forty citizens of Hartford later gave sworn depositions that during 1845 Wells extracted teeth for them without pain, using the gas as an anesthetic.

Meanwhile, in 1846, the first printed claims to Wells's discovery of anesthesia appeared in the December 7 edition of the *Hartford Courant*. This was two months after Morton's results had been published by Henry J. Bigelow in the issue of the *Boston Medical and Surgical Journal* dated November 18, 1846.

Wells's health began to decline. With the seeds of conflict among Morton, Jackson and himself already well sown, Wells decided upon a change of scene. Early in 1847, he sailed for Paris. There he made the acquaintance of an

American dentist, C. Starr Brewster. Brewster was much interested in Wells's story of what had taken place. He brought Wells's case before several French learned societies although the Paris Medical Institute had already granted, somewhat precipitately, 2,500 francs and its recognition to Charles T. Jackson for the discovery of the principle of anesthesia, and the same sum to Morton for his work in the discovery's application.

Wells published a letter, dated February 17, 1847, in *Galignani's Messenger,* stating his claims to priority over both Jackson and Morton, and declaring he had used ether as well as nitrous oxide. His story was viewed with widespread sympathy. He was lionized at parties and fêtes, hailed everywhere as a hero.

An account of his accomplishments was sent before the Paris Medical Society for review. But Wells had meanwhile made a considerable speculation in works of art and was anxious to be off for home so that he could resell them.

On his return to America, he found that other developments had taken place which cast a deeper shadow over his accomplishments. The tide of influence had turned completely in favor of the use of sulfuric ether. Nitrous oxide and its first proponent were all but forgotten.

Morton and Jackson were squabbling viciously over which of them should receive the credit for ether's introduction. And chloroform, meanwhile, had been brought forward by James Young Simpson of Scotland, and bade fair to challenge ether as a general anesthetic.

Wells still believed utterly in the superiority of nitrous oxide over ether. He went to New York to accomplish a three-fold mission. He wanted to introduce nitrous oxide there, urge his claim as the discoverer of anesthesia, and to experiment with chloroform and compare it with the gas of which he had been the first to make practical use.

He succeeded in promoting a number of major operations performed under nitrous oxide. These were largely successful. On April 27, 1848, however, the influential Henry J. Bigelow removed a carcinoma of the breast under nitrous oxide at the Massachusetts General Hospital. The state of prolonged asphyxia produced by the gas—a characteristic which was later modified by the admixture of oxygen—nearly proved fatal. Bigelow instantly concluded that for protracted operations of this type, nitrous oxide was inferior to ether.

The rival claims of Morton and Jackson preyed horribly upon Wells's mind. His pioneering was all but forgotten. His years of experimentation with the gas had undermined him. Tests of the efficacy of chloroform, to which he devoted himself, produced a complete collapse.

His actions became uncontrollable. Whether his long-dormant religious preoccupations now rose to find sick expression in his disordered psyche can only be imagined. He was caught in the act of hurling deadly acid upon the clothes of some New York street-walkers. He was arrested and sent to Tombs Prison to await sentence.

The sense of guilt and shame was more than he could bear. He penned his wife a last letter in which he begged forgiveness for the act he was about to commit. On January 24, 1848, he anesthetized himself with the chloroform he had been inhaling on the week-long spree that ended with his seizure. In the last conscious second before he succumbed to its influence, he slashed the femoral artery of his thigh with a razor.

Twelve days earlier a letter addressed to Wells had been posted in Paris. Transportation was slow in that day and Horace Wells was never to read:

My Dear Wells:

I have just returned from a meeting of the Paris Medical Society, where they have voted that to Horace Wells, of Hartford, Connecticut, United States of America, is due all the honor of having successfully discovered and successfully applied the use of vapors or gases whereby surgical operations could be performed without pain. They have done even more, for they have elected you honorary member of their Society. This was the third meeting that the Society had deliberated on the subject. On the two previous occasions, Mr. Warren, the agent of Dr. Morton, was present and endeavored to show that to his client was due the honor but he, having completely failed, did not attend the last meeting. The use of ether took the place of nitrous oxide gas, but chloroform has supplanted both, yet the first person, who first discovered and performed surgical operations without pain, was Horace Wells, and to the last day of time must suffering humanity bless his name.

Your diploma and the vote of the Paris Medical Society shall be forwarded to you. In the interim, you may use this letter as you please.

Believe me ever truly yours,
Brewster

THIRTEEN

Charles Thomas Jackson

(1805–1880)

On October 6, 1832, one of the first trans-oceanic packet-ships lay at her berth in the port of Le Havre, waiting for favorable weather to start her Statesward voyage. The time of the year was bad for a crossing, the winds adverse, with gales predicted. The *Sully* finally up-anchored, loaded with goods, mail and passengers, and started to buck what proved to be forty days and nights of headwinds. The crossing was an eventful one for human destiny. Among the *Sully's* passengers were Samuel F. B. Morse and a young physician, Charles T. Jackson, now returning to Boston to establish himself in the practice of medicine.

In Paris, Jackson had purchased an electro-magnet along with other electrical equipment he was taking home with him, and he proceeded to amuse the passengers with demonstrations. His little show promptly took root in the fertile brain of Samuel F. B. Morse, a brilliantly versatile man. After studying physics at Yale, he had temporarily yielded himself to a career in portraiture which had already brought him success.

Morse remarked to Jackson at the dinner table, "If the presence of electricity can be made visible in any part of the circuit, I see no reason why intelligence may not be transmitted instantaneously by electricity." The idea gripped Morse, who spent the rest of the rough voyage making sketches of his invention which later proved rudely serviceable. Morse, with collaborators, perfected the device and patented it in 1837. But some years later, as we shall see, Jackson claimed the invention of the telegraph as his.

Jackson was a bizarre character. And if there was one thing that could easily be foretold of this eccentric man of science, it was that he would lay claim, like a scientific octopus, to any new developments that showed themselves within his reach.

Jackson suggested the use of ether to Morton, its first demonstrator. But upon witnessing Morton's extraordinary success and seeing him hailed as a great benefactor, Jackson was gnawed by a savage jealousy which drove him, true to form, to claim the triumph for himself.

Besides the Morse episode, which was not to emerge in all its unsavory notoriety until 1839, seven years after the demonstration on the *Sully*, Jackson had also made a characteristic effort to obtain for himself the glory of no less a figure than William Beaumont.

The year was 1834, some twenty-four months after Jackson had been a fellow-passenger of Morse. Beaumont was a military surgeon who, through the famous gunshot accident to Alexis St. Martin which left a "window" in the young French-Canadian's stomach, made the first great researches on the processes of digestion.

Beaumont toured with St. Martin, exhibiting him before various medical societies, and left some gastric fluid with Jackson, in Boston, for a chemical analysis of its properties.

Jackson soon used up his supply, and learned to his dismay that Beaumont had been ordered to the West, making St. Martin no longer available for further experimentation, on which Jackson had become keenly intent.

The incredible Jackson vigorously set about forestalling their departure. He caused a petition to be circulated among the members of Congress, more than two hundred of whom willingly signed it. The petition was presented by Edward Everett to the Secretary of War just as Beaumont started for his new post under military orders. In view of the fact that Beaumont had already made epochal discoveries in a series of experiments performed by himself, Jackson's petition makes curious reading.

It ran as follows:

Being informed that Dr. Charles T. Jackson, an eminent chemist of Boston, is successfully prosecuting an analysis of the gastric fluid of Alexis St. Martin, the Canadian boy attached to Dr. Beaumont, surgeon of the United States Army, and that the analysis cannot be satisfactorily accomplished without the presence of Dr. Beaumont and Saint Martin; and regarding the case as furnishing a rare and fortunate opportunity of demonstrating important principles in physiology, by which credit may be conferred on the medical science of our country and important benefits accrue to humanity; also, understanding that several scientific bodies are anxious to draw Saint Martin from this country for the purpose of prosecuting the investigations now making by one of our countrymen, who is in every way competent to the work; and persuaded that the opportunity now afforded, if neglected, will be lost to our country forever, we request that the Honorable Secretary of War WILL STATION DR. BEAUMONT AT BOSTON, OR IN THE VICINITY, FOR THE TERM OF FOUR MONTHS, OR LONGER IF NECESSARY FOR THE OBJECT.

It is well-nigh unbelievable that Jackson had never consulted Beaumont as to his wishes on the subject. In the light of Jackson's later behavior, of which this is the first striking example, one may be sure that if the request had been granted Jackson would have claimed for himself Beaumont's discoveries in physiology. And these experiments of Beaumont were not to be surpassed until the close of the century, with the work in Russia of Pavlov and his pupils.

To return to Samuel F. B. Morse and the telegraph: it was quite true that the revelation of the telegraph occurred to Morse on the *Sully*, and that Jackson had stimulated him with his conversation on the subject. But Morse had been familiar with the electro-magnet since 1824, when it was described in a lecture by James Freeman Dana that Morse attended at the New York Athenaeum. His development of the idea embraced a range far beyond Jackson's shipboard demonstration. The scope of Morse's shipboard notes involved a sending-apparatus to transmit signals by the closing and opening of an electric circuit; a receiving-instrument to record the signals on a strip of paper fed by a clock movement; and the Morse code for enciphering letters and numbers into dots and dashes.

But the envy-eaten Jackson pressed his claim for years. In May of 1839, an item appeared in *The Boston Post* which read:

> We are informed that the invention of the electro-magnetic telegraph, which has been claimed by Mr. S. F. B. Morse of New York, is entirely due to our fellow citizen, Dr. Charles T. Jackson, who first conceived the idea of such an instrument during his return voyage from Europe on the packet ship *Sully* in October 1832.

Jackson renewed his claims in 1846 and 1849, but by the turn of the first half of the century, he had been so thoroughly discredited that no one paid much attention to him. Morse later wrote of a legal deposition made by Jackson: "There was never a more finished specimen of wholesale lying than is contained in it. He is certainly a monomaniac, no other conclusion could save him from an indictment for perjury."

In 1846, the year Jackson "discovered" anesthesia, he was also to claim the prior discovery of gun-cotton after it had been announced by C. F. Schönbein.

Charles Thomas Jackson was born of old New England stock on June 21, 1805, at Plymouth, Massachusetts. He was the son of Charles and Lucy Jackson, and a descendant of Abraham Jackson who celebrated his nuptials at Plymouth in 1657 with a Puritan maid who bore the quaint name of Remember Morton.

Charles received his early education in the town school, and later passed to the intellectual supervision of Dr. Allyne, at the latter's private school in Duxbury.

Jackson's preparation for a career in medicine was begun under the sponsorship of Walter Channing, pioneer user of ether in childbirth, the first Professor of Obstetrics and Medical Jurisprudence at the Harvard Medical School, and James Jackson, Professor of the Theory and Practice of Physic at the same institution, one of the founders of the Massachusetts General Hospital and a pioneer in the use of vaccination in this country. With such tutors, Jackson was swiftly prepared for his entrance into the Harvard Medical School. While there, he began to turn to other interests, chiefly geology and chemistry. He twice made trips to

Nova Scotia in the company of his friend Francis Alger to further his knowledge of geology.

He received his degree in 1829, and in the same year took passage to Europe to study medicine at the Sorbonne and, at the same time, continue his researches in geology at the *École des Mines*. He made the enduring friendship of L. Élie de Beaumont and other geologists. He visited Vesuvius and Aetna, made long walking trips in Switzerland, Austria and Auvergne, as well as Italy. Nor did this many-sided student neglect his medical work. In Vienna in 1831, the year of the famous cholera epidemic, he did post-mortems on its victims. And before he took passage for home in 1832, he stopped at Pinder and Son's Paris establishment to provide himself with the laboratory equipment for physical and electrical research which was mentioned earlier.

Jackson began the practice of medicine in 1832. As his attempts to encroach on Beaumont's work with Alexis St. Martin revealed in 1834, he already had begun to transfer his activities to chemistry, where his services were more in demand.

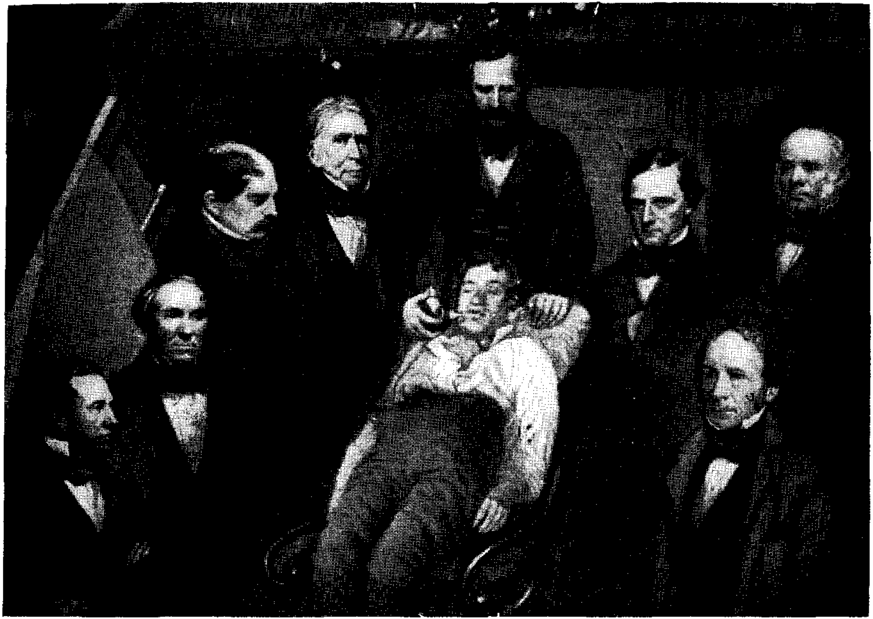
On February 27, 1834, he married Susan Bridge of Charleston, who bore him two daughters and three sons. His reputation as a mineralogist brought him many clients in those days when the world's wealth was conceived as being literally in the ground. In 1836, he established a laboratory where those with scientific interests frequently gathered, attracted by his wide associations and knowledge.

The year following, Jackson formally entered public life. A state geologic survey was established in Maine and he was designated as the official geologist. He completed a survey of the public lands of both Maine and Massachusetts, taking three years for the work, and in 1840 completed a similar estimate for Rhode Island. Even before this last task was completed, he was appointed state geologist for New Hampshire, the years between 1841 and 1844 being spent chiefly on this last assignment. The fact is interesting in the light of Jackson's later claim to experiments with ether during this same interval. The period of 1844-47 saw Jackson freed from his other preoccupations and teaching chemistry in Boston.

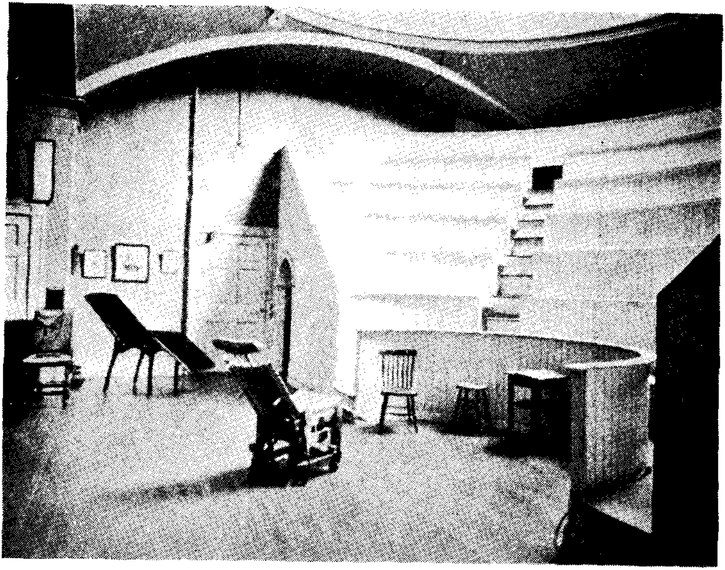
Before we examine Jackson's behavior in connection with the discovery of anesthesia, there is one more episode, though it occurred after the historic events of 1846, that gives insight into his peculiar character and concludes the chronology of his career as a public figure.

In 1847, he was appointed by Congress as a United States geologist to report upon the mineral wealth of lands in the region of Lake Superior. He engaged two aides to work under his direction, to whom he was compelled to leave the completion of the project. Complaints of inefficiency, drunkenness, and inattention to duty forced Jackson's resignation from his post.

Prior to the Lake Superior episode, Jackson had already become savagely embroiled with Morton over the discovery of anesthesia. Jackson harked back to the year 1834, the period already colored unpleasantly by his efforts to have William Beaumont stationed in Boston. He declared he had observed that an alcoholic solution of chloroform when applied to a nerve rendered it insensitive to pain. In 1837, Jackson, then deeply involved in geological surveys, had found time—or so he stated—to investigate the properties



The first public demonstration of anesthesia with ether (From Rice's *Trials of a Public Benefactor*, 1858)



ON OCTOBER 16 1846 IN THIS ROOM THEN THE OPERATING THEATRE OF THE HOSPITAL
WAS GIVEN THE FIRST PUBLIC DEMONSTRATION OF ANAESTHESIA
TO THE EXTENT OF PRODUCING INSENSIBILITY TO PAIN DURING A SERIOUS SURGICAL OPERATION
SULPHURIC ETHER WAS ADMINISTERED BY WILLIAM THOMAS GREEN MORTON A BOSTON DENTIST
THE PATIENT WAS GILBERT ABBOTT THE OPERATION WAS THE REMOVAL OF A TUMOR UNDER THE JAW
THE SURGEON WAS JOHN COLLINS WARREN
THE PATIENT DECLARED THAT HE HAD FELT NO PAIN DURING THE OPERATION
AND WAS DISCHARGED WELL DECEMBER 7
KNOWLEDGE OF THIS DISCOVERY SPREAD FROM THIS ROOM THROUGHOUT THE CIVILIZED WORLD
AND A NEW ERA FOR SURGERY BEGAN

Ether Room in the Massachusetts General Hospital and the plaque commemorating "the first public demonstration of anesthesia" of nitrous oxide and to determine that its effects were partly due to asphyxia, and in 1841-42, he stated further, he discovered the effect of ether.

His own words make interesting reading:

> In the winter of 1841-2 I was employed in giving a few lectures before the Mechanics Charitable Association in Boston, and in my last lecture, which I think was in the month of February, I had occasion to show a number of experiments in illustration of the theory of volcanic eruptions, and for these experiments I prepared a large quantity of chlorine gas, collecting it in gallon glass jars over boiling water. Just as one of these large glass jars was filled with pure chlorine, it overturned and broke, and in my endeavors to save the vessel, I accidentally got my lungs full of chlorine gas, which nearly suffocated me, so that my life was in imminent danger. I immediately had ether and ammonia brought, and alternately inhaled them with great relief. . . . I determined therefore to make a more thorough trial of ether vapor. . . . I continued the inhalation of the ether vapor, and soon fell into a dreamy state, and then became unconscious of all surrounding things. . . . Reflecting on these phenomena, the idea flashed into my mind that I had made the discovery I had for so long a time been in quest of—a means of rendering the nerves of sensation temporarily insensible, so as to admit of the performance of a surgical operation on an individual without his suffering pain therefrom.

These statements appeared long after Morton's first public demonstration of ether.

On September 30, 1846, Jackson suggested to Morton that he use ether in extracting a tooth, and told him how to administer it. There is almost no objective evidence that Morton was merely acting as Jackson's "agent," as Jackson later declared brazenly, or that he was exploiting Morton merely as a tool in "a series of experiments," or that Jackson had any notion whatever of the true scope of Morton's information on ether or his plans for using it as an anesthetic.

Jackson was not present at Morton's famous demonstration of ether's use in surgery, nor did Jackson take any interest in the rapid developments that immediately followed Morton's success.

But then the roar of acclaim for Morton reached Jackson's ears. Among those who hailed Morton was Oliver Wendell Holmes, whose letter is worth quoting:

November 21, 1846

My Dear Sir:

Everybody wants to have a hand in the great discovery. All I will do is give you a hint or two as to names, or the name, to be applied to the state produced, and to the agent.

The state should, I think, be called *anæsthesia*. . . . The adjective will be *anæsthetic*.

This and other signals of Morton's overnight triumph were more than Jackson could bear. On December 21, 1846, he addressed two letters to his old friend, L. Élie de Beaumont. He requested that they be read to the French Academy of Sciences, and without so much as mentioning the name of Morton, he announced himself as the discoverer of surgical anesthesia.

On March 2, 1847, he read a paper to the American Academy of Arts and Sciences in which he first publicly proclaimed himself as ether's discoverer. This brief paper Jackson caused to be printed in the *Boston Daily Advertiser* of the day before so that he could send copies abroad on the March 1 mail packet. The effect of this action was to make it appear that the Academy had actually given its endorsement to Jackson's claim. The impression prevailed in Europe for a considerable time thereafter, even though the Academy did everything it could to counteract Jackson's stratagem.

The Vice-President of the Academy was Edward Everett, the same who had handed Jackson's petition to the Secretary of War when Jackson sought to have William Beaumont stationed at Boston. Everett was acting president of the organization at the time. In a letter to Morton he severely condemned Jackson's publicity-wise action, and disclaimed all responsibility.

Morton freely acknowledged the exact degree of his indebtedness to Jackson. This consisted in the information Jackson furnished from his admittedly authoritative knowledge of chemistry on the kinds of ether and the manner of their preparation. Jackson recommended a rectified product sold by Burnett's which proved most efficient. It was this information Morton admitted receiving from Jackson. He later said of Jackson's claim, "But my obligation hath this extent, no more!"

The remainder of Jackson's career is a compound of excursions to Congress, either to obtain recognition for himself or to prevent it for Morton; of commissions to assay mining properties; of routine laboratory work; and writing. In 1861, he published his *Manual of Etherization* which, curiously enough, contained researches Jackson claimed to have made on the use of ether in cases of insanity. One of these cases is interesting. Jackson wrote:

The first patient . . . was so refractory that a pint of ether was soon exhausted, and then we made use of the mixture of chloroform and ether, which finally subdued him and cast him into a profound snoring sleep. We then returned him to his room . . . and he was kept in a deep sleep for many hours. When he awoke he was quite calm and rational, and continued so for months afterwards, and was finally discharged, relieved if not cured. We have heard nothing from him since.

This experiment was conducted at the McLean Asylum, a department of Massachusetts General Hospital. Twelve years later, McLean was to admit another patient, a man who had performed scientific researches there, who had attended lectures within the walls of the hospital of which it formed a part. His name was Charles Thomas Jackson. He was to spend the last seven years of his life at the asylum. No record exists that the gas whose discovery as an anesthetic he claimed, and with whose use in insanity he experimented, was used in his own case or had any value if it was actually employed. He died there on August 28, 1880.

FOURTEEN

William Thomas Green Morton

(1819–1868)

AT NINE O'CLOCK on the evening of September 30, 1846, an event of the greatest significance occurred in the office of William Thomas Green Morton, a Boston dentist. On this early fall evening, well past the time when a patient could be expected, Morton's aide, a Doctor Hayden, answered a knock at the door. He admitted Mr. Eben H. Frost who had been suffering from a terrible toothache for several days, and had finally decided that the torture of an extraction was preferable to another sleepless night. Hayden conducted Frost to Morton's operating chair and the patient seated himself nervously.

"Doctor," he said, "can't you give me something for this tooth? How about this mesmerizing I've been reading about?"

Here was just the man Morton had been waiting for.

"I have something much better than that," he said. He called his assistant. "Hayden! Bring the lamp."

It was now quite dark. Morton needed a good light to see what he was doing. He took out a container of rectified ether he had purchased a few days earlier from Joseph Burnett, the apothecary to whom he had gone at the suggestion of Charles T. Jackson. Carefully, he poured the fluid on a folded pocket-handkerchief and gave it to the trembling Frost to hold beneath his nose. Frost inhaled almost greedily. In less than a minute, his hand dropped into his lap. He slept.

Morton worked with a speed acquired from countless extractions where the faster the dentist worked, the less pain the patient felt. Hayden held the lamp close to Frost's yawning mouth. The gods of chance were with Morton. The highly inflammable ether fumes did not ignite as they well might have. Morton gripped the abscessed bicuspid with his forceps. The patient did not so much as stir. Morton yanked. The tooth was in the air, but still the patient slept and showed no sign of pain. Morton exchanged a look of utter triumph with Hayden.

Morton was no fool. He promptly obtained from Frost this certificate, which he doubtless wrote himself for Frost's signature:

This is to certify that I applied to Doctor Morton, at 9 o'clock this evening, suffering under the most violent toothache; that Doctor Morton took out his pocket-handkerchief, saturated it with a preparation of his, from which I breathed for about half a minute, and then was lost in sleep. In an instant I awoke, and saw my tooth lying on the floor. I did not experience the slightest pain whatever. I remained twenty minutes in his office afterward, and felt no unpleasant effects from the operation.

The statement was signed: "Eben H. Frost, 42 Prince Street, Boston." While the patient was recovering, and in a scant twenty minutes at that, Morton had his certificate, which he took the further precaution of having Hayden and A. G. Tenney sign. They added these words:

We witnessed the above operation, and the statement is, in all respects, correct; and, what is more, the man asked where his tooth was, or if it was out.

Morton was practical, and a practical man does not let a matter like this drop after having gone so far. The next day, October 1, 1846, there appeared in the *Boston Daily Journal* the following advice:

Last evening, as we were informed by a gentleman who witnessed the operation, an ulcerated tooth was extracted from the mouth of an individual, without giving the slightest pain. He was put into a kind of sleep, by inhaling a preparation, the effects of which lasted for about three quarters of a minute, just long enough to extract the tooth.

Although Morton later professed that the newspaper had somehow got this information without his knowledge, there is more than a little reason to believe that the *Journal's* informant was none other than the good doctor himself.

How long Morton had been experimenting with ether is a matter of question. That he was a witness to Wells's experiments with nitrous oxide, the reader knows. And that Jackson contributed the suggestion that ether be used instead of laughing gas, and a purified ether at that, has also been established.

The question raised so often is: if Morton had been using ether in certain trials himself, why did he pretend ignorance of it when Jackson casually recommended it? Morton, the man of business, was on the trail of something he knew would be a money-maker and a patient-getter. Jackson's reputation, which had certainly begun to tarnish as a result of his claim to Morse's telegraph, his attempt to detain St. Martin, and his assertion that he was the prior discoverer of Schönbein's collodion, would not have seemed conducive to any confidences of Morton's. So the dentist, whose knowledge of chemistry was sketchy, cannily pumped Jackson.

Morton took the essentially business-like precaution of revealing the nature of his "preparation" to no one. Energetically, he set about capitalizing on the *Journal* story of October 1. A bit of judicious word-of-mouth advertising spread the news that William Thomas Green Morton was the dentist who made tooth-pulling painless. The patients began to come. Within the next few days, he had at least four or five opportunities, perhaps more, to test ether. In one instance, it produced nothing but a protracted vomiting spell. In another, it merely made the patient drowsy. In other instances, it worked as well as it had on Frost.

Morton appeared to recognize that the trick lay in the method of administration. He settled on a funnel-like flask with one outlet which fed vapor from an ether-soaked sponge via a rubber tube. It worked. He determined to offer his preparation to the Massachusetts General Hospital.

There are many legends how ether came to the attention of John Collins Warren, the surgeon before whose class Wells failed, and who was to perform the first operation with ether. Morton himself said that physicians of the hospital, hearing of his tooth-extractions with the mysterious pain-killer, called on him and asked that he demonstrate it. Rice, Morton's paid biographer, relates that Morton determined to visit Warren at his home and lay the matter before him.

The latter version seems more probable. Morton is a notoriously unreliable reporter of his own actions, judging by the fantastic discrepancies in his various printed utterances. That he was a go-getter, there is not the least doubt. One would pronounce with only the slightest hesitation that, even as he had Frost certify the effects of the preparation and somehow saw that the story of the painless extraction got into the papers, he sought out Warren and persuaded him to give the nameless pain-killer a trial.

Morton had attended lectures at the Harvard Medical School for at least two years and certainly had relations with its staff. He had evidently been of assistance to Wells in obtaining the interviews that led to the Hartford man's tragic fiasco before Warren's students in 1844. To seek out the same Warren, to go before the same hard-boiled audience, was something that cannot be lightly glossed over. It took either great courage, a rash indifference to his own professional future, or, perhaps, a total lack of scientific judgment.

Morton, as should certainly be evident by now, was not well-grounded academically, or in experimentation. It is plain that less than a week elapsed between his operation on Eben H. Frost and his approach to John Collins Warren. He had had neither the time nor the equipment, nor, indeed, the faintest notion of any methodology for conducting further researches on the subject.

To what extent—it is a question one may well ask at this point—was Morton indebted to Wells? It is true that Morton visited Wells after the Boston disaster, and learned from him all he knew about nitrous oxide, its preparation and effects. That Wells put him on the anesthesia trail there is no gainsaying, and Morton was not justified in ever belittling Wells or the degree of his own indebtedness.

But in all fairness, did Morton extract the tooth of Eben H. Frost with nitrous oxide? Did not Morton use a wholly different agent? True it is that ether was suggested by Jackson—Morton never denied that. But Jackson recommended ether instead of nitrous oxide with the indulgence of a teacher giving a bright if slightly addled student enough rope. There is ample evidence, including Jackson's own statements, that he himself doubted its usefulness. The incredibly circular story of who should get the credit is amusing if one does not get lost in the mazes of conflicting evidence, most of it manufactured years after the events occurred.

A short time after Morton's interview with Warren, he received this note:

Dear Sir:

I write at the request of Dr. J. C. Warren, to invite you to be present on Friday morning at 10 o'clock, at the hospital, to administer to a patient who is then to be operated upon, the preparation which you have invented to diminish the sensibility to pain.

It was dated October 14, 1846, and signed by C. F. Heywood, House Surgeon to the Massachusetts General Hospital. Morton received the letter at the home of Augustus A. Gould, a Boston physician with whom he and his wife resided. The now anxious Morton discussed the inhaler with Gould, who thought its chief disadvantage was that the patient breathed back his own expired air through the apparatus's sole outlet.

A sketch was given to N. B. Chamberlain, a Boston instrument maker, who agreed to take on the rush assignment. The morning of the operation, the apparatus was not ready. Morton was in a fever of impatience, fearful lest Warren's operation proceed without him and the great opportunity be lost, and equally concerned that the improved inhaler be used.

At last the workman handed him the glass globe. Morton examined it hastily. It was fashioned with two openings, the one in relation to the other as would be the hands of a clock at five minutes to three. The uppermost opening was to contain the notched cork, after the ether-saturated sponge was admitted through it. The lower opening, cocked at an angle slightly above the horizontal so the vapor could rise freely through it, was closed by a spigot to which a rubber tube could be appended. Morton nodded his satisfaction. He took it and ran. On the way to the hospital, he picked up Eben H. Frost. If he failed, as Wells had, he wanted Frost to testify that in his own case, at least, the Morton preparation had been a success.

At the Massachusetts General Hospital, the scene had already been set for some fifteen minutes. The seats above the surgical pit in the hospital's operating room were jammed with students and staff members. Among the doctors present were Gould, Henry J. Bigelow, C. F. Heywood, and S. D. Townsend. John Collins Warren, who was to perform the operation, had already delivered his clinical lecture. The patient, thin and pale Gilbert Abbot, a consumptive young man with a tumor at the angle of the jaw, waited resignedly. Warren stilled the whispering with a slight cough.

"As Dr. Morton has not arrived," he said dryly, "I presume he is otherwise engaged."

It was fortunate for Morton that he arrived when he did. He came puffing into the large, domed chamber just as a great laugh greeted Warren's sally. Warren nodded his acquiescence to a brief delay while Morton retired to a room behind the seats of the amphitheater. Morton camouflaged the characteristic odor of ether with aromatic essences. He saturated his sponge, inserted it in the globe which he thereupon corked, and once again made his appearance.

Warren said, "Well sir! your patient is ready."

Morton, a big hearty man with upswept moustaches and a predilection for fancy waistcoats, immediately gained Abbot's confidence. The patient was strapped to the red plush operating chair, a customary precaution which the attending physicians saw no reason to discontinue. Morton pointed out Eben Frost to Abbot.

"There is a man who has breathed the preparation and can testify to its success."

Frost nodded from across the room that this was so.

"Are you afraid?" Morton asked Abbot.

This pale figure about whom so little is known was evidently something of a man. He would not admit fear before an audience of his fellows at a time like this. "No," Abbot replied. "I feel confident and will do precisely as you tell me."

Morton put the tube to his lips and told him very carefully to breathe in and out of the globe through his mouth. Abbot obeyed orders perfectly. At first his face flushed and his arms and legs moved spasmodically in the fashion that most of the students, familiar with the exhilarating effects of the vapor, knew and expected. But Morton held the glass globe in one hand and kept the tube at Abbot's mouth with the other for what must have seemed an interminable length of time to the witnesses, an interval far longer than had been dared or dreamed by any. Actually, it was only three to four minutes.

"Sir," said Morton, bowing in turn to Warren, "*your* patient is ready."

Warren seized the extruded veins of the tumor in one hand, and with the other made his first incision of the skin. Years of hearing that initial outcry under the knife did not prevent him from steeling himself unconsciously for the screams of anguish that usually attended his swift, but coldly controlled, movements. Above him, in the stalls where the students sat, many a hand must have clenched tightly, remembering the bedlam of previous operations.

But no sound issued from Abbot's mouth. Rapidly, but with the calm self-discipline for which he was noted, Warren continued his operation. When he insulated the veins, as this procedure was then called, the patient moved his legs a bit and uttered incoherent sounds. But it was evident to all that an extraordinary thing had transpired. The wound was closed, the patient's face washed of blood. Gradually he emerged from the effects of Morton's "preparation." Morton questioned him; Abbot had felt no pain; he remembered vaguely something blunt scratching his cheek.

Warren turned to his students and colleagues. Perhaps remembering their hisses and catcalls at Wells's demonstration in 1844, he employed the very word they had hurled at the Hartford dentist. "Gentlemen," said John Collins

Warren in the midst of an impressive silence, "this is no humbug." Warren, the granite-faced surgeon with the biting wit, unbent completely. He later wrote:

A new era has opened on the operating surgeon. His visitations on the most delicate parts are performed, not only without the agonizing screams he has been accustomed to hear, but sometimes in a state of perfect insensibility, and, occasionally, even with an expression of pleasure on the part of the patient.

Who could have imagined that drawing a knife over the delicate skin of the face, might produce a sensation of unmixed delight? That the turning and twisting of instruments in the most sensitive bladder, might be accompanied by a delightful dream? That the contorting of anchylosed joints should coexist with a celestial vision?

If Ambroise Paré, and Louis, and Dessault, and Cheselden, and Hunter, and Cooper, could see what our eyes daily witness, how they would long to come among us, and perform their exploits once more.

And with what fresh vigor does the living surgeon, who is ready to resign his scalpel, grasp it, and wish again to go through his career under the new auspices.

As philanthropists we may well rejoice that we have had an agency, however slight, in conferring on poor suffering humanity so precious a gift.

Unrestrained and free as God's own sunshine, it has gone forth to cheer and gladden the earth; it will awaken the gratitude of the present, and all coming generations. The student, who from distant lands or in distant ages, may visit this spot, will view it with increased interest, as he remembers that here was first demonstrated one of the most glorious truths of science.

This was indeed the high point of Morton's career. From this time onward, he was to plunge into a dizzy maelstrom of controversy, charges and counter-charges, even to lobbying in Congress for national gratitude in the form of financial grants. For Warren was wrong when he called this gift "unrestrained and free as God's own sunshine."

Morton not only sought to make money from his "invention" but the thought had obsessed him from the very first. He patented it and made a vigorous effort to sell it to the government for use on the Mexican front. Years later he was suing a charitable institution for infringing his rights.

What was Morton's background? The son of James Morton, a farmer, and Rebecca Morton, he was born at Charlton, Massachusetts, August 9, 1819. His early schooling did not lack for difficulties that set the pattern for his later "persecutions." On one occasion, he was "falsely accused by another student, outrageously punished." His biographer declares that his health was so affected by the hiding he received that he was ailing for months. He left this school, and attended others at Northfield and Leicester. His formal education ended at the age of seventeen.

From seventeen until twenty, Morton tried his hand at various jobs in Boston. Most were with publishers, which may account for his unusual facility in propagandizing his own cause, commissioning spokesmen and paid propagandists, and getting out circulars for the furthering of his claim.

Here again the persecution complex seems to manifest itself. He evidently had a whirl at going into business for himself—its exact nature has never been satisfactorily established—as the following quotation from his biography discloses. The lines are appropriately captioned, "Adverse Circumstances."

With . . . a natural dislike to the bustle, annoyance and drudgery of his present mode of life, his knowledge of the routine of business could not be very great, nor his powers of protecting himself from the cunning designs of others sufficient to assure him any profit. Such a result followed, therefore, as would be expected; and duped by his partners, who were older, more shrewd, and better versed in business, his mercantile career terminated in decided disaster, and its abandonment forever.

Thus Morton turned from a career in commerce, and embarked upon the study of dentistry. The accounts of his life that Morton sponsored relate that he began the study of dentistry in 1840, at the College of Dental Surgery in Baltimore. There is no verification that Morton was a student at Baltimore. It appears as though he invented this supposed fact in order to eliminate conclusions that might have been drawn from his having been Horace Wells's pupil. We do know, however, that he recited to Wells at Hartford, after the fashion of the times.

Morton's first professional venture was a partnership with Wells during the years 1842-43. Once again a fog has been cast over the nature of the contribution of each to this cooperative enterprise. The teacher and his former pupil had an idea. During this epoch, dentures were made by fitting false teeth to a gold plate and setting the plate in turn upon the old roots, which were seldom removed. A gold solder was used in affixing the false teeth to the plate. The trouble was that it was thought necessary to have the solder of a softer character than the plate since any heat great enough to melt the solder would also have fused the plate.

Invariably, the color of the solder changed, leaving an ugly dark line around the margin of each tooth. What is more, the gap between the old roots and the plate left a bad taste in the mouth, to say nothing of a distressingly foul breath. The point is worth attention for two reasons.

The first is that the idea of the solder was originally neither Wells's nor Morton's. John Mankey Riggs, another student of Wells whom the reader has already come to know, was the man who hit upon the desirability of an improved gold solder and perfected it. Wells and Morton tried to persuade him to let them exploit the invention but Riggs refused to give it up. Whereupon it was Wells, not Morton as his biographers proclaim, who set about producing a compound of his own which would make 18-carat solder flow upon 18-carat gold. Wells succeeded. Interestingly enough, Jackson was consulted at this point, the first of the occasions when these three later claimants to anesthesia were to meet. Jackson gave Wells and Morton a certificate attesting that the properties of the solder were wholly as they claimed them to be.

The second point worthy of notation is the reason for the failure of the Morton-Wells combine. They thought they had a great thing because they could make infinitely better-looking plates. But people failed to beat a pathway to their door. Why? To fit these plates perfectly, it was necessary to have old roots removed. And this torture the average patient flatly refused to undergo. If something could be invented that would enable teeth to be pulled painlessly, one's fortune could be made in the fabrication of expensive dentures for the grateful patient.

This money-making germ was planted in both Wells and Morton. Wells returned to Hartford. Morton, the ambitious and worldly, stayed in Boston so that he might enroll in the

Harvard Medical School. In 1844, he purchased tickets for two years of lectures and set about preparing himself for admission to the practice of medicine.

And in May of the same year, Morton married Miss Elizabeth Whitman of Farmington, Connecticut. The courtship had been long, and apparently not viewed with enthusiasm by the girl's parents. They were well off, and it was only when Morton decided to qualify as a physician that they gave their grudging approval. A son, William James Morton, born in Boston, July 3, 1845, deserves a few words of his own.

Physician to a mining company in Cape Town, South Africa, prospector and big-game hunter as well, he eventually turned to psychiatry and neurology. Later physics and chemistry engrossed him. He was one of the first to experiment with X-ray in this country, establishing its therapeutic value in skin diseases and cancer.

The resemblance to the father is etched in sharp outline. The search for the philosopher's stone, the elixir which would alchemize knowledge into gold, finally betrayed him, too. In March 1913, he was convicted of using the mails to defraud by promoting the sale of stock in worthless Canadian mines. He was paroled after serving only a few months of his sentence, was later restored to the practice of medicine, and died of heart disease in 1920—the same year his father was elected to the Hall of Fame.

But no such honor attended the last days of Morton's life, for he met no less disagreeable an end than did Wells and Jackson. In July 1868, he returned to New York from one of his countless trips to the nation's capital in a condition bordering on complete breakdown, brought on, it has been said, by his encounter of an article which favored Jackson's claim. Doctors Sayre and Yale were called to his New York residence on July 15. They pronounced him in critical condition, ordered in a trained nurse, prescribed leeches for his temples, cups for his spine, ice for his head.

But Morton refused to submit to treatment. Following the physicians' departure, he jumped into his buggy and headed for the Riverside Hotel, declaring he knew he would feel better if he could only get out of the hot city.

He drove furiously up Broadway and through Central Park. At the upper end of the park he leaped from his buggy, ran to the lake and plunged his head into the water. Persuaded to get back into his rig, he drove a short distance, leaped out, hurdled a fence, and fell down unconscious. He was taken to St. Luke's Hospital where he died a few hours later.

FIFTEEN

The Controversy

THE FIRST THING that Morton did with his "discovery" was to patent it. The patent was sought in the name of Morton and Jackson less than a fortnight after the first successful demonstration of ether at the Massachusetts General Hospital.

To protect his discovery, Morton used every means to prevent anyone from learning that the preparation he used was ether. He disguised the typical odor as well as he could with aromatic essences. When the skeptical doctors smelled it, they instantly recognized the familiar specific for catarrh and whooping cough. Taxed with this fact, Morton admitted ether was *in* the compound, but denied that it was responsible for producing insensibility. And when the Massachusetts General refused to continue its use because of his refusal to divulge his secret, Morton finally admitted that the *Letheon*, as he called it, was nothing more nor less than highly rectified sulfuric ether.

Morton's justification for his attempt to maintain exclusive control of the formula was not only that his family and he were in need of compensation, but that he deserved it for his arduous labors and large expenditures. But the manufacture of the first inhalers and the cost of a few containers of ether could hardly have accounted for more than a few hundred dollars in the very brief interval between the experiment on Eben Frost and the patent application. Clearly, it was in trying to commercialize ether *after* it had been accepted that Morton went heavily into debt. But this was money he spent not in experiment, but to make more money, and the method devised to accomplish this end was the licensing system, described by Morton's biographer, N. P. Rice:

> In order to give the reader some idea of the revenue expected . . . I will give . . . a brief estimate, calculated from one of the early licenses sold under the patent. The exclusive use of the agent in Essex County, Massachusetts, was conveyed to Dr. Fisk of Salem, in the same county, for the sum of $850.
>
> The area comprised in this license contained a population of 100,000 inhabitants. The duration of the license was for five years.
>
> The American patent extended to fourteen years, and, supposing the license to Dr. Fisk to remain equally valuable all the time of this period, the license for fourteen years would have been worth $2,380. At the same rate the sale of licenses for the whole state of Massachusetts, containing a population of over one million, would have been worth $23,800, and for the whole United States, whose population was then estimated at twenty-three millions, $547,400, of which the solicitor's share would have been $136,850. The party to whom 10% was to be given, $54,740. While the remainder, the share of Morton, would have been $355,810—and this exclusive of the income from the English patent—or any increase in the price of licenses, as the value of the patent became more fully developed.

Included in the contracts that bound the license sales was a clause guaranteeing the repayment of the fee should the government of the United States adopt the "invention."

As events proved, the patent had as little validity as if Benjamin Franklin had sought the same protection for electricity. The government itself shortly infringed it, and a renewal of the patent was never granted.

Jackson meanwhile had seen that opportunities for money-profit did not match the prestige value of being anesthesia's discoverer. He assigned his rights in the patent to Morton, taking an agreement that Morton would pay him ten per cent of all he made. Then he double-crossed Morton by writing to Paris as narrated earlier. And when the Monthyon Prize of the French Academy of Medicine was awarded to Morton and Jackson jointly, Morton refused to accept it, insisting the credit belonged solely to him.

In 1847, a memorandum was sent to Congress by the physicians and surgeons of the Massachusetts General Hospital praying that adequate compensation be given the discoverer, i.e. Morton, of the anesthetic use of ether. And two years later, when his patent and the memorandum to Congress brought him nothing, Morton himself solicited Congress for financial reward.

As a result of this and other pressure, bills were introduced into Congress appropriating $100,000 to Morton for the discovery of practical anesthesia. These were voted down at three separate sessions of the legislature, due to the efforts of Jackson, the Congressional supporters of Long, who finally came forward, and the vigorous polemics of the Honorable Truman Smith, Senator from Connecticut, who fought for the recognition of the rights of the impoverished widow and infant son of Horace Wells.

Then came the Civil War, and the issue over awards and priority was lost in a maze of infinitely more pressing matters. Ether was used extensively on the battlefields. And by both sides. Ether had triumphed, even though no one of the claimants had succeeded in establishing priority.

A mere two years after the discovery became generally known, the American public was wearied to death of the controversy, which continues to this day. After a century, Long, Wells, Jackson, and Morton still have their partisans. The controversy will never be settled, but the wisest verdict is still that of Oliver Wendell Holmes: "To e(i)ther."

THE RECEPTION OF THE DISCOVERY IN EUROPE

Robert Liston

(1794–1847)

FRANCIS BOOTT was born in Boston, the son of an English father and a Scotch mother. Educated at Harvard and receiving his doctor's degree at Edinburgh, practicing in London but making numerous voyages between England and America, he had many friends on both sides of the Atlantic. It was therefore natural that when Jacob Bigelow, Professor of Materia Medica at the Harvard Medical School, wished to announce the news of ether anesthesia to his colleagues abroad, he should write to Francis Boott:

Boston, Nov. 28, 1846

My dear Boott:

I send you an account of a new anodyne process lately introduced here, which promises to be one of the important discoveries of the present age. It has rendered many patients insensible to pain during surgical operations, and other causes of suffering. Limbs and breasts have been amputated, arteries tied, tumours extirpated, and many hundreds of teeth extracted, without any consciousness of the least pain on the part of the patient.

The inventor is Dr. Morton, a dentist of this city, and the process consists of the inhalation of the vapour of ether to the point of intoxication. I send you the *Boston Daily Advertiser*, which contains an article written by my son Henry, and which is extracted from a medical journal, relating to the discovery.

Let me give you an example. I took my daughter Mary, last week, to Dr. Morton's rooms, to have a tooth extracted. She inhaled the ether about one minute, and fell asleep instantly in the chair. A molar tooth was then extracted, without the slightest movement of a muscle or fibre. In another minute she awoke, smiled, said the tooth was not out, had felt no pain, nor had the slightest knowledge of the extraction. It was an entire illusion.

The newspaper will give you the details up to its date, since which other operations have been performed with uniform success.

This was a private letter, but not a letter to be kept private. Soon after Boott received it, his house on Gower Street became the scene of the first operation under ether in Europe. On Saturday morning, December 19, 1846, the dentist, James Robinson, extracted a firmly fixed molar tooth from a young woman, insensible under ether. She was the first across the seas to taste the American waters of Lethe.

Francis Boott despatched a note to Robert Liston, guessing correctly that its contents would interest the surgeon. On the same day as James Robinson's operation, a little past midday, Liston burst upon his friend, Peter Squire, the well-known chemist of Oxford Street. The excited Liston towered over the calm, middle-aged, gray-haired dispenser of drugs. Pulling a letter from his pocket, he exclaimed: "Just read that." Peter Squire read it and answered: "This is most interesting and important."

There was animation in Liston's voice as he continued:

"Yes, and you must fix me up something so that we can have it Monday at the hospital. I have an amputation of the thigh to do, and we will try it then." In another moment Liston was gone, for he was one of the busiest surgeons of his day. Peter Squire knew he would return for the ether.

The chemist was thinking the matter over, when his nephew William came in. The uncle told the nephew what had happened, and William Squire, who subsequently became a physician, spoke like a true scientist: "Why not try it on me first?" Peter Squire replied: "Come in tomorrow, and we will see what can be done."

Early Sunday morning William Squire arrived for the test. His uncle "had fitted together a Nooth's apparatus and packed the upper detachable cylinder with a sponge and to the exit a flexible tube was attached with an ordinary bronchial inhaler mouth-piece." The uncle poured some sulfuric ether on the sponge and said to his nephew: "Lie down on the couch there. Take the mouth-piece between the teeth, close the lips over it, and hold the nose firmly."

Inhaling the pungent vapor with enthusiasm, the young man soon began to cough. Then he seemed to grow accustomed to the ether, all was quiet, and he was completely anesthetized. When he awoke, his uncle discussed the matter with him, and informed him he would be needed the next day at the hospital to administer the ether.

It was Monday, December 21, 1846: at the University College Hospital of London, ether was to have its great European trial. Among the students in the crowded amphitheater sat the handsome Quaker youth, Joseph Lister, that day only a spectator in surgery. William Squire was the anesthetist, and before the operation began he asked if anyone would volunteer to try the ether. As no one responded, the hospital porter, strong Sheldrake, a skilled boxer, was requisitioned and placed upon the table. He inhaled the ether for some seconds, then springing up struck the anesthetist a blow which toppled him over, brushed aside his assistants as if they were children, and leaped with shouts among the students who dodged and fled as best they could. Falling upon the top bench, he was seized and sat upon until reason returned. On that day, farce and progress were one moment apart.

An aproned giant entered the arena. It was Liston, driven from Edinburgh by the success and sarcasm of his cousin James Syme. Liston had often annoyed Syme, writing in the subscription-book of Syme's hospital, "Don't support quackery and humbug." Suit for libel and Liston's apology followed. There was Little Syme lecturing, and Liston picking up an ape's skull and pointing out its resemblance to the lecturer. Syme, younger than Liston, forging ahead, gaining deserved recognition as one of the greatest surgeons that ever lived, securing the chair of Edinburgh—by purchase? Liston likewise acquiring renown, his methods of crushing stone, excising the jaw and amputating thighs being the despair of other operators.

Liston was a wizard with the scalpel. He amputated a thigh by compressing the artery with his left hand and cutting and sawing with his right. If he needed the use of both hands he held the saw between his teeth. Liston's knife flashed, and if you sneezed or winked or turned your head, you missed the operation because it was over.

In spite of his speed, Liston had harrowing memories. Patients shrieked and tore madly at their straps, and had to be held down by force . . . a man to be cut for stone, losing his courage on the operating-table, rushing down the long corridor, locking himself in the lavatory . . . Liston making a battering-ram of his powerful shoulder, breaks down the door, carries the patient back, and operates with success.

If the report from Massachusetts is true, these horrors already belong to the past, and a new era has dawned. But is it true? Is there not a sneer on Liston's lips as he addresses his audience: "We are going to try a Yankee dodge today, gentlemen, for making men insensible."

A butler named Frederick Churchill lies before Liston, and for the first time in his career the surgeon stays his hand; only when the patient sleeps, Liston removes his diseased thigh. Churchill, who has felt nothing, awakes from insensibility, and does not know the limb is off until the towel is lifted and he is shown the stump. The rough-mannered Liston, whose voice so often struck terror to his associates, trembles with a strange emotion. This feeling sweeps through surgeon, patient and every spectator—they have seen the conquest of pain. It is Robert Liston's gentlest and greatest moment. He was moved to write to Francis Boott:

Clifford-street, Dec. 21, 1846

My Dear Sir:

I tried the ether inhalation to-day in a case of amputation of the thigh, and in another requiring evulsion of both sides of the great toe-nail, one of the most painful operations in surgery, and with the most perfect and satisfactory results.

It is a very great matter to be able thus to destroy sensibility to such an extent, and without, apparently, any bad result. It is a fine thing for operating surgeons, and I thank you most sincerely for the early information you were so kind as to give me of it.

Yours faithfully,
Robert Liston

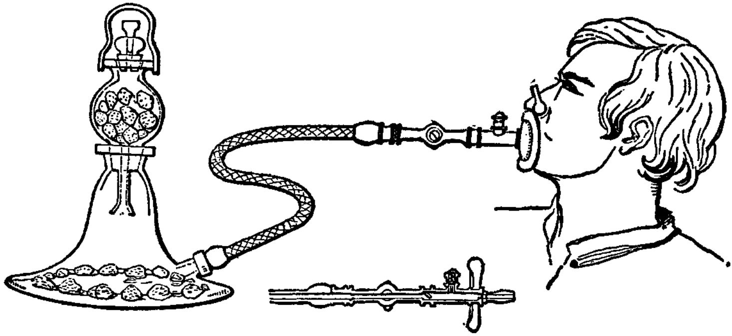
It is a day of intensity. The butler had said, "When are you going to begin? Take me back, I can't have it done." He is shown the elevated stump, he drops back, and weeps a little. Liston exclaims, "This Yankee dodge, gentlemen, beats mesmerism hollow." Liston writes the following notes:

Not the slightest groan was heard from the patient nor was the countenance at all expressive of pain. This was the first capital operation which had been performed under the narcoting influence of ether vapor, and it was perfectly successful. The patient did not know that the limb was removed and declares distinctly that he has no remembrance of having suffered any pain, either in the theatre or coming away. There was a great sensation of cold and a desire to be covered up expressed as he was being removed back; and this is remembered now one hour after the operation. It was some minutes after being laid in bed before any pain was felt.

Post-operative pain, sadly, is pain outside the realm of anesthesia.

At a dinner party that night, Liston could talk of nothing but the wonder that had come to pass. He suggested to the company that they come to the hospital and watch him experiment on his assistant William Cadge (afterwards the celebrated surgeon of Norwich). They came. Cadge lay down, and sucked away at the tube of the apparatus.

Liston heard one of the ladies present say: "Liston, I won't stand it, you'll kill that poor young man." Liston roared with laughter, and kept on holding young Cadge down until he was insensible.



The apparatus for rendering surgical operations painless (From the *Illustrated London News,* Jan. 9, 1847)

Morton had an agent in England, James A. Dorr. A letter from Dorr to the *Lancet,* January 2, 1847, threatening legal prosecution, is typically Mortonian:

Sir:

Having noticed, in several periodicals and newspapers, reports of two operations recently performed by Mr. Liston, at the University College Hospital, upon patients under the anodyne influence of inhaled vapour of ether, in which amputation of the thigh in one case, and evulsion of the nail of the great toe in the other case, were effected without pain to the patients, I take this earliest opportunity of giving notice, through the medium of your columns, to the medical profession, and to the public in general, that the process for procuring insensibility to pain by the administration of the vapour of ether to the lungs, employed by Mr. Liston, is patented for England and the Colonies, and that no person can use that process, or any similar one, without infringing upon rights legally secured to others.

I am aware that doubts exist in the minds of some as to the liberality of rendering inventions or improvements, which tend to alleviate suffering, subjects of patents; but I cannot see why the individual who, by skill and industry, invents or discovers the means of diminishing, or, as in this instance, annihilating human suffering, is not full as much entitled to compensation as he who makes an improvement in the manufacture of woollen or other fabrics. Indeed, he is entitled to greater compensation, and for a stronger reason—he has conferred upon mankind a greater benefit.

With this view, I have accepted from the American inventors, or their representatives, the agency of affairs connected with the English patent; and it is my intention, while I hold the trust, to adhere to such a course, that the charge of illiberality shall rest upon any persons rather than upon the proprietors of the patent, or upon their agent,

James A. Dorr

Duke-street, St. James's,
Dec. 28, 1846.

These pages have already related how Robert Liston removed the thigh of Frederick Churchill—painlessly and brilliantly under anesthesia. But we did not inquire: what made the operation necessary? The butler had fallen and injured his tibia, a discharging sinus being formed. It would have been better for him had he been on the high seas or in a desert. But he lived in a medical center, and came to the University College Hospital of London, no doubt congratulating himself that so great a surgeon as Liston would take his case.

Liston probed the sinus, made an incision, put in his finger, felt the bone, and plugged the wound. The inevitable happened—fever, sweat, pulse rapid and feeble, headache, nausea, twitching, exhaustion: septicemia, requiring amputation. It was the same sickening old story all over again: the doctor, knowing nothing of infections, had unknowingly infected his patient. The hand of Liston was cunning—but unsterilized. Churchill's limb was sacrificed to the ignorance of the age, and Hospitalism claimed another victim. The youth Joseph Lister, who watched Liston amputate the infected thigh of the butler, would one day abolish infection as anesthesia abolished pain.

Robert Liston, a man of immense strength, six feet two in height, was the personification of vigor. Yet in less than a year after his first operation under ether, an aortic aneurysm killed the mighty man in his prime. And in that brief time, ether had become as indispensable to the surgeon as his sharpened scalpel.

SEVENTEEN

Central Europe

At the beginning of January 1847 there appeared in a German paper a sensational piece of news:

STORY OF THE DAY

NORTH AMERICA, BOSTON

In a lecture by Dr. Bigelow, surgeon of the Massachusetts General Hospital in Boston, there was announced a new method of rendering patients insensitive to the pain of surgical operations. The method, originated by Dr. Morton, Boston dentist, consists of the inhalation of a prepared vapor. Such inhalation requires only a few minutes, whereupon unconsciousness ensues, commonly persisting two or three minutes. During this time a total insensibility obtains. No harmful results are produced. . . .

The method still remains a secret; the purchase of it may be made through the agency of the office of the *Deutsche Allgemeine Zeitung*. It is said that Liston has already performed successful experiments with this method in London.

This report of the discovery "of a new method of rendering patients insensitive to the pain of surgical operations" burst like a bombshell. The impression it made on both the European medical profession and the general public is comparable only to the furore created in our day by the first reports of the miraculous powers of penicillin or the destructive force of the atom bomb and its limitless possibilities. The wildest hopes were pinned to this incredible, mysterious, "American" panacea; word of its discovery spread over the entire European continent within two months.

The interest in ether anesthesia became so keen in official circles that even the Royal Bavarian government made public announcement of its successes. At the beginning of March, the following official notice was published: "The experiments performed in the Surgical Clinic at Erlangen with sulfuric ether for the achievement of painlessness during surgical operations, which experiments already number forty [by March 9 they had reached sixty] have almost without exception yielded favorable results, while no accidents, etc., have occurred." During the first days of March there foregathered in the Imperial stables "in the presence of His Excellency the Lord High Master of the Horse . . . the entire official personnel of the Master of the Horse and of the School of Veterinary Science in Vienna. A stallion was castrated; during the operation he stood firm and motionless. All the animals which were treated with ether vapors were uncommonly lively after the operation, enjoyed the fodder set before them and were put into harness again the very same day."

A similar spectacle was afforded the public at the beginning of September in Munich on the occasion of the general convention of veterinarians of Upper Bavaria. Here "in the presence of His Highness the Prince Eduard of Sachsen-Altenburg, in the artillery barrack square, operations were performed on three large domestic animals by means of sulfuric ether narcosis, which spectacle attracted hundreds of onlookers."

In Budapest public lectures were given in the university halls "to accord the public the insight into this medical subject that they so greatly desire today." At these lectures "experiments in intoxication" were arranged, and the entrance fees paid by the spectators were devoted to charitable purposes. Several professors vigorously opposed the university's sponsoring this "scandalous practice," contending that "this subject belongs within the sanctuary of the science of healing and must never be made a people's spectacle." Whereupon the Rectorate obligingly discontinued the lectures.

Professional interest in the new anesthetic had been quickly aroused, and widespread experimentation had immediately begun in all the great hospitals of Germany and Austria, Bohemia and Hungary.

The first experiments undertaken in Germany—in Munich and Erlangen—yielded results as surprising as they were gratifying. According to the record, the ether failed to bring on sleep in only one case, and that was because the patient "behaved very stupidly and inhaled most improperly." The general rule was that "some of the subjects, awakening from the narcosis after the extraction of teeth, did not perceive that one or several teeth had actually been drawn until they noticed the blood flowing from the gap or felt the gap with their finger, while others became aware that an operation had been performed only when they felt the sticking-plaster applied to the spot." So ran the first reports in the German medical periodicals and newspapers, which never wearied of describing the details of the new discovery and its results.

The Munich and Erlangen successes were fully confirmed by the experience of Johann Christian Jüngken in the Berlin Surgical Clinic, recorded by his assistant, Rudolf Virchow. In his report the latter, at that time an unknown doctor twenty-six years old, remarked

> that in the case of refractory or anxious persons great caution is necessary in order that they may not be thrown into a state of intoxication as a result of improper or prolonged inhalation, which state of intoxication can have grave consequences even during the operation. We must gain further knowledge as to the subsequent condition of those who are obliged to make repeated inhalations of the gas during a longer operation, and in connection therewith it is well to note that the application of ether in this fashion in the hands of inexperienced persons is more than dangerous.

Jüngken's experiments led to the important discovery that ether must be administered without interruption as long as the operation lasted so that the patient would not regain consciousness during it or suffer pain. He also found it advisable to accustom the patient to the inhalation of the vapors before the operation, on the theory that familiarity with the procedure would remove his fear and assure better results.

Franz von Pitha also obtained excellent results at the surgical clinic in Prague:

> The inhalation of ether vapors is an inestimably beneficial aid in all painful surgical operations. When we consider how many unfortunates must for years suffer the most acute anguish in fearful anticipation of the operation even where cure is promised,

such sufferers often falling victim to this unconquerable fear of pain, we realize the priceless value of this blessed discovery for suffering humanity. But it is as great a gift to the operating surgeon, who is no longer such a terrifying figure to his patient and can dare the most painful operations with entire composure and tranquilly complete such operations without the often seriously disturbing emotions of sympathy within himself which can easily degenerate into unseasonable pity.

As early as April 1847, Johann Ferdinand Heyfelder of Erlangen published a monograph in which he was able to report 200 cases of sulfuric ether inhalation without a single mishap. Heyfelder also made use of muriatic ether, which has a much faster action than sulfuric. He assumed, however, and rightly, that muriatic ether would not supplant sulfuric ether because of its great volatility, which sharply limited the duration of its effect, and its exorbitant cost.

The general enthusiasm for the American discovery was epitomized in the reaction of Konrad Johann Martin Langenbeck of Göttingen, of whom it was said in pre-ether days that he operated with such speed that he "amputated a shoulder while a colleague was taking a pinch of snuff":

This discovery that has come to us from the New World will prove a blessed gift to many who need operative aid. It can be predicted with certainty that this method will not, like so many others, remain in use only a short while and then fall into oblivion, but will be employed by us as a proved and tested aid until we have found one yet more excellent.

Yet amidst the general chorus of acclaim a few dissident or skeptic voices were heard. Even Langenbeck warned that ether anesthesia "can prove harmful as soon as it is applied *without* any limitation and without the most careful

An affair of honor in 1847

Abolition of physical pain

Trying on new shoes

An unpleasant use of ether

A French reaction to the introduction of ether (From *Charivari,* 1847)

A wooden leg while you sleep

A new sport for French national holidays

A dream at the dentist's

Disadvantage of having a very fast dentist

A French reaction to the introduction of ether (From *Charivari,* 1847) consideration of the cases involved. The greatest caution must rule where the respiratory apparatus is prone to inflammation or to the coughing up of blood or where tubercles are present."

Other powerful voices were raised in more vigorous opposition. Geheimrat Johann Friedrich Dieffenbach, director of the Surgical Clinic in Berlin and an eminent plastic surgeon, attacked the new ether vapor treatment as dangerous and immoral:

It is not without hesitation that I have finally resolved to attempt this experimentation, which is in truth highly tempting, for who has it in his power to determine the quantity of ether vapor which will not cause the patient's instant asphyxiation through a paralyzing of the lungs from the brain?

On the other hand, permit me to inquire wherein lies the distinction between this state of insensitivity and that created by any wine, beer or brandy intoxication through the stomach?

Hitherto at least we have always regarded the injuries suffered by intoxicated persons who are conscious of little or no pain as far more dangerous than injuries sustained by the sober. Should we not look upon a doctor who wishes to operate on an intoxicated patient as ignorant or unconscientious? It has indeed been sufficiently established by experience that serious injuries to intoxicated individuals produce the most dangerous nervous shocks. It is true that surgeons formerly gave the patient *a sleeping-draught before an operation to lesson his suffering during their long, clumsy labors;* but a number of dangerous accidents soon brought this practice to an end, happily for all those who must undergo operations.

Franz Schuh, avoiding both extremes, cautioned against over-optimism:

Do not count your chickens before they are hatched. . . . In all likelihood the results obtained with sulfuric ether vapors have been accorded an excessive and a premature confidence which a dispassionate examination must find not wholly justified.

The recognition of a need for safeguards led to government orders controlling the administration of anesthesia. The Budapest "intoxication experiments" described earlier resulted in an edict placing the administration of ether under strict medical control. And the governments of Hannover, Hesse, and Bavaria issued decrees in 1847 whereby "the employment of this method was henceforth permitted only to physicians scientifically trained and possessed of a formal medical degree, and was prohibited to barber-surgeons, country doctors, and surgeons, as well as dentists without medical degrees and all midwives, and accoucheurs without medical degrees." Ironically, dentists were forbidden to use the method introduced by a dentist.

Since the Austrian dentists also bore the title of medical doctor, the famous Viennese professor of dentistry, Moritz Heider, was able to make experiments with sulfuric ether, concluding that ether narcosis was useful for dental operations. Heider advised the public to use caution in their selection of a dentist "first because of the narcosis to be administered, further because the operation entails many difficulties not ordinarily met with and because imprudent and unconscientious dentists are apt to operate with still less care in the belief that the patient will know and feel nothing."

Some restrictions were clearly necessary in view of the astonishing naïveté sometimes shown in the application of ether anesthesia during the months immediately following its discovery. Yet, strangely enough, in all the medical literature of the year 1847, not a single case of death from ether inhalation was reported, whereas some later applications of the method by medical scientists and skilled technicians proved far from safe.

When the ether discovery was first announced, the phe-

WONDERFUL EFFECTS OF ETHER IN A CASE OF SCOLDING WIFE.

Patient.—"THIS IS REALLY QUITE DELIGHTFUL—A MOST BEAUTIFUL DREAM."

An English reaction to the discovery of ether (From *Punch*, 1847) nomenon that caught most people's attention was "the realm of dreams." As Langenbeck describes them:

The dreams appear to be pleasant and sweet for the most part, but that they *always* have a definitely erotic direction, especially with women . . . is probably deniable. On the contrary, they are manifold and concern themselves chiefly with whatever most interests the individual, whatever pervades his entire being.

The ether sets the pious to praying, the bully to drawing his dagger and the loafer to carousing in the tavern. . . . The subjects hear music, behold landscapes, or sit at a well-laid table.

Understandably enough, the use of ether to ease the pain of childbirth was of keen public interest, and investigations in this field were quickly undertaken. In Göttingen the famous gynecologist, Eduard Caspar von Siebold, used ether anesthesia successfully during a normal birth. Many hospitals throughout Germany and Austria followed his example with such marked success that, as one writer expressed it, "the hour of liberation of the female sex from the keenest suffering seems to have struck."

Europe, like America, became embroiled in a priority controversy of its own. In Germany, the contenders fought not for the credit of discovering ether but for the credit of devising a preferable method of inhalation. As Albert Heinrich Kreuser, assistant physician of the surgical clinic at Tübingen, pointed out, the oral method originally used was "critical" in all cases involving operations on the lips, jaws and oral cavities. "The passage of the ether inhalation *through the nose* should in any case be preferred to its passage through the oral cavities, and the invention of a safe method of inhalation through the nose would be most welcome."

Since there were other disadvantages connected with oral administration, various contrivances were invented in rapid succession for nasal inhalation. The principal claimants for priority of invention were Joseph Bergson and a Berlin chemist named Wolff. In an article entitled "Contribution to the History of Ether Inhalation," Wolff charged Bergson with misappropriating his own invention:

> Shortly before ether intoxication seized the European physicians, Dr. Bergson paid me a visit, on which occasion, under cover of recommending a patient to me, he examined my apparatus, the same then being in operation. With all readiness I explained to him the manner of its use and gave him the full and exact details of its application for the inhalation of the most varied vapors, especially the inhalation of ether vapors through the nose. Thus when the Jacksonian discovery came into use in Berlin, Dr. Bergson could not rest until he had effected the substitution of inhalation through the nose for the oral inhalation practiced till then and had proclaimed in the medical and political newspapers that this admirable modification was his own invention.

Thus the recriminations which had embittered the American discoverers of ether found their echo across the Atlantic.

It was gradually established that failures with ether anesthesia were not to be ascribed to the inefficiency of the drug but either to improper technique of administration or faultiness of the apparatus. As a consequence many doctors, chemists and manufacturers of medical instruments set about constructing new apparatuses designed to eliminate failures. As early as the first months of 1847, numerous improvements and innovations appeared; these aimed chiefly at forcing the patient to inhale and exhale the ether properly, either through the mouth or, better, through the natural air passage, the nose.

In July 1847 it was reported that a physician in a small Prussian town had suggested "that in place of all those complicated apparatuses for ether inhalation there should be substituted a simple sponge and perforated horn plate, or the like." In this contrivance we recognize the direct precursor of the ether masks in use today.

EIGHTEEN

France

IN FRANCE, as everywhere in Europe, the news of the great discovery, bringing promise of magical relief from pain, electrified the medical profession.

The Academy of Sciences in Paris devoted its January 1847 session to anesthesia. Twenty experiments were undertaken, some of them by the celebrated surgical historian, Joseph-François Malgaigne. An eyewitness wrote: "A workman had fallen under a railway car and his leg was crushed. The limb was thereupon severed from the body below the knee, following the inhalation of ether; upon awaking, the patient declared he had suffered no more than if he had been scratched with a needle." Malgaigne did not write surgical history that day: he saw it made before his eyes.

In a report to the Academy of Sciences on February 1, 1847, Alfred Velpeau, who on the eve of the discovery had declared that surgery and pain were inseparable, announced that his own and others' experiments had removed all doubt of the efficacy of ether. Anesthesia, he said, was one of the most important discoveries ever made, of incalculable implications not only for surgery but also for physiology, chemistry, and even psychology. A Parisian report sent to Berlin later that month stated:

All England, France and even Germany are enraptured with this transatlantic discovery; it is being accorded unqualified approval at learned society meetings and academies everywhere and its wider application is unhesitatingly advocated; it is being used with astounding success not only in surgery but in obstetrics and pediatrics, so that it may truly be said that the Biblical words "in sorrow thou shalt bring forth children" have been banished into the realm of legend.

Only François Magendie, the great physiologist, and Ludger Lallemand, a military surgeon, remained unconvinced. Magendie's protests were based not only on moral and ethical grounds but also on the conviction that if pain were eliminated, surgical operations could be doubly dangerous. In his famous speech to the Academy on February 8, 1847, he acknowledged the analgesic effects of ether inhalation but asserted that this very "intoxication" could produce "the most violent and intolerable pain and the most distressing dreams." He even contended that "if the ether intoxication is carried too far death can occur on the spot. This has been observed with animals at least." It is notable, however, that this leading adversary of anesthesia in France did not claim knowledge of any human deaths resulting from its use.

The objections of Magendie and Lallemand found little support among the surgeons of Europe. Magendie's unfeeling query, "What interest can the Academy of Sciences have in whether people suffer more or less?" was bitterly attacked by men eager to relieve the extremities of suffering they had for so long been forced to inflict.

In the ensuing months, ether found ever wider and more successful application. With its aid, Velpeau easily set a dislocated upper thigh, an operation regarded for centuries as extremely difficult. Many other operations, such as lithotomy, formerly faced with particular dread by surgeon and patient alike, were performed with equal success.

At the suggestion of Velpeau and Bouvier, ether was early introduced into the practice of obstetrics. Paul Dubois first tried it on a very young woman bearing her first child. The results were highly successful. After unduly long and painful labor endured by the mother, recourse was had to the forceps; a few minutes of ether inhalation sent her under and the child was then easily delivered, much more quickly than had ever been possible before in similar cases. "The lamentations of the newborn child brought the mother back to consciousness and she joyfully assured us that she had suffered nothing during the delivery."

The most important result of Dubois' obstetrical experiments was his conclusion that even during the deepest narcosis the contractions of the womb in labor go on with complete normalcy. By placing his hand on the abdomen of the woman in labor, he was able to ascertain definitely that contractions of the belly muscles continued vigorously, presenting a strange contrast to the mother's totally relaxed, insensible appearance. Dubois thus believed there was no ground for the fear that the relaxing effect of ether would cause the activity of the womb to slacken or stop, with consequent peril to the life of the child because of retarded delivery.

Two of Dubois' cases died in childbed a few days after forceps delivery under ether. But the autopsies clearly indicated that the deaths had been caused not by the ether but by the epidemic of puerperal fever then raging in the

Maternité. No evidence was found to distinguish these two from all the other puerperal fever deaths; no organ revealed any condition that could be ascribed to the effects of the anesthetic.

French physicians experimented with ether as a therapeutic agent in a variety of diseases, including epilepsy, various forms of mental disorder, and cerebrospinal meningitis. The results in epilepsy and mental disorders were largely negative, and Falret reported that "all hope of a profitable application of ether in this field must be abandoned." But in July 1847, ether was reported to have been used with success in the treatment of meningitis in Algiers, where the disease was then reaching epidemic proportions.

Ether was also introduced into forensic medicine in France in a fashion which seemed to foreshadow the modern lie-detector. Two conscripts suspected of seeking to evade military service were anesthetized. In the case of the first, who had presented himself before the examiners with a large hump on his back, the total relaxation produced under narcosis caused the hump to disappear, and the young man subsequently confessed to malingering. In the second case, the symptoms of joint deformity shown by the conscript remained exactly the same as before the anesthetization.

The work of the French surgeons contributed much to the improvement of anesthetic methods. But it was the physiologists of France who made the most vital contributions to the subject. Gerdy, Longet, Flourens, and Figuier, among others, published significant findings in rapid succession during the early months of 1847.

The French also played an important rôle in the field of appliance design. From the beginning physicians and surgical instrument manufacturers vied with each other to contrive improved types of ether apparatus, and French manufacturers have helped to make anesthetic appliances the marvels of precision which they are today.

France had its own contenders for the honor of priority. The most vocal claimant was Granier de Cassagnac, who maintained that he had discovered the effects of ether in 1830. Like Jackson in the United States, Cassagnac asserted that he had accidentally inhaled the vapors from a large ether bottle and, upon observing the usual initial effects, had performed further experiments on himself. But he made no other use of his alleged discovery than to ease his own migraine. Commenting on Cassagnac's claim, Dieffenbach wryly observed:

> Cassagnac seems to have stopped at the halfway mark. He really came no further than a man who sniffs at a bottle of cologne or vitriolic naphtha or camphor or some other spirituous substance to relieve a violent toothache. The *punctum saliens,* the suspension of general sensitivity, especially to the pain of wounds, remained completely hidden from him as from others. If he had recognized this power in ether and kept it for himself, he might properly be held responsible for all the pain endured by suffering mankind for seventeen years of surgical operations.

There yet remains to place on record a little-known episode in the early development of anesthesia in France. At a session of the Academy of Sciences, on April 5, 1847, Marc-Dupuy, of the Ether Commission, read a brief paper called "The Effects of the Injection of Ether in the Rectum." It was a summary of his experiments on animals, and concluded with the suggestion that rectal anesthesia might be safer than inhalation anesthesia. This paper followed by only three days the announcement of the basic researches in this field by Nicolai Ivanovich Pirogoff.

NINETEEN

Nicolai Ivanovich Pirogoff

(1810–1881)

IT SO HAPPENED that many of the pioneers of anesthesia were mediocrities. By the accident of location, chance information, or other fortuitous circumstances, they had their hand in the Discovery. Their squabbles and petty jealousies have left unpleasant echoes in the halls of science. But a few figures of higher rank have also a place in the story, and easily the greatest among them, as man and scientist, was Nicolai Ivanovich Pirogoff.

Living in the darkness of czarist Russia, when it was illegal to teach the alphabet to peasants and workers, and it was the deliberate policy of the government to persecute racial minorities, Pirogoff emerges as a moral giant. Like his great successor, Pavlov, he was a Russian patriot with a Western outlook. He did much for medical education in Russia, advocated more freedom and opportunity for women, and fought hard in the prolonged struggle for the civic equality of all the races of his native land. One of the foremost of military surgeons, and a lover of humanity, it was Pirogoff, sickened by the experiences of the battlefield, who coined the epigram: "War is a traumatic epidemic."

Pirogoff was a young prodigy who early developed a lasting love for medicine. Although no students were accepted in the university under sixteen years of age, Pirogoff passed the entrance examinations before he was fourteen—with the cooperation of his father, who forged his son's birth certificate. After graduating at eighteen, he was sent, at the expense of the government, to the newly opened medical institute at the University of Dorpat.

One of Pirogoff's early interests was topographic anatomy, hitherto unknown in Russia and even in Germany, and he did much to make anatomy the basis of surgery. He was a great teacher as well as a great surgeon, doing his best to devise means of imparting his own wide knowledge to his students. He instituted many reforms to remedy the horrible conditions he found in the hospitals in which he worked, though he met with vigorous opposition. Indeed, his crusading zeal in his first hospital assignment in Petersburg aroused such active enmity that he was accused of being insane by the medical director of the hospital.

With the extraordinary originality of mind which characterized his whole career, Pirogoff introduced various procedures which foreshadowed the concept of antisepsis many years before Lister's great discovery. For example, he isolated patients suffering from infectious diseases, shaved the operative area before the patient was placed on the operating table, used dry sutures, excised infected parts, advised against the common practice of exploring wounds with fingers, and employed antiseptic agents such as alcohol, iodine, and nitrate of silver.

In the Crimean War it was Pirogoff, in association with the Grand Duchess Helena Pavlovna, who introduced the use of women nurses on the battlefield, at about the same time that Florence Nightingale began work in the Crimea with her band of thirty-eight British nurses. The corps of women organized by Pirogoff for nursing the wounded and sick later became the Russian Red Cross, which first attained prominence in the Russo-Turkish War of 1877.

Pirogoff made numerous original contributions to surgery, particularly in the handling of amputations, gunshot wounds, and surgery of the bones. His name lives in the Pirogoff amputation, a method of osteoplastic amputation of the foot, which he devised in 1854; the Pirogoff operation for hernia; and the Pirogoff (venous) angle.

As a great humanitarian and scientist, it is not surprising that Pirogoff speedily adopted the new discovery of anesthesia. But more than that, he gave it a new application which, after an irregular history, has become an accepted method. In an historic communication to a scientific journal, April 2, 1847, only a few months after the announcement of the discovery itself, Pirogoff described his experiments with anesthesia by the intestinal route—rectal anesthesia:

New Method of Introducing Ether Vapors for Surgical Operations

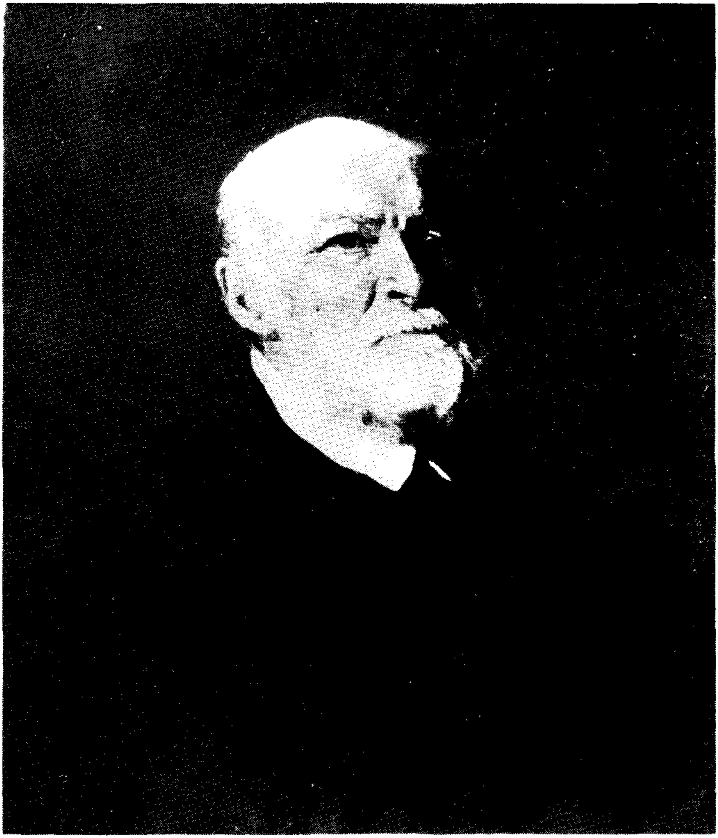
I have found out, by experimenting on animals, that the ether vapors can be brought into the circulation through a different method from the currently used inspiration method, and that it not only stops all sensations as easily and surely, but that this end is obtained with less trouble for the patient and much faster, it seems. I have come to this conclusion through operating experiments, and therefore have reason to assume that the inspirational method should be completely abandoned.

I first clean the lower part of the intestinal canal, either with a plain water clyster, or a soap-suds clyster, then introduce a rubber tube, the size of a sound (3-4 inches) deep into the rectum. By means of a screw placed at the outer end of the rubber tube, I attach this tube to some container, or, better, to a syringe, less than half-filled with half ether, half air. I cover this ether-reservoir with a towel and pour continuously hot water over it. The ether vapor rises immediately, and mixed with the air penetrates gradually into the rectum.

If one uses a syringe, one can facilitate the penetration of the gases into the body by a light pressure on the piston-rod. Two ounces of ether were sufficient, in the cases which I observed, for anesthetization. After two minutes one can already observe that the expired breath smells of ether, that the pulse is accelerated, and all other symptoms of etherization appear (this happened after about five minutes in the cases I observed). As soon as anesthesia is established, one should take the whole apparatus away, including the rubber tube. Anesthetization is in this manner brought about in a much milder way, insofar as the respiratory organs are not affected by it in the least.

It is most essential not to give the ether liquid in the form of a clyster, but to bring the ether vapor into the rectum. Otherwise, as I found out by experimenting on animals, the injected liquid changes very quickly to vapor, while still in the rectum: the rectum is expanded with too much violence, and most of the ether is lost in gases.

It is furthermore essential to clean the rectum beforehand of all hard excrements, to enable the vapor to spread better. This kind of etherization obviously offers considerable advantages over the inspiration method used now, the main advantage of course being that the respiratory system is not directly affected. Other advantages are: no special apparatus is needed; the action of the vapor in this case is much less liable to be avoided because the etherization is completely independent of the will of the



Nicolai Ivanovich Pirogoff (From a painting by Repin)

Sir James Young Simpson (From Gordon's *Sir James Young Simpson and Chloroform*, 1897) patient; and finally, the performing of many operations, made very difficult by the inspiration method, such as operations of the mouth, lips and the face in general, are very much facilitated.

Pirogoff followed up this preliminary communication with a monograph of 109 pages entitled: *Recherches pratiques et physiologiques sur l'éthérisation,* St. Petersburg, 1847. This is one of the earliest books on anesthesia, and the first on anesthesia by the intestinal route. Thus another leaf must be added to the laurel-crown of Pirogoff, regarded by the Russians as the greatest figure in their medical history.

CHLOROFORM

TWENTY

Samuel Guthrie

(1782–1848)

THE GUTHRIES were as much a part of Scotland as its granite. It was the staunch Covenanter, James Guthrie —Oliver Cromwell's "the short man that would not bow"— whose famous head is immortalized on the Martyr's Monument at Greyfriar's Churchyard at Edinburgh. Other Guthries, deciding to keep their heads, fled to America to escape religious persecution. What Scotland lost, Massachusetts gained. In the early days of the American struggle for independence, the Guthries did their share. The martyr's descendant, also a James Guthrie, a month before Jefferson's document was autographed, signed a little Declaration of Independence of his own, and calling his sons Samuel and Joseph from their farm at Lenox, marched off to war.

The war's end found James's son, Samuel, practicing medicine and surgery in the Massachusetts village of Brimfield. Here was born another generation of Guthries, Samuel, James, Rufus, Alfred. Samuel was regarded as a well-to-do village physician, and undoubtedly earned as much as the average, but his last testament indicates the extent of his poverty. One encounters in it such items as a dollar, a watch-seal, a pair of sleeve-buttons, and a set of books. With the exception of James—who became a preacher in Dayton, Ohio, and fought ferociously for the literal interpretation of every word in the Bible—all the sons of Samuel Guthrie followed in their father's footsteps as country practitioners.

Samuel Guthrie, the younger, was twenty-six years of age in 1808, when he inherited the dollar, the catheters and the works of Benjamin Rush. Years before his father's death he had left home. Whether his father's second marriage, or a desire for early independence, caused him to bid farewell to the old homestead we do not know. Little indeed is known of the boyhood of Samuel Guthrie, Jr.

In Samuel's day there already existed many famous medical faculties in America—men like Benjamin Rush, John Morgan, Nathan Smith, the Warrens, the Jacksons, Valentine Mott, David Hosack, will never be surpassed as teachers or clinical observers—but medical college was regarded as a luxury beyond the dreams of many students of medicine. Thousands of youths became physicians and surgeons by entering the office of a busy practitioner. It is scornfully said today that they studied medicine by sweeping out the office, running the doctor's errands, polishing his instruments, and holding his horses. If this is true—and to some extent it is—it is all the more odd that these youths should compare so favorably with the highly trained graduates of today. A century ago, many an ungainly disciple of Aesculapius would take his equipment out of his much-traveled saddle-bags and enter the patient's house chewing tobacco. While spitting the juice over the carpet, he would roll up his sleeves and sit down by the patient's bedside; while shifting the quid to the other cheek, he would diagnose the disease and prescribe treatment.

Samuel Guthrie, Jr., studied medicine with his father, and when ready to practice alone, moved to the State of New York. He settled in Sherburne, Chenango county, where his grandfather was living. His grandfather organized in his home the Second Calvinistic Congregational Society of Sherburne, and naturally young Guthrie became one of the charter members. Among others who joined the Society was a Sybil Sexton, originally from Connecticut. When Miss Sybil and Samuel Guthrie hitched up the old buggy and rode over to the neighboring village of Smyrna to be married, she was sixteen and he was twenty-two. They had no money. Life was simple in those days.

The chief medical event in the early years of the nineteenth century was Jennerian vaccination. Both the method and the vaccine were introduced into America by Harvard's first professor of theory and practice, the disputatious and much-disliked Benjamin Waterhouse. "That rather peculiar personage" Oliver Wendell Holmes called him. When Benjamin Waterhouse vaccinated his own children and conducted them through a smallpox hospital with safety, the papule ceased to be the most terrible menace on the American continent.

Around that period, a young doctor's first professional call was often in response to a case of smallpox. To these calls Samuel Guthrie responded eagerly. Following the example of Waterhouse, he vaccinated his cousin, Sarah Guthrie, who had volunteered to act as nurse in these cases. The bit of virus was armor against a malady that had destroyed millions. Dr. Guthrie was launched in practice.

During the winter of 1810-11, he attended a course in the College of Physicians and Surgeons of New York. In the month of January 1815, he listened to lectures at the University of Pennsylvania. These courses constituted his entire formal medical education.

Guthrie was evidently of the true pioneer breed, for in 1817, he moved to the wilderness about Sackett's Harbor, Jefferson County, in the extreme north of the State of New York. Here Guthrie was indeed a country doctor. Sackett's Harbor was a new town, but had already tasted war in its short history. The harbor was a battlefield in the War of 1812. It was from this port that the British launched attacks on the former colonists. When the British began to evacuate the garrison, they left some of their men to explode three hundred barrels of gunpowder in the midst of the advancing and victorious Americans. The carnage that resulted was described in his diary by a young doctor from Connecticut who had just quit his preceptor:

A most distressing scene ensues in the Hospital—nothing but the groans of the wounded and agonies of the dying are to be heard. The Surgeons wading in blood, cutting off arms, legs, and trepanning heads to rescue their fellow creatures from untimely deaths. To hear the poor creatures crying . . . "Do, Doctor, Doctor! Do cut off my leg, my arm, my head . . . I can't live, I can't live!" would have rent the heart of steel, and shocked the insensibility of the most hardened assassin and the cruelest savage. It awoke my liveliest sympathy, and I cut and slashed for 48 hours without food or sleep. My God! Who can think of the shocking scene when his fellow-creatures lie mashed and mangled in every part, with a leg, an arm, a head, or a body ground in pieces, without having his very heart pained with the acutest sensibility and his blood chill in his veins. Then, who can behold it without agonizing sympathy!

The surgeon who wrote these words never saw the inside of a medical college, but he is one of the glories of American science—William Beaumont.

Dr. Guthrie did not long continue his practice at Sackett's Harbor, for matters of domestic economy soon required his full energy and attention. His lancet rusted, while pick and ax cleared the wilderness away. Virgin clay from the nearby bank made a comfortable dwelling. Gardens, orchards and vineyards spread throughout the forest; stone walls enclosed well-cultivated fields, and barns and other buildings arose on both sides of the creek. The blacksmith shop had its forge, bellows, anvil; on the shelves were tools, spelter and borax, solder and resin; in the corners were found sheet copper, crucibles, melting ladles, and Dr. Guthrie was coppersmith, gunsmith and tinker.

His vinegar house was patronized by farmers' wives for miles around, and he distilled a brand of alcohol that reputedly was unequaled in Jefferson County. He built a large building, in which he could manufacture in great quantities the Percussion Pill or priming powder which he invented. The "flash in the pan" and "picking the flint" soon became obsolete expressions. Guthrie was the first man to fire a cannon by means of percussion priming powder. The tin canisters of one ounce each, labeled "Water Proof, Percussion Priming, S. Guthrie, Sackett's Harbor," became favorably known to all sportsmen in the United States and Canada.

In the midst of the vineyards, rose a building which is not often found on the outskirts of civilization—a chemical laboratory. Within this building one could perceive a still with its condensing worm immersed in a barrel of water—a still destined to make medical history.

Over this empire Dr. Guthrie presided with a firm but kindly hand. Here his own children found a real home. Grandchildren came, grew up in Sackett's Harbor, ate the fruit of his orchards, romped in his workshops and ventured into his laboratory. The doctor was a busy man, but sometimes he hunted or fished, took part in a game of whist, or played his violin. Now and then, he would pay a visit to the growing metropolis on the Hudson, and be jostled by the crowds. Sometimes, he returned home with interesting news—on one occasion, with the news that a man named Morse, who had studied electricity at Yale under Silliman, had just invented the telegraph.

Guthrie's reading was not confined to the Bible, as was often the case in those days. He had Shakespeare, Don Quixote, Gil Blas and Rasselas in his library. He consulted the Edinburgh Encyclopedia, and subscribed to the standard medical and chemical works. When he was about fifty, Dr. Guthrie himself became an author, contributing six articles to the *American Journal of Science*, in the form of letters to the editor.

He informed Benjamin Silliman of his experiments on the vaporization of mercury in the fumes of nitric ether, on making sugar from potato starch, on fulminating preparations, purification of oil of turpentine, and a new process for manufacturing gunpowder.

From the latter communication, we quote characteristic passages that illustrate some of the dangers of pioneer chemistry:

With this preparation (nitrated sulphuret of potash), I have had much to do, and I doubt whether, in the whole circle of experimental philosophy, many cases can be found involving dangers more appalling, or more difficult to be overcome, than melting fulminating powder and saving the product, and reducing the process to a business operation. I have had with it some eight or ten tremendous explosions, and in one of them I received, full in my face and eyes the flame of a quarter of a pound of the composition, just as it had become thoroughly melted. . . .

Since writing my article on starch sugar, I perceive in Gray's Operative Chemist, a direction that the wooden converter should be lined with lead. This is wrong—in the first place, it is entirely unnecessary, as the acid so much diluted does not act on wood. In the second place, either the acid or the syrup or both will act upon the lead and poison the product.

You have told me to write freely, and I trust you will not complain of the length of this communication. Nor must you complain against the fulminating character of my letters; for I have lived for many years in the midst of explosions, and even whilst writing this letter, I have been interrupted by the noise of a heavy explosion, followed by the shrill scream of "fire" from my alcohol distillery. The history of the accidents, effects of explosion, danger, escapes, and contrivances growing out of my yellow powder business would fill a volume; and with the percussion powder which I now make I have had probably one hundred explosions more or less severe. Thirty pounds of the powder is the largest quantity I have had burned at one time; but the most distressing accident I have encountered, scarcely excepting the severe burn which I sustained from yellow powder, arose from putting my hand into a keg containing about four pounds of percussion powder, and cracking a piece of it between my thumb and finger, by which it took fire; roasting my hand and arm, and tearing off most of the skin of my breast, neck, and face. But enough of this. I am now making two hundred pounds of the chlorate of potash, and when I get through, I shall be able to estimate the comparative value of carbonate and caustic potash in making this salt.

With great respect, your obedient servant,
Samuel Guthrie

Professor Silliman was surprised and pleased to find such chemical sagacity at Sackett's Harbor, and he inserted several complimentary notices about Samuel Guthrie. For example: "Mr. Guthrie's preparations have all arrived, and although I reserve the trial of most of them, to my winter course of experiments, I am impressed with admiration both at his skill and intrepidity.—Ed." "I add a notice of the following facts, communicated by Mr. Guthrie in his letters, not for publication, but which I conceive are honorable to the rising chemical arts of this country. I presume it was little suspected that such things were doing in a remote region on the shore of Lake Ontario.—Ed."

In 1830 the second volume of Silliman's *Elements of Chemistry* was published. On page 20 of that book, one may find a paragraph which played a decisive rôle in the discovery that was to make Guthrie famous. The paragraph dealt with chloric ether:

(h) Properties.—Resembles an oil, color yellowish, but white, when purified; sinks in water in distinct globules, which readily run together. Sp. gr. at 45 1.22. By much agitation, is diffused in the water, and partially dissolved, imparting to the water its own peculiar taste, which is sweetish, aromatic and agreeable. Taken internally, it is stimulating and reviving. For this purpose, it is dissolved in alcohol, which happens instantly by agitation in a vial, and the alcohol can then be diluted to any desired degree. Its medicinal powers have not been ascertained, but from its constitution and properties, it is highly probable that it would be an active diffusive stimulant.

Many skipped this passage, some read it, few remembered it, but Guthrie took it to his laboratory, and before putting the book on the shelf, he sent Silliman a brief and undated letter. Under the title of "New mode of preparing a spirituous solution of Chloric Ether," this letter was published in *Silliman's Journal* in 1831. It proved so important in the history of anesthesia that it is obligatory to give the full text with the remarks appended by the editor, Silliman:

Article VI: New Mode of preparing a spirituous solution of Chloric Ether

by Samuel Guthrie, of Sackett's Harbor, N. Y.

Mr. Editor:

As the usual process for obtaining chloric ether for solution in alcohol is both troublesome and expensive, and as from its lively and invigorating effects it may become an article of some value in the Materia Medica, I have thought a portion of your readers might be gratified with the communication of a cheap and easy process for preparing it. I have therefore given one below, combining these advantages with unerring certainty in the result.

Into a clean copper still, put three pounds of chloride of lime and two gallons of well flavored alcohol, of sp. gr. .844, and distil. Watch the process, and when the product ceases to come highly sweet and aromatic, remove and cork it up closely in glass vessels. The remainder of the spirit should be distilled off for a new operation. These proportions are not essential—if more chloride of lime be used, the etherial product will be increased; nor is it necessary that the proof of the spirit should be very high, but I have commonly used the above proportions and proof, and have every reason to be satisfied with them. From the above quantity I have usually obtained about one gallon of etherial spirit. The affinity of chlorine to lime, is so weak, and to alcohol so strong, that the chlorine is all taken up, long before the distillation is over; hence, the absolute necessity of watching the process, so as to know when to set aside the etherial portion.

By re-distilling the product from a great excess of chloride of lime, in a glass retort, in a water bath, a greatly concentrated solution will be obtained. This new product is caustic, and intensely sweet and aromatic. By distilling solution of chloric ether from carbonate of potash, the product is concentrated and refined. By distilling it from caustic potash, the ether is decomposed, and muriate of potash is thrown down, while the distilled product consists of alcohol.

During the last six months, a great number of persons have drunk of the solution of chloric ether in my laboratory, not only very freely but frequently to the point of intoxication; and so far as I have observed, it has appeared to be singularly grateful, both to the palate and stomach, producing promptly a lively flow of animal spirits, and consequent loquacity; and leaving, after its operation, little of that depression consequent to the use of ardent spirits. This free use of the article has been permitted, in order to ascertain the effect of it in full doses on the healthy subject; and thus to discover, as far as such trials would do, its probable value as a medicine. From the invariably agreeable effects of it on persons in health and the deliciousness of its flavor, it would seem to promise much as a remedy in cases requiring a safe, quick, energetic, and palatable stimulus. For drinking, it requires an equal bulk of water.

Remarks: Mr. Guthrie states in a letter to the editor, that his attention was called to this subject by the suggestion in Vol. II, p. 20, of the Yale College Elements of Chemistry, that the alcoholic solution of the chloric ether is a grateful diffusive stimulant, and that as it admits of any degree of dilution, it may probably be introduced into medicine. Mr. Guthrie's method of preparing it is ingenious, economical and original, and the etherized spirit which he has forwarded as a sample, is exactly analogous, in sensible properties to the solution made in the manner described in the above work. We shall take care to distribute portions among our medical friends for experiment, and as chlorine possesses so many peculiar powers, it is not impossible that this combination may prove curative or restorative, beyond what belongs to properties merely stimulating.

In this latter respect, Mr. Guthrie's experiments have certainly been quite sufficient; and we ought to discountenance any other than a medical use of this singular solution, unless indeed it should be found of utility in some of the arts. He would be no benefactor to his species who should add a new attraction to intoxicating spirit.

Editor [Benjamin Silliman]

Little did the writer suspect that with these five hundred words he had made immortal the name of Samuel Guthrie. Guthrie thought he had devised an easier and cheaper way of preparing chloric ether, or what was long known as the Oil of Dutch Chemists, but in reality he had discovered, in purity, strength and sufficient quantity, one of the most remarkable of fluids—chloroform. If instead of fearing that the new method might introduce a new intoxicating beverage, Silliman had realized that it could produce insensibility to pain, the period of waiting for anesthesia would have been considerably shortened.

The failure of Guthrie to date his chloroform communication has resulted in reams of controversy, for about the same time that chloroform was made by him in America, it was discovered by Soubeiran in France and by Liebig in Germany. These are the facts in the case: Soubeiran's first article on chloroform was written for the October 1831 issue of *Annales de Chimie et de Physique;* but inasmuch as France was undergoing a little revolution at that time, publication of the October issue, containing the complete meteorological report for that month, was delayed until January 1832; Liebig's initial contribution was a mere note in Poggendorff's *Annalen,* under the date of November 1831; Guthrie's letter is in Silliman's quarterly for October 1831 (which made its appearance in January 1832) and although Guthrie's article is undated, subsequent contributions bear the date of July 1831—which indicates that his chloroform article was written prior to that month and that his manuscript reached the printer before Soubeiran's or Liebig's. However, there is sufficient glory for all. It is clear that Guthrie, Soubeiran, and Liebig discovered chloroform, each independently of the others, and practically at the same time.

Silliman gave several samples of Guthrie's fluid—Guthrie's *sweet whiskey* it was then called—to some of his medical friends, especially to Eli Ives, for clinical tests. In the appendix to volume XXI of Silliman's journal appear the reports of Eli Ives and of his son, Nathan B. Ives, with comments by Silliman. This was the first time that chloroform was discussed therapeutically.

Eli Ives was a man of note in his day. He was born the same year as Silliman, also in Connecticut. His father, Levi Ives, was one of the leading practitioners of New Haven, and a founder of the New Haven Medical Society. He had the advantage of a thorough education. He was graduated from Yale College. His father and the famous clergyman-physician, Eneas Munson, were his preceptors. At the University of Pennsylvania, he studied under men who helped to lay the cornerstone of American medicine: Rush, Wistar and Barton.

Chance frequently placed the name of Eli Ives in the introductory chapter of new ventures: when the Yale Medical School was being founded, Ives was on all the committees; when the School was opened he was the first professor of materia medica; when Lyman Spalding issued the call for the first convention of the United States Pharmacopoeia, Ives was the delegate from Connecticut; when the American Medical Association met for the first time in New Haven, Ives was chosen president; when chloroform was discovered in America, the first bottle for experimental purposes was put into the hands of Eli Ives. Destiny, in the shape of Guthrie and Silliman, gave Ives an opportunity to become a pathfinder—but he remained Professor of the Theory and Practice of Medicine in the Medical Institution of Yale College. It was not in the land of its discovery that chloroform revealed its secret.

Many others besides Ives, however, approached the truth without divining the riddle of chloroform. As early as July

1832 Daniel Smith, one of the principal founders of the Philadelphia College of Pharmacy and of its journal, wrote: "The action of this ether on the living system is interesting and may hereafter render it an object of importance in commerce. Its flavor is delicious, and its intoxicating qualities equal to or surpassing those of alcohol. It is a strong diffusible stimulus similar to the hydrated ether but more grateful to the taste." In the following year, 1833, Black of Bolton, England, recommended it in spasmodic asthma, and spoke of it as a new remedy "brought into use by our American brethren." In 1834, Dumas analyzed it, showed that Soubeiran's solution was impure and Liebig's formula incorrect, and the great French chemist gave to the fluid the name by which it has since been known—chloroform.

This thick colorless liquid lay in Guthrie's vats. His children and grandchildren dipped their fingers in it and tasted of its peculiar sweetness. He gave it to his daughter Harriot in her illness. His grandson Ossian states in his memoirs that "the writer in his childhood, had free access to Dr. Guthrie's laboratory, where he was frequently attracted by the agreeable and never-to-be forgotten odor of chloroform." The following letter from his granddaughter, written to her cousin, Thaddeus Samuel Chamberlain, is now published for the first time:

Grandfather used to let my mother play in his laboratory when he was experimenting. He had large tubs of liquid standing on the floor and she used to stick her fingers in the tub and taste the liquid, one tub she liked to taste, so did often, and he was watching her and one day she got too much and fell over and he ran to her and picked her up and then found that the liquid in this tub put her to sleep, hence his accidental discovery what chloroform would do. She was about eight years old at that time.

Hattie [Griffin]

But even with this hint in his hands, Guthrie did not realize that he had discovered the waters of the modern Lethe.

The years passed, but they were not years of tranquillity for the patriarch at Sackett's Harbor. Usually the encroaching railroad increased the wealth of a section, but in the north country commerce left the lake shore to follow the iron horse. The prosperity of Sackett's Harbor passed, and Dr. Guthrie's fortune declined. Yet, although Ossian is of a contrary opinion, he was able to leave his children and grandchildren thousands of dollars, village lots along Black River Bay of Sackett's Harbor, and tracts of lands in Iowa and Indiana.

It is strange that after 1831-32, in spite of the cordial encouragement of the famous Silliman, and although sixteen years of activity remained to him, Samuel Guthrie never published another contribution in the *American Journal of Science* or in any other periodical.

In the evening of Guthrie's life, the medical world rang with a new name. A Scotsman who remained in Edinburgh had risen to greatness on the fumes of chloroform. In 1847 James Young Simpson uncorked a bottle of the heavy fluid, and at the same time opened a new era in anesthesia. The power of chloroform to conquer pain, assuaging the pangs of parturition, spreading the blessed mantle of oblivion over operative tortures, was finally revealed.

Shortly afterwards, Guthrie wrote one of his last letters—full of interest and pathos, addressed to his daughter Harriot, February 29, 1848. He had enough money . . . "but there is no happiness without a home and now I have none . . ."

. . . I could have made a fortune if I had gone to New York as I was urged last fall by making sweet whiskey which you remember taking when suffocated with Charcoak. You see it called Chloroform and the newspapers are beginning to give me the credit of discovering it. I made the first particle that was ever made and you are the first human being that ever used it in sickness. This is likely to prove the grandest discovery in medicine the world ever saw. By breathing it a few seconds the person falls apparently into a sweet sleep—when breasts, legs and arms may be cut away—painful labors ended and all without pain or injury. . . .

TWENTY-ONE

James Young Simpson

(1811–1870)

IN SCOTLAND is Linlithgowshire, and in this county is the village of Bathgate. Cows and children lingered along Main Street, stepping aside only on the rare occasions when a fashionable coach dashed by on its way between Edinburgh and Glasgow. Houses with roofs of thatch and colored tiles were not considered quaint. The inhabitants took them for granted. The steady whirr of the weaver's shuttle mingled with the fragrance of baking bread.

The village baker, David Simpson, and his wife Mary, obeyed the biblical injunction to replenish and multiply. A daughter and six sons ate their bread. The mother of the family was forty years of age when she conceived again, giving birth to an eighth child who was the seventh son. Doctor Dawson, the local practitioner, wrote in his visiting-book:

"275.—June 7. Simpson, David, baker, Bathgate. Wife, Mary Jarvie. Age 40. Lab. nat. easy, rapid. 8th child. Son. Natus 8 o'clock. Uti veniebam natus. Paid 10s. 6d." The son thus announced was James Young Simpson.

Jamie, if we are to believe his relatives and biographers, was "a peculiarly attractive child," and there is no doubt he was "a rosy bairn wi' laughin' mou' and dimpled cheek." His superior ability was early in evidence, and despite the meager income of the family it was understood he must go to the university. All the Simpsons agreed to save and struggle and sacrifice for the sake of the little brother with the big head.

At fourteen, Simpson enrolled in the arts classes of the University of Edinburgh. Years later he recalled the picture of himself at that time: "Very, very young and very solitary, very poor, and almost friendless." Then medical studies, graduation at twenty-one as a Doctor of Medicine, and an assistantship at his alma mater.

Medicine in Edinburgh is all post-Renaissance—its university is the youngest in Scotland—but after that period no spot on earth is richer in medical memories. How familiar is the phrase, "an Edinburgh graduate." Who walks the great quadrangle, walks on medical history. The atmosphere of Auld Reekie is tinctured with the Old Infirmary. Its cemeteries and churchyards hold illustrious medical dust. Linked with the Modern Athens are—

Robert Sibbald, the first professor of medicine at the university, and founder of the Royal College of Physicians; his kinsman, Andrew Balfour, "the Morning Star of Science in Scotland," establishing the physic gardens with a thousand plants; Archibald Pitcairne, of such renown that he was called to the University of Leyden where he taught a Mead and a Boerhaave, the former of whom saved Pitcairne's son from execution in the Tower of London by pleading with Walpole, "If I have saved your life or the life of any member of the royal family, I owe the power to this young man's father"; the Monro dynasty in anatomy which lasted for one hundred and twenty-six years, the dull grandson nearly wrecking the university; Robert Whytt, a pioneer in neurology, the first to describe tuberculous meningitis in children; William Cullen, master of materia medica; Joseph Black, that cautious man, one of the foremost names in chemistry; the rough-mouthed John Brown who divided Europe into Brunonians and anti-Brunonians, and that other and gentler John Brown who gave us *Rab and His Friends;* the numerous Gregorys and Hamiltons, and the great brothers Bell; John Barclay and the stuffed elephant of which he was so proud, and which has been an elephant indeed to subsequent curators; John Hughes Bennett, whose account of leucocythemia was the first description of a blood disease.

. . . The terrible days of the body snatchers and resurrectionists—criminals thriving on science because the authorities would not provide dissecting-material—Hare and Burke smothering men and women and selling the bodies to Robert Knox who had four hundred eager students to instruct—burking the popular Daft Jaimie and Bonny Mary Paterson, the prettiest public woman in the town—Knox preserving her beautiful body in alcohol—the trial and sentence, and many carpenters offering to build a scaffold for Burke's hanging; by a strange freak of justice, Hare and his wife, equally guilty, going scot-free—the mob enraged at Knox, and threatening his life—the intrepid man walking abroad with pistol and dirk concealed beneath his cloak . . . John Goodsir, investigator of tissues, to whom Virchow dedicated his *Cellular Pathology* as "one of the earliest and most acute observers of cell-life, both physiological and pathological"; his friend Edward Forbes, a John Hunter in the making, perishing before forty; the inimitable hospital verses of Henley; Liston, Hercules in the operating room; William Fergusson, the silent operator, noble founder of Conservative Surgery; Syme, whose tongue stammered, his scalpel never, whose character might be summed up in *verax, capax, perspicax, sagax, efficax, tenax;* his assistant and son-in-law Lister, who had an idea which revolutionized the entire practice of surgery.

Among primitive races the male is rigidly excluded from the mysteries of the lying-in chamber, and even the father is not permitted to see the child until the navel-string has fallen off. Among civilized people conditions were not much different, and it is only within recent times that examinations in obstetrics became compulsory for the medical degree. As late as the mid-nineteenth century, physicians desiring to devote themselves to midwifery were confronted with epithets similar to those which assailed females who wished to enter the medical profession. In *Man-Midwifery Exposed*, published in Boston in 1848, fifty indignant pages teem with the refrain: "The employment of men in midwifery practice is grossly indelicate, and always constitutes a serious temptation to immorality."

Despite this indictment, men became obstetricians, and James Hamilton, Professor of Midwifery at the University of Edinburgh, fought a lifetime to have his subject recognized. It is understood that the present faculty of Edinburgh is decorous, but in those days the appellation of viper, uttered in the broadest of Scottish accents, was a familiar sound in the vicinity of the quadrangle. The professors battled, not only with Latin quotations and pamphlets, but with fists and canes, at times requiring the intervention of unlearned policemen.

James Gregory, who admitted in print that he would willingly see some of his medical enemies hanged, gave James Hamilton such a thrashing with a stick that the law deprived him of some cash, which he paid with the remark that he would gladly repeat the performance under the same conditions. This Professor Gregory, big and domineering, quarreled so chronically that he wrangled himself out of the College of Physicians, but his popularity increased with his feuds, for the Gregorian roaring and brawling added to the vivacity of life in the highlands. It is sad to think that nothing remains of his memory except *pulvis rhei compositus* (compound powder of rhubarb).

As for his pugnacious little adversary, Hamilton was defined by the mellow-voiced Christison as "a snarling, unfair, unfeeling critic," and this seems to have been the consensus of opinion. John Hughes Bennett, not content with civil warfare, carried his altercations to foreign countries. There was no better hater in all Edinburgh than the surgeon Syme —his controversies were plentiful, personal, vindictive, and lasted a lifetime. Let us conclude these distressing reminiscences with the defense of the hard-hitting Christopher North: "The Animosities are mortal, but the Humanities live for ever."

It is on record that when Simpson attended James Hamilton's lectures, which were given in the late afternoon, he invariably went to sleep; after graduation, however, he determined to follow in Hamilton's footsteps, and on seeing the aged professor shuffle by, remarked with youthful confidence: "Do you see that old gentleman? Well, that's my gown!"

Soon afterwards, Hamilton died, and Simpson at the age of twenty-eight applied for the vacant chair. Here we find we must again refer to the state of belligerency existing in Caledonia's metropolis. As usual, the academicians and the town council disagreed: all the chairs opposed Simpson, and probably for that reason the councilors supported him. The professors objected to his youthfulness, his celibacy, and his lowly origin. James Syme, of whom it was said that "he never wastes a drop of blood or ink," on this occasion certainly wasted a good deal of breath in talking against the baker's son. The greatest physiologist since Harvey, Charles Bell, who dwelt on the Olympian heights of science, came down to earth to write a letter against Simpson. The professors were in favor of Emory Kennedy, imported from Dublin, already master of the Rotunda and author of a treatise on obstetric auscultation.

The contest that followed resembled a political campaign: vituperation of course cost nothing, but a fortune was expended on posters, postage and printing, the latter item including octavos of testimonials. During the fracas, Simpson discomfited his rivals by suddenly marrying Miss Jessie Grindlay of Liverpool. He and his bride arose at four in the morning and worked until midnight to prepare for publication the catalogue of the private museum he had accumulated.

As the balloting drew near, Simpson wrote to his father-in-law:

> The contest now lies between Dr. Kennedy and me, and each sends his spurs deeper into his horse's sides as we approach the winning post.

The result was announced on the fateful Tuesday, February 4, 1840: all the thirty-three deciding members were present; sixteen voted for Kennedy and seventeen for Simpson. Dr. Kennedy, bidding a last farewell to his alma mater, returned to the Dublin Lying-in Hospital, and Dr. Simpson wrote hastily and happily to his mother-in-law:

My dear Mother:
Jessie's honeymoon and mine is to begin tomorrow. I was elected Professor today by a majority of one. Hurrah!!!

Your ever affectionate son,
J. Y. Simpson

In this episode, we have evidence of Simpson's powers of fascination. The least known and experienced of all the rivals who entered the race, he rode to victory on his personality. His popularity broke all records, and thrifty hotel-keepers who wept over their ledgers upon Simpson's election soon found themselves rich beyond the dreams of Hamilton. "When I called for Simpson," said Christison, "his two reception rooms were as usual full of patients, more were seated in the lobby, female faces stared from all the windows in vacant expectancy, and a lady was ringing the door bell." He was summoned to attend duchesses in London, many calls came from the continent, and while Simpson rushed back and forth, the steamship and railroad brought thousands of foreign ladies to the shrine of gynecology.

Worshiped by women, he was regarded with extravagant affection by hard-boiled army officers. Not only was his office overcrowded, but his home swarmed with visitors—Jessie Simpson poured out more tea than any woman in

Scotland. No. 52 Queen Street became an international hotel where men of every clime, creed and color, speaking the various tongues of earth, felt the charm of Simpson. His winning ways, cordiality, sympathy, curiosity, proved irresistible. In the presence of his smile, only Syme remained grim. Simpson's enormous head with its flowing tangled locks, the melting blue eyes looking out of the broadish face, his shortened rounded limbs—"head of Jove and body of Bacchus," as Gerald Massey said of him—became as familiar a landmark in Edinburgh as Arthur's Seat or Calton Hill.

In Edinburgh, amid the masters of surgery, where even the queer John Lizars found time between law-suits to introduce new operations, the scalpel of Simpson did not shine, and evidently he was fonder of the ink-well than his instrument-case. He wrote with facility, and if his writings are no longer read, it is because most clinical literature is for one generation only: in their day, all gynecologists perused Simpson's contributions. His papers on pelvic cellulitis, hematocele, and uterine cancer; his comprehensive monograph on hermaphroditism; his suggestion of version in deformed pelves; his lectures which were said to brighten the gloom of an Edinburgh winter; his devising of such terms as ovariotomy and coccyodynia, though the operations themselves are of American origin; his work on uterine displacements; his method of cervical dilatation with sponge-tents; his introduction of the polyptome, hysterotome and the long forceps; and his popularization of the uterine sound, gave a tremendous impulse to gynecology.

Although Syme continued to speak contemptuously of physician-accoucheurs, Simpson invaded the surgical field with acupressure—a new hemostatic process of "passing a needle through the flaps or sides of the wound, so as to cross over and compress the mouth of the bleeding artery or its tube, just in the same way as, in fastening a flower in the lapel of our coat, we cross over and compress the stalk of it with the pin which fixes it, and with this view push the pin twice through the lapel." Since a pin figures prominently in this operation, Simpson who was an accomplished Shakespearean—despite his turning his back on Mrs. Siddons—headed his brochure as usual with a Shakespearean quotation: "Tut, a pin!" When Syme read this contribution to general surgery, instead of merely doubling the tuts, he brought a copy to his class, spoke of Simpson's "vulgar insolence," and in a rage tore the pamphlet in half, consigning the pieces to the sawdust box.

Simpson continued to labor on acupressure until he produced a volume of 580 quarto pages, which Syme could not tear so easily—but aside from his deplorable manners, Time sides with Syme. It is pleasant to relate that once Syme and Simpson were able to cooperate: synchronously, they fought to exterminate homeopathy in Scotland, though no doubt each wished the other in the opposing camp.

Like several Scottish physicians, Simpson was interested in archeology, and considerable ingenuity and erudition went into his antiquarian studies: leprosy and leper-hospitals in old Scotland and England, a Roman practitioner's medical stamp found near Tranent, ancient Greek medical vases, syphilis in Scotland in the last years of the fifteenth century, a Pictish inscription in the churchyard of St. Vigeans, Scottish magical charm-stones or curing-stones, John de Vigo's relationship to acupressure in the sixteenth century, ancient sculpture on the walls of caves in Fife, cupcuttings and ring-cuttings on stones near Liverpool, the Cat Stane of Edinburghshire, the pyramid at Gizeh and meteorology, pyramidal structures in Egypt and elsewhere—a noteworthy achievement of one of the busiest practitioners of the age.

If any additional evidence of Simpson's versatility is required, it will be found in this extract from one of his letters: "This summer I get a return of £2700 from my three Liverpool vessels, which is a better return than I ever yet got from railways. Did I tell you when I last wrote that Professor Thompson and I have taken out a joint-patent?"

Sufficient examples have already been given to illustrate the ease with which Simpson entered various fields. Sagacious, a born showman, with a knack for saying the right thing at the right time, he held success in his hands. Many scientists, dying in obscurity and disappointment, if they were able to revisit this earth would be astonished to find that posterity had erected statues to their memory or had buried them in Westminster Abbey. Marshall Hall, whose discovery of reflex phenomena gave us a new insight into the physiology and pathology of the nervous system, lectured to his private students until his voice failed, yet he held no academic position, never received a decent hospital appointment, and several of his most important papers were rejected by the Royal Society with undisguised scorn—even the enthusiasm of Johannes Müller in his behalf did not avail in Great Britain. "I appeal," said Marshall Hall, "from the first half of the nineteenth century to the second." It was not necessary for Simpson to make such an appeal: beneath his ample hat his contemporaries pressed the laurel. A druggist recommended a bottle which when opened by Simpson carried him to medical immortality.

Soon after the introduction of anesthesia in the British Isles, Simpson had an inspiration: he, professor of midwifery, would banish pain from the lying-in chambers of the world. Here he had no precedent, unless, perchance, the murdered spirit of Lady Eufame Macalyene, who in this very city of Edinburgh had been burnt at the stake by the ecclesiastics for attempting to assuage the pangs of labor by artificial means.

The first anodyne which Simpson employed in an obstetric case, January 19, 1847, was, naturally, ether. Not being quite satisfied with its efficiency, he searched for an anesthetic of more energetic action. With George Keith and Matthews Duncan, he tested the properties of the vapor of iodoform, acetone, benzine, chloride of hydrocarbon, nitrate of oxide of ethyl, and various oils and gases. None of these caused him to conclude his research. Every morning, James Miller, known as the surgeon who disliked to operate, looked in at 52 Queen Street—he was alternately Simpson's friend and enemy—to see whether the experimenters had survived.

On another evening, November 4, 1847, Simpson and his associates inhaled several substances without any marked effect. At this moment Simpson happened to remember that a Liverpool chemist, David Waldie, had spoken to him about a certain heavy colorless liquid. Waldie, who had met Simpson in Scotland, promised to prepare some for him upon his return to Liverpool, but before he had time to do so, the impatient Simpson procured it elsewhere. Simpson looked for the bottle, but could not find it. When he was probably upon the point of remarking that it was not of importance anyhow, the amber-colored bottle was pulled out from the bottom of a heap of waste paper. Simpson scrutinized it again and shook his head dubiously. It seemed to him too ponderous to be of much value.

But he took out the stopper, poured the contents in the tumblers, and the three inhalers eagerly shoved their noses to the brim. They arose, happier than when they had sat down. Keith's eyes grew bright and he laughed heartily; Duncan waltzed around the room, and Simpson also showed evidence of a peculiar inebriety. Some ladies came into the room—these experiments were conducted in Simpson's dining-room and not in the laboratory—and found the gentlemen remarkably amiable and loquacious. Suddenly the scene changed—Simpson and his crew became confused, lost their senses and fell to the floor.

When Simpson awoke and made contact with his surroundings, he realized that the usually alert Duncan was snoring, that Keith's legs were attempting to overturn the table, and that he himself was prostrate. His thought was as follows: "This is better than ether." One of the young ladies, Miss Petrie, wishing to prove that she was as brave as a man, inhaled the chloroform, folded her arms across her breast, and fell asleep chirping, "I'm an angel! Oh, I'm an angel!"—but Simpson was too occupied just then to search for her wings.

He wrote a paper, which he read before the Medico-Chirurgical Society of Edinburgh, dwelling especially on the superiority of chloroform over ether. He began at once to use chloroform in his obstetrical practice, and since the first child vaccinated in Russia was named Vaccinoff, it was appropriate that the first child born under the influence of chloroform should be named Anesthesia. (A photograph of Anesthesia at the age of "sweet seventeen" used to hang over Simpson's desk, and his daughter Eve testified that the professor was very proud of chloroform's first-born.)

It is interesting to recall the arguments which were urged against Simpson's introduction of anesthetics into obstetrics. Objections were seldom raised primarily on the ground that the administration of chloroform would prove injurious to either mother or child. The disputants did not claim that the anesthetic would interfere with the natural progress of labor, or impede the uterine contractions, or that there would be an increased elimination of nitrogen in the new-born babe. Such statements, though incorrect, would have been entitled to the gravest and most careful consideration.

Instead, much stress was laid on the fact that an anesthetic sometimes arouses amorous feelings, and that some women who have been under the influence of ether or chloroform have confessed that, while anesthetized, they believed they were engaged in the act of coition. That such occurrences, unlike labor-pains, were exceptional and unusual was not taken into account, and it was both seriously asserted and solemnly maintained that if anesthetics were used in obstetrics, the holy pangs of labor would be metamorphosed into exhibitions of sexual passion. It was argued that the maternal instinct was in danger of being abolished, as a mother could not love children whom she had brought into the world without suffering.

But even these were not the main contentions. Indeed, they were only breezes of irritation in relation to the whirlwind which was to overwhelm Simpson. In endeavoring to assuage the pangs of child-birth, Simpson, though orthodox, had forgotten to reckon with *Genesis* iii, 16—the passage which contains God's malediction to mothers: "I will greatly multiply thy sorrow and thy conception; in sorrow thou shalt bring forth children."

But Scripture can be answered by Scripture, and Simpson, in retaliation, quoted *Genesis* ii, 21: "And the Lord God caused a deep sleep to fall upon Adam, and he slept: and he took one of his ribs, and closed up the flesh instead thereof." The argument appeared unanswerable. God was the first anesthetist.

It would be interesting to write a book on medical history from non-medical sources—the writer would learn much during its preparation. Nothing that any physician has written about the early days of chloroform anesthesia is more suggestive than the reaction of that magnificent idler, Charles Cavendish Fulke Greville. A man with such a name does not have to work in this world, and Charles Cavendish Fulke Greville did not. One of the numerous dukes in his family had him appointed secretary of Jamaica, a deputy without a pedigree went over and did the work, and Charles Cavendish Fulke Greville never visited the island.

His chief interest in life was the horse, and his most important quarrel was over a mare. Welcomed in palaces and stables, his knowledge of the turf brought him into association with the leading men and horses of his era; Greville himself owned such famous horseflesh as Preserve and Orlando, yet by a curious fatality, never achieved the

Derby. The accident which befell his horse Alarm, while not exactly a national calamity, is considered of sufficient importance to be mentioned in the Dictionary of National Biography.

It may have appeared to some of his contemporaries that this high-bred man of fashion squandered on stud the talents that would have gained applause in Parliament, but Greville courted fame in his own manner. Because of his connections and the confidence in which he was held, he knew so much about the secret history of Europe that he was able to whisper into the ear of Lord Palmerston and the Duke of Wellington. For forty years, while serving as clerk of the privy council, he kept a diary—chiefly political, but interjected with autobiography—which immediately upon its posthumous publication placed Greville among the foremost and most significant historians of the nineteenth century. In these memoirs Greville describes the operation under chloroform which he witnessed about a month after Simpson's discovery:

I went yesterday to St. George's Hospital to see the chloroform tried. A boy two years and a half was cut for a stone. He was put to sleep for a minute; the stone was so large and the bladder so contracted, the operator could not get hold of it, and the operation lasted above twenty minutes, with repeated probings by different instruments. The chloroform was applied from time to time, and the child never exhibited the slightest sign of consciousness and it was exactly the same as operating on a dead body.

A curious example was shown of what is called the etiquette of the profession. The operator (whose name I forget) could not extract the stone, so at last he handed the instrument to

Keate, who is the finest operator possible, and he got hold of the stone. When he announced he had done so, the first man begged to have the forceps back that he might draw it out and it was transferred to him; but in taking it he let go the stone and the whole thing had to be done over again. It was accomplished, but not of course without increasing the local inflammation and endangering the life of the child. I asked Keate why, when he had got hold of the stone he did not draw it out. He said the other man's dignity would have been hurt if he had not been allowed to complete what he had begun.

I have no words to express my admiration for this invention which is the greatest blessing bestowed on mankind, and the inventor of it is the greatest of benefactors whose memory ought to be venerated by countless millions for ages yet to come. All the great discoveries of science sink into insignificance when compared with this. It is a great privilege to have lived in times which saw the production of steam, of electricity, and now of ether, that is, of the development and application of them to human purposes, to the multiplication of human enjoyment and the mitigation of pain. But wonderful as are the powers and the feats of the steam and the electric telegraph, the chloroform far transcends them all in its beneficent and consolatory operations.

It is impossible to predict what would have been the immediate fate of anesthetics in general, and chloroform in particular, had not Simpson unexpectedly found an ally more influential than God, at least in Great Britain. Queen Victoria was pregnant; there was a quickening within the royal womb; the day for labor arrived; John Snow stood by her bedside and the regal mother inhaled chloroform. A few years later England's Queen conceived once more, and on the approach of parturition, again availed herself of Simpson's anesthetic.

What had become of blasphemy? Where was sacrilege now? How about that passage in *Genesis*? Who now dare call anesthesia an invention of the devil? Did not God's right-hand favorite approve of it? Instead of a heretic Simpson became a hero; instead of a rebel, a savior. Queen Victoria was grateful to the man who had eased her passage through life, for in due time the baker's son had a Sir in front of his name and a Bart. after. The doctor adopted for his coat-of-arms the rod of Aesculapius over the motto *Victo dolore* (Victory over Pain).

Had Simpson reached the years of his grandfather, he would have lived to see the fulfillment of his graduation address prophecy: "Possibly even by the concentration of electrical and other lights we may render many parts of the body, if not the whole body, sufficiently diaphanous for the inspection of the practised eye of the physician and surgeon." Overwork combined with angina pectoris—alas, the doctor's disease, again—closed his career at fifty-nine. At sundown, on May 6, 1870, he died in the arms of his elder brother Alexander—the beloved Sandy, who had helped him at every stage of his adventures, who had watched him grow from a barefoot lad of Bathgate village to the chief citizen of Scotland. The doors of Westminster Abbey were open to receive his dust, but Edinburgh could not give up its Simpson. The flags of the city floated at half-mast, the classrooms of the University remained locked, the Stock Exchange closed down, business throughout the metropolis ceased, and among the countless thousands who followed the fallen chief there was no sound but sobbing, until across the silence pealed the solemn bells of St. Giles'. The body of Simpson was laid at rest in Warriston Cemetery, where five of his nine children had already preceded him, and where Lady Simpson was so soon to follow.

Simpson was a warrior of anesthesia, battling valiantly for the Victory over Pain. He was a gallant fighter, though not always a scrupulous one. In his writings, he forgot David Waldie, to whom he owed so much, for Waldie practically put chloroform into Simpson's hands. As the discoverer of the anesthetic power of chloroform, Simpson may be excused for praising it as the best and safest of anesthetics, destined to supersede all other anesthetics, but when men, women and children died from chloroform, he refused to admit it and actually twisted statistics to his purposes.

When the Encylopedia Britannica invited Simpson to write the article on Anesthesia, he readily agreed, but his contribution will not be found under the A's: Simpson wrote the article under Chloroform. When he received the freedom of the city of Edinburgh, and the Lord Provost referred to him as the discoverer of anesthesia, Simpson did not whisper a correction in his ear. Simpson always belittled the American discovery. He preferred to be regarded as the discoverer, not only of chloroform anesthesia, but of the principle of anesthesia itself.

Personally, Simpson was affectionate, warm-hearted, and a lover of the human race. In the evening of his life, the animosities were fading, and when he was laid to rest, Scotland felt it had buried its most celebrated son since the author of the Waverley Novels dropped his pen. The name of Simpson is secure among the fighters against pain.

TWENTY-TWO

An Anonymous Letter

THE MAIL for Simpson was enormous, and it arrived from many nations. He could have enriched the albums of all the zealous young philatelists of Edinburgh simply by tearing off the foreign stamps he received. Simpson was one of those men who preserve their correspondence: he saved thousands of communications from his family, friends, practitioners, and persons of distinction. Letters were never thrown away, but frequently they were put in the wrong bundle, and unrelated items would absent-mindedly be stuck in the same envelope. He never had time to institute order in his filing-system.

One day Simpson sat at his desk, reading an anonymous letter. It was not from a foreign land, but from someone in Edinburgh. The further he read, the more absorbed he became. The letter was about anesthetics in surgery, from the point of view of a patient. Simpson realized that the letter was the most eloquent argument for his own views that had ever been written. It is well worth while, even today, to read this fascinating letter in full:

I have recently read, with mingled sadness and surprise, the declarations of some surgeons that anesthetics are needless luxuries, and that unendurable agony is the best of tonics. Those surgeons, I think, can scarcely have been patients of their brother surgeons, and jest at scars only because they never felt a wound; but if they remain enemies of anesthetics after what you have written, I despair of convincing them of their utility. My present object in writing is not to supplement your arguments in favour of the administration of anesthetics to those who are about to undergo surgical operations; but, as one who knows from personal experience what operations were to the patient before ether or chloroform was employed anesthetically, I am anxious to state certain reasons in justification of their use, which only those who suffered without their help are in a condition to urge.

Several years ago, I was required to prepare, on very short warning, for the loss of a limb by amputation. A painful disease, which for a time had seemed likely to yield to the remedies employed, suddenly became greatly aggravated, and I was informed by two surgeons of the highest skill, who were consulted on my case, that I must choose between death and the sacrifice of a limb, and that my choice must be promptly made, for my strength was fast sinking under pain, sleeplessness and exhaustion.

I at once agreed to submit to the operation, but asked a week to prepare for it, not with the slightest expectation that the disease would take a favourable turn in the interval, or that the anticipated horrors of the operation would become less appalling by reflection upon them, but simply because it was so probable that the operation would be followed by a fatal issue, that I wished to prepare for death and what lies beyond it, whilst my faculties were clear and my emotions were comparatively undisturbed, for I knew well that if the operation were speedily followed by death, I should be in a condition, during the interval, in the last degree unfavourable to making preparation for the great change.

The week, so slow, and yet so swift in its passage, at length came to an end, and the morning of the operation arrived. There were no anesthetics in those days, and I took no preparative stimulant or anodyne of any kind, unless two cups of tea, which with a fragment of toast formed my breakfast, be considered such.

The operation was a more tedious one than some which involve much greater mutilation. It necessitated cruel cutting through inflamed and morbidly sensitive parts, and could not be despatched by a few swift strokes of the knife. I do not suppose that it was more painful than the majority of severe surgical operations are, but I am not, I believe, mistaken in thinking that it was not less painful, and this is all that I wish to contend for.

Of the agony it occasioned, I will say nothing. Suffering so great as I underwent cannot be expressed in words, and thus fortunately cannot be recalled. The particular pangs are now forgotten; but the black whirlwind of emotion, the horror of great darkness, and the sense of desertion by God and man, bordering close upon despair, which swept through my mind and overwhelmed my heart, I can never forget, however gladly I would do so. Only the wish to save others some of my sufferings makes me deliberately recall and confess the anguish and humiliation of such a personal experience; nor can I find language more sober or familiar than that I have used to express feelings which, happily for us all, are too rare as matters of general experience to have been shaped into household words.

From all this anguish I should of course have been saved had I been rendered insensible by ether or chloroform, or otherwise, before submitting to the operation. On that point, however, I do not dwell, because it needs no proof, and the testimony of the thousands who have been spared such experiences by the employment of chloroform, is at hand to satisfy all who are not determined not to be satisfied.

But there are other modes in which anesthetics may serve a patient than by rendering him insensible at the period of his undergoing a surgical operation, and it is to these modes of service, which may not strike even the most humane and thoughtful surgeon, and cannot be matters of experience except to patients who have not taken anesthetics, that I seek mainly to refer in this letter.

I am not gifted with physical courage. Physical courage I understand to signify that consciousness of a power to endure bodily agony, which accompanies a certain temperament. Its possessors know from the first instinctively, and by and by learn from experience, that a blow, a cut, a burn, an attack of toothache, or the like infliction of injury, or onset of pain, can be endured by them, though unwelcome, up to an extent of considerable severity, without excessively incommoding them or exhausting their patience. From severe injuries and dangerous diseases such persons recover, fortified by the assurance that they can bear without flinching what would make others complain loudly, and they are not afraid to anticipate suffering, believing that they will be able to bear it. This estimable virtue is possessed more largely by men than by women, and by savage than by civilised men, and may or may not be accompanied by moral courage.

I belong, on the other hand, to that large class, including most women, to whom cutting, bruising, burning, or any similar physical injury, even to a small extent, is a source of suffering never willingly endured, and always anticipated with more or less of apprehension. Pain in itself has nothing tonic or bracing in its effects upon such. In its relation to the body, it is a sheer and unmitigated evil, and every fresh attack of suffering only furnishes a fresh proof of the sensitiveness possessed to pain, and increases the apprehension with which its attacks are awaited.

When I, accordingly, made up my mind to submit to the operation proposed to me, it was with the fullest conviction that the pain it would occasion would far exceed my power of patient tolerance, and I prepared for it, simply as for a dreadful necessity from which there was no escape. I awoke each morning from troubled sleep to reconsider the whole reasons for and against submitting to the surgeons, and by a painful effort reached again the determination not to draw back from my first resolution. From all this distracting mental struggle, which reacted very injuriously on my bodily constitution, I should have been exempted, had I been able to look forward to the administration of chloroform. A far greater amount of internal composure and serenity would then have been mine, and this mental peacefulness would have been a powerful aid towards sustaining my strength, and fitting me to bear the shock of the operation.

Again, I concealed from the relatives who were about my sickbed what awaited me, knowing that an announcement of the impending operation would occasion them the greatest grief, and fearing that the expression of that grief would utterly shake my resolution. On the very morning of the operation, I performed my toilet with peculiar pains and care, with a view to disarm their apprehensions on hearing that the surgeons were to pay me a visit that day; and I had at least the satisfaction of afterwards learning that the ruse was successful. But I need scarcely say that the mental tension occasioned by this reserve, and the continued effort to play a part, was a prejudicial exertion, and kept my faculties injuriously on the strain. Could I have told my friends that the operation would be painless, we should have conferred about it, and they and I would have been saved much distress.

Further, during the operation, in spite of the pain it occasioned, my senses were preternaturally acute, as I have been told they generally are in patients in such circumstances. I watched all that the surgeons did with a fascinated intensity. I still recall with unwelcome vividness the spreading out of the instruments; the twisting of the tourniquet; the first incision; the fingering of the sawed bone; the sponge pressed on the flap; the tying of the blood vessels; the stitching of the skin; and the bloody dismembered limb lying on the floor.

Those are not pleasant remembrances. For a long time they haunted me, and even now they are easily resuscitated; and though they cannot bring back the suffering attending the events which gave them a place in my memory, they can occasion a suffering of their own, and be the cause of a disquiet which favours neither mental nor bodily health. From memories of this kind, those subjects of operations who receive chloroform are of course free; and could I, even now, by some Lethean draught erase the remembrance I speak of, I would drink it, for they are easily brought back, and they are never welcome.

How far my experiences agree with those of others who have undergone similar operations I do not know, but except that I may have a more active and roving fancy or imagination than some of my fellow-sufferers, I cannot doubt that my experiences are not singular.

That the dread of pain keeps many a patient from submitting to operations which would save life, is notorious; but the dread of a particular mode of inflicting pain is a more dissuasive motive with many than the dread of the pain so inflicted. Hundreds every day endure the great torture of toothache, rather than the small torture of the extraction of the tooth. Women, in particular, suffer prolonged agonies for months, rather than submit to a fraction of the same amount of pain at a surgeon's hand, because, as produced by him, it takes the form of an incision with a sharp knife; and a red-hot iron is held in such horror by most persons, that, rather than be touched by it, though the pain it occasions is but momentary, they will endure the application of chemical caustics which occasion torture for hours.

Anesthetics render all such persons as great a service by rendering them insensible to the accompaniments of an operation, as by rendering them insensible to its pain. It is true that if they felt no pain, they might be as calm and even curious spectators of the dismembering of themselves as in dreams all men are, of what in waking life would be the most agonising realities. But it is not less true, that sufferings equal to those of the severest operations are experienced by patients, in the course of acute or aggravated maladies, without being followed by the crushing effect of the operations which they rival in power to occasion agony; and surely this is not to be wondered at. Before the days of anesthetics, a patient preparing for an operation was like a condemned criminal preparing for execution. He counted the days till the appointed hour came. He listened for the echo on the street of the surgeon's carriage. He watched for his pull at the door-bell; for his foot on the stair; for his step in the room; for the production of his dreaded instruments; for his few grave words; and his last preparations before beginning. And then he surrendered his liberty, and revolting at the necessity, submitted to be held or bound, and helplessly gave himself up to the cruel knife. The excitement, disquiet, and exhaustion thus occasioned, could not but greatly aggravate the evil effects of the operation, which fell upon a physical frame predisposed to magnify, not to repel, its severity. To make a patient incognizant of the surgeon's proceedings, and unable to recall the details of an operation, is assuredly to save him from much present and much future self-torture, and to give him thereby a much greater likelihood of recovery.

Further, the horror with which attached relatives regard the prospect of operations on those very dear to them—a horror far surpassing that with which they would, in many cases, hear of such operations awaiting themselves—leads them often to dissuade their friends from submitting to surgical interference. The issue in too many cases is, that the poor patient listens, though but half-convinced, to their arguments; tries doctor after doctor, and remedy after remedy, only to be compelled in the end, after weeks or months of prolonged suffering, to submit to the operation. The prospects of recovery, however, in such cases, are too often immensely lessened by the physical exhaustion and enfeebled general health which have resulted from the delay. The knowledge, on the other hand, that a mother, a sister, a wife, or a child, will be carried unconsciously through a severe operation, cannot but rob it of half its horrors in the eyes of friends, and will make them often the allies rather than the opponents of the surgeon, and keep them from showing the false kindness to their relatives, of dissuading them from submitting to the only treatment which promises a cure.

The sum you will perceive of what I have been urging is that the unconsciousness of the patient secured by anesthetics is scarcely less important than the painlessness with which they permit injuries to be inflicted on him. To steep his senses in forgetfulness, and throw the whole intellectual machine out of action, when, if allowed to work, it only moves with a rapidity and irregularity which threaten its integrity, and permanently injure it, is to do him a service, second only to that of saving him from suffering. And to make it impossible for him to recall a scene of horror, and torture himself by going over and over all its incidents again and again, is able to do him a signal service. Nor need more be said concerning the service done to his friends.

I plead, therefore, for the administration of anesthetics on the grounds enumerated. I fear you may think my confessions exaggerated, but I can most honestly declare that they are not. When I first heard that anesthetics had been discovered, I could not and would not believe it. I have since thanked God many a time, that He has put it into your heart, and into that of other wise and humane men, to devise so simple and so safe a way of lessening pain.

As for the fear entertained by some, that the moral good which accrues from suffering, and is intended by the Ruler of all to be secured by it, will be lost if agony is evaded by sufferers having recourse to anesthetics, we may surely leave that to the disposal of Him who does all things well. The best answer to such complaints I have heard, was that given by an excellent old lady to another, who was doubting whether any of the daughters of Eve were at liberty to lessen by anesthetics the pangs of child-bearing: "You need not be afraid," said the wiser lady, "that there will not be enough of suffering in the world."

I think not; but may you be honoured still further to reduce its sum.

—An Old Patient

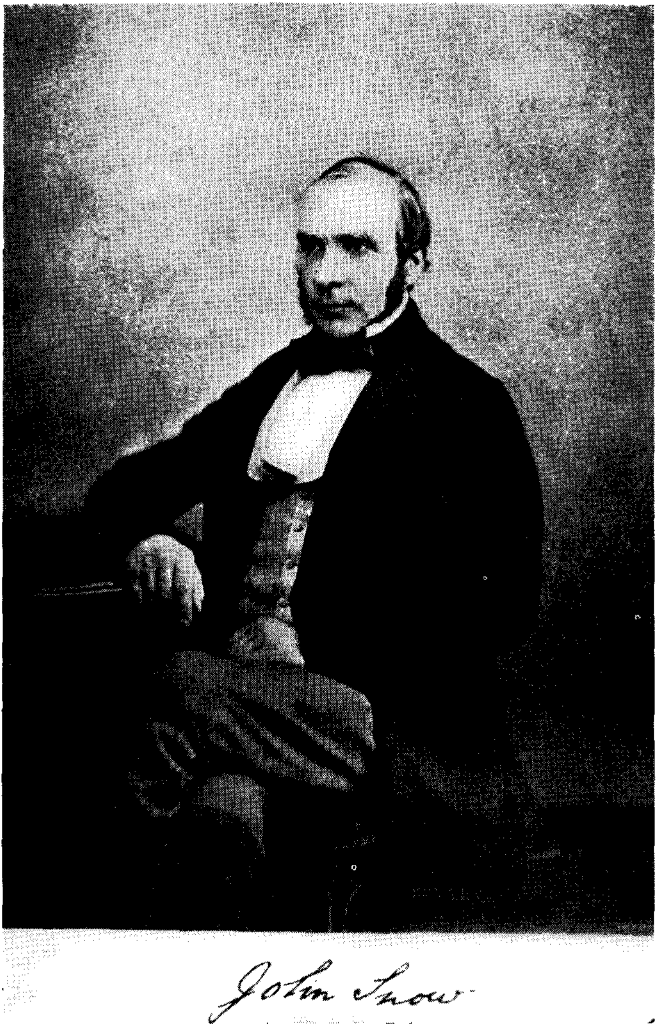
In the composition of this letter, caution was taken to conceal the name, occupation, and even the sex, of the writer. Such expressions as "I belong to that large class, including most women," and "I performed my toilet with peculiar pain and care," were calculated to convey the impression that the writer was a woman. But Simpson knew who was attempting to hide in the anonymity of An Old Patient. No signature was needed for a description of such extraordinary vividness. The writer of the letter was that brilliant, unfortunate and lovable man, George Wilson.

A graduate in medicine at the University of Edinburgh, Wilson did not become a practitioner because he fell so in love with chemistry that he served as unpaid assistant to such famous chemists as the toxicologist, Robert Christison, who discovered the active principle of the hemlock which Socrates drank, and Thomas Graham, the father of colloid chemistry.

Before his twenty-fifth birthday, Wilson took stock of his life and tabulated the result: "a bankrupt in health, hopes and fortune." A minor injury to his left foot, which would have passed without consequences in a more robust man, in his case meant the operating-table and the knife of James Syme in January 1843. Fate had not finished with Wilson, and soon after the operation he found himself afflicted with tuberculosis.

Success overtook him in his sickness. At thirty-five, he was no longer a bankrupt in hope, for important positions had been opened to him, and he now passed through the scientific circles of Edinburgh, a crippled and gallant figure. He was forty when the goal of his ambition appeared within his grasp: the chair of chemistry at the university. But Wilson turned away from the most coveted chemical prize in Scotland; he knew it had come too late. The following year he was dead.

George Wilson's anonymous letter to Simpson is the bleeding wound of a sensitive man beneath the surgeon's steel. It is the deeply felt response to an amputation that was performed four years too soon. The letter is a masterpiece on pain that cuts across two ages: before and after anesthesia.



John Snow (From the *Asclepiad*, 1887)

Plastic caricature of the first chloroform narcosis in Berlin (From Holländer's *Die Karikatur und Satire in der Medizin*, 1921)

John Snow

(1813–1858)

ONE OF the most significant names in the history of anesthesia is that of John Snow, a medical pioneer of the first order. The first physician to specialize in anesthesia, Snow stood first among his contemporaries in championing the new anesthetic discoveries of his time, and in developing techniques for administering them. It is justly said of him that he made the art of anesthesia a science.

But John Snow's creative work was not limited to anesthesia. In the field of public health and preventive medicine his name will live in perpetuity as the first to state the theory that cholera is water-borne and taken into the system by the mouth.

In 1832 mankind was terrorized by the pestilential progress of cholera. The scourge marched unhaltingly along the lines of human traffic, invading nation after nation. The mortality was appalling, and everywhere physicians theorized in the darkness of ignorance. When the dreaded visitor came up the tidal river and over the remains of the great Roman wall of Newcastle-upon-Tyne, striking down the workers in the Killingworth Colliery, the surgeon William

Hardcastle sent his apprentice and pupil, John Snow, to the aid of the sufferers.

A farmer's son of York, Snow, then eighteen years of age, shouldered responsibility with great spirit. Day and night he labored among the sick miners, and for the rest of his life studied the mystery of cholera. John Snow could not go to Oxford, but in London he sat on the benches of the Hunterian School of Medicine in Windmill Street; attended cases at the Westminster Hospital; became qualified in medicine by passing the examinations of the Royal College of Physicians, and of Apothecaries' Hall; graduated in medicine from the University of London; and was admitted a licentiate of the Royal College of Physicians.

The cholera in London in 1854 exhibited a special intensity in a certain area having a radius of 250 yards, where death claimed over five hundred victims within ten days. Inhabitants fled in panic from their homes and families, as in the days of the medieval plagues. Not only distinguished physicians, but even the leading sanitarians of the time still attributed the spread of infectious diseases to effluvia and miasmata. The London cholera struck with such virulence that officials sat in helpless despair seemingly waiting for a modern Pied Piper of Hamelin to rid the town of the scourge.

The vestrymen of St. James's felt the approach of Doomsday. They knew something had to be done, but did not have the faintest idea what to do. As they deliberated with blank faces, a stranger humbly asked for admission. They would have admitted Satan himself, if he had come with a suggestion. The name of the stranger was John Snow. He asked the vestrymen to take off the handle of a street-pump.

Snow had traced the infection to the Broad Street pump. A cartridge factory, which drew tubs of drinking water from this pump, was ravaged by the disease; a brewery on the same street, whose workmen drank malt liquor instead of water, was not attacked. The almshouse, which had its own well, remained exempt, though surrounded by houses in which the cholera raged fiercely; people from out of town, passing rapidly through London, died of cholera if they drank a single glass of water from the Broad Street pump.

It was the evening of Thursday, September 7, 1854, when Snow requested the vestrymen to close the source of the infection; it was late, as the epidemic had already begun to decline. Despite widespread skepticism, the pump-handle was removed on September 8. On September 10, the epidemic ceased. This was the earliest case in which water was demonstrated to convey a specific disease: the Broad Street pump is the most famous pump in the history of epidemic diseases.

Snow, who had previously written a monograph, *On the Mode of Communication of Cholera* in 1849, expanded it greatly in the second edition of 1855, offering a remarkable prevision of the modern germ theory. The book is a pioneer landmark in the control of communicable disease. John Snow's map of the relationship of Asiatic cholera to the Broad Street pump saved many Englishmen from certain death; but it taught the author that research is an expensive luxury. He spent more than £200 for the publication of his book, and its sale brought back only a few shillings.

But let us return now to Snow's earlier days, to trace from the beginning his interest and work in anesthesia. His very first article, published in the *London Medical Gazette*, November 5, 1841, was entitled: "Asphyxia and on the Resuscitation of Newborn Children." In this paper Snow suggested that where artificial respiration of the newborn was required, a double air-pump be used: one cylinder to draw off the expired air from the lungs, and the other cylinder to feed a stream of fresh air back into them. He emphasized the need of oxygen in the system: if the mother's placenta does not perform its function of supplying oxygen, the unborn child makes convulsive efforts to breathe, like a drowning animal.

Thus concerned with the physiological problems of suffocation and respiration, the mind of Snow was prepared to appreciate the epochal news from America in 1846: *operations could be performed painlessly under the influence of ether.*

In the early days of its introduction, the enthusiasm of Britons for anesthesia fell off rapidly: it subsided almost as soon as it began. Oddly enough, the earliest cases were easy and successful. But in some subsequent cases, the results were dubious. There were failures; dangers were perceived; death intervened. Skepticism deepened into mistrust; conservative surgeons prophesied that anesthesia would never become common practice; others maintained it would be and should be abandoned altogether.

A few years after its introduction, striking proof that anesthesia was not generally employed is furnished by the case of one of the most famous statesmen in British history. In the House of Commons, the popular Sir Robert Peel argued for Greek independence and international goodwill; with the plaudits for his great speech still ringing in his ears, he was riding up Constitution Hill, enjoying the summer beauty of June 29, 1850, when suddenly he was thrown from his horse.

The first physician to reach the injured man was Sir James Clark. This in itself was an ominous sign, for the royal physician was considered an awful bungler. Queen Victoria should have dismissed him long before, but she was stubborn. Robert Peel's left collar-bone had been broken by the fall, and the ribs beneath the left shoulder-blade were fractured; splinters of bone pressed into the blood-vessels, causing bleeding and swelling. Sir James had him placed in a carriage and conveyed to his residence in Whitehall Gardens.

The galloping of the horses, the jogging and jolting of the carriage, caused the jagged edges of the broken bones to penetrate deeper into the internal jugular vein and to increase the hemorrhage. The leading surgeons of the realm, Benjamin Collins Brodie and Caesar Henry Hawkins, were called to attend the national favorite.

So intense was the pain, that not even a bandage could be borne; the surgeons were helpless, for they could not touch the patient. Never was there a clearer call for an anesthetic. Neither physician nor surgeon suggested it. After three days of excruciating agony, death applied its permanent anesthetic. Sir James and Sir Benjamin had not brought their medical arts up to date, and a nation wept.

But not everywhere was the ether can disdained. Emerging from a hospital, Snow met a druggist of his acquaintance, and wished him a "Good morning!" Holding a large ether apparatus under his arm, the druggist replied: "Good morning to you, doctor! but don't detain me, I am giving ether here and there and everywhere, and am getting quite into an ether practice. Good morning, doctor!"

An ether practice! Snow had devised an improved inhaler and conducted experiments in etherization upon animals and upon himself, but the practical aspects had not dawned upon him. Now, however, he requested permission to administer ether to the out-patients of St. George's Hospital in cases of extraction of teeth. The surgeon Fuller, standing by, recognized the master's touch.

The following day, the surgeon Cutler had a major operation which he intended to perform without anesthesia, for he was disappointed with ether. Fuller told Cutler about John Snow, his improved inhaler and superior method. The trial was so successful that on subsequent operating days Snow was called in to give the ether.

Snow likewise administered ether at University College. The leading surgeon, Robert Liston, saw Snow at work, and literally pounced upon him. They became a well-known team: Liston the operator, Snow the etherizer. Other surgeons followed the celebrated Liston. To John Snow fell almost the entire ether practice of London.

It was by using ether that Snow built his reputation in anesthesia. Then from Edinburgh came the report of the anesthetic properties of a new agent—chloroform. Snow gave chloroform immediate trial, and because of its ready applicability it subsequently became his favorite anesthetic. Snow was an investigator without prejudice, one who constantly tested new ideas and materials.

He continued to experiment with any volatile substance which he thought would produce insensibility. After ascertaining their effect upon animals, he experimented upon man, always beginning with himself. His friends protested loudly that he would kill himself some day, and it is certain he took grave risks. Snow could not resist trying out any volatile substance, and he even experimented with that deadly poison, hydrocyanic (prussic) acid, which has treacherously taken the life of more than one investigator.

Snow made innumerable measurements of dosage and calculated the weight and amount of blood in the animal or patient, reaching the stage where he could tell to a fine degree just how much anesthetic was needed to produce insensibility. Compared with the attainments of Snow, the knowledge of the American pioneers of anesthesia was primitive and empirical. Snow was the first physician to specialize in anesthesia; he was the first scientific anesthetist.

Although Snow was for many years an inarticulate member of the Medical Society of London, he ultimately became orator of the Society in 1852 and president three years later. He lived a very lonely life in the great metropolis. He was not connected with any creed or sect or party. He was a vegetarian and a teetotaler. He remained unmarried, and there is no evidence that he ever had a love affair. He could not relax on his infrequent holidays, but always hurried back to his studies.

Snow missed many of the good things in life, for he had no family and could not take his ease with his fellows in a tavern. After becoming established, he administered chloroform or other anesthetics about four hundred and fifty times annually. In many instances he contributed his services with his compliments. The rumor that he was rich was exaggerated: his income never exceeded £1000 a year.

Suddenly, Fame took John Snow by the hand: the shy doctor was commanded to present himself before that austere and august personage, His Royal Highness, Prince Consort Albert. The Prince's wife was going to have another baby, and had decided to take chloroform to assuage the pain of childbirth. The Prince, who was interested in the arts and sciences, asked questions which were answered by the most competent anesthetist in the kingdom.

So John Snow, who never went anywhere, went to court. This man, too busy to know whether his trousers were pressed or baggy, now found it essential to pay meticulous attention to his attire. Going on forty, getting quite bald, low-voiced, bashful-looking and homely, the doctor arrayed himself in a court suit, complete with sword and flattened hat, and issued forth in all his finery. A little girl, walking with her mother, held up her hands and exclaimed, "Oh! isn't he *pretty*, mamma?" The childish admiration warmed the heart of the lonely man. Despite his habitual reserve, he could not help repeating the unexpected compliment to his friends.

Thus to John Snow was accorded the honor of administering chloroform to Queen Victoria at the birth of Prince Leopold, April 7, 1853. Snow gave the anesthetic in fifteen minim doses; the inhalation lasted fifty-three minutes. Snow was called again to administer chloroform to Her Majesty, at the birth of Princess Beatrice on April 14, 1857. On each occasion, Her Majesty expressed her satisfaction.

These events gave a decided impetus to anesthesia, and made the anesthetist a celebrity. Science reached the throne through a baker's son who discovered the anesthetic power of chloroform, and a farmer's son who poured it on a handkerchief for the Queen of England. John Snow became an object of curiosity. His eyes had seen the Queen on the day when she had become as other women. Therefore women especially plied Snow for details, perhaps not realizing they were asking him to violate the Hippocratic Oath. For all questions, the doctor had the invariable answer: "Her Majesty is a model patient."

On one occasion, a lady in the act of taking chloroform flatly informed Snow she would inhale no more, and would get off the table unless he repeated to her, word for word, what the Queen had said when she was taking it. The doctor replied: "Her Majesty asked no questions until she had breathed very much longer than you have; and if you will only go on in loyal imitation, I will tell you everything." The loyal lady imitated her Queen, and in another moment lapsed into unconsciousness. When she awoke, the anesthetist was no longer there.

Snow's early monograph on the inhalation of the vapor of ether in surgical operations, published in 1847, was followed by papers on chloroform and the entire field of anesthesia. There are references to him in Simpson's defense of anesthesia, and when Lister wrote the section on Anesthetics for Timothy Holmes's *System of Surgery* (1860-64), he referred frequently to John Snow.

As the foremost exponent of anesthesia in his time, Snow considered it his duty to give to his profession the authoritative textbook on the subject. He worked zealously on his manuscript, and the result was *On Chloroform and Other Anesthetics*. As he approached the end, death took the pen from the author's hand and wrote Finis to his volume.

The book was published posthumously in London in

1858 by John Churchill and edited with a memoir by Benjamin Ward Richardson. The author's epitaph inscribes itself:

IN BROMPTON CEMETERY THERE WAS LAID TO REST, AT THE AGE OF FORTY-FIVE, JOHN SNOW (1813-58), EXEMPLARY CITIZEN AND USEFUL PHYSICIAN. HE DEMONSTRATED THAT CHOLERA IS COMMUNICATED BY CONTAMINATED WATER; AND HE MADE THE ART OF ANESTHESIA A SCIENCE.

TWENTY-FOUR

Death as Anesthetist

WHENEVER MAN marches forward, wresting another secret from nature, Death may be waiting in his path. The mercy inherent in the fumes of ether and chloroform brought relief to the majority undergoing surgical pain: for others it would have been better if anesthesia had never been discovered. Death hid in the ether inhaler; Death suddenly came out of the chloroform bottle.

Hannah Greener was a girl of fifteen, but she already suffered the agony of ingrowing toenails. Perhaps she wore ill-fitting shoes, perhaps it was a blunder of nature: whatever the cause, ingrowing toenails must be removed. So Hannah Greener went to the Newcastle Infirmary in November 1847. Ether was administered and the nail of the great toe extracted. But that was not the end of Hannah Greener's troubles, for she had an ingrowing nail on the other toe which likewise required operation.

Again she awaited her ordeal, this time scheduled for January 28, 1848. In the interval between the operations, chloroform had been introduced. It was decided to use chloroform for the second operation. A medical man named Meggison came to the house at Winlaton, near Newcastle, and found the patient highly nervous. She began sobbing as soon as she saw him, and could not stop.

She was placed in a chair in an upright posture. It was the infancy of modern anesthesia: the operation was minor, but the error was major. A teaspoonful of chloroform was poured on a handkerchief, and the inhalation began. After drawing her breath twice, the girl pulled the anesthetist's hand from her mouth. He told her to put her hands on her knees, and to breathe quietly, which she did. In half a minute, the anesthetist lifted the girl's arm, and found it rigid; he looked at her pupil and pinched her cheek, and found them insensible.

Meggison requested the other doctor, a surgeon named Lloyd, to commence the operation. He made a semilunar incision, whereupon the girl gave a kick. Thinking that not enough chloroform had been inhaled, the anesthetist was about to pour more on the handkerchief. Instead, he threw down the fatal handkerchief, for the girl's lips suddenly blanched, and there was froth at her mouth. The operation was abandoned for resuscitation.

They dashed cold water in the girl's face, and gave her some to drink. Then they gave her a teaspoonful of brandy, which was swallowed only by the force of gravity; there was no response. They laid her on the floor, opened a vein in her arm, and then the jugular vein; no blood flowed. Two minutes sufficed for the tragedy of inhalation, operation, venesection, and extinction. Whether the cause was failure of respiration or paralysis of the heart, to young Hannah Greener belongs a melancholy distinction: she was chloroform's first victim.

After Hannah Greener had been ten years dead, John Snow, master of chloroform, described fifty cases in which the inhalation of it extinguished life. In some instances, Death struck like lightning, as in *Case 26:* "The patient, Madame W., was 32 years of age, and of good constitution. She was in very good spirits, and was only waiting the operation of having a tooth extracted, before going to dinner. It was stated that only twenty or twenty-five drops of chloroform were put on a sponge, which was surrounded by a handkerchief. After four or five inspirations, the operator inquired if his patient did not feel a singing in the ears." At that instant, Death answered the question.

The first fifty fatal cases of chloroform collected by John Snow included: a housewife in Cincinnati, a young woman of Boulogne, a young woman at Hyderabad, two young men in the Hôtel-Dieu at Lyons, a young Australian visiting his relatives in Scotland, an Irish seaman in the American Navy, a laborer in the dispensary in Westminster, an artilleryman on board ship at Mauritius, a patient in the Seraphim Hospital in Stockholm, a boy from the Highlands who had come to the Glasgow Infirmary, and various other cases in the hospitals of London, and in Germany and France. What adds to the pathos of the situation is that several of these cases were for such minor procedures as the pulling of a tooth or the removal of an ingrowing toenail. In the course of a century, these first fifty who succumbed to chloroform were followed by an army whose numbers are countless.

The first chloroform administered in Berlin—the year was 1852—centers around the formidable figure of Johann Lucas Schönlein. According to the verdict of the sensitive Fanny Mendelssohn-Hensel, Schönlein was a boor; posterity has accepted this verdict. Even Virchow, in his eulogy of Schönlein, referred to his rudeness. An elderly physician, once insulted by Schönlein, called attention to his gray hairs, whereupon Schönlein retorted: "Asses, too, are gray." There is also the story of a time when Schönlein met his match. He was consulted by a patient who had a red nose due to acne. Schönlein's advice was brief and brusque: "Don't booze so much." The patient politely paid the physician's fee, but in the doorway turned around and, gazing at Schönlein's own large and ruddy proboscis, remarked, "Professor, if ever you want your nose coated with tin, I commend myself to you—I am a coppersmith."

Schönlein's bad manners did not prevent him from being a founder of clinical teaching in Germany. He was lazy with his pen, and even when he demonstrated the fungus of favus (honeycomb ringworm), he described his important discovery in a brief letter of twenty lines in *Müller's Archiv*. Schönlein was one of the most acute clinical observers of the age, and made many pioneer contributions to medicine.

This is the man who decided to ascertain the effects of chloroform. There was, at that time, in the zoological gardens of Berlin, an old bear which had become blind from cataract. Schönlein received permission from Frederick William IV for the administration of chloroform to the bear while its cataract was being couched by the surgeon Jüngken. The operation was performed expertly, but the bear never awoke from the chloroform. This incident was made a vehicle for ridiculing the doctors.

A sculptor named Wilhelm Wolff, hearing of the affair, made a group in bronze, in which he gave animal countenances to the physicians: the anesthetist is depicted as a sheep holding the chloroform bottle in his hand; the surgeon Jüngken is pictured as an ape; and the bear as Schönlein himself. When the King saw Wolff's caricature of the group around the bear, he was naturally puzzled; a prize was offered for the best explanation in verse. The prize was won by a young man who later became famous as a poet and novelist, Paul Heyse. The prize-winning verse was as follows:

Der Bär ist jetzt ein toter Mann
Das Chloroform ist schuld daran,
Ein ärtzliches Kollegium
Ging mit dem Vieh zu menschlich um.
Das Füchslein grinst, das Bärlein flennt.
Der Wolf setzt ihm dies Monument.

A dead man is the bear, I fear,
The reason, well, this chloroform here.
A consultation of medical men
Treated too humanly the animal then.
The foxlet grins, little bear will lament,
The wolf erects his monument.

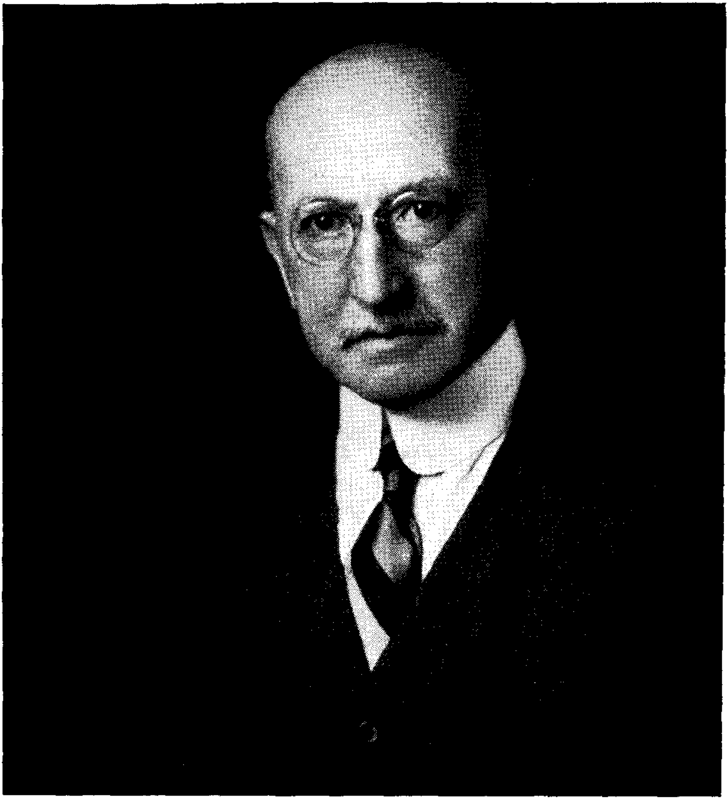
Notwithstanding the accident to the bear, the German surgeons began to administer chloroform to their patients. When the Philadelphia surgeon, William Williams Keen, was a student in Berlin he heard that a short time earlier H. B. Sands, then a leading surgeon of New York, had been in Germany and had urged Langenbeck to use ether, which he insisted was safer than chloroform. Langenbeck, as a courtesy to his foreign colleague, invited him to give ether in the next case in his clinic. Langenbeck, however, never operated on that case, for while he waited with his scalpel, the patient died on the table from the ether. This unforeseen tragedy naturally delayed the acceptance of ether in Germany.

Years later, when Keen had become the counselor of American surgery and was invited to deliver the Ether Day Address, October 16, 1915, at the Massachusetts General Hospital, he chose a topic which may have seemed ungracious in the birthplace of modern anesthesia. Keen spoke on the dangers of ether as an anesthetic, but emphasized that the recognition of danger is the first step in its elimination; he said that when life is at stake, ignorance is not bliss. He pointed out that especially trained anesthetists are essential for safety; and there was value also in his warning that the percentage of mortality from ether in America was over three times as large as in Great Britain. Since etherization was an American discovery, it was inexcusable that ether should take a greater toll of human life in this country than abroad.

Keen made it plain: "What we want is such an anesthetic and such anesthetists that there shall be no deaths at all." The search for the ideal anesthesia is still going on, but after a century it has not been found. Since every case of anesthesia brings the patient to the gates of death, anesthesia remains the most dangerous specialty in medicine.

Eternal vigilance is the price of safety in anesthesia. Despite the remarkable advances that have been made within the past two decades, it must never be forgotten that any incompetence, or even the carelessness of a moment, may place Death in the rôle of anesthetist. This is the solemn note that must be sounded in any celebration of the Victory over Pain.

Sir Benjamin Ward Richardson (From Richardson's *Disciples of Aesculapius*, 1901)



Carl Koller

THE BEGINNINGS OF LOCAL ANESTHESIA

TWENTY-FIVE

Benjamin Ward Richardson

(1828–1896)

As a rule, a young lady should not be aroused from deep sleep at five o'clock in the morning. But an exception must be made if the Archbishop of Canterbury and the Lord Chamberlain (particularly if the Lord Chamberlain is Conyngham), are nervously pacing back and forth, knocking, thumping and hallooing. The drowsy porter at the gate refuses to awaken the girl at that hour, and the governess, who has finally been summoned, is equally reluctant. The visitors insist there are times when the business of state must take precedence even over sleep.

So the governess gently touches the girl and whispers to her. The girl rubs her eyes, yawns, and asks what time it is. With a shawl thrown over her white nightgown, her feet in loose slippers, and her hair falling down her back, she goes to meet her visitors. At the sight of her, the chamberlain and the archbishop drop to their knees, and with bowed heads they kiss the girl's extended hand. It so happened that an old man had passed away in the night, and this girl of eighteen summers, less than five feet in height, has become the Queen of England and all its colonies.

Not long after this awakening came Coronation Day, June 28, 1838. The royal procession is greeted with enthusiasm. The people realize that the girl-queen knows little of world affairs, but her very youth and inexperience are a relief: "Since the century began there had been three kings of England—men all advanced in years—of whom the first was an imbecile, the second a profligate, and the third little better than a buffoon." The girl-queen typified innocence and virtue, qualities pleasing to the British character. Thus began the Victorian Era.

A boy who had not yet reached his tenth birthday was among those who saw the girl-queen pass through the cheering crowds on Coronation Day. His agitation was extreme, yet he managed to fall asleep that night. In the morning, he went to the bed of his sick mother and told her he had seen the horses, the carriages, the soldiers in their grand uniforms, and a little girl carried around a field while all the people kept shouting that she was the Queen.

The mother smiled as he prattled childishly while looking at her son with infinite love. She felt that the time had come for her to reveal to him the truth, for there was so little time remaining to her. She reminded him that he had not seen her eat her meals as the rest of the family did. She said that she would not be his companion much longer and that her sister would soon be his second mother. Of course, he would never forget her entirely, but as the years passed the memory of her would gradually fade.

The mother informed the boy of her last desire: he must be a doctor. She had arranged for his preliminary education with a minister near whose rectory stood the house in which William Cheselden, the great London surgeon, was born.

She reminded him of the oil painting which hung in their dining-room. When she had been strong, she had often lifted him up to look at it. That picture had belonged to Cheselden himself, and therefore, she admonished him, he must never part with it.

Moreover, his father was acquainted with her wishes, and would do his utmost for their fulfillment. But the boy must do his share. He must be a good boy, pay attention to his studies, and enter the medical profession. Then the dying mother breathed a prayer for the dear young Queen Victoria. She hoped that the life of Her Majesty would be long and happy and that the boy—his name was Benjamin Ward Richardson—would grow into one of the useful men during her reign.

When Richardson was a medical student in Anderson's University in Glasgow, there was one day in the week that the class dreaded—operating day. The students as a whole were a merry and indifferent lot, tough and thoughtless, but the sight of a knife cutting into human flesh, the blood spurting over the conscious and frightened patient, the paleness and silence of the victim suddenly giving way to nerve-shattering screams—all this, combined with the knowledge that the operation would be followed by profound shock and prolonged depression, was more than they could endure with composure.

One of Richardson's practical teachers informed him that watching surgical operations was like learning to smoke—difficult at first, but one got used to it. When Richardson was about to witness his first major operation, he attached himself to an older classmate in the hope that he would derive courage from the latter's maturity. His confidence was misplaced. As the patient entered the surgery, the elder student went white and left the room.

In those days many students fainted in the operating theater. Some found it necessary to abandon their medical studies for less harrowing occupations. Richardson himself passed through his early operations in a haze of semi-consciousness which acted as a protective shield. Like others, he became hardened at last, but he never lost sight of the fact that the pain of surgical operations was too great for the nervous system of mankind. The order of the day soon became obvious to him: "The quicker the surgeon, the greater the surgeon."

On one occasion, Richardson's class waited for a lecture by Moses Buchanan, a professor noted for his punctuality. When he did not appear on time, the class began to stamp, whistle, and sing to the chorus of "Let's Go." They announced their vehement intention of departing for home. Suddenly, the janitor, John MacDougal, opened the door at the back of the lecture-table, and there stood the missing anatomist. "Gentlemen," said Moses Buchanan, "no lecture today." The astonished class waited silently for an explanation of this unexpected announcement.

Evidently laboring under deep emotion, the teacher explained that the ship *Arcadia* had arrived from America, bringing the wonderful news that surgeons at the Massachusetts General Hospital had operated on patients—while they were asleep. He could not lecture; he was on his way to the Royal Infirmary to take part in the first trial of the new system there. If the reports were true, it would prove epochal in the life of every man in the class and indeed for mankind. If true, it was the greatest news that had ever been received by surgical science. If true, it heralded the abolition of pain.

Never had the Royal Infirmary been so crowded. Every seat was taken, every inch of space occupied. Students, among them Richardson, climbed into the pulpit; others pushed their way into the precentor's pew—for the operating room served as a chapel on Sunday. These places were of course forbidden to students, but no one gave a thought to formal rules. In the arena, the students recognized Moses Buchanan and the other house-surgeons in their blue-striped gowns.

Then Andrew Buchanan stepped to the front—there were several medical Buchanans in Glasgow—for he was the operator of the day. He explained that the new process from the Massachusetts General Hospital consisted of inducing deep sleep by the inhalation of the vapor of ether. It was called *an-æs-the-si-a,* a term derived from the Greek and meaning "not to feel." Andrew Buchanan informed the audience that his colleagues and he, after due consultation, had decided to put the new method to the test with as much care and precision as they could possibly command in a first trial.

After these preliminary words, the patient was brought in. Now the students perceived the dawn of a new era, for it stood realized before them in the form of a smiling, confident patient. Hitherto, in all the operative cases they had ever witnessed, the patients seemed frozen in an attitude of hopeless despair; but this patient entered with his face wreathed in smiles, his confident brogue resounding throughout the arena. To be cut without pain seemed indeed a pleasure, and to be the first man in Scotland to be put to sleep on an operating-table was an unexpected honor.

The patient lay on the table without fear, and the ether vapor was administered from a sponge with a towel wrapped around it. While the class awaited results in a fever of expectation, the patient began to sing and recite a verse from Robert Burns, then proceeded to relate some intimate details about himself. Suddenly, there was complete silence. The atmosphere in the room became filled with suspense as the operation proceeded. When the operation was at an end, the patient awakened, and he was asked how he felt. A broad smile spread over his features as he confided he felt "just a wee bit fou."

Only those who had witnessed surgical operations before and after the advent of anesthesia could fully appreciate the difference that had been wrought in the operating-room. The medical life of Richardson was long and unusually diversified, but it is not surprising that toward the end of his life he wrote: "The most treasured day in my life is that day when I witnessed for the first time the physical miracle of the abolition of pain during a surgical operation, the grand transformation of the phenomenon of agony into the phenomenon of sleep."

Having had anesthesia thrust upon him in so dramatic a manner, it was natural that Richardson, despite the press of numerous other affairs that claimed his attention, nevertheless worked incessantly for the conquest of pain. He prepared an alphabetical list of all substances which might possess anesthetic properties, and investigated all of them.

Not content with current agents, he tested various fluids and gases in the hope that he might discover the perfect anesthetic of the future. It was characteristic of him that in this search he should invade the sanctuaries of the past, and seek again the anesthetics of antiquity. But no apothecary shop in the British Isles could furnish a sample of the true mandragora of the ancients. The most famous of drugs had become obsolete.

In his dilemma, Richardson appealed to the Quaker pharmacist, Daniel Hanbury, the authority on the history of Chinese materia medica, and co-author of the standard *Pharmacographia*, London, 1874. In response to these fervent appeals, Hanbury would smile in his gentle manner and request his impetuous friend to be patient. Within a few months, Hanbury sent him a splendid specimen of the mandragora root, gathered in the isles of Greece.

Upon receiving the mandragora root, Richardson powdered and macerated it with alcohol. He could then justly claim: "I made, perhaps for the first time since the thirteenth century, the Wine of Mandragora." He tested the tincture on pigeons and succeeded in making them unconscious; upon recovery they flapped their wings and made imperfect efforts to fly. Then he tested it on rabbits, which went to sleep and upon awakening staggered in running. He applied it to his own lips and tongue, and found them numb and insensible to pain. Although there was no doubt of the narcotic potency of the Wine of Mandragora, Richardson realized that it was a far from perfect anesthetic.

In his prolific efforts to conquer operative pain, Richardson introduced fourteen anesthetics in a span of four years. His were the first carefully conducted experiments with the object of securing local anesthesia.

The pleasant event which put him on the right path demonstrates that a savant does not necessarily waste his time by going to a gay party. It is best put in his own words:

One night my wife and I went to a ball after I had been busy in the laboratory for many hours. A young lady with whom I was about to dance let a little eau de Cologne fall on my forehead, by blowing it briskly through a small tube. The cold produced was intense, and pinching the bit of skin affected by it I found that it was benumbed. Thank you! I said, and seized upon the fact.

Richardson was a hard worker, but dancing was a delightful relaxation, and it was too late to return to the laboratory after the ball. The next day, however, he entered his laboratory with a feeling of gratitude for his dancing partner. He recalled the sensation produced by the blowing of the eau de Cologne on his skin. An idea crystallized in his mind. Having this much clue, he studied the effects of rapid evaporation of volatile liquids in producing cold at a given spot on the skin. He would obtain local anesthesia by the rapid evaporation of volatile substances. He then produced local insensibility by freezing the part with the ether spray which he devised in 1867, a method which remained in general use for many years.

Richardson was never an investigator of the first rank; not sufficiently profound, he was rather a spectacular and brilliant dilettante than a scientist. He was extremely versatile and dispersed his talents in too many directions. When he edited *The Asclepiad* (1884-95), several of his colleagues sent him articles for publication, all of which he returned, for he wrote every word of the eleven large volumes himself. He found time, despite his voluminous contributions to medical literature, to try his hand at composing songs, poems, and plays.

Richardson was one of the famous doctors of the Victorian Era. He was knighted in 1893, but today he is an antiquated, half-forgotten figure, the man who did not believe in bacteriology and asserted, "I have never seen a germ." But the history of medicine should preserve an honorable place for Richardson. For he was one of the pioneers of preventive medicine and labored valiantly for half a century to place the entire matter of anesthesia on a scientific basis. Until the advent of cocaine, in 1884, the only known method of local anesthesia was the Richardson ether spray.

TWENTY-SIX

Carl Koller

(1857–1944)

THE CENTURY which witnessed the Renaissance of the Old World likewise saw the obliteration of the culture of the New. The zeal of the Spanish ecclesiastics of Mexico in destroying the Aztec manuscripts was equaled only by the greed with which the conquistadors of Peru looted the treasures of the Incas. No complete codex has survived, and not a single gold-and-silver flower ornament escaped those voracious melting-pots. The engineering projects of the Incas, including the aqueduct five hundred miles in length, their unrivaled masonry, the magnificent tapestry, the human clay images, the trephined skulls, mummies, bandages, and huacos or water-jars depicting obstetric, pathologic and surgical scenes, will arouse regret in every generation that Pizarro and his followers left so little even for the archeologist to contemplate. Here the medicine-bag is more fortunate than pickax and spade, for while the Spaniards destroyed men and their products, they left the trees whole. These trees were destined to bring to the human race healing and relief from pain.

The forest of Peru which gave quinine to mankind, contained a smaller tree or shrub whose vivid green leaves held a darker secret. Visitors in the early days, returning from Peru, related exotic tales of a coca-plant. They told that the natives regarded this plant as sacred and used it as an offering to the sun. The most august title held by the queen of the Incas was Mama Coca. When an Indian chief was ennobled, he received from the king the two most precious gifts that could be bestowed in the estimation of the Incas —women and coca. While holding a few leaves of coca mixed with ashes in his mouth, the Peruvian Indian, foregoing food and sleep, could perform incredible feats on the slopes of the Andes. While Sydenham was reporting cases in which the Peruvian bark was described as "the great remedy for intermittents," a physician of less repute, the poet Abraham Cowley, extolled the coca-plant in laudatory Latin verse. The medical authorities ignored the travelers' tales, nor did they pay attention to Cowley's lyrical botany.

The Divine Plant of the Incas, classified as *Erythroxylon coca* by Lamarck, waited until the second half of the nineteenth century for chemical examination. Scherzer, an Austrian naturalist returning from a scientific expedition around the globe, brought back from Peru the sun-dried leaves which broke readily and gave off a pleasant odor like tea. These specimens reached Friedrich Wöhler's chemical laboratory in Göttingen.

Wöhler's great days of discovery were drawing to an end, and he entrusted the puzzling plant to his assistant, Albert Niemann of Goslar. Young Niemann, in need of a theme for his inaugural thesis, exhausted the leaves with acidulated alcohol, treated the tincture with milk of lime, and then filtered it. He added acid to this filtrate and distilled off the alcohol. Now, he had a syrupy mass from which he separated the resin and water. The residue he precipitated with sodium carbonate; the deposit he subjected to a vigorous shaking with ether. Then he allowed this ethereal solution to evaporate. The ether disappeared into space, but the crystals remained behind. Niemann knew he had isolated coca's active principle, which from the parent plant he called cocaine (1860). Niemann declared that it "benumbs the nerves of the tongue, depriving it of feeling and taste."

In 1862 Schroff, the first to experiment on man with the new alkaloid, publicly called attention to its power of producing the anesthetic state. Moreno y Maiz (1868) after a hypodermic injection of cocaine into the leg of a frog, found that sensation had been abolished when he laid bare the sciatic nerve, and hinted that "it might be used as a local anesthetic." In 1880 Vasili Anrep, after an elaborate series of experiments upon an ascending scale of animals, which included himself, also pointed out the possibility of cocaine's becoming a useful local anesthetic. These suggestions apparently carried so little weight that during this same year a British Medical Commission pronounced cocaine an undesirable substitute for caffeine, but otherwise devoid of medical interest. It is startling to recall that for fully a quarter of a century after Niemann's discovery, cocaine remained only a graphic formula. Standard texts on materia medica and therapeutics did not mention it, nor did any pharmaceutical house manufacture it. This neglect had a negative virtue; there was not a cocaine addict in the world.

The medical profession became actively conscious of cocaine in an oblique manner. A brilliant young physiologist, afflicted with neuromata in the stump of an amputated thumb, sought relief from his agony in the drowsiness induced by poppy. Unable to free himself from his addiction, he consulted the physicians Joseph Breuer and Sigmund Freud. Oblivious of the dangers involved, they combated the morphinism of their colleague by the substitution of cocaine. A drug which so powerfully affected the nervous system could not but fail to fascinate the man who founded psychoanalysis. Freud's publications on coca are among his first contributions to medical literature.

Freud, wishing to learn more about the systemic effects of cocaine, invited the collaboration of a recent Vienna graduate, Carl Koller, who was then interne and house surgeon at the Allgemeines Krankenhaus. Freud and Koller took the alkaloid by mouth, and measured their muscular power with the dynamometer. The instrument would have registered well even without the alkaloid, for in those days Freud was twenty-seven, and Koller a half year his junior. But Freud's and Koller's interest in cocaine was not identical.

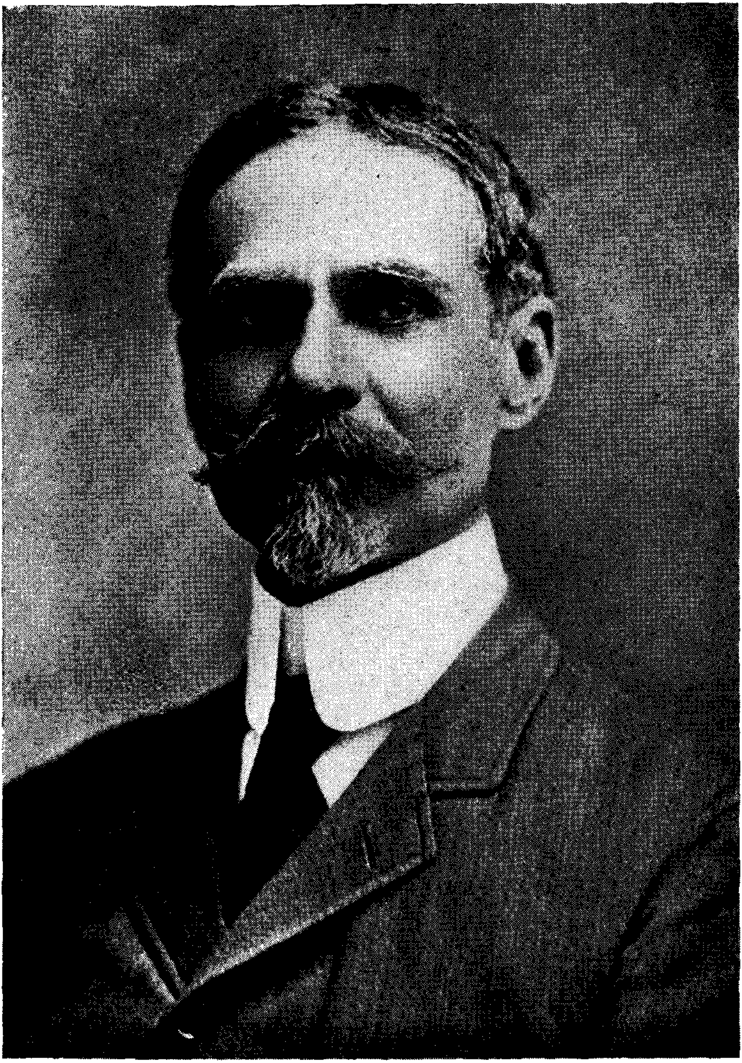
While Freud was familiar with the local anesthetizing power of cocaine and its salts, and felt that their uses might readily be extended, he was primarily concerned with the general action of the drug. Koller, who had previously searched for a local anesthetic for the eye and had failed with chloral, bromide, morphine, and other substances, wondered if cocaine would succeed. In surgical ophthalmology, such procedures as general narcosis, compression instruments, the ancient method of constricting the carotids, and the Richardson ether spray did not avail. Ancient and modern ophthalmologists alike operated upon the sensitive organ of vision without benefit of insensibility.

Koller, already familiar with the experimental workshop of the pathologist Salomon Stricker, again entered his laboratory, well-stocked with the indispensable frog, rabbit, guinea-pig, and dog. After applying a few drops of cocaine solution to an animal's eye, he touched the cornea with the head of a pin. No reflex closure of the lids occurred, the eyeball did not move, and the head was not jerked backward. He scratched and pricked the cornea with a needle, irritated it with a powerful electric current, and cauterized it with a silver nitrate pencil until it became milky white. Never before had an eye remained insensitive to mechanical, chemical, thermic and faradic stimulation. Not once did the animal betray any distress, and Koller no longer hesitated in testing the alkaloid upon the human eye—his own first.

A Congress of Ophthalmology met at Heidelberg on September 15, 1884. The leading figure was the Bohemian Ferdinand Arlt. Though retired from his professorship at Vienna because of age, he was frequently on his feet during the clinical discussions, speaking in that clear voice which his colleagues knew so well. His monograph on glaucoma, which had just come from the press, was admired by all. Josef Brettauer of Trieste carried in his pocket a brief communication and a vial of liquid forwarded by Koller, who was not in attendance. With Arlt and others looking on, Brettauer instilled a few drops of the solution into the eye of a patient from the Heidelberg Clinic. A probe was pressed into the cornea until its surface was indented, the conjunctiva was seized by fixation forceps and the globe moved in all directions.

The following day the experiment was repeated for the

William Stewart Halsted (From a painting by Sargent)



James Leonard Corning

entire Congress. The patient's declaration, that he felt nothing, sent a thrill through every ophthalmologist present. It was their most significant gift since Helmholtz had brought them the ophthalmoscope. The era of operating on the eye of a writhing and screaming patient belonged to the past: the era of local anesthesia had dawned.

At this point it is interesting to recall that Freud, and not Koller, might have been the discoverer of the power of cocaine, had not romance interfered with research. Freud thus explained the circumstances of his failure to enter the temple of fame in his youth:

In 1884 a fortuitous but intense interest caused me to send for Merck's then little known alkaloid cocaine, so as to study its physiological operation. While I was engaged on this work, the opportunity of a visit presented itself, in the course of which I should meet my fiancée, whom I had not seen for two years. When I returned from my holiday, I found that one of my friends, Carl Koller (now in New York), with whom I had discussed the possibilities of cocaine, had made the decisive experiments on an animal's eye, and had demonstrated them at the ophthalmological congress in Heidelberg. Koller has therefore quite rightly been hailed as the discoverer of local anesthesia by cocaine, which has become so important in minor surgery. I bore my fiancée no grudge for my failure!

In the summer of 1884, the world's supply of cocaine was limited to a few grams manufactured by Merck of Darmstadt for Freud. In the autumn of that year a single grain of the alkaloid cost many times its weight in gold. Koller started a new industry, and Peru began to export over three thousand pounds of cocaine annually.

The discovery was everywhere received with acclamation. Fashionable young men began openly snuffing cocaine at theater parties. An eye surgeon in the South was sufficiently enthusiastic to propose the eponyms: Kollerism, Kollerized, Kollerization. So lively was the discussion that arose between two other surgeons as to priority in using cocaine anesthesia that a medical editor was constrained to write: "The loneliest doctor in the world is the ophthalmologist who hasn't written an article on cocaine."

Among the developments stemming from Koller's discovery was Halsted's conduction anesthesia. William Stewart Halsted, one of America's greatest surgical thinkers, working at The Johns Hopkins University, demonstrated that anesthesia of almost any part of the body could be effected by injecting local anesthetic drugs (he worked originally with cocaine) around important nerves supplying the operative area. Within a year of Koller's announcement, Halsted created neuro-regional anesthesia, and was able to report the invariably successful employment of cocaine in more than a thousand surgical operations.

In the following year, however, there was no contribution from the pen of Halsted, for in the course of his experiments he had taken cocaine until he could no longer do without it. There were many tragedies before cocaine's terrible power became known, and Halsted, upon the threshold of illustrious achievement, was one of the few who freed himself from the most devastating of all drug addictions. Henry Dewey Noyes had written with prophetic insight: "We may yet find that there is a shadowy side as well as a brilliant side in the discovery." William Stewart Halsted, a secret patient on ship and in hospital, knew both sides of cocaine.

For a long time, Halsted's important work went unnoticed until the New Orleans surgeon, Rudolph Matas, called attention to his great contribution. In an article which appeared in the *Philadelphia Medical Journal* in 1900, Matas reviewed what had been done in the field of local anesthesia up to that time and described in detail most of the procedures which are still in use today in performing local anesthesia. He pointed out the importance of controlling the psyche in patients undergoing operations under local anesthesia. He recommended the use of morphine as a preliminary to the local for this purpose, and he showed the value of using morphine and inhalation anesthesia with local anesthesia in difficult cases. He was the forerunner of that school of thought which today advocates "balanced anesthesia." In addition, he was a pioneer of spinal anesthesia in the United States. Matas was a tireless experimenter, and to his careful work must go much of the credit for present-day knowledge in the field of local anesthesia.

The progress of local anesthesia, however, waited upon the development of a better drug than cocaine. It was soon evident to those who used cocaine that there were altogether too many unfavorable reactions. In part, this was due to the use of too high a concentration of the drug, as Matas noted. But even with proper percentages, cocaine was still too toxic. Especially was this true when it was used for spinal anesthesia.

It is interesting at this point to mention an invention which was to play a significant part in making possible the administration of local anesthetics by injection. This was the invention of the hypodermic syringe in 1853 by Charles

Gabriel Pravaz of France, after whom it has been named, though it was first used for the injection of narcotics by Alexander Wood of Edinburgh in 1855. When cocaine and other drugs were discovered many years later, the instrument for their administration lay ready to hand.

Stovaine, discovered by the Frenchman, Ernest Fourneau, enjoyed favor for a time as one of the first cocaine substitutes to be synthesized.

Then, in 1904, Alfred Einhorn synthesized procaine, the drug better known under its trade name—novocaine. This proved to be an advance in local anesthesia because it was less toxic than cocaine and produced much less systemic reaction when injected into the tissues. Much weaker than cocaine, it is not suited for producing topical anesthesia (anesthesia of the surface of mucous membranes) but when injected it takes effect fairly promptly and when used in proper amounts produces practically no undesirable effect.

In 1905, the German Heinrich Braun introduced novocaine into clinical use. Surgeons everywhere recognized it as a satisfactory local anesthetic agent, and it is favored today over the newer drugs because of its low toxicity.

The newest improvement in the use of novocaine has come in the search for a solvent which would be retained by the tissues for a longer time and thus exert a more prolonged anesthetic effect. Novocaine dissolved in peanut oil has made it possible to prolong the action of novocaine for several days. This formula has become increasingly popular in operations on the anus, such as hemorrhoidectomy, because relief is afforded for a period of several days.

Thus, the work of Koller spread its blessing over the earth, but the man himself remained in the background. The year following his discovery he went to Utrecht as assistant to Snellen and Donders, who almost made ophthalmology a Dutch province. In May 1888 he came to New York, serving as ophthalmic surgeon to the Mount Sinai Hospital and Montefiore Home.

The pen was not his instrument, and he never wrote if he could avoid it. Yet many could testify to his ophthalmic excellence. Years ago he had a ten-year-old patient who could not see as other boys did; with Koller's prescription, his vision became so keen that on the tercentenary of the publication of *De motu cordis,* he was able to give us an admirable translation from a wretchedly printed Latin edition of William Harvey's classic treatise on the circulation of the blood. The boy, Chauncey Leake, became a scientist, known to all anesthetists as the discoverer of divinyl oxide.

In his later years, Carl Koller, courteous but reticent, spoke and moved with military precision. His visitors were immediately impressed with his competence. He was an early riser, and reached his office on foot at seven o'clock in the morning. By noon, he had despatched an extensive practice, and then walked home. Daily, in the crowded streets of the city, he must have been elbowed by people to whom cocaine had been a boon, but who little realized that the man they passed unheedingly was their benefactor. No doubt, from time to time, he also encountered mere shadows of men, for whom it would have been better if cocaine had never been known.

It is not at all certain that the tight-lipped Carl Koller would have been grateful even for these guarded personalia. Although he was implored to remember that the father of local anesthesia was a public figure, he would not indulge in autobiography. Yet this much at least it is permissible to say: Carl Koller was a physician who lived for sixty years after his discovery, serving his fellow-men, and keeping inviolate the Hippocratic Oath.

FROM RAG AND BOTTLE

TWENTY-SEVEN

Techniques

ANESTHESIA BEGAN with the "rag and bottle." Whether the "rag" was the sponge which Morton used, or the folded pocket handkerchief employed by Simpson, a fluid was turned into a vapor by pouring it from a bottle on a rag. This was the first method of inhalation anesthesia, and though a century of progressive mechanics has evolved machines of remarkable ingenuity, the lowly "rag and bottle" still has its champions. Despite masks and valves and stopcocks and multiple cylinders, the "rag and bottle" should never become a term of reproach—the "rag and bottle" was the baptismal font of anesthesia.

At the turn of the century, anesthesia, then an accomplished fact of more than fifty years standing, was still a developing science. Advancement was now made, not through a series of startling discoveries, but as a laborious process of applying existing knowledge in the basic sciences to the practical everyday problems. Pharmacologists, physiologists, surgeons and clinical anesthetists in increasing numbers turned their attention to discovering new drugs and methods, plucking many of them from the archives of medical literature where they had been buried as isolated adventures of scientific curiosity.

In 1882, for example, August Freund discovered the drug cyclopropane; almost forty years later Lucas and Henderson unearthed it to establish its anesthetic potentialities. In 1902 Emil Fischer synthesized barbital (veronal), yet for almost twenty years the application of this important drug to the field of anesthesia lay dormant, until in 1920 Bardet, utilizing a combination of veronal and another barbiturate, pointed out the possibility of using this type of drug for intravenous anesthesia. It took an additional twelve years before a suitable drug of this series (evipal) and later another (pentothal) were found to be satisfactory in intravenous anesthesia.

In the period from Wells and Morton to 1900 one writer lists sixty-nine outstanding events in anesthesia, and in the period from 1900 to 1944 an additional one hundred and thirty-two. But it is remarkable that with one or two exceptions this latter period does not present us with any basic discoveries. Although advances were made in methods and drugs, the outstanding feature of this period was the struggle to elevate the profession of Anesthesiology to its deserved place as a scientific specialty in the general field of medicine. One might say that this has been the period when the man "with the rag and bottle" has begun to give way to the specialist.

"When giving a volatile anesthetic, the modern anesthetist is like the stoker in an oil-fired liner—having set the taps, all he has to do is to give an occasional glance at the gauges to see that all is well." This statement is a bit inexact, yet it indicates, in a fashion, the extent of the developments in anesthesia apparatus.

The history of anesthesia cannot be fully told without an account of the significant advances that have been made in equipment. This aspect of our story, while lacking in the dramatic clashes of personality which we witnessed earlier, has its own attraction for the modern mind, geared to a world of cogs and wheels.

The beginnings of present-day apparatus go back to the eighteenth century, when James Watt constructed a gas inhaler for Thomas Beddoes's Pneumatic Institution. Four years later, Humphry Davy designed his "gas machine" for the storage and inhalation of nitrous oxide. This too was built by Watt.

With the Discovery, of course, a flood of equipment appeared, good, bad, and indifferent. The early ether inhalers, modeled on Morton's original device, gave way to the ether sponge. This was a sea sponge, probably similar to the sponge of Theodoric of the thirteenth century, hollowed to fit the face and then saturated with ether.

In England, closed inhalers were the favorite apparatus. There was the inhaler of John Snow and in 1862, his successor, J. T. Clover, published an account of a chloroform inhaler which made possible a more accurate regulation of the percentages of chloroform and air. Clover, whose frail physique kept him out of the surgical arena except as an anesthetist, also devised what has been called the most advanced piece of apparatus prior to the twentieth century. This was a machine by which either nitrous oxide or ether, or both, could be administered separately or simultaneously. The Clover inhaler, however, had two serious short-comings: (1) no provision for admitting oxygen in mixture with the nitrous oxide; (2) since the patient was breathing into a closed apparatus, i.e., closed to the outside, it consequently made no provision for the removal of the carbon dioxide fraction of each exhalation.

For the most part, nitrous oxide was being administered in a pure state without admixture of oxygen. Perhaps some believed that Sir Humphry Davy's conception was correct: that the tissues received oxygen given up by the nitrous oxide molecule, and that therefore oxygen was not necessary.

But to Edmund Andrews of Chicago the idea that nitrous oxide should be administered without admixture with oxygen went counter to good principles of human physiology. As early as 1868 he had pointed to what might result from an oxygen-want, that the giving of pure nitrous oxide produced convulsions and cyanosis.

But twenty years were to elapse before a machine was introduced which allowed for the mixing of these two gases. Such a machine was devised by Sir Frederic W. Hewitt, who was one of the first to make practical application of the principles laid down by Andrews. Hewitt devoted himself to anesthesia because his weak eyesight prevented him from becoming an operating surgeon. It was a great gain for anesthesia.

Hewitt was concerned almost entirely with dental anesthesia. His text on anesthesia, first published in 1888, is still, in its current revised form, a model of authoritative writing. But there was one unfortunate consequence of Hewitt's work, arising from his underestimation of the proper concentration of oxygen in nitrous oxide and oxygen anesthesias. Since Hewitt was preoccupied with dental anesthesia, his formula was safe enough for the very brief administration during which a dental extraction is made.

Unfortunately, however, his idea was carried over into general surgical practice.

This was the start of one of the most violent controversies in anesthesia, which even today is not settled. Men who practiced nitrous oxide anesthesia pointed to the millions of administrations without any report of fatality. But, in the main, they failed to take into account that most of these administrations were for very brief periods, largely for the purpose of extracting teeth.

Paul Bert, the great French physiologist, whose basic work in altitude physiology had such important impact on aviation combat in World War II, tried to solve the problem of nitrous oxide anesthesia by constructing a special tank, large enough to include the operating-table with patient and all the operators. Bert was a keen physiologist. He knew that the mixing of very small quantities of oxygen with nitrous oxide was dangerous to life. He tried to solve this problem by subjecting the patient to increases in atmospheric pressure in his special tank, but it was soon evident that the idea, feasible though it sounded, did not work.

Subsequently, S. S. White, C. K. Teter, E. I. McKesson, and J. A. Heidrink devised important anesthesia appliances, following the principles laid down by Hewitt. In all instances the mixtures of nitrous oxide and oxygen were roughly approximated.

Teter developed a large practice in anesthesia in Ohio during the early 1900's, and has given 100,000 dental anesthesias with his apparatus. He also did a great deal of work with the famous surgeon George W. Crile, in Cleveland, while Crile was developing his important contributions on the combination of local and general anesthesia.

None of these machines was designed to measure the rate of flow of gases. Provision was made merely for the rough gauging of the proportions of the two gases, while the anesthetist depended mainly on physical signs evinced by the patient to indicate whether the nitrous oxide or the oxygen flow should be changed.

In this same period McKesson had invented a gas machine for proportioning mixtures of nitrous oxide, but while it may have added slightly to the degree of accuracy of gas mixtures, the principle of administering nitrous oxide and oxygen did not change. The practice of very low mixtures of oxygen was still followed.

In 1910, W. D. Gatch and in 1912, Walter Boothby, devised machines which added another feature, that of a partial rebreathing of the anesthetic gases. This followed close upon the work of Yandell Henderson on the rôle of carbon dioxide in stimulating respiration. The Gatch apparatus was unique in that it was the first machine to provide a means of actually seeing the flow of gases, referred to as sight-feed.

The next important step was taken by James T. Gwathmey, one of the great figures in anesthesia, whose machine, first built by Richard Foregger in 1914, provided a separate flow of gases which could be easily visible. In the following year this machine was calibrated so that the rate of flow could be roughly gauged; it was also provided with an ether vaporizer. Gwathmey did not recommend low concentrations of oxygen, but proposed using liberal amounts and adding ether when necessary to improve the anesthesia. A modification of the early Gwathmey machine, devised by H. E. G. Boyle, with the addition of a few improvements, is still the standard machine in use in England.

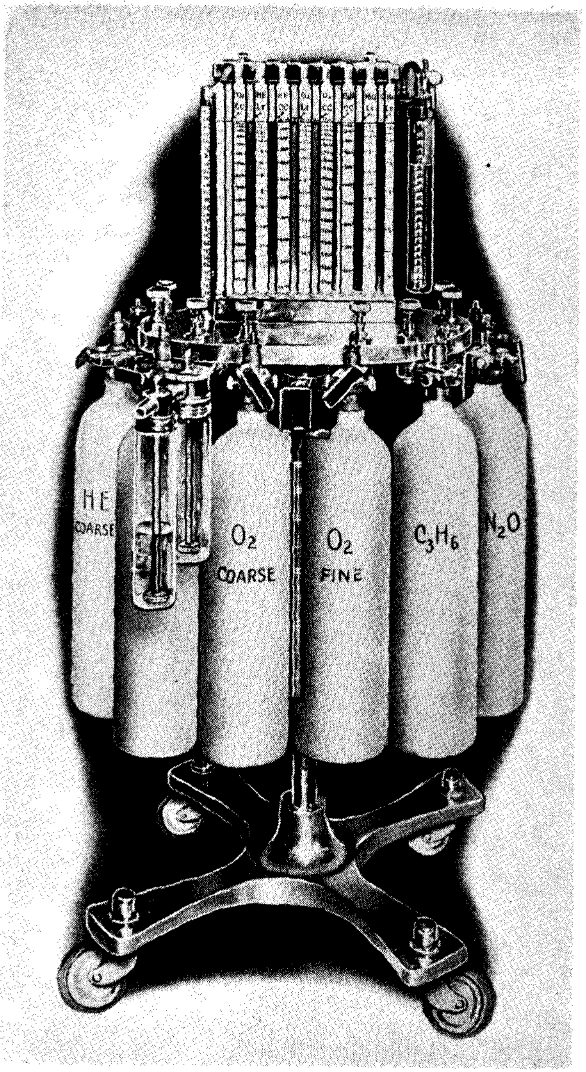
For some time physiologists had questioned the validity of Henderson's ideas on the utility of carbon dioxide, and had demonstrated in the laboratory the deleterious effects of inhaling excessive amounts of carbon dioxide over prolonged periods. This new view was reflected in a series of papers published in 1915 by D. E. Jackson. In these papers, Jackson described an anesthesia apparatus in which the patient breathed into a closed system while the carbon dioxide was being constantly removed. To absorb the carbon dioxide Jackson utilized aqueous solutions of sodium and calcium hydroxide.

When soda lime became available, Ralph M. Waters devised a simple system which has come to be known as the closed carbon-dioxide absorption system. This method of anesthesia has effected a complete change in anesthesia practice, providing a completely closed system of rebreathing the carbon dioxide, filtered out by soda lime. In 1923, Waters described the apparatus and the technique, pointing to its several advantages over former methods. He showed that by breathing into a closed system, the patient conserved heat and water and that much less anesthetic was needed to reach the desired depths of anesthesia. Moreover, he proved by clinical experience, that by not rebreathing carbon dioxide his patients were in better physical condition at the end of operations, especially if the procedure were somewhat prolonged.

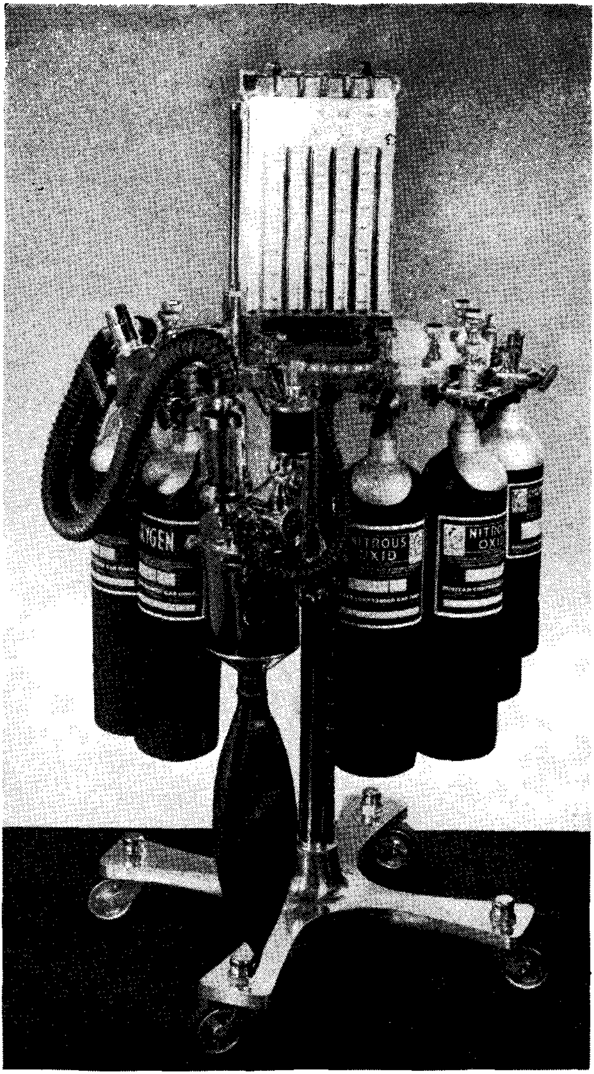
This system required a further refinement in equipment, and in response to a letter from Waters, Foregger provided him with the first accurate anesthesia appliance in which the separate gases were individually measured by the metric system. After the Foregger metric machine had been devised, other manufacturers also adopted this system for their machines.

For many years, the name most often heard in the anesthesia circles of America was "the Frank McMechans." For a generation it seemed that nothing could be accomplished for the development of anesthesia without the enterprise and the enthusiasm of "the Frank McMechans" of Cleveland, Ohio—Francis Hoeffer McMechan (1879-1939) and his wife, Laurette van Varseveld McMechan. In the organization of the American Association of Anesthetists (1912), the name of McMechan was in the forefront. When the anesthetists had no publication of their own, McMechan induced Joseph McDonald of the *American Journal of Surgery* to add a *Quarterly Supplement of Anesthesia and Analgesia.* Under McMechan's editorship, the supplement rapidly made its mark, and is still consulted for its valuable historical articles. Throughout the years of effort for the professional recognition of anesthesia, the McMechans retained an ardent interest in its history.

A dream was realized upon the organization of the International Anesthesia Research Society in 1922, when McMechan became editor of its official organ, *Current Researches in Anesthesia and Analgesia.* This was the first journal to be devoted exclusively to this specialty, and was soon followed by H. M. Cohen's *British Journal of Anesthesia.* McMechan lived to see the establishment of the American Board of Anesthesiology in 1937, which in the first decade of its existence has had considerable influence on the progress of anesthesia as a medical specialty.



Modern anesthesia apparatus: an 8-flowmeter unit of the Metric Anesthesia Apparatus



Modern anesthesia apparatus: base and upright model of the Metric Anesthesia Apparatus

TWENTY-EIGHT

Twilight Sleep

FROM THE point of view of the public, Twilight Sleep is by far the most exciting single experiment in anesthesia. It was certainly heralded with much fanfare and received with great enthusiasm. Even today, although methods of anesthesia in childbirth vary from one country to another, from one locality to another, and even from one hospital to another, and nearly every sedative and anesthetic drug is used, the most widely known to the public is still that method which bears the romantic title, "Twilight Sleep."

Twilight Sleep stems from the German word *Dämmerschlaf*, a term used by Carl Gauss of Freiburg in his report, *"Geburten in Kunstliche Dämmerschlaf," published* in 1906, to describe that "state of clouded consciousness" induced by the use of scopolamine-morphine.

In the summer of 1914, eight years after Gauss's report, Twilight Sleep made news in the popular *McClure's Magazine*. Not to be outdone by *McClure's*, the *Ladies' Home Journal* and the *Woman's Home Companion* sent correspondents to Freiburg to investigate Twilight Sleep. The published accounts were optimistic. Medical science had solved one of the world's greatest problems. The agony of women in childbirth was a thing of the past. Motherhood at last was released from its ancient travail. A new era had dawned.

A sense of the meaning of the new development is revealed in the testimony of several mothers who had experienced Twilight Sleep: "In describing their sensations after injections [they] tell of a sense of drowsiness stealing over them, a pleasant feeling of don't care-ness which finally merges into an overpowering sleepiness. There is never a single disagreeable sensation associated with the experiment." "I didn't even feel the injection of scopolamine," another mother was reported as saying, "for they first used cocaine on the spot before using the hypodermic needle. Very soon after, I found myself growing drowsy and in about half an hour I fell off to sleep just as naturally as I do on any night when going to bed. The next thing I knew I was awake and I heard the sympathetic voice of Dr. Krönig saying all is well, and then I thought to myself, 'I wonder how long before I shall begin to have the baby,' and while I was still wondering a nurse came in with a pillow and on the pillow was a baby. . . ."

Mrs. Francis Carmody was advertised as the first woman to go to Freiburg in direct response to the painless childbirth propaganda. In reporting her experiences, she wrote: "I came to the klinik about five o'clock and was put to bed in the birth-room; about six o'clock I received the scopolamine injection. The next thing I knew I woke up. I just sat right up in bed and looked at the clock. It was seven o'clock and I realized the night had passed. 'Well,' I thought, 'I must get dressed and go back to the pension. Perhaps the baby will come tomorrow.' Then I noticed I felt lighter, and sat up easily, and my figure had changed. . . ."

It sounded wonderful to the women of America. Here was a panacea for woman's age-old agony. All they had to do was demand it.

In the concluding chapter of her book *Truth About Twilight Sleep,* the correspondent of the *Ladies' Home Journal* wrote:

> I now make my last appeal to every woman who has read this book to take up the battle for painless childbirth where I left off. . . . Fight not only for yourself, but for your sisters, your sex, the cradle of the human race. . . . Through Twilight Sleep a new era has dawned for woman and through her for the whole human race.

If it was true that Twilight Sleep was known to the American medical profession, why did not women know of it? Why did the medical profession withhold it? It was made to appear as though, by some arbitrary conspiracy, doctors were resolved to keep this wonderful discovery from women.

But it was hardly that, and hardly, as charged, indifference on the part of the medical profession to the pain of their patients that caused them to withhold the benefits of Twilight Sleep. For "the mitigation of pains of childbirth has always been the anxious concern of physicians all over the world, but more than ever since the discovery of chloroform and ether and their uses for this purpose," said Barton Cooke Hirst, Professor of Obstetrics of the University of Pennsylvania. In recent years, he said, several methods had been proposed that it was hoped might prove superior—"among them the hypodermic injections of morphia and scopolamine."

The combination of scopolamine and morphine had been in use in surgery for some time, and in 1903 the obstetrician von Steinbüchel of Graz used it in obstetrical cases. Subsequent experiments with it were carried on in a number of clinics without notable success, until, in 1905, Bernhard Krönig and Carl Gauss began large-scale experiments with the drug combination at the Frauenklinik of the State University of Freiburg. In the 1906 report Gauss described the use of the drug on some 500 patients under carefully observed conditions. He concluded:

The *Dämmerschlaf* produced by scopolamine-morphine is able to limit the suffering of the woman in labor to the lowest minimum imaginable. This objective is attained without disagreeable secondary effects upon the subjective condition of the woman in labor, without substantial interference with the labor itself, without danger to the mother, without injury to the child.

But like all anesthetics, scopolamine-morphine had its drawbacks. The drug itself was unstable. It affected different women differently. A small dose might induce *Dämmerschlaf* in one woman, while another might require a considerably larger dose. The dosage, furthermore, must not be too small, for then the amnesia would be incomplete and leave "islands of memory." It must not be too great or it would have poisonous effects on mother and child. The environment for its application must be carefully adjusted: the lighting must be subdued and absolute quiet maintained. For the proper maintenance of Twilight Sleep, uninterrupted watching of the patient was extremely important.

The peculiar quality of scopolamine-morphine was its effect on the memory. It wiped out all traces of memory.

Although the patient might be aware of the actual pains and discuss them with those about her, and groan and scream with agony, she would retain no memory of what had taken place under the influence of the drug. But Krönig would not permit any member of the patient's family to be present because, despite the fact that the patient might have no recollection of her pain afterwards, her outcries might be just as bad as those of women who received no treatment. Not only laymen but even professional observers were thus led to doubt the efficacy of the drug. And the story was often told of the case of a patient who abused her doctor all through the Twilight Sleep, begging for relief, and declaring wildly, "If this is your Twilight Sleep, I don't think much of it," until the doctor almost resolved that this would be his last Twilight Sleep case. Yet some hours later, after the baby's birth, the patient recollected nothing and expressed the hope that labor would soon begin.

Some critics argued that since Twilight Sleep did not actually do away with pain, it was misleading to call it Painless Childbirth. On the other hand, it was held that since there was no memory of pain, the doctors were justified in giving it the name. "If there is no memory of pain, it is equivalent to having no pain. . . ."

Said Gauss, concerning the condition of the patients while under the influence of the drug, "The patients react in very varying manner whilst in this condition of clouded consciousness. The majority of the patients impress one as being indeed sleepy, but otherwise quite normal. . . . So much the more astonishing is it subsequently to learn that the patient whom one believed to be completely conscious has, after the birth, not the slightest idea of what she has just been through." Indeed, after the drug wore off, the patient vowed she had not experienced any pain at all.

But unfortunately good results could be obtained only under the most exacting conditions. Specific requirements had to be met. Gauss insisted that his method be followed in every detail. Experiments were undertaken with the hope of working out a fixed dosage, so that all the delicate adjustments could be dispensed with, but it was soon clear that no routine method could be developed. "If you could trust to having an average woman," Gauss said, "you could use an average dose; but the dose is easier to standardize than the woman."

If there could be no standardization of dosage, then how was a physician to tell when the patient had reached the Twilight stage? Only, said the Gauss formula, by a "memory test." Although the patient may be rational in all other respects, when she fails to remember an object that was shown her a short time before, she has reached the Twilight stage. The memory test is begun, he stated, about half an hour after the second administration of the drug:

Some object is then shown the patient and she is asked to observe it. Sometime after, it is shown her again. If she recalls having seen it before, it is considered an indication that a third dose of the same quantity as the second is required as no clouded consciousness has yet been established. . . .

An effective maintenance of artificial *Dämmerschlaf* is impossible without both a continuous and skilled testing of the condition as to consciousness at the moment. In cases, therefore, where it is impracticable for the medical man, or . . . for a skillful and well-trained, experienced obstetric nurse to keep a close observation on the whole course of the birth, nothing but repeated failures are to be looked for in the general result. . . .

Following publication of the 1906 report, experiments with scopolamine-morphine were widely undertaken. The Berlin Charité sent Hocheisen to Freiburg to study the method. Returning to his hospital, he made numerous experiments and at a meeting of the Society for Obstetrical Practice and Gynecology in Berlin, reported on 100 cases. He found that "the expulsion period averaged 6 hours and 15 minutes against the normal 1 hour and 45 minutes," and he concluded that "Scopolamine causes protraction of birth and protraction of birth causes asphyxia." As the Berlin Charité stood high in the medical world, this report received wide attention and had a profound effect on the profession.

In turn, Gauss pointed out several deviations in Hocheisen's method from his own. He said he could take no responsibility where his directions were not followed. And Preller of the Mannheim Klinik affirmed that "only by systematically following Gauss's instructions can a correct *Dämmerschlaf* be obtained."

There ensued a bitter controversy between the Berlin Charité and the Freiburg Klinik. Adherents of the Freiburg school suggested that Hocheisen had spent more time at the sports than at the clinic. They imputed jealousy, holding that "if Berlin had originated it, it would now be the practice of all Germany." The quarrel rested with Hocheisen's declaration:

If I am right, scopolamine, together with Gauss's cleverly coined word "*Dämmerschlaf*" will disappear from the scene after a time, just as many other loudly praised methods have done. If he is right, within a few years all women will share painless birth without risk and I shall have to admit having been wrong. For the present, however, I take the liberty to continue to warn all practitioners—the optimistic reports from Freiburg notwithstanding.

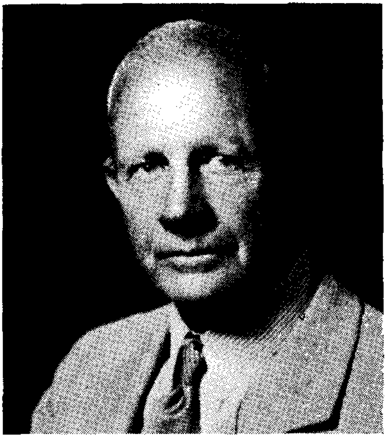
In London, too, the method was tried out extensively. At a meeting of the Section of Obstetrics and Gynecology of the Royal Society of Medicine on December 6, 1917, a special committee presented reports on 252 cases in British hospitals. They were discussed at length, pro and con.

In America, the Twilight Sleep method was employed variously. At Long Island College Hospital in Brooklyn it was used whenever a patient expressed a desire to have it—and almost always with success. On the other hand, The Johns Hopkins Medical School abandoned it after using it in two separate series at the school's hospital.

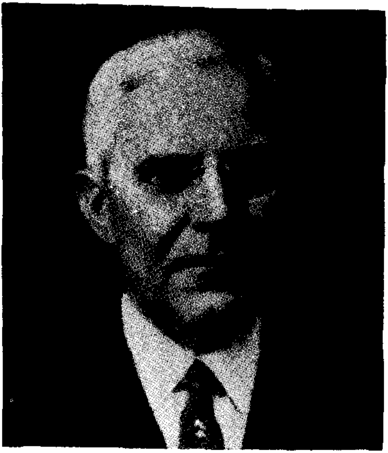
The administration of Twilight Sleep proved to be a difficult and exacting science. The acquisition of skill in the technique was a laborious process. Its use at home was impractical because of its peculiar demands that a patient must have constant watching over a period that might extend to sixteen or more hours. Its use in large hospitals was impractical because, as Krönig stated: "If (as is the custom) the medical man on observation duty is relieved every twelve hours, the colleague who comes on duty will not be sufficiently well informed as to the condition of the various patients in labor. In such a case, failure is certain beforehand."

How to find the absolutely proper conditions?

"Twilight Sleep," said Gauss in 1911, "is a narcotic con-



James T. Gwathmey



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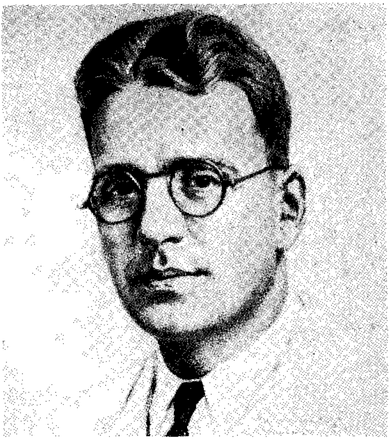
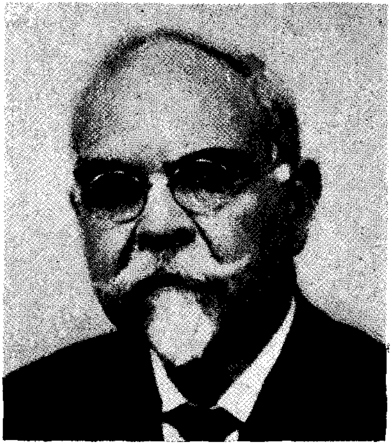


Chauncey D. Leake

Ralph M. Waters

Arthur E. Guedel



Rudolph Matas

Paul M. Wood

Francis H. McMechan

dition of extremely narrow breadth, like a narrow mountain crest. To the left of it lie the dangers of too deep action, with narcosis and absence of birthpains; to the right, the danger of shallow action, with retention of consciousness and sensibility of pain."

Even in the hands of skilful practitioners of the Freiburg method the treatment was by no means sure. An analysis of Gauss's report on 3,000 cases treated at the Frauenklinik up to 1911 shows an important relationship between the degree of care obtained and the effectiveness of Twilight Sleep. Eighty-two per cent of the patients in well-furnished rooms experienced perfect Twilight Sleep, as against fifty-six per cent of the patients in open wards. Thus, in the conditions obtaining at the Freiburg clinic, only two in three who received morphine-scopolamine were blessed with painless delivery.

The whole subject of Twilight Sleep was one to be neither lightly dismissed nor lightly accepted. In too many cases doctors obtained, instead of Twilight Sleep, narcotized or asphyxiated babies and delirious mothers. Earnest discussion of the process in all its ramifications was carried on in the medical journals. Many questioned the value of an anesthetic which, while relieving pain, might lengthen labor or make its normal termination less likely. The discussions would undoubtedly have remained in the medical journals and forums had not the popular press discovered the method and heralded it as a wonder-working panacea. They made it sound altogether marvelous and accessible, and in effect accused the medical profession of trying to bury it. *The Literary Digest* summed up the situation:

Probably the lay public has never interested itself so widely in any purely surgical method as in the so-called Twilight Sleep for painless childbirth. We do not see articles in newspapers and magazines calling on the medical profession to adopt this or that procedure in operations for appendicitis or cataract. But many writers clamor loudly for this particular method and assert that all medical men who do not agree are either malicious or incompetent.

The medical press naturally disliked the publicity given Twilight Sleep in the public press, and the resultant demands for its use. It taunted the popular writers with discovering a new method which "while not entirely obsolete, has been practically discarded." The *Journal of the American Medical Association* referred to the *McClure's* article as the production of "two women apparently without medical training," and of the later publications as a mass of "pseudo-scientific rubbish" emanating from a host of sob-sisters.

But if the lay press seemed ridiculous in some of its claims, no less ridiculous were some of the members of the medical profession who willy-nilly were drawn into the controversy. One brusquely dismissed the subject of Twilight Sleep as though it were unworthy of his time and attention. Another stated flatly that it was dangerous to mother and child. A third, that it was a scheme of two German doctors seeking notoriety and that it was an "outright fake."

Others said, "The pains of labor are not very severe and with proper dispositions are borne quite easily by a great majority of women," and asserted further that the painfulness of having the first child never kept a woman from having another.

Even stranger voices were heard on the subject. Such a method as Twilight Sleep was "against the dictates of God." Even—that "it makes dope fiends of the patients."

If the public discussions in press, forums and public debates did nothing else, they awakened women to the existence of pain-saving devices in child-bearing. And throughout America, some form of anesthesia was used in most of the difficult cases. But now women demanded relief even in normal cases, and the demand was so great that the Public Health Division of the American Academy of Medicine came out with a statement to medical men, saying, in effect, "Take the consideration of *Dämmerschlaf* out of the public press and into your own hands . . . and if not by this means then by some other seek to abolish the pains of maternity!"

The subject of Twilight Sleep has remained in the realm of controversy. At the White House Conference on Child Welfare in 1933, it was reported:

The impression of many clinicians is that scopolamine causes a definite amnesic effect with psychic depression. The drug is unstable, does not keep well except under favorable conditions. From the literature on the subject it would seem that scopolamine is being used by most obstetricians in smaller dosages than formerly and that while a certain degree of amnesia is obtained no attempt is made to secure complete amnesia as was done in the early days of Twilight Sleep.

The search for an ideal analgesic for childbirth still continues.

TWENTY-NINE

Continuous Caudal Analgesia

TWILIGHT SLEEP enjoyed great popularity. But it became evident that by its use, while the mother slept, so did the baby. Although Twilight Sleep is still used today, it is confined to those cases where it is plainly indicated.

Attempts have been made to use some of the newer barbiturates like nembutal and seconal. These have produced results similar to Twilight Sleep; in general, the baby often suffered for the easing of the mother's pain.

In 1942 R. A. Hingson and W. B. Edwards introduced a new idea: continuous caudal analgesia. Forty-one years earlier, two Frenchmen, M. A. Sicard and M. F. Cathelin, had established the fact that cocaine could be injected into the caudal canal—the canal at the base of the spine—and that this would effect anesthesia of the nerves in that region. A few obstetricians had used it on occasion to secure anesthesia for delivery. It seems strange that none of them was impressed by the fact that while getting anesthesia for their deliveries they were also securing complete abolition of the pain resulting from the contractions of the uterus.

Hingson and Edwards studied the problem very carefully from the anatomic and physiologic standpoint. After numerous experiments on cadavers, they established the fact that it was relatively simple to inject drugs into the caudal canal, and that injection of the proper amount of solution would bathe the nerves carrying the pain from the uterus and thus abolish that pain. They seized upon the continuous spinal method devised by W. T. Lemmon in 1940. They constructed some special needles for the purpose. After introducing the needle into the caudal canal and connecting it by tubing to a syringe and a source of local anesthetic, they could indefinitely prolong the anesthesia.

But as in the case of Twilight Sleep, premature enthusiasm in the popular press created false hopes that the perfect form of analgesia for obstetrics had been found. Syrupy accounts and life-sized pictures began to appear in certain publications showing patients doing everything from playing cards to eating steak dinners while having a baby.

The final story on continuous caudal analgesia has yet to be written. This method will require the seasoning which comes through use in hundreds of thousands of cases before certainty is possible. We do know now that it is not suited for all patients. Where there is doubt whether the patient will be able to deliver in the normal fashion, the use of continuous caudal is not advisable; in obese cases, the method is practically useless.

This method of mastering pain in the lying-in chamber seems destined to hold a high place in the annals of anesthesia. When the final verdict, whatever it may be, is given by time, it will be stated to the credit of the originators of continuous caudal analgesia that they consistently warned against its indiscriminate use.

THIRTY

Endotracheal Anesthesia

THE LITERAL MEANING of trachea is "rough artery," thus called because of its rings of gristle; the medieval writers actually called it the *tracheartaria.* Despite its inaccurate name, the trachea is the main air-passage in the body; it is the tube of muscle and membrane which begins at the larynx (organ of voice) and ends at the bronchi; its function is to convey air to and from the lungs, and hence it is popularly known as the windpipe.

The Renaissance anatomist, Andreas Vesalius, whose remarkable description of the human body marked the beginning of scientific anatomy, made a famous experiment upon the trachea. He passed a tube into the trachea of an animal, the chest wall open and the lungs exposed; of course the animal no longer had the power to breathe, but by blowing air into the tube the experimenter was able to maintain artificial respiration. Robert Hooke, deformed physically but gifted with genius, both the wasp and the eagle of the Royal Society, expanded and explained this experiment in 1667.

John Snow, already mentioned as the master anesthetist of his time, made an opening into a rabbit's trachea (tracheotomy), and inserted a wide-bore tube connected with a bag of chloroform; the rabbit, breathing through the vapor-filled tube, was soon chloroformed. This was the earliest case of anesthesia through the trachea, and the inauguration of endotracheal anesthesia.

The pioneer in the application of this procedure to man was the German surgeon, Friedrich Trendelenburg. In 1869 he performed several tracheotomies, passing a wide tube into the trachea and administering chloroform vapor with a gauze-filled funnel attached to this tube. Trendelenburg made an advance in technique by placing an inflatable cuff around the far end of the tube before inserting it. Thus after inserting the tube he would inflate the cuff, achieving an absolutely watertight fit with the wall of the trachea. By this means nothing could get beyond the tube into the lower reaches of the respiratory tract.

Obviously to make an opening into the trachea before introducing the tube was in itself a perilous task. For the next forty years, many surgeons tried to solve this difficulty by finding means to insert a tube into the trachea through the mouth. The Scotch surgeon, William MacEwen, in 1880 devised a curved metal tube which he inserted into the trachea, using a finger to guide the tube through the larynx.

Joseph O'Dwyer, the children's specialist who watched helplessly as four of his eight sons perished from summer complaint caused by infected milk, also sorrowed for the children of others. He could not sleep, for ever before him he saw children suffocating to death from the false, invading membrane of diphtheria. In his time, diphtheria was one of the most terrifying and destructive visitors to the nursery. At the New York Foundling Asylum to which he had been appointed physician, O'Dwyer labored unceasingly until his invention of intubation of the larynx. In the 1880's, with his set of intubation tubes, O'Dwyer showed his hitherto scoffing colleagues how to conquer diphtheria.

The next step was an idea of Karel Maydl, professor of surgery in Prague. In 1893 it occurred to him that the O'Dwyer tube could be used for anesthesia if he connected a funnel like Trendelenburg's to the near end of the tube. Maydl packed gauze around the tube just above the larynx to prevent the aspiration of blood; and in the same year Victor Eisenmenger added an inflatable cuff like Trendelenburg's to the Maydl tube.

The first really exhaustive study in endotracheal anesthesia was made by the German surgeon Franz Kühn. In 1911 he published a work in which he summarized ten years of patient effort in this field. Kühn devised certain special tubes of his own which were similar to the Maydl tube, but his was semi-rigid. Thus he was able to pass it through the nose into the trachea and provide a clear field for operations in the mouth. Kühn anticipated all the present-day applications of this technique. He was the first to point out that operations in the upper abdomen could be more easily carried out if a perfectly clear air-passage was provided at all times by the use of the endotracheal catheter. Kühn was also aware of the possibilities of using the endotracheal catheter as a very efficient method of controlling the inflation of the lung during open chest surgery, anticipating the modern method of controlled respiration.

While the Europeans were using the endotracheal catheter mainly for protecting the lower respiratory tract in cases of operations about the pharynx, Americans began to adopt the method for controlling the pressure in the lung when the chest was opened. Rudolph Matas, the great New Orleans surgeon who did so much to advance local anesthesia, fitted a plug around the end of the O'Dwyer apparatus. Matas attached a side tube to the O'Dwyer tube and thus was able to administer anesthetic vapor under pressure sufficient to keep the lung inflated. Two years earlier F. W. Parham had vividly described a case in which the patient's life had been saved by the use of the Fell-O'Dwyer tube after he had collapsed following the opening of the chest for the removal of a tumor.

Samuel J. Meltzer and John Auer took the next forward step. Again the idea had its roots in earlier procedures, but their exhaustive physiologic studies put it on a firm foundation. They showed that if a small catheter were passed into the trachea almost down to its very end, and if oxygen were blown into the trachea under a certain pressure, even if the animal's respiration were paralyzed the lungs would receive sufficient oxygen for the animal to function properly. All this in spite of the fact that the animal was not breathing. This idea was taken up in surgical practice, enjoying, for a time, wide acceptance in operations on the chest. C. A. Elsberg in 1910 wrote a report of the use of this principle in his surgical practice, to be followed by numerous reports in America and in Europe.

It was inevitable that the principle of Meltzer and Auer would not last, for it still did not provide for adequate protection to the lower reaches of the respiratory tract. Blood or pus could still slide down into the lung around the small catheters which they recommended. While many adopted the method of Meltzer and Auer, some, including Kuhn, continued to use a wide-bore catheter. As matters progressed the method of Meltzer and Auer gradually lost favor for the more physiologic method of the earlier times.

The principle of introducing tubes into the trachea by any method was still being utilized blindly. The operator usually introduced the catheter by feeling the larynx and trying to guide the catheter in over his finger. This method was always uncertain. But endotracheal techniques gained a decided stimulus when a more exact method was assured by the great improvement in the laryngoscope effected by Chevalier Jackson around 1910. With the use of this laryngoscope the operator could directly see the larynx and the introduction of tubes then became a certainty.

World War I provided the next impetus to the development and popularization of the endotracheal technique. I. W. Magill and E. S. Rowbotham, as anesthetists for the British plastic surgery group headed by Sir Harold Gillies, were called upon to utilize techniques which would provide aseptic operating conditions about the face. This meant that anesthesia appliances such as the face mask had to be done away with. The logical answer was the endotracheal method. They discovered that a soft rubber catheter, properly curved, could be passed through the nose, and that in a high percentage of cases it could be made to enter the larynx without any resort to the use of the laryngoscope. They called this the blind intubation method. Where the tube would not pass into the trachea blindly they could expose the larynx with the laryngoscope and guide it in under vision. Magill developed a special forceps for picking up the tube in the pharynx and guiding it into the larynx.

As men in Europe and in America became more familiar with Magill's method, the Meltzer and Auer technique of blowing gases into the lung was gradually abandoned for that of inhaling gases through large catheters.

When Ralph Waters introduced the carbon dioxide absorption technique into clinical practice of inhalation anesthesia, the endotracheal catheter received another boost. For it was with the endotracheal catheter and the inflatable cuff around its far end that a perfectly closed system of anesthesia could be achieved. Waters, working with Arthur E. Guedel, revived the inflatable cuff that Eisenmenger had used.

Guedel and Waters described an interesting experiment with the use of this endotracheal catheter, conducted at Indiana University before a large audience, an experiment now referred to as the "dunked dog."

Dog of about 20 pounds weight was anesthetized with ethylene after preliminary morphine. The catheter was introduced and inflated. The apparatus was connected and the dog together with soda lime container, were completely submerged in water and kept there for a period of one hour. During this time there was nothing unusual in respirations, or pulse or general conduct of the animal under anesthesia. There were no air bubbles, after the first displacement of air from the upper respiratory passages. At the end of the hour, the breathing bag, one of 4 liter capacity, was emptied and refilled with oxygen. After 2 minutes this was repeated, but the dog awakened and sat up in the tank before the bag could be completely filled. The catheter was removed and the dog placed on the floor, where he stood up, shook the water off, and lay down for a nap.

Finally, the introduction of cyclopropane completed the picture. The anesthetists had achieved a combination of technical procedures and an anesthetic agent which offered to the chest surgeon the best working conditions. The endotracheal catheter was the means by which the anesthetists had direct control of the respiratory tract and its contents. Any and all secretions could be easily aspirated by passing a small catheter through the large endotracheal catheter. The pressure inside the lung was also under direct control of the anesthetist. Using cyclopropane, the anesthetist could synchronize the movements of the lung with the work of the surgeon. In operations in the upper abdomen, on the stomach and gall bladder, surgeons were often disturbed by the rapid and jerking movements of respiration transmitted from the diaphragm. Guedel showed how the anesthetist could provide a perfectly quiet field for the surgeon to work in with the use of the endotracheal catheter, cyclopropane and controlled respiration.

There have been several types of endotracheal tubes introduced, but the original Magill tube is still preferred by most anesthetists. It is used without a cuff for passage through the nose, and with a cuff for passage through the mouth.

The latest development in endotracheal anesthesia has been the work of Gale and Waters, who have shown that the catheter may be placed into the main branch of the trachea on the sound side and anesthesia administered through that lung only while the opposite lung is being operated upon.

Without question the endotracheal catheter is the greatest safety device that the anesthetist possesses today. Whenever there is any question as to the openness of the air-passages or the presence of secretions in the respiratory tract, the modern skilled physician in anesthesia does not hesitate to introduce the endotracheal catheter to correct matters, and many times he does so without disturbing the surgeon or the operation which is in progress.

Rectal Anesthesia

THYROID DISEASE is an example of a disorder which renders patients so extremely nervous that they suffer more than the normal apprehension at the prospect of a trip to the operating-room. Their over-excitement may, in fact, reach such a point as to make the operation hazardous. Such a patient is usually put to sleep before the operating-room is reached, by means of an ordinary enema containing the drug avertin, a chemical relative of alcohol. He is unconscious, and has escaped the fearsome moment of the mask, and the rising dread of the trip to the operating-room.

This method of producing unconsciousness—rectal anesthesia—was first attempted and described by Pirogoff in April 1847 and later that month by Marc-Dupuy. Apparently the method did not "catch on," for nothing more is heard of it in the medical literature until 1884.

In that year, Daniel Mollière of France reintroduced anesthesia produced by the administration of ether via the rectum. At first he employed a hand bellows which forced ether vapor into the intestine. Later, he warmed the ether by placing the container in a water bath at a temperature of 120° F., the resulting pressure forcing the ether vapor into the intestine. In the same year at least a half-dozen other surgeons recorded their experiences with this method, and since unfavorable results were numerous, it was abandoned.

However, in 1903, it was revived by J. H. Cunningham and F. H. Lahey, who introduced a new technique in which air was utilized as a means of transporting ether vapor into the intestine. Later, W. S. Sutton used oxygen instead of air in vaporizing the ether, and while this was an improvement, too large a volume of oxygen still had to be used, not all of which could be absorbed.

Gwathmey, an enthusiastic advocate of the rectal method, developed an oil-ether mixture which was found to be quite constant. Subsequently, he modified the mixture and recommended it for use in childbirth; quinine was added to reinforce the contractions of the uterus while the ether was in effect. In 1930, Gwathmey reported on 20,000 cases in which this method had been used successfully for the relief of pain in childbirth. Now called obstetric analgesia, it has been widely adopted and is used in many clinics.

Avertin was discovered by Eichholz in 1917, and its use for rectal anesthesia was reported by Butzengeiger in 1927. While it was found to be an excellent agent for producing a preliminary narcosis, its use for complete anesthesia was ill-advised since a dose too great for safety was required. Brain surgeons took to the use of avertin because they learned that it had a tendency to reduce intra-cranial pressure (pressure of the fluid surrounding the brain).

Gwathmey in 1936, and Hogan in 1938, recommended evipal, a barbiturate used ordinarily for intravenous anesthesia, for use as a rectal basal narcotic. Weinstein in

1939 recommended the use of pentothal, another intravenous barbiturate anesthetic, for the same purpose.

Rectal anesthesia appears to be a simple procedure, but is actually one of the most complex methods of producing unconsciousness; its administration should be limited to especially experienced hands.

Intravenous Anesthesia

THE EXTRAORDINARY method of introducing the anesthetic directly into a vein—intravenous anesthesia—had its origin in the seventeenth century, age of experimental science. At Oxford Christopher Wren, in the hope of discovering a new therapeutic procedure, conceived the idea that if he could insert a pipe in the blood vessel of an animal, he would be able to inject drugs directly into the blood stream. In 1656 he persuaded his friend Robert Boyle, the chemist, to make some experiments with him. A quill attached to a syringe was inserted into a superficial vein of a dog and a solution of opium was injected. The two men found that the opium stupefied but did not kill the dog. Later they used an infusion of oxide of antimony (an emetic), but in this case the dog died.

In 1665 Sigismund Elsholtz used a solution of an opiate to obtain unconsciousness—perhaps the first genuine attempt at intravenous anesthesia. And in the same year we have the first authenticated documents of direct transfusion of blood from one animal to another, performed by Richard Lower of Cornwall. In France, the physician to Louis XIV, Jean-Baptiste Denis, was the first to perform a blood transfusion on a man, on June 12, 1667. In these early experiments, the blood of animals, usually lamb's blood, was used, and a great interest in transfusion spread throughout Europe. But because of the period of abuses which followed these early attempts at transfusion, the transfusion of blood to human beings was prohibited by law in France and England.

Because medical science had not progressed sufficiently to manage adequately the complex factors involving blood transfusion, the practice was all but abandoned until the early nineteenth century, when its rebirth was accomplished by the English physiologist and obstetrician James Blundell, who approached the subject scientifically. To Blundell is given the credit for performing the first transfusion with human blood.

Other investigators took up the method, varying it in one respect or another. New ideas for transfusion developed with increasing investigation of the properties of blood. The problem of clotting was one of several, fundamental to the successful practice of blood transfusion. To Prevost and Dumas, who experimented with defibrinated blood, is attributed the idea of preventing clotting by the addition of an anticoagulant. The substance they used for this purpose was caustic soda. And Theodore Bischoff, who popularized the idea of injecting defibrinated blood, demonstrated that whereas whole blood injections into animals of another species produced toxicity and death, defibrinated blood of the same type was tolerated without ill effects.

In 1872 Pierre-Cyprien Oré advocated the intravenous injection of chloral hydrate to produce general anesthesia. He used the method on human beings after successful animal experimentation. But chloral hydrate was not well suited to anesthetic purposes, for its effects were slow in disappearing and the required dosage left too narrow a margin for safety.

In 1902, Emil Fischer, Nobel Prize winner, synthesized barbital, the first of a new class of drugs—the barbiturates, which were to revolutionize the method of intravenous anesthesia. Barbital itself was not suited for the purpose since its effects were too slow in reaching a peak and took too long to wear off; it was a good sedative, but nothing more.

It was fully thirty years after the discovery of barbital before a suitable drug in the barbiturate series was found for intravenous use—evipal, first reported by Weese and Scharpff in 1932. Evipal caught on in magical fashion on the European continent, and in particular in Germany, where it was used for practically all anesthesia purposes. Geyer estimated in 1941 that about 4,000,000 evipal anesthesias had been given.

Two years later, pentothal, another barbiturate, appeared in the United States, superseding evipal almost immediately, because it was more potent, and did not have the failing of producing muscular spasms. John Silas Lundy of the Mayo Clinic gave pentothal an extensive clinical trial. Lundy described the method of leaving the needle in the vein and of renewing the drug as necessary to maintain anesthesia.

Pentothal is regarded as being suitable for most operations except abdominal. In abdominal operations, when pentothal is used, the common practice is to combine it with local anesthesia. Pentothal has proved valuable in light surgical procedures and had an extensive clinical trial during World War II. Its intravenous use under skilled direction was recommended for wartime conditions by John Farquhar Fulton, Sterling Professor of Physiology at Yale.

Grinker and Spiegel made one of the most interesting applications of pentothal in the treatment of neuroses occurring at the battlefronts of World War II. With the use of pentothal, they produced an easily controlled hypnotic state, during which they were able to uncover the basis for the neuroses. They coined the term narcoanalysis to describe this method.

There are a great many barbiturates on the market today—amytal, nembutal, dial, neonal, phenobarbital, pentobarbital, etc. Made by different drug manufacturers, the action of each varies somewhat. Some have prolonged action, others short; some act rapidly, others slowly; some are weak, others strong. The skilled specialist will try to select the one most appropriate to the needs of the case.

THIRTY-THREE

Spinal Anesthesia

August Bier is generally credited with having performed the first spinal anesthesia in man in 1898. But, as Matas has pointed out, it was James Leonard Corning, a New York surgeon, who performed the first injections of cocaine into the human spine. Corning, in his important monograph, *Local Anesthesia in General Medicine and Surgery,* described in detail his technique for injecting cocaine into the spine for the relief of certain severe pains. And while it is true that Corning did not use spinal anesthesia for surgery but for therapeutic purposes, credit for priority is perhaps rightfully his.

Bier's experiments first on animals, then on himself, were so successful that he became firmly convinced of the potentialities of spinal anesthesia in surgery on human beings. The drug he used for the purpose was cocaine.

In the summer of 1899, a stir was created by a demonstration of spinal anesthesia given by the French surgeon Theodore Tuffier at the thirteenth meeting of the International Medical Congress in Paris. It was witnessed by many American surgeons, who came home as enthusiasts for the new method.

This early burst of enthusiasm suffered a check when

Matas in the same year published an article pointing to reports of unfavorable results, some of them stemming from Tuffier himself. Matas held up the warning that thorough knowledge of the proper technique in spinal anesthesia was imperative.

Some of the early reactions were attributed to the toxicity of cocaine and for this reason some surgeons, like Matas, discontinued its use. Then, in 1905, when novocaine came into use, spinal anesthesia underwent a revival, with better results, but still entailing too high a percentage of unfavorable reactions. So much has been learned since 1900 respecting the physiological dangers of spinal anesthesia, its selective use by doctors, and the control of the action of the drugs, that it has finally emerged as a very useful method. Novocaine still ranks as the favorite drug in most instances, although three newer drugs, pontocaine, metycaine, and nupercaine, have come into great esteem. These latter drugs are longer-acting than novocaine and for prolonged operations are often indicated.

But there remained one great difficulty that required solution—the problem of time. The drug when injected into the spine would act for only a limited period. When its effects wore off and the surgeon had not yet finished, the patient had to be subjected to further anesthesia of some sort. Obviously, this was both an inconvenience to the surgeon and a burden to the patient. Larger doses of the anesthetic were tried, but were found likely to cause unfavorable reactions; longer-acting drugs were tried, but frequently proved too toxic, and there was no guarantee that even these drugs could produce the desired duration of anesthesia. Some surgeons gave up spinal anesthesia entirely because they did not like to work against time. It remained for a Philadelphia surgeon to solve the difficulties.

In 1940 William Thomas Lemmon reported a new method. His idea was quite simple. A specially constructed needle made of a very soft metal was introduced into the spine, connected by a section of tubing to a syringe containing the local anesthetic. The patient was turned on his back on a specially constructed mattress with a hole cut in the middle, so that there would be no pressure against the needle. Since the needle was of soft metal, it could not break; and since it was left in the spine for the duration of the operation, connected to its source of local anesthetic, the spinal could not wear off. When there was evidence of its wearing off, the anesthetist could inject more of the drug.

This method proved to have more than one virtue. Its most important advantage was that it did not require the injection of too large an amount of drug in order to prolong the anesthesia; very small doses could be used, since there was never any concern about the wearing off of the anesthetic.

Spinal anesthesia is today one of the favorites in the anesthetist's comprehensive armament of methods, and when *properly performed,* it can be one of the most convenient methods for patient and surgeon alike. Like other discoveries, it enjoyed a great initial enthusiasm, then disrepute; today it has assumed a secure position among the many forms of anesthesia.

Refrigeration Anesthesia

IN THE WRITINGS of Avicenna there is a passage in which this eleventh century Persian "Prince of Physicians" declared: "The most powerful of narcotics is opium . . . and among the less powerful are snow and ice water." In the following century, when the blustering Richard the Lion-Hearted came out to conquer the Holy Land, he killed many Moslems before the climate disagreed with him. As the English warrior tossed in his sun-baked tent, he received a rare anodyne from his hospitable enemy, the Sultan Saladin: a caravan of camels carrying snow to soothe his fever.

Centuries were destined to pass before lowered temperature was scientifically employed to reduce sensibility. Frequently cited are the snow and ice mixtures in surgical anesthesia recommended by the Italian surgeon, Marco Aurelio Severino, through his Danish pupil Thomas Bartholinus; the speculations of that titan of biology and surgery, John Hunter, on the possibility of scientifically freezing human beings and warming them back to life generations later; and the painless amputations performed on half-frozen soldiers by Napoleon's favorite surgeon, Dominique-Jean Larrey. Unfortunately, none of these old reports was convincing enough to induce general adoption of the method, though it would have meant an enormous advance in the control of pain before the discovery of ether.

Popular instinct associates heat with life, cold with death. Actually, elevation of temperature is tolerated to a less degree and for a shorter time than reduction. Thus, heating of the human body to ten degrees above normal means an acutely fatal fever, while a reduction by ten degrees can be tolerated for a week and a reduction by twenty degrees can be tolerated for hours or days. Physiological functions are often slowed by cold, as illustrated by the sluggishness of man, hibernating animals, and many cold-blooded animals at low temperature; but the many exceptions are exemplified by the trout and salmon, which are intensely active in icy water. Likewise, even the lowest forms of life are destroyed by temperatures somewhat below the boiling point of water. But some, such as bacteria and unicellular animals and plants, tolerate a range of reduction which is far greater than their range of elevation.

Isolated tissues or bodily parts of the highest species retain a high degree of this primordial resistance. It is well known that human ears or fingers survive brief freezing without harm. Within certain ranges of temperature, cold acts to preserve living structures in a state of suspended animation. Of this fact there are startling examples in the recovery of living bacteria from inside the trunks of mammoths which had been frozen in the Siberian ice for thousands of years, the survival of mouse cancer cells after freezing for two years, and the familiar practice of keeping human skin grafts and other tissues in a refrigerator for days or weeks, where they retain unimpaired vitality.

Physiologists have long been familiar with the "cold block" of nerves, which means that nerves cooled below a certain temperature cannot transmit stimuli or sensations. It is known that when cold-blooded or hibernating animals become sluggish at low temperatures they become largely insusceptible to pain or shock, a result which must be attributed to the reduced functions of both the nervous system and the general protoplasm. Folk-lore in cold countries, notably among the Russian peasants, describes instances in which men have been buried under snow for days, have been found unconscious and torpid like hibernating animals, and have recovered after careful warming.

But no one thought of using chilling for therapy until about 1938, when Temple Fay, of Temple University School of Medicine, inaugurated the artificial hibernation of human beings and found that by cooling he could control infections, including the dreaded gas gangrene. Using sedatives and ice or refrigerating apparatus, he reduced body temperatures to levels between 80° and 90° F. for as long as a week or to even lower temperatures for brief periods. A person at such a temperature is in a twilight of consciousness, and afterward remembers nothing. In the use of this treatment for cancer, the principal benefit to date has been the relief of otherwise uncontrollable pain, a relief which sometimes lasts for many days or weeks after the treatment. Other intractable pains may likewise be dulled. But the most important known usefulness at present is in the treatment of shock. Reversing the former practice of warming patients in surgical shock, authorities now agree that a mild reduction of body temperature is helpful for both prevention and treatment.

Refrigeration anesthesia originated from experiments concerning diabetic gangrene, in which one of the pioneers was the New York internist, Frederick Madison Allen. In these experiments on animals, blood circulation of the limbs was stopped by means of a tourniquet, and it was found that the tendency to gangrene or shock was lessened in proportion as the temperature of the limb was lowered. Legs immersed in ice water did not give rise to shock after ligations of six hours or longer, and the protection against gangrene was even more remarkable. Legs deprived of all circulation by a tourniquet were preserved for fifty-four hours; the tissues did not die and the blood did not coagulate. In other words, the conditions of preservation in an ice box were reproduced in tissues still connected with the body.

Since pain was abolished as well as tissue decomposition and shock, the refrigeration method appeared to offer the solution of the original problem under study: the saving of gangrene cases in an advanced stage when death without operation was certain and shock was quite as likely to cause a fatal outcome if operation were tried. The results have amply justified these hopes.

The Chicago orthopedist, Robert Talbot McElvenny, reported a classic example of the value of refrigeration anesthesia in the immediate management of injuries. In a railroad accident, both of a man's legs were amputated. He arrived at the hospital nearly dead from hemorrhage and shock. Packing the mangled stumps in ice controlled infection and tissue necrosis, while strength was restored by transfusions and other treatment. The pain was resistant to large doses of morphine but was abolished by the refrigeration. Fifty-eight hours later the patient was in condition for successful operation. It is noteworthy that any drugs powerful enough to control the pain during such a period would have been distinctly harmful, and the anesthetic action of cold clearly contributed to the recovery.

Harry Edgar Mock, notable for his work in industrial medicine and surgery, has had considerable experience with refrigeration anesthesia. In association with his son, he published a survey of refrigeration anesthesia in amputations, reporting successful handling of trunk fractures, combined with thrombosis of a femoral or iliac artery. Had there been no amputation, the patient would have died from gangrene; amputation in the state of shock would also have caused death. Mock solved the dilemma by packing the threatened leg in ice for two weeks, until the patient had sufficiently recovered from the other injuries to permit of successful amputation.

A classic example of ice anesthesia was reported by Isidor Kross, of the Mount Sinai Hospital of New York. A burn of a woman's leg, neglected for four days, resulted in fever, delirium and prostration of such degree that she was sent to him for an emergency thigh amputation. Because she seemed beyond operative relief, he merely packed the leg in ice. Prompt and striking improvement caused the refrigeration to be continued for several days. Milder cooling was maintained for a record duration of eleven weeks, as warming above this point brought return of pain and fever. The result was the saving of the leg with the loss of only three toes. Comfort, clear consciousness, and unimpaired appetite and digestion were obvious factors in the recovery.

At the New York City Hospital, Frederick Madison Allen and his surgical associate, Lyman Weeks Crossman, have brought refrigeration anesthesia to its present important position. Using cracked ice, snow ice, or ice water as the sole anesthetic in amputations and cases of shock, where narcotics would have been harmful or dangerous, Allen and his co-workers have written a saga of science: ice anesthesia.

Cold and snow and ice are the symbols of gloom and despair and death. Science gained another Victory over Pain when it transformed cracked ice into an agent of mercy. The anesthetic action of cold has demonstrated its value in hemorrhage, embolism, gas gangrene and other infections, shock, frostbite, burns, and venomous bites and stings. Dead tissue is beyond the power of refrigeration or any other human help, but traumatized or mangled tissue can be preserved by refrigeration. In many cases, refrigeration has brought operative patients a comfort hitherto unknown. Refrigeration is not the final word, but it is the present climax of local anesthesia, and at times partakes of the nature of general anesthesia. Medicine has traveled far from the days when it had no better weapon than the ether spray of Richardson.

THIRTY-FIVE

Three Twentieth Century Anesthetics

THE DEATH of carnations in the greenhouses of Chicago gave to anesthesia its most important agent since ether and nitrous oxide; the story of the discovery of ethylene as an anesthetic is of particular significance as an example of true scientific method.

Ethylene, or olefiant gas, was first prepared by Becker, the exact date being unknown. In Joseph Priestley's book, *Experiments and Observations Relating to Various Branches of Natural Philosophy*, mention is made of Johannes Ingenhouss, famous Dutch-English physician-physicist, as the first to prepare ethylene in 1779. In 1849, Thomas Nunneley, a surgeon of Leeds, reported on the examination of some thirty-seven compounds, noting the narcotic properties of ethylene, but not recommending it as an anesthetic agent because his results with this gas were unsatisfactory. Coal gas, according to his experiments, was a superior agent. Nunneley also reported on the use of ethylene dichloride, and apparently had better results than those noted by Simpson, who had also used this preparation.

The physiologist Ludimar Hermann was the next to experiment with ethylene, first noting its lightly intoxicating action in 1864, and Eulenberg in 1876 demonstrated experimentally its anesthetic qualities. Benjamin Ward Richardson regarded it as an admirable agent, though finding its gaseous state a disadvantage.

In 1908, carnation growers were having trouble with their flowers. The carnations which had been shipped to Chicago and put in greenhouses seemed to go to sleep. The buds failed to open. Two men, Crocker and Knight of the Hull Botanical Laboratory, went to work on the problem of these ailing flowers. They discovered that the illuminating gas which was used in heating the greenhouses contained as much as four per cent ethylene, a concentration far in excess of the amount that would ordinarily inhibit the development of flowers.

A decade later, Arno Benedict Luckhardt, the University of Chicago physiologist, became interested in the fatal effect of ethylene on carnations, castor oil plants, and sweet pea seedlings. Then he made an exciting discovery: he found that ethylene did not kill, but only anesthetized a frog. His work was temporarily laid aside during World War I but was resumed in 1922. After animal experiments had been completed, Luckhardt and Jay Bailey Carter tried the gas on themselves. Convinced by their successful experiments of its efficacy in surgical practice, they reported their work in the *Journal of the American Medical Association*, May 19, 1923. The conclusive demonstration of Isabella Bird Coler placed ethylene in clinical anesthesia.

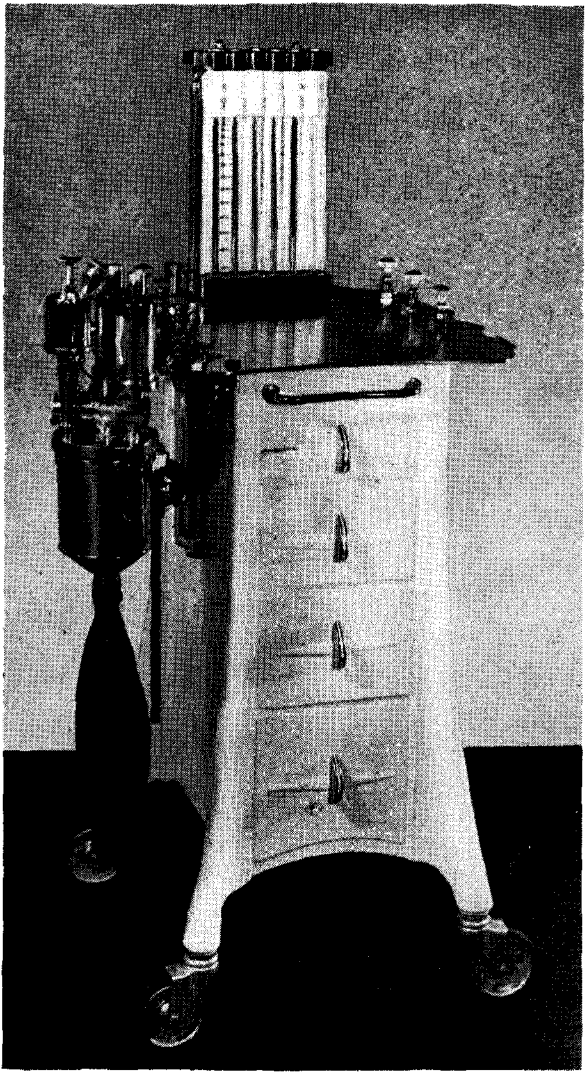
Ethylene has enjoyed great popularity since its introduction about twenty-five years ago. It has a not unpleasant sweetish odor, and produces anesthesia in three to five minutes. Like nitrous oxide, it is practically devoid of any deleterious effect upon the body as long as it is given with at least twenty per cent oxygen, and is only slightly more potent than nitrous oxide. At its best, ethylene is suitable only in light surgical conditions. Moreover, ethylene is inflammable and explosive, and great care must therefore be exercised to avoid using it near a naked light, cautery, or diathermy apparatus; but the question of explosiveness in the case of ethylene has undoubtedly been exaggerated.

It is one of the strange paradoxes of medicine that ethylene has been barred in many hospitals where mixtures of nitrous oxide and ether are being used daily. For it is a scientific fact that a mixture of nitrous oxide and ether is fully as explosive as ethylene. As a matter of fact, with the exceptions of nitrous oxide and chloroform, all anesthetics given by inhalation are inflammable and explosive.

In the very muscular, the very excitable, or the chronic alcoholic, unless the patient is practically asleep with other drugs first, ethylene may not produce complete anesthesia. Thus, while it was accepted as a great improvement over nitrous oxide, it still did not provide the final answer in the quest for an ideal surgical anesthetic.

In 1929, Lucas and Henderson, of the University of Toronto, after laboratory search for an anesthetic superior to ethylene, reported their discovery of cyclopropane. It had cost them five years of the most absorbing and painstaking animal experimentation before they felt justified in announcing that cyclopropane "did not upset metabolism or show evidence of any toxicity to any of the organs."

Ralph M. Waters conducted his own series of animal experiments, which confirmed the findings of Lucas and



Modern anesthesia apparatus: Texas Model of the Metric Anesthesia Table

Henderson. Next, Waters and his associates subjected themselves to anesthesia with the new gas and, convinced of its safety and efficacy, introduced it into the surgical amphitheaters of the Wisconsin General Hospital. Cyclopropane seemed an ideal anesthetic. It reached the brain rapidly, thus inducing insensibility with very little or no excitement, and its effects disappeared quickly. Moreover, it was found to have very little deleterious effect upon any of the special organs: the brain, heart, liver, kidneys, etc.

Cyclopropane was adopted in all hospitals equipped with efficient anesthesia machines. But it was evident at the outset that the new agent could only be trusted to skilled hands, for it proved to have a marked tendency to depress the respirations even in light anesthesia. To a professional anesthetist well versed in the physiology of the circulation and respiration, this was no problem, for if a patient did not breathe properly, he would know exactly how to support the breathing and thus protect the patient against asphyxia.

Cyclopropane has been a great boon to surgeons in operations on the heart and the mediastinum (the median dividing wall of the thoracic cavity), as well as in general chest surgery. Chest surgeons are agreed that cyclopropane has been responsible for the greatly increased possibilities of success in lung operations.

Following the discovery of ethylene as a safe and practical anesthetic, Chauncey D. Leake, then Professor of Pharmacology at the University of California, began, with the collaboration of a talented Chinese associate, Miss Mei-yu Chen, to test its action on animals, in comparison with ether, chloroform and nitrous oxide. It occurred to him that a cross between ether and ethylene might reasonably produce a substance which would embody the uniquely desirable qualities of both agents. Ether was potent but slow in action; ethylene was fast in action but too weak.

At this point, Leake had nothing but a theory represented by a set of chemical symbols on paper. But now the practical pharmacologist went into action, and his friend, Lauder Jones, Professor of Organic Chemistry at Princeton, was asked to prepare some divinyl ether for him, and thus the liquid divinyl ether made its appearance. Its anesthetic properties were presently tested in a series of animal experiments carried out by Arthur Guedel and Peter Klerner Knoefel of the University of California, and since that time divinyl oxide has had a wide clinical trial, especially for dental extractions in children, because of its ability to produce a rapid and brief anesthesia.

In general surgery it is widely used to render ether anesthesia more pleasant. Used in combination, the anesthesia is usually started with divinyl oxide, and when the patient becomes unconscious, the change to ether is made. For short operations, such as the opening of boils, infected ears, and on ambulatory patients in general, it has found a wide field of usefulness. It is natural that an anesthetic that can be carried around in a bottle in a physician's bag, and can serve for short anesthesias outside the operating room, should find an important place in the roster of anesthetic agents.

Curare

NATURE, in her cruelest moment, created curare. Of all the plants that creep over the fertile bosom of Mother Earth, curare is the most to be dreaded. Curare is the arrow poison of the Orinoco Indians of South America. Poisonous plants are familiar enough to botanists and physicians, but curare is peculiar: when a curare-tipped arrow finds its victim, it does not kill him immediately: it immobilizes him. The violent poison paralyzes the ends of the motor nerves of the voluntary muscles; the victim is utterly helpless, for he cannot move—but his intelligence is not affected. A naked Orinoco boy, armed with an arrow dipped in curare, may well strike terror into the heart of man and bird and beast.

After the discovery of the New World, curare was noticed by the Italian traveler, Antonio Pigafetta (1491-1543), who circumnavigated the globe with Magellan; the Spanish historian, Francisco Lopez (1510-60); and the Spanish physician, Nicholas Monardes (1493-1588). The interest excited by curare is seen in the graphic description by Sir Walter Raleigh (1552-1618), in his work on the discovery of Guiana:

The Aroras . . . are very valiant, or rather desperate people, and have the most strong poison on their arrows, and most dangerous, of all nations, of which I will speak somewhat, being a digression not unnecessary.

There was nothing whereof I was more curious than to find out the true remedies of these poisoned arrows. For besides the mortality of the wound they make, the party shot endureth the most insufferable torment in the world, and abideth a most ugly and lamentable death, sometimes dying stark mad, sometimes their bowels breaking out of their bellies; which are presently discolored as black as pitch, and so unsavory as no man can endure to cure or to attend them.

Throughout a long lifetime, the foremost citizen of the world was Alexander von Humboldt (1769-1859). He wrote *Cosmos,* and was its most illustrious inhabitant. Since Humboldt was so often the "first," it is not strange that he was the first European traveler who actually saw the making of curare. Humboldt obtained a specimen of curare, but the bottle was imperfectly corked, and the poison spilled over his linen. He noticed it in a stocking which he was about to pull over his insect-bitten toes—a narrow escape from a horrible death. Humboldt's detailed description of curare contains the passage:

When we came to Esmeralda most of the Indians were returning from a trip eastward beyond the Rio Padamo where they had gathered a creeper from which they obtain curare. This return was accompanied by festivities corresponding to our harvest and vintage celebrations. The women had prepared large quantities of a fermented beverage, and for two whole days one saw only drunken Indians. As luck would have it we met an old Indian who was in the midst of preparing the curare poison from the fresh plants. This man was the chemist of the place. We found in his possession large earthenware pans for the cooking of the plant juices, shallower vessels which due to their larger surface area favored evaporation, banana leaves rolled into the shape of funnels for the purpose of straining fluids containing fibrous substances in greater or lesser quantity. The greatest cleanliness and order prevailed in this hut which had been arranged as a chemical laboratory. The Indian who acted as our informant is known in the mission as the poison master. He had the same affected attitude and pedantic tone with which apothecaries in Europe were formerly reproached. "I know," he said, "that the white men understand the art of making soap and the black powder which has the disadvantage that it makes a great deal of noise and scares away the animals, if they are not hit. Curare, the preparation of which is transmitted among us from father to son, is better than anything which you make over there beyond the sea. It is the juice of a plant, which kills very quietly without anyone knowing whence the shot came."

Curarine, the alkaloid or active principle of curare, was discovered by Boussingault and Roulen in 1828. The brothers Robert and Richard Schomburgk investigated curare, and gave it the technical name of *strychnos toxifera.* Virchow found that curare, although kept in a dried state for several years, still acts with rapidity and intensity even in small doses. Rudolf Böhm and Louis Lewin further studied the poisonous creeper of the jungle, the annihilator of motion, the destroyer of life.

Georges Barral, in a passionate tribute to Claude Bernard, the foremost of French physiologists, urged:

Read his studies on curare, that terrible poison of the South American Indians which produces absolute insensibility in all the organs and leaves the poisoned human being a living mind, without the means of manifesting itself. You will be driven to the very extreme of terror and pity. Before Claude Bernard's experiments it was believed that death caused by curare was nothing but a sweet slumber. On the contrary, the victim retains all his lucidity. What terrible drama one can imagine! What cruelty of the savage who knows how to steal from Nature this subtle refinement of vengeance!

Georges Barral was right when he said, "Listen to Claude Bernard." Bernard's description of the action of curare reads as follows:

Within the motionless body behind the staring eye, with all the appearance of death—feeling and intelligence persist in all their force. Can we conceive of a suffering more horrible than that of intelligence present after the succumbing, one by one, of all the organs which are destined to find themselves imprisoned alive within a cadaver? In all times, poetic fiction endeavoring to move us to pity, drew before our eyes sensitive beings imprisoned in motionless bodies. The torture which the poet's imagination invented is produced by Nature by the action of the American poison. Only here we may say that reality surpasses fiction. When Tasso depicted Clorina incarcerated alive in a majestic cypress tree, he left to her at least tears and sobs to bemoan her fate and to move to pity those who made her suffer in wounding her sensitive body.

Science was not content to let curare remain in the jungle. Science not only isolated the active principle of curare, but learned how to produce curarine in the laboratory. Pharmacologists did not forget that while curare stops impulses from the motor nerves to the muscles, it has no effect on the circulation. Muscular rigidity has always been a surgical obstacle. Surgeons wanted a drug which would cause muscular relaxation without the necessity of inducing profound depths of anesthesia. The answer to this surgical need was curare.

H. R. Griffith and G. E. Johnson introduced curare into anesthesia in 1942. In twenty-five cases, they gave injections of curare to patients under cyclopropane anesthesia, to improve the relaxation of the muscles of the operative area. They reported that instead of having to produce very deep anesthesia to obtain the proper relaxation of the muscles, they could obtain this effect by inducing very light anesthesia followed by the injection of a suitable dose of curare.

Richard Gill, the chief modern investigator of curare, who studied its South American source before bringing it to the laboratory, emphasizes that only the most skilful of anesthetists, thoroughly versed in respiratory physiology, should use so dangerous a drug.

At the present writing it is too early for curare to have a place in the textbooks of anesthesia, but it will be included in future editions. Curare, the horror drug of the forest, has been tamed by science and turned into a messenger of mercy.

EPILOGUE

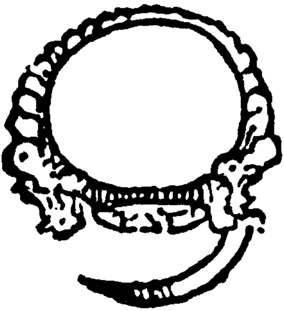
Musings by the Nameless Monument

IN THE Public Garden of Boston stands a monument to Ether. On the rear of the monument is the name of the citizen who was its generous donor. This monument bears no man's name as the discoverer of Anesthesia, but upon it is inscribed the ancient prophecy (*Revelation* xxi, 4): "Neither shall there be any more pain."

It is well that no man's name appears as the giver of Anesthesia, for many lands and many ages contributed a stone to the building of the Nameless Monument. Merciful Sleep is depicted on it; Pain slumbers in the enfolding arms of Anesthesia; the Nameless Monument brings back memories of the generations of Pain:

The waters of Lethe, the silent stream of oblivion; the fatherless child of night, Hypnos, the god of sleep, and his son Morpheus, the god of dreams; the mystery of the nepenthes of Homer, and the helenium of Pliny; the dittany stalk which Venus dipped in water to ease the pain of the wounded Aeneas.

The ancient anodynes our forefathers knew: the herbs of *drowsiness, hashish and henbane; the legends of mandragora and its undoubted narcotic power; the hemlock that Socrates drank, and Galen's lettuce, and the thorn apple; the milky juice of the poppy, whose opium produced sleep and abolished pain; alcohol, in all ages and all lands the anodyne of mankind.*



Surgeon's Lancet Ring

The sleeping sponges and narcotic draughts of medievalism; the deceiving Lancet Ring, which, worn on the finger in the usual way, appeared to be merely an ornament, but, as the surgeon examined the patient, shot a hidden curved blade out of a groove and suddenly pierced his flesh.

The attempt to deaden the nerves by compression, producing as much pain as it prevented and injuring all tissue it compressed, this torturing screw of surgery, gruesome reminder of surgery's helplessness in the presence of Pain.

The dawn of the wonderful nineteenth century, but laggard still in the control of pain, the methods for its conquest as crude at the opening of its fourth decade as when Dioscorides wrote the great Herbal; the need for fast surgery, for if the agony of operation was not soon over, the patient began to die on the table from pain.

Long, Wells, Morton, Jackson, holding in their hands America's greatest gift to mankind.

Destiny worked obliquely with these men: from laughing-gas parties and ether frolics to the cutting of a wen by Long under anesthesia; from a wandering lecture-show to the *historic removal of a tooth under anesthesia, with Horace Wells as his own patient; from the large bottle of chlorine which Jackson accidentally broke, to his immediate inhalation of ether which produced anesthesia; from the trickery of Morton to his public demonstration of anesthesia, with ether disguised as Letheon.*

The incontrovertible news from the Massachusetts General Hospital: a way had been found for the surgeon to perform his task while the patient slept. A tumor was removed from the neck of a patient (October 16, 1846); a tumor was removed from the arm of a patient (October 17); a thigh was amputated from a patient, definitely a major operation (November 7). None of the patients felt any pain. It was the culmination of the ancient dream of painless surgery, the fulfillment of the prophecy: "Neither shall there be any more pain."

The four men did not meet in a tavern and pledge eternal brotherhood as the world rejoiced in the Victory over Pain. Alone they drank the wine of bitterness, and tasted the lees of hatred. There was limitless glory for all, but not one would grant a share to another.

The first to go, dying in prison, cut down in his youth by the razor of suicide; the second dying before the age of fifty in an apoplectic rage on a hot day in Central Park; the third dying in obscurity at the age of sixty-two; the first-born of the four the last to go, he alone of the group reaching the allotted years of the Psalmist, but passing them as a hopeless lunatic in an asylum.

The memory of Abraham Jacobi, who escaped from a German prison and who for years was a cultural bridge be-

tween the medicine of Europe and America. At the age of seventy-five, before his career had reached its meridian, this passionate democrat told the boys at Yale:

"The greatest gift America has given the world is not the realization of a republican government—ancient culture exhibited it before and allowed it to perish by political short-sightedness, lust of conquest and undemocratic jealousy—it is anesthesia."

Dark clouds hover over the Nameless Monument on the approaching Ether Centennial. There has been a recent outcry because of the increase of fatal cases: Death haunts the dental chairs and operating-rooms of America. Every year thousands of Americans needlessly die from preventable asphyxial accidents, a sad commentary after one hundred years of surgical anesthesia in the land of its birth.

Continual training is needed by the doctors, dentists, nurses and technicians who bring the patient to the gates of sleep through anesthesia. Eternal vigilance is the price of safety in anesthesia. The ancient legend of Sleep as the twin-brother of Death gains a new meaning in the slumber of Anesthesia.

Yet the portents are bright for the future. The days are past when anesthesia can be regarded as a mechanical and subsidiary adjunct of surgery, to be administered by hands that can be spared from other duties. The first centennial of anesthesia finds it emerging as a youthful and vigorous specialty.

As the importance of full-time devotion to anesthesia gains increasing recognition, the beautiful phrase of Oliver

Wendell Holmes will be even more true than when first written: "By this priceless gift to humanity, the fierce extremity of suffering has been steeped in the waters of forgetfulness, and the deepest furrow in the knotted brow of agony has been smoothed forever."

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