THE HISTORY OF CARDIOVASCULAR SURGERY

ΟΜΙΛΙΑ ΤΟΥ ΞΕΝΟΥ ΕΤΑΙΡΟΥ ΤΗΣ ΑΚΑΔΗΜΙΑΣ κ. MICHAEL E. DeBAKEY

Your Eminence, the Archbishop of Athens and All Greece,
Mr President of the Greek Parliament.
Mr Deputy Prime Minister of the Greek Government,
Honourable Ministers of the Greek Government,
Members of the Greek Parliament,
Your Honour, the Mayor of Athens,
Representatives of the Greek Armed Forces and Police,
Colleagues, Ladies and Gentlemen.

Mr President of the Academy of Athens: Let me begin by expressing my sincerest thanks for your gracious and cordial welcome on behalf of the Academy. I am grateful to the entire membership of the Academy for including me in this, the highest spiritual and intellectual institution of this nation.

I am also deeply grateful to Dr Skalkeas for his warm introduction, and his kind and magnanimous views of my modest contributions to the world of science and medicine.

I consider it a privilege and an honour to be chosen as a member of the oldest Academy in the world, the Academy of Athens, which is the continuation of the Academy of Plato.

Medical practice, in one form or another, is rooted in the dawn of history and has paralleled, reflected, and sometimes influenced man's development. True cognizance and understanding of the societal role of surgery require a broad review of certain periods in the history of man's development. Neither necessary nor appropriate for this purpose, however, is a detailed historical account of surgery, which is available in many other publications.[1-22]*. Accordingly, historical considerations in this presentation are highly selective, with a focus on those personalities and events, including the social and cultural settings, pertinent to my thesis that surgeons, throughout recorded history, have viewed obstacles, adversaries, antiscientism, and anti-intellectualism as challenges and opportunities for improving their discipline by engaging in research, analysis of clinical experience, and other intellectual pursuits.*

Recorded history began some 5000 years ago in two centers of civilization of nearly equal development situated in two of the world's great river systems: Mesopotamia, between the Euphrates and Tigris, and the Nile Valley of northeastern Africa.[23-33] *Although recorded history was sparse in these early civilizations, medicine was already well developed, and its practitioners must have had a heritage of experience that was handed down by precept and word of mouth through earlier, perhaps countless, centuries.*

Medical Papyri

Such heritage is reflected in the Edwin Smith Egyptian papyrus (Fig. 1), believed by some historians to have been recorded between 1600 and 1500 B.C., and intended primarily for the use of a surgeon.[34] *About the Smith papyrus, Ranke*[35] *wrote: "That the bulk of the main text goes back to the Old Kingdom [believed to have begun circa 3200 B.C.] is shown by a great number of glosses . . . added to the text of some of the cases, which explains words that in the course of time had become obsolete." Although Breasted*[34] *dated the Smith papyrus in the 17th century B.C., he believed it was a copy of a document at least 1000 years older. The significance of the Smith papyrus lies in the fact that surgery, as a well-defined discipline, assumed an important role in earliest recorded medical history. The Smith papyrus differs from other medical papyri in that it is the oldest in date of origin and the only one that deals primarily with surgery, describing a series of cases logically arranged, beginning at the head and progressing downward.*

The other medical papyri consist essentially of a jumble of prayers, incantations, and fanciful prescriptions.[36] *That surgery assumed high status at that time is further supported by the fact that the first treatise on surgery (dated about 2700 B.C.) was written by Imhotep, the Pharaoh's grand vizier (prime minister), whose status and reputation became so great that he was eventually declared to be a god and was worshiped for many years. Imhotep was the architect for the Step Pyramid Saqqara, the first massive monument of hewn stone, built in 2650 B.C. for King Zoser of Dynasty 3.*[37] *Called Ptah (Fig. 2), this god resembled in many ways the Greek god Asklepios of a much later period. Interestingly, while a few medical practitioners achieved sainthood, only a surgeon achieved godhood.*

Early Egyptian Surgery

Reflected in these early writings was a high level of knowledge, with emphasis

on correct diagnosis before initiation of treatment. These early Egyptian surgeons placed great value on hygiene and personal cleanliness, which undoubtedly contributed to the high quality of the surgery. The priests, who often functioned as physicians, emphasized ritual washings several times daily and, to avoid bringing dirt into the sanctuaries, had to be both head-shaven and circumcised (Fig. 3). Indeed, circumcision, depicted in a carving of the relief at Memphis (about 2200 B.C.), was one of the earliest surgical procedures. These early Egyptian surgeons were equipped with good surgical instruments made of flint, and later of bronze, with wooden handles, some of which may have been developed in connection with mummification (Fig.4). There was also evidence of specialization, which sometimes extended to absurd lengths; in the courts of the Pharaohs, virtually every organ or illness had its own specialist. There was even a doctor who was ranked as "keeper of the royal anus." Some historians believe that such overdevelopment and specialization may have hastened a decline in the standards of medicine during the last 1000 years of the Egyptian empire.

Mesopotamian Surgery

In the other cradle of civilization, Mesopotamia, often called Babylonia, evidence of physicians also dates as early as 3000 B.C. Among the earliest surgeons was Urlugalidina (2300 B.C.), whose seal, displaying two knives together with Gods and plants of biology, can be seen today at the Louvre Museum of Paris. Of particular significance is the Code of Hammurabi (circa 2000 B.C.),[38] *which recognized not only a regular medical profession but also the practice of some surgery. The Code provided strict regulations for the practice of medicine, which was government controlled, as reflected in these excerpts by Charles Edwards:*

> *If a doctor has treated a Freeman with a metal knife for a severe wound, and has cured the Freeman, or has opened a Freeman's tumor with a metal knife, and cured a Freeman's eye, then he shall receive ten shekels of silver.*
>
> *If a man's slave, the owner of the slave shall give two shekels of silver to the doctor.*
>
> *If a doctor has treated a man with a metal knife for a severe wound, and has caused the man to die . . . his hands shall be cut off.*[39]

Early Indian Surgery

Further evidence of the role of surgery in the early history of man appears in

the Indian Suśruta-samhitā *or "The Collection of Suśruta"*[40,41]. *Although the exact dates of his lifetime are not known, most historians have placed him as early as 400 B.C. His philosophy has a somewhat modern perspective, as expressed in his* Samhitā: *"A physician, well versed in the principles of the science of medicine [Āyur Veda] but unskillful in his art through want of practice, loses his wit at the bedside of his patient, . . . On the other hand, a physician, experienced in his art but deficient in knowledge . . . is condemned by all good men as a quack, and deserves capital punishment at the hands of the king. Both these classes of physicians are not to be trusted, because they are inexpert and half-educated. . . A physician well versed in the principles of surgery, and experienced in the practice of medicine, is alone capable of curing distempers, just as only a two-wheeled cart can be of service in a field of battle." Such a statement gives lie early to the fallacious modern labeling of surgery by some as a noncognitive discipline.*

Suśruta emphasized proper surgical instruments, having described some 125, including tongs, hooks, forceps, sharp scalpels, needles and thread, rectal speculum, and magnetas for removal of foreign bodies. He described extensively various types of bandages and dressings, as well as surgical procedures, such as lithotomy, amputations, ophthalmic operations (especially for cataract), hemorrhoidectomy, alloplasty, operations for fistulae-in-ano, and rhinoplasty (Fig. 5).

Greek Surgery

The rise of Western surgery had its origin in the peoples of Greece and Asia Minor. The Homeric poems, the Iliad *and* Odyssey, *provide the oldest source of knowledge about Greek medicine.*[42] *Believed to have been composed around 700 B.C., these epics may be based on events and customs five or six centuries earlier. Asklepios was well established at this time as the god of medicine. According to Greek mythology, Asklepios was killed by Zeus after Hades, god of the underworld, became angry at the declining death rate, for which he blamed Asklepios and complained to Zeus that Asklepios was responsible for it. Asklepios was subsequently worshiped as the doctor's divinity. The cult of Asklepios spread across all Greece and even to Rome by 293 B.C., with more than 200 temples.*

During this same period, a more scientifically oriented medical philosophy was emerging. The more theoretical education held to the theurgical idea that illness was a divine punishment, but the nonpriestly assistants of the Asklepiads,

whose large experience with patients allowed them practical observations, began to accept a more natural scientific way of thought. The initial medical school of importance established by these secularized Asklepiads was founded around 700 B.C. at Cnidos in Asia Minor. They completely abandoned theurgical medicine and based their diagnoses on bedside observations. A tumor was considered by them to be a malignant growth and not a visitation from some angry god.

Hippocrates

About 100 years later, this Cnidian school acquired a competitor on the nearby Aegean island of Cos (Fig. 6). The leader was a Greek physician named Hippocrates, who was born on the island of Cos about 460 B.C. and has since been honored as the "father of medicine". Some questions have been raised regarding the authenticity of the 72 medical works known as the "Hippocratic Corpus" or "Collection". Most scholars believe that Hippocrates wrote some of them and that a circle of doctors of Cos wrote some during his lifetime or shortly afterwards[43,44].

The greatest significance of these Hippocratic writings lies in the fact that they repudiated the old theurgical and philosophic medicine and stressed the naturalistic approach, with great emphasis on observation of disease processes. Accordingly, medicine was considered a systematic science. Internal medicine was combined with surgery, and, in fact, the books on surgery in the Corpus Hippocraticum, *believed to be the very ones written by Hippocrates, are generally regarded as its best section. His meticulous attention to details is evident from the following quotations from Hippocrates's writings on surgery: "What concerns surgery are the patient, operator, assistants, and instruments; the light. . . . The nails should be cut to the fingertips. A surgeon must learn to use his fingers through assiduous practice. The index finger and thumb are especially important. They must be trained in all kinds of work, individually as well as together: they should function well, elegantly, rapidly, easily, cleanly and immediately".*[43] *These books on surgery also indicate that great skill was applied in the treatment of wounds, fractures, and dislocations, as well as in operations for fistulae-in-ano, hemorrhoids, trephining of the skull, and drainage of empyema. According to Allbutt,*[45] *"The chief lesson of the Hippocratic period for us is that, in practice as in honour, medicine and surgery were then one. The Greek physician had no more scruple in using his hands in the service of his brains than had Pheidias or*

Archimedes; and it was by this co-operation that in the fifth century an advance was achieved which in our eyes is marvellous [sic]. As we pursue the history of medicine in later times, we shall see the error, the blindness, and even the degradation of the physicians who neglected and despised a great handicraft".

Alexandria

The second great peak of Greek medicine was reached in the third century B.C. in Alexandria, which was founded by Alexander the Great after he defeated Darius III, the Persian king, and thus opened the way to Egypt. During this period, Aristotle, who was a teacher of Alexander the Great and founded his famous Lyceum, was a great creative thinker. He was especially interested in zoology and anatomy and often conducted dissections. He is considered to be the father of comparative anatomy, and his view of anatomic findings dominated medical thinking for 500 years, indeed until the time of Galen.

In addition, two important contributors to the Alexandrian school of surgery were Erasistratus and Herophilus.[18] *The former, who studied and wrote on the heart and lymphatics, was interested in function, experimented in the field of digestion and circulation, describing the bicuspid and mitral valves, and apparently was aware of cardiac contractions and dilations. Herophilus was an able surgeon and contributed to the science of anatomy, with particular interest in the nervous system. He is generally considered the founder of anatomy.*

The third peak in Greek medicine developed in Rome in the early centuries of the Christian Era and was symbolized by Galen.[46-49] *Before Rome conquered Greece in 146 B.C., medicine and surgery had a low status in Italy for several reasons. For one thing, most of the doctors were Greeks, whom the Romans despised. A Roman citizen considered a doctor's work beneath him. This was clearly revealed by the note made by Pliny the Elder, that because Romans had gotten along without physicians for more than 600 years, they should be able to survive with out "the cult of Aesculapius". He stated that, "Medicine is the only one of the arts of Greece, that, lucrative as it is, the Roman gravity has hitherto refused to cultivate. It is but very few of our fellow-citizens that have attempted it, and so soon as ever they have done so, they have become deserters to the Greeks forthwith"*[50].

Celsus

Some Romans were willing, however, to write about the practice of healing, as, for example, Aulis Cornelius Celsus in his De Re Medica Libri Octo *("Eight Books on Medicine") published in 30 A.D., which provides an extensive picture of surgical art during the first century of the Christian era.*[51] *In his VIIth and VIIIth Books, there is evidence that surgery and midwifery had made considerable progress since Hippocrates and the Alexandrian School. Celsus described fully the techniques for lithotomy, piles, fistula, ulcer, fractures, luxations, excision of tumors, hernia repair, and certain plastic surgery procedures. Wound management was similar to that of Hippocrates. Ligatures were applied above and below the bleeding vessels, and amputation of larger limbs were done for the first time, but only in extreme need. He warned the surgeon not to use the suture until the depth of the wound had been cleansed and cautioned that no clot should remain, for this turns into pus, excites inflammation, and prevents union. He regarded surgery as an integral part of medicine and protested strongly against the tendency to separate them.*

By that time, surgery was considered a science, not a handicraft. Celsus expressed the relatively high status of surgery thus: "And even in the cases where we count most on medicaments, it is evident not only that they often fail to restore health, but that health often returns without them. Whereas in the surgical branch of medicine, one can see that every successful cure, however supported to some degree by the other branches, is due primarily to the manual treatment".[51]

Galen

The most influential figure in ancient medicine besides Hippocrates was Galen (130-199 A.D.). For almost 15 centuries, Galen's views reigned over European medicine[46-49,52-54]*. Not until 1543 did Vesalius rectify Galen's anatomic errors, and only in 1628, when Harvey discovered the circulation of the blood*[55]*, was Galen's faulty physiology abandoned. Galen's father, who yearned for the son to become a great doctor, sent him first to teachers of the Hippocratic school and then to medical school in Smyrna, Corinth, and Alexandria. In 158, on his return to Pergamon, he became physician to the gladiators and learned much practical surgery. In 162, he returned to Rome, where he again attended the gladiators, lectured actively, published profusely (more than 400 works), and became personal physician to the emperor, Marcus Aurelius.*

Because autopsies were forbidden in Rome, Galen never dissected a human body. Instead, he based his anatomy on dissection of animals (Fig. 7) and was therefore sometimes in error. His physiology, based on his anatomy, was also, naturally, sometimes faulty. Yet his contributions to medical science cannot be gainsaid. He cautioned against cutting the laryngeal nerve and showed that urine flowed from the kidneys through the ureters to the bladder. Galen's surgery was based largely on the Hippocratic and the great Alexandrian anatomical and medical schools. He applied the ligature in amputations and stated that he obtained his "Celtic linen thread", which he used for this purpose, "at a shop in the Via Sacra between the Temple of Rome and the Forum", a shop near his own home[45].

More important than his achievements in surgery, however, were those in pathology and internal medicine, a further refutation of the myth that all surgeons are traditionally technicians, not creative thinkers. His work was concerned with all phases of medicine, as well as surgery, with detailed instruction on the use of surgical tools. Within the range of his interest was the preparation of an anatomical treatise, more complete than any previously attempted, together with observations and speculation as to function. His physiologic views are based, in significant part, on actual animal experimentation and brought him additional fame as founder of experimental physiology.

Galen's tremendous posthumous influence, which dominated medicine for more than 14 centuries, can be ascribed in large part to the treatise entitled "On the Utility of Parts'[48]. *It carries the philosophic principles of Aristotle to the extreme, where it closely resembles a religious dogma, explaining that only a thoughtful Creator could have designed each part of the human body for the very function for which it was intended.*

Galen's everlasting monuments were his remarkable scientific achievements and a large body of writings he left behind, including descriptions of surgical procedures on various parts of the body (Fig. 8). These became canonized in later centuries to the point that disagreement with them was tantamount to heresy, and the posthumous reverence extended to him far surpassed his contemporary fame. The concomitant arrest of all medical thinking to conform with Galenical concepts seriously impeded scientific progress.

Although Galen was the dominant figure of his era in all of medicine, one of his contemporaries, Antyllus, assumed an important role in the field of surgery. Little is known about his life except that he lived during the first half of the second century A.D. His works have been lost, but they are presented in the writings of

Oribasius[56]. *Obviously a highly skilled and experienced surgeon, he gave precise description for a number of individual operations. Moreover, he gave specific direction regarding the indications and contraindications, as well as complications, of operations. Among these operations were tracheotomy, extraction of cataracts, fistulas, phimosis and hypospadia, and plastic surgery for alleviation of defects on the eyelids, ear, and nose. His operation for aneurysm was his most remarkable achievement; it remained the standard procedure for 16 centuries, indeed, until it was modified by Hunter and Matas. The operation consisted of ligating the artery above and below the aneurysm and then opening the aneurysm and evacuating its contents. He gave detailed and precise instruction concerning its performance. He also advised against operating on certain types of aneurysm of large volume but recommended the procedure for aneurysms in the extremities. Another important surgeon during this period was Soranus of Ephesus, whose treatise on "Diseases of Women" is regarded as a classic*[57].

Byzantine Surgery

The Byzantine Empire began in 330 A.D. after the Roman Emperor Constantine the Great made Byzantium the capital of the Roman Empire and renamed it Constantinople. This period came to an end in 1453, after the Turks captured Constantinople, later named Istanbul.

Byzantine medicine (and surgery), which derived from the Greeks, contributed greatly to medieval scholarship[20]. *The first to compile an encyclopedia of Greek medicine was Oribasius (325-403 A.D.), personal physician to Julian the Apostate. The 70 volumes of his* Synagoge *comprised the best in Greek and Roman medicine*[56].

Although the status of surgery was not greatly enhanced during this period, there is some evidence that it did not regress. Indeed, reports of some technical procedures reflect reasonably good knowledge of anatomy and bold adventurousness. This is demonstrated by the writings of Aetius of Amida, during the seventh century on De vasorum dilatatione *(On the Dilatation of the Vessels), which is now in the Vatican Library*[58,59]. *It deals with aneurysms and suggests that the author had some knowledge of the Antyllus operation, as evidenced by the following passage:*

> *An aneurysm located in the bend of the elbow is treated thus. First we carefully trace the artery leading to it, from armpit to elbow, along the inside of the upper arm. Then we make an incision on*

the inside of the arm, three or four finger-breadths below the armpit, where the artery is felt most easily. We gradually expose the blood-vessel and, when it can be lifted free with a hook, we tie it off with two firm ligatures and divide it between them. We fill the wound with incense and lint dressing, then apply a bandage. Next we open the aneurysm itself and no longer need fear bleeding. We remove the blood clots present, and seek the artery which brought the blood. Once found, it is lifted free with the hook, and tied as before. By again filling the wound with incense, we stimulate good suppuration[58].

Paul of Aegina (607-690), the last of the classical Byzantine physicians, was a contemporary of emperor Heraclitus I and wrote an Abridgement of Medicine in Seven Books, *which remained a bible for surgeons for a long time*[60]. *Translated into Arabic, it was the basis of the Arabian age of medicine, and leading Arab writers like Albucasis adopted almost verbatim Paul's sixth book, on surgery.*

In his historical assessment of Byzantine surgery, Bliquez[61] *stated that the Byzantines were generally considered to have originated little but to have passed on a great deal. His own studies of Byzantine surgery bore out this conclusion. The fact is that dissection of the human body was practiced continually, suggesting that surgeons were directly acquainted with human anatomy, and this, according to Bliquez, was probably a significant factor in preventing Byzantine surgery from sliding backward. A careful review of the surgical instruments representing this period provided Bliquez with "the firmest evidence at hand that most of the major surgical tools employed by Paul and his predecessors (and therefore most of the operations for which they were used) were in use from at least the Macedonian dynasty through the Comneni. It appears, therefore, that the state of surgery did not decline significantly in the Middle Byzantine Period. It may be that in some respects it even advanced a bit"*[61].

A final commentary about the Byzantine Period is concerned with the development of hospitals beginning in the third century and evolving into a well-organized structure and facility for the care of the sick.

In a letter addressed to the Governor of Cappadocia, in Asia Minor, Bishop Basil of Caesarea (370-379) referred to several lodges or inns that he had built outside his city to serve strangers, both those passing through and those needing care for illness. Basil hired nurses and doctors[62].

John Chrysostom, Bishop of Constantinople (398-404) opened similar institutions in the capital. His biographer, Palladios, called these philanthropic houses "nosokomeia", *places to care for the sick. To staff them, John appointed two priests as directors and hired physicians, cooks, and servants. Although Palladios*

adds that these institutions served both those stricken with disease and the strangers, the term nosokomeion, *derived from* nosos *(disease), suggests that the care of the sick predominated in these foundations. According to Miller*[62], *by the end of the fourth century, philanthropic Christian institutions began offering hospital services to the poor. Within the next several centuries and by the reign of Justinian, hospitals stood at the center of the medical profession in the Byzantine Empire. Staff physicians, including surgeons, were assigned to these hospitals and had a hierarchal order. They also had time for private practice.*

Arabic Period

With the disintegration of the Roman Empire and the rise of the political and military power of Islam, the Mohammedan Empire, beginning in the seventh century, spread through the Near and Middle East into North Africa, Spain, and part of France and assumed cultural leadership in virtually all fields of endeavor, particularly philosophy, mathematics, science, and medicine. This leadership it maintained until the Renaissance. The Arabs had inherited much Greco-Roman knowledge and culture well before the founding of Islam. As early as 76 A.D., Jews had fled to Arabia when the Romans destroyed Jerusalem. In the fifth century, the Nestorian Christians, who had been expelled from Constantinople in 431 A.D., had settled in Edessa in Mesopotamia but later were driven away to Gundishapur in Persia (where they founded another hospital)[63].

Some historians have stated that Arabic medicine "contributed no original or novel ideas"[22] *and served principally as compilation and preservation of their Greco-Roman inheritance. Because surgery was held in low esteem, its status declined and many of the surgical procedures used at that time, such as cutting, bandaging, cauterizing, and cupping, were performed by untrained laymen or folk doctors and charlatans. Of interest is the statement made some centuries later by Guy de Chauliac that ". . . one finds that until [Avicenna] . . . all were physicians and surgeons combined, but since then, whether because of delicacy or because of too great a preoccupation with cures, surgery has become separated and abandoned to the hands of mechanics"*[64].

The fact remains, however, that there were some outstanding physicians who practiced surgery and wrote about their observations and experiences. Among these the most important were Rhazes[65] *and Avicenna*[67] *in the eastern caliphate and Albucasis*[68], *Avenzoar*[69], *and Maimonides*[70] *in the western caliphate. Abu Bakr*

Muhammed ibn Zakaria Al Razi (852-925), known as Rhazes, wrote brilliant, and perhaps the first accurate, descriptions of measles, smallpox, and other diseases[66]. *Although his medical views were influenced by Hippocrates and Galen, his erudition was broad and deep, and he demonstrated considerable originality. His* Al Hawi *was a 25-book encyclopedia of medicine and surgery*[65].

Perhaps the most influential Arabic contributor to medicine was Avicenna (abu-Ali al-Husayn ibn-Sina, 980-1037), whose status in Islam as well as Christendom was equal to that of Galen. He was apparently a boy prodigy, having mastered the Koran at the age of 10 years, and he wrote a scientific encyclopedia at twenty-one years. The most famous of his approximately 100 books was The Canon *(Al-Qanun) (Fig. 9), which constituted the basis for medical ideas and procedures as well as the curriculum for Christian universities for hundreds of years, indeed until the mid-17th century. Unfortunately, his attitude toward surgery —a necessary evil— remained popular and probably helped to influence the decline of surgery.*

Perhaps the most important Islamic surgeon was Albucasis (Abul Qasim al-Zahrawi, 936-1013), whose encyclopedic Al Tasrif *(The Method), the first illustrated and systematic text, greatly influenced the Christian West*[68]. *Guy de Chauliac (1300-1380), for example, used some 200 quotations from him. His work contained many illustrations of surgical instruments, and he was obviously a skilled surgeon who advanced the teachings of Paul of Aegina and others. He embraced surgery as a worthy art, revealing a cautious, ethical, and thoughtful approach, in contradiction to the prevalent attitude of Arabic medicine to relegate surgery to an inferior status.*

Although the preservation of Greco-Roman medicine was the greatest contribution of Islam to medicine, the Islamic thinkers and the Christians, Persians, Jews, and others who lived in the Mohammedan Empire (sometimes refered to as "Arabists" because their writings were mostly in Arabic) added much to their Greco-Roman heritage. Through their translations, they bridged Arabic and Latin learning and thus returned Greek work to the Christian West. Another and equally important contribution of Islamic medicine was its establishment of the hospital system. Whereas there were a few Christian hospitals in the West compared to the Islamic hospitals, they were inferior in facilities, organization, sanitation, and medication. Among the best Islamic hospitals were those at Baghdad (9th and 10th centuries), Damascus, and Cairo. Rhazes taught and practiced in the hospital in Baghdad, where he collected clinical reports for teaching. The hospital-medical

school in Damascus was known for its elegant rooms and extensive library. The Al-Mansur Hospital in Cairo, founded in the 13th century, was considered the largest and most magnificent, with separate wards for different diseases[71].

Medieval Medicine (476-1453)

The Medieval period or The Middle Ages (also sometimes called the Dark Ages) spanned the millenium, beginning, according to most historians, with the fall of Rome to the Goths in 476 and ending with the fall of Constantinople to the Turks in 1453, or when printing was discovered in 1440. Although some great constructive activities occurred during this period, as exemplified by the building of great cathedrals in Europe and the founding of great universities, in science and medicine there was progressive deterioration of the intellect.

The decline in medicine and particularly in surgery has been attributed to a number of factors. Included among these were the unsettled conditions of this period as a consequence of marauding conquerors and warring factions that produced a longing for certainty and authority[72]*. This was met to a large extent by the rising domination of the church producing what some historians term "the Age of Faith". Although Galen was not a Christian, his teleologic reasoning was embraced readily by the Christian Church. Moreover, his dogmatic, didactic, and pedantic style, along with his encyclopedic codifications integrating all previous knowledge, provided a ready source of medical information. In addition his name was enshrined by subsequent compilers and commentators of high repute such as Oribasius*[56]*, Aetius*[58,59]*, Alexander of Tralles*[73]*, and Paul of Aegina*[60]*. With the Church crushing any opposition to its dogma and the acceptance of Galen as the fountainhead of all medical knowledge, new ideas were considered heresy, and so religious medicine returned, with illness interpreted as retribution from heaven. Since the cure depended on God's will, operations did not seem worthwhile. Autopsies were absolutely forbidden, and hygiene was nonexistent. Surgery suffered tremendously.*

Christ's healing mission became institutionalized, and in some areas such as Paris, rigidly fixed by sacrodotal scholastics, it was to control medical care for centuries. In the statutes founding his order at the monastery on Monte Cassino (on the site of the ancient temple of Apollo), St. Benedict of Nursia encouraged the care of the sick, but because the cure of disease was possible only through prayer and divine intervention, St. Benedict forbade the study of medicine[22]*.*

Still another important factor that influenced the decline in the status of medi-

cine (and surgery) was the hagiolatry that characterized the early part of the Middle Ages and was subsequently strengthened by the Church. Indeed, miracles became an important mainstay of the growth and development of the Church, and those deemed to be particularly holy were considered intercessors for these actions. While St. Luke was himself a physician, the most famous of all medically inclined saints were probably St. Cosmas and St. Damian, Arab twins who became the special patrons of surgery because of their miraculous operations[74-77]*. One legend was that they appeared post humously to amputate a cancerous leg and replaced it with one taken from a Moor who had just died (Fig. 10). This feat has been portrayed many times by artists such as Andrea Mantegna and can be seen today in the* Antiphonarium S. S. Cosmae at Damiani *in London. Later in the Middle Ages, there developed an increasing number of saints associated with relief from a single disease or condition. Thus, St. Christopher, considered a patron of travelers, also was called on to deal with the plague and sudden death; St. Anthony gave protection against erysipelas; St. Margaret of Antioch became the patron of women in childbirth; St. Erasmus offered protection against seasickness and stomach ulcers.*

The Salerno School

In western Europe during the Middle Ages, medicine in general and surgery in particular assumed low status. For this reason, the establishment of the Salerno School, or Civitas Hippocratica *as it became known, assumed great significance*[78]*. Although the exact date of its establishment is uncertain and although the legend concerning its origin is probably apocryphal, there is recorded evidence that it had become highly regarded by the ninth century. Differing from almost all other universities, it was purely secular and therefore not under ecclesiastic control. Its rapid expansion and flowering during the 12th century was encouraged by the wisdom of its rulers after the Norman conquest of southern Italy*[79-81]*.*

The medical students at Salerno received training in medicine and surgery, although the period of time was longer for medicine. A small group of these students completed the entire course of medicine and then became surgeons. Since there were few places in the medieval world where this combination occurred, there were only a few university-trained surgeons, among them Hugo of Lucca[19]*, Theodoric*[82]*, William of Salicet*[83]*, Arnold of Villanova*[84]*, Lanfranc*[85]*, and Pitard*[86]*. Although Hugo of Lucca left no written record of his work, his achievements are*

known from the writings of his disciple, Theodoric (1205-1296), who was thought by some to have been his son. Although the university-trained surgeons were few, they constituted the basic development of European Surgery and thus enhanced the status of surgery.

The secular medical school established at Salerno flourished from about 1000 A.D. until the 13th century. Probably the first legitimate degree for physicians, which was introduced by Roger II, was awarded by this school. His grandson Frederick II, Holy Roman Emperor, established an examination with standards of knowledge that ranked medicine together with surgery. Surgery, having been reduced to a lowly handicraft under earlier Roman and subsequent Arabian domination, now entered rehabilitation. Not only had the Arabs lacked interest in surgery, but the European priests, according to canon law, immediately lost their jobs if they caused anyone's death during surgical treatment, and therefore were frightened from operating.

One of the men who helped develop the Salerno School into the leading European center of medical education was Constantine, known as "Africanus". His translations of Greek and Arabic texts into Latin fashioned the Salerno School's curriculum, and thus spread Arabian medical knowledge, as well as that gained from the classic Greco-Roman period, to the West. The only other educational center of similar repute was Montpellier in France, near the border of the Arabs' western caliphate. The 20 volumes of the "Royal Book", Al-Maleki *by Ali Abbas, a handbook of all of medicine, was called* Pantegni *("The Total Art") by its translator, Constantine*[87]*. Constantine revived Hippocrates and Galen, long forgotten in Italy.*

The teachers of the Salerno School began producing their own writings, at first about internal medicine and medical ethics, in the Arabian tradition. Of great significance were the surgical books produced at Salerno, based primarily on the surgeons' personal experiences. Although they still did not dare dissect human bodies, they studied the anatomy of pigs, and they observed the findings of the otherwise spurned cataract-knitters, hernia-carvers, and lithotomists. From a combination of these clinical skills, clinical knowledge, and lessons from Greece and Arabia developed a sound surgery, and Salerno became the cradle of modern Western surgery.

Salerno's first great surgeon was Ruggiero Frugardi (Roger of Salerno), who wrote Cyrurgia Rogerii[88] *(1170 A.D.) (Fig. 11), called the first independent surgical work in the Western world. The book spread throughout Europe.*

Salerno's Successors

After Roger's death, medical leadership moved from Salerno to Bologna, with its large university. The medical school's founder, Ugo di Borgognoni, sometimes called Ugo or Hugo of Lucca (1160-1257)[19], *and his disciple Theodoric (1205-1296), denied that healing of wounds required pus formation, as promulgated by Roger and his apprentice Roland. "Such a practice", Theodoric maintained in* Chirurgia *(1267), "is indeed to hinder nature, to prolong the disease and to prevent the conglutination and consolidation of the wound"*[82].

The other most important surgical text of this period, besides that of Roger of Salerno, was the Cyrurgia *by Guglielmo da Saliceto known as William (1210-1280)*[83], *who argued that any distinction between medicine and surgery was absurd: the surgeon was merely a doctor who treated with his hands.*

Three Great Frenchmen

Guido Lanfranchi, known as Lanfranc (d. 1315) (Fig. 12), the founder of surgery in France, was born in Milan and educated by William of Saliceto. In 1295 he moved to Paris, having been driven from Italy by the urgencies of civil war, and became affiliated with the independent college of Saint-Côme, which, according to historians, was established around 1240 and was independent of the University of Paris. Subsequently, it became the examining body for the lay surgeons of Paris. By bringing to France the great attainments of Italian surgery, he advanced French surgery toward leadership for several centuries. He finished writing his Chirurgia magna *in 1296*[85]. *Additional evidence that Lanfranc's influence in the enhancement of surgery went beyond the borders of France is exemplified by one of his pupils, a Flemish physician named Yperman, who subsequently became known as the father of Flemish surgery and, like Vesalius, holds a special place in Belgian medicine. In his* La Chirurgie[89,90], *Yperman followed the teachings of Lanfranc and described in detail the indications and technique of ligature of arteries. Lanfranc subscribed to his mentor William's view: "Oh Lord", he wrote, "why is there so great a difference between a surgeon and a physician? But the philosophers have taken the craft in laymen's hands. Or as many men have disdain for to work with their hands. And yet many men ween that it is impossible for one man to know both the crafts. But thou shalt know well this, that he is no good physician that knows nothing of surgery, and the contrary thereof, a man may be no good surgeon if he knows no physic"*[91]. *He became the personal physician of Philip the*

Fair, a post that was next filled by one of France's most illustrious surgeons, Henri de Mondeville (1261-1320)[92].

A student of Theodoric's, Henri carried further his mentor's doctrine about the care and hygiene of wounds. Like Theodoric, he vigorously denounced the concept of "laudable pus", despite severe criticism. In his instruction on wound management, he emphasized washing the wound to remove all foreign matter and to avoid applying oily or irritant matters. "Wounds", he stated, "dry much better before suppuration than after it"[45]*. He cautioned against the cautery for control of hemorrhage, and for large vessels he advised the use of the ligature. Unfortunately, the vigorous message of Theodoric and Henri concerning wound management and the promotion of healing by first intention went unheeded and the "advocates of suppuration won all along the line; and for centuries to come poultices and grease were still to be applied to fresh wounds; and tents, plastered with irritants to promote suppuration, were still to be thrust into the recesses of them, even when there was no foreign matter to be discharged"*[45]*. His book* Chirurgie *(? 1306-1320) was the first surgical textbook by a native Frenchman and made France the world leader in surgery. Henri, while acknowledging that many of Galen's teachings were correct, asserted that "God surely didn't use up all genius on Galen"*[45].

The third great medieval French surgeon, Guy de Chauliac (d. 1368), produced a textbook, La Grande Chirurgie[64]*, which, except for that of Hippocrates, was proclaimed to have no other of equal value. Both Garrison*[10] *and Allbutt*[45] *have accused Guy de Chauliac of retarding the management of wounds for centuries by his rejection of the nonsuppuration methods, but this view is not shared by Zimmerman and Vieth*[20]*, nor, according to them, by his definitive biographer, Nicaise*[64]*. A careful reading and interpretation of his chapter on wounds suggests his general support of primary intention, his indications for the use of sutures and bandages, as well as the indications for drains and packs. During Guy de Chauliac's residence in Avignon, the Black Death struck in two epidemics, and to his credit and that of other surgeons, he stayed and cared for the victims of the plague when most of the physicians fled. His graphic description of the epidemic, which appears under the title, "The Great Mortality of 1348 and 1360", is one of the earliest records of the ravages of the bubonic plague. Guy himself contracted the disease, as he described, but recovered after 6 weeks. The methods of Guy de Chauliac dominated surgery in France until Vesalius and Paré revised them some 200 years later.*

Influence of the Church

As previously stated, the decline in the status of surgery in medieval Europe has sometimes been attributed to the Church. Even in pagan Rome, however, there was a tendency to separate medicine and surgery, with the latter being considered a lower caste occupation. Certain attitudes and policies of the Church, however, were said to exert a demeaning influence on the practice of surgery. Although some historians have contended that surgery was forbidden to the clerics by the Council of Tours (1163) on the basis that, "The Church abhorreth bloodshed" (Ecclesia abhorret a sanguine), *de Moulin labeled this Latin phrase "a literary ghost", since it could not be found in the text of the Council of Tours*[93]. *A binding prohibition to that effect, however, was detailed by the Fourth Lateran Council in 1215, as well as the Council of Nimes (1284), Wurzberg (1298), and Bayeux (1300): "Let no subdeacon, deacon, or priest exercise any act of surgery which extendeth to cautery or incision"*[18,45,93].

Barber-Surgeons

The significance of these policies and edicts lies in the fact that, more often than not, the institutions in which an education could be obtained were operated by the Church. Thus, in the medical school of the University of Paris, surgical instruction was inhibited. This ultimately led to a professional caste system in Paris, consisting of physicians, surgeons of the long robe (licensed by the College of Saint-Côme), surgeons of the short robe or barber-surgeons (Fig. 13), and lithotomists or oculists. The introduction of the barbers into the hierarchy of medicine appears to have had its origin with the ecclesiastic custom that required shaving of the crown of the head and later periodic, and supposedly prophylactic, phlebotomy. After the College of Saint-Côme, which was founded by a confraternity of surgeons in Paris and named after St. Cosmas, obtained the privilege of surgical licensure, the physicians, jealous of the growing influence of this group, encouraged untrained barbers as creatures of their own and even hired them to perform various procedures, such as routine "prophylactic" phlebotomies so popular at that time, tonsorial work, and operating baths. These barber-surgeons were called surgeons of the short robe in contrast to the surgeons of the long robe.

A surgeon of the short robe, and barber of King Charles V (Charles the Wise, 1337-1380), who was master of the guild of barbers, persuaded the King to issue an edict permitting them to treat wounds and sores and forbidding surgeons to inter-

fere with them. The relative status of these three kinds of medical practitioners is reflected in the following order issued by King Charles V during an epidemic of the pest in 1383: There "small be selected to visit the sick four physicians, two surgeons, and six barbers, and the fees of the doctors shall be three hundred livres, of the surgeons one hundred and twenty livres, and of the barbers eighty livres"[5]*. It is thus apparent that there is nothing new or original in the current concept of the Resource-Based Relative-Value Scale (RBRVS) promulgated by the Harvard School of Public Health.*

Medieval English Surgeons

John of Mirfield, chaplain at Saint Bartholomew's Hospital in London, was also a librarian and an unschooled, amateur doctor. His Breviarium Bartholomei, *a collection of original works by authorities such as Galen and Guy de Chauliac, was interspersed with his own notes about treatment and prognosis. In his* Florarium Bartholomei, *he pointed out, like Lanfranc in France, the fallacy of making a distinction between physicians and surgeons: "Long ago, . . physicians used to practice surgery, but nowadays there is a great distinction between surgery and medicine, and this, I fear, arises from pride, because physicians disdain to work with their hands, though, indeed, I myself have a suspicion that it is because they do not know how to perform particular operations; and this unfortunate usage has led the public to believe that a man cannot know both subjects, but the well informed are aware that he cannot be a good physician who neglects every part of surgery, and, on the other hand, a surgeon is good for nothing who is without knowledge of medicine"*[94]*.*

The disdain for surgeons, however, persisted in England longer than anywhere else, and even today the tradition of addressing physicians as "Doctors" but surgeons as "Misters" remains. Interestingly, British surgeons now regard "Mister" as an honorific title.

England's first important surgeon was John of Arderne (1306-1390), the world's first proctologist[95]*. He gained considerable surgical experience during the Hundred Years War and was actively engaged during the Seige of Algiers against the Moors when, for the first time, gun powder was used. In his practice he included the whole of surgery but became particularly interested in diseases of the rectum. Following his move to London, he was admitted to the Surgeon's Guild as a Master Surgeon. His* Treatises of Fistula in Ano, Hemorrhoids and Clysters *was his most important contribution to surgery.*

Surgery in the Renaissance

The 15th century in Europe was marked by a fresh look at many aspects of life. Criticism and revision flourished. Antonio Benivieni (1440-1502) grew wealthy from his practice of surgery and kept careful notes on his patients, with follow-ups from autopsies. In 1507, his friend Rosati published these notes as De abditis morborum causis *("The Hidden Causes of Illnesses")*[96]*. Much new information about pathology thus became known that was of great value to surgeons. Some referred to the book as "the end of the old humoral tradition"*[20].

The first Pope to approve autopsies was Sixtus IV (1414-1484), who, by this act, stimulated further study of the structure of the human body[21]*. A further stimulus was provided by artists, who rejected the stylized Gothic portraits of the 15th century in favor of greater reality. Donatello and Pollaiuolo were among the first artists to study anatomy of the human body by dissection, followed by Leonardo da Vinci, Michelangelo, Dürer, and Titian. Da Vinci (1452-1519) left 779 anatomical drawings, among which was a precise drawing of transverse veins in the lower leg, now at the archive of Windsor Castle. The theater of anatomy at Padua, built in 1446, allowed Vesalius to teach, Realdus Colombus*[97] *to describe pulmonary blood circulation, and William Harvey*[55] *to participate in dissections.*

After the Alexandrian school, the Italian school showed early appreciation of anatomy. Thus, approximately two centuries before Sylvius in Paris was teaching anatomy, Mundinus (Mondino de Luzzi, 1275-1326) was reviving the study and teaching of anatomy at the University of Bologna, where he also practiced surgery. The combination of professorship of anatomy and surgery continued at Bologna for 250 years. Mundinus's Anathomia[98]*, written in 1316, was considered an essential manual of anatomy and dissection for two centuries until displaced by Vesalius's* Fabrica.

Jacob Sylvius (1478-1555) in Paris, considered the first great anatomist of the Renaissance, accepted Galen's anatomy unreservedly[97]*. Among his many students was Andreas Vesalius (1514-1564). Born in Brussels and educated at the University of Louvain, he went to Paris, where he studied under Sylvius. Later he went to the University of Padua, where he obtained the degree of Doctor of Medicine "with highest distinction". On the following day, at the age of 23 years, he was appointed Professor of Surgery. His duties in this position included the teaching of anatomy and holding of public dissections. During the next 5 years he worked on the monumental task of preparing an entirely new book of the complete anatomy of the human body based on his personal dissections and was able to enlist an excellent*

artist, Jan Stefan van Kalkar, also a native of Flanders and Titian's favorite pupil[20]. *Entitled* De Humani Corporis Fabrica *(Fig. 14), the seven books were published in Basel in 1543, when the author was 28 years old*[99].

There ensued a fervent academic controversy between Vesalius and almost all the rest of the medical world, with Sylvius heading the opposition. Embittered and disillusioned by these attacks, Vesalius retired from further academic pursuits and began practicing surgery, serving in several military campaigns. In the preface to his book addressed to "The Divine Charles V", the Emperor of Spain, whose physician he became after resigning his chair at Padua, he expressed his resentment and obvious bitterness against the physician's attitude toward surgeons as follows: "Thus in course of time the art of healing has been so wretchedly rent asunder that certain doctors, advertising themselves under the name of physicians, have arrogated to themselves alone the prescription of drugs and diet for obscure diseases, and have relegated the rest of medicine to those whom they call surgeons and scarcely regard as slaves, disgracefully banishing from themselves the chief and most ancient branch of the medical art, and that which principally (if indeed there be any other) bases itself upon the investigation of nature"[100].

In 1564, at the age of 50 years, returning from a pilgrimage to the Holy Land, he was shipwrecked on the tiny Peloponnesian Island of Zante, where he died. The reason for this pilgrimage, according to Major[19], *lies in the fact that when Vesalius opened the chest of a Spanish nobleman who had died in his care, he found the heart beating and the parents accused him of murder and brought in the Inquisition. The King intervened and had the punishment commuted to a journey of penitence to the Holy Land.*

Vesalius's remarkable textbook of anatomy, considered among the greatest of all medical texts, not only revolutionized surgery but greatly stimulated the development of physiology and pathology, as well as anatomy.

From Barbers to Paracelsus

As occurred earlier in France, the caste system among medical practitioners in England became embroiled in the effort to achieve separate status. Accordingly, before 1369, the surgeons organized "The Guild of Surgeons Within the City of London", whose purpose was to separate themselves from the barbers, but it was not very successful in persuading people that surgeons were the equal of doctors[101]. *Doctors of internal medicine, known as herbalists because they prescribed*

mainly healing plants, continued their conflict with surgeons about a new regulation regarding the right to practice medicine professionally. The herbalists won, and the surgeons became covered by a rule that placed them on the same level as bakers, brewers, and public notaries. The surgeons reacted by affiliating the themselves with barbers again.

Surgeons and barbers worked side by side, if not too harmoniously, in the army of Henry V at Agincourt (1415), and it was not until two centuries later that Henry VIII established some order in the relationship by uniting the barbers and surgeons by an Act of Parliament of 1540, made famous by Holbein's painting (Fig. 15)[102]*. Thomas Vicary (1490-1562)*[94]*, "sergeant-chyurugeon to King Henry VIII", became the first master surgeon. This Company of Barber-Surgeons continued until 1745, when it became organized as the Company of Surgeons. In 1800, it became the Royal College of Surgeons of London, and in 1843 the Royal College of Surgeons of England*[102].

Philippus Aureolus Theophrastus Bombastus von Hohenheim (1493-1541) (Fig. 16), a controversial figure in his time, has been called one of the great medical innovators of the Renaissance. Immodestly, he called himself Paracelsus — or the equal of the Roman physician Celsus. Born in Switzerland, he traveled extensively, although there is no evidence that he ever studied medicine or had a right to the title of doctor, but he apparently learned much from conversations with doctors, pharmacists, and chemists. At Basel, he was made professor of medicine, as well as city doctor, in 1527. His main thesis was not to rely on books but on the doctor's own experience and on nature's teachings (Fig. 17). In Grosse Wundartznei, *he wrote: "Internal medicine and surgery are based on philosophy and must not be separated except in practice; every physician must be a doctor of both medicines ... You will not find everything written in the books of Galen and Avicenna, all of surgery has not been written, for new times bring new diseases and new books will outmode the old"*[103].

Greatest Surgeons of the Renaissance

It was Ambroise Paré (1510-1590)[104]*, born in Laval, France, himself a barber-surgeon and personal physician to five French kings, who rehabilitated surgery (Fig. 18). A journeyman with a barber-surgeon, Paré attended lessons at Hôtel-Dieu hospital in Paris (Fig. 19), where he participated in dissections. He then became a field surgeon in the army. During that service, he ran out of the boiling oil*

that was used in treating gunshot wounds and applied instead a healing salve made of eggwhite, rose oil, and turpentine. To his surprise the next morning, those he treated thus showed no inflammation or swelling and little pain, whereas those treated with the burning oil had high fever, great pain, swelling, and inflammation. Thus he resolved never to use burning oil again. His dissertation on gunshot wounds in 1545 became a classic. From their experience and keen observations in military service through the years, consistently surgeons have derived new knowledge from which they have developed new surgical techniques that have benefited not only military personnel but also the civilian population as well[105].

Paré's second book, primarily about anatomy but containing some obstetrics, was based on his revered Vesalius. His reputation grew, and he became a member of the prestigious College of Saint-Côme, an unusual honor for an unschooled barber-surgeon. His Anatomie Universelle du Corps Humain *(1561)*[19] *made Vesalius famous among surgeons. Paré also reintroduced routine ligature of bleeding vessels for wound treatment and amputations (Fig. 20), invented new surgical instruments, designed prostheses for limbs, and improved the hernia band.*

At the age of 75 years, Paré published his greatest work, Oeuvres[104], *in French; the medical faculty in Paris objected to his breaking the rule that its permission was required for the publication of any medical book, whereupon Paré wrote a denial of the faculty's authority and declared surgery independent of "official whims". His integrity, judgment, surgical skill, and moral stamina elevated him to the height of his profession in his time.*

Specialists of Italy and Germany

In the late medieval period, academic education was at a low ebb, although universities were flourishing in Italy, France, and England. In Germany, where surgeons were definitely in the handicraft tradition, surgery lay dormant; the surgeon, like the carpenter, simply did not study books. Yet the handicrafters were more skilled at caring for wounds than their more learned foreign colleagues, having gained much experience from various wars. The book by Heinrich von Pfolspeundt, Buch der Bundth-Ertzney[106], *published in 1460, was notable in urging cleanliness; he considered handwashing and clean bandages important.*

Medicine as a Science

The descriptions by Andreas Vesalius of the true structure of the human body greatly stimulated medicine and promoted an interest in the functions of the organs, bringing a resurgence of interest in physiology. Vesalius's successor at Padua, Realdus Colombus (1516-1559), who wrote De Re Anatomica, *taught Michelangelo anatomy.*

Heironymous Fabricius ab Aquapendente (1537-1619), a professor of anatomy at Padua, discovered the valves in the veins that permit blood to flow centrally even from parts of the body below the heart[107]. *From this discovery, Fabricio's student, William Harvey (1578-1657), was inspired to solve the problem of blood circulation*[18,19].

The New English School

The royal favor shown the Barber-Surgeons' Company elevated its social status, although not on a par with that of the internists. Thomas Vicary began an era of new surgical skills that saw many well-read, inventive, and technically superb surgeons. With his colleague William Clowes (1540-1604), Vicary greatly improved the status of surgery — by supervising the training of apprentices, by teaching, and by watching for untrained charlatans. Clowes, personal physician to Elizabeth I, was the greatest surgeon in Elizabethan England. His A Profitable and Necessarie Booke of Observations *was a collection of cases from his own experience*[108]. *Like Vicary before him and Alexandertly served his apprenticeship in the Dutch navy. His life was most eventful with extended naval and military service, gaining considerable experience in the handling of the severely wounded. After Charles II became King of England in 1660, Wiseman was appointed Surgeon to the King. Suffering from tuberculosis, he was forced to curtail his activities and turned to writing, analyzing more than 600 personal cases and presenting both his successes and failures, in order "that those that come after me may learn what to avoid". His publication on "Surgical Treatises" not only enriched surgical literature but enhanced the status of surgery*[109,110].

Continental Surgeons

Wilhelm Fabry von Hilden (1560-1634) was the leading German surgeon of his time[111]. *With little formal education, he became an apprentice to a succession of barber-surgeons over a period of 12 years. He later became eminently successful in the practice of surgery. He published his experience with more than 600 cases on Observations and Descriptions in Wound Surgery. His careful analysis of this wealth of experience included postmortem examinations to determine the causes of death and the nature of the diseases. He has been regarded as "the best of the surgical empiricists, and not only advanced the surgery of his native country, but also imbued it with the spirit of science"*[112].

The Enlightenment

The 18th century in England was a period of vigorous development, not only in statesmanship but also in art, literature, and medicine, built on foundations laid by earlier generations.

William Cheselden, Surgeon

William Cheselden (1688-1752), learned anatomy from another surgeon, William Cowper (1666-1709), who although derided as a "bone-setter", made new discoveries about human anatomy, including Cowper's glands. Competing for corpses, Cheselden ran afoul of the Barber-Surgeons' Society; eventually, he succeeded in separating the surgeons from the barbers with the help of his son-in-law, Dr. Charles Cotes, a member of Parliament and chairman of the special committee of the House of Commons, who brought the matter under consideration, which then resulted in a Bill[113]. *He became well known, was officially recognized as personal physician to Queen Caroline, and held three positions as "first lithotomist". Cheselden helped found the new Surgical Society, in 1745, and served as its president until his death in 1752. His significance and influence are best reflected by his disciples and successors, such as Percival Pott, the Hunters, and Astley Cooper, who for almost a century gave British surgery great prestige*[114].

William and John Hunter

Two imposing figures in British surgery were William (1718-1783) and John

Hunter (1728-1793) (Fig. 21). William's Anatomy of the Gravid Uterus[115] *is, according to some, unparalleled. It was John Hunter, however, who put surgery on a sound scientific basis and completed the ascendency of surgeons from artisans to scientists. The anatomical drawings that survive reflect his affinity for precision, teaching, and aesthetic sensitivity.*

John Hunter was admitted to the Royal Society in 1767; only those with important scientific writings were accepted, and his entrance article was on digestive fluids. He became the city's leading surgeon, inspector of all its hospitals. His writings, published primarily in Philosophical Transactions, *were later collected into a book.*

Hunter's surgical daring is illustrated by an operation he performed for popliteal aneurysm on a patient at St. George's Hospital. Having observed that a rich network of blood vessels developed when the crown of a deer's horn was in its prime and therefore needed nourishment but that the size and number of vessels decreased when the horns shed, Hunter theorized that such reserve (collateral) vessels also developed in human beings when their arteries became obstructed. Thus, the vascular system was not static, but dynamic, subject to supply and demand. When he had a patient with a pulsating aneurysm in his knee-fold who could hardly walk, presumably from an obstructioin just below the aneurysm, he rejected amputation in favor of cutting the inner thigh just above the knee (Hunter's channel) and ligating the superficial femoral artery above the aneurysm. The wound formed pus, but this cleared, and the patient left the hospital with his leg intact. Three of four subsequent operations of this kind were successful, the fourth patient, however, having bled to death[116].

The fact that Hunter never referred to Antyllus[56]*, who performed basically the same procedure about 15 centuries previously, or Aetius*[58,59]*, who also performed a similar procedure about 1000 years earlier, provides written evidence of the discontinuity in the transmission of earlier knowledge and the decline in medical and surgical activities in the Medieval period.*

Hunter developed angina pectoris, and his attacks became increasingly severe and frequent. He did not know the cause of his condition but recorded its manifestations in detail, and he recognized the role of emotional disturbances. He said, in fact, "My life is in the hands of any rascal who chooses to annoy me"[20]*. That statement was prophetic for in a quarrel with his colleagues at St. George's Hospital regarding teaching programs, he became furious and died within a few minutes. The couch on which he died remains enshrined in the lobby of St. George's Hospi-*

tal. Long after his death from coronary arteriosclerosis, his admiring disciples succeeded in having his remains moved to Westminster Abbey, where an inscription by the Royal College of Surgeons reads: "to record admiration of his genius, and as a gifted interpreter of the Divine power and wisdom at work in organic life, and its grateful veneration for his services to mankind as the founder of scientific surgery"[117]*. Some historians have stated that his contributions to surgery have possibly not been surpassed by anyone before or after his time.*

Surgeons Versus the Academicians

The division between surgeons and "learned doctors" was wider in France than elsewhere, due in part to the pomposity of medical faculties and their resistance to constructive thinking. The surgical competence of the practitioners, however, was not the highest, and, except for Ambroise Paré and some well-known obstetricians, surgery was performed primarily by barber-journeymen. But in 1645 a few surgeons with some literary education merged with the barbers' guild to form a college. The reaction from university physicians was immediate: they forbade the surgeons to bear academic titles and thus prohibited them from calling themselves doctors. Furthermore, the new association was not permitted to call itself a college, which might suggest higher education. Nevertheless, the new organization had money —which the medical faculty lacked— and so built its own demonstration hall for surgical instruction next to the École de Médicine*, an annoyance to the professors*[10,20]*. At the inauguration, a first fight erupted, and the professors were forced to retreat in humble fashion.*

Georges Maréchal (1658-1736), personal physician to Louis XIV and Louis XV, established the Académie Royale de Chirurgie[10,20]*. It irritated the medical faculty that the monarchy decreed that the Academy would be completely independent and its members would have equivelent ranks and rights as the faculty. Consisting initially of the 70 "master-surgeons" of Paris, the Academy played a major role in rehabilitating French surgery.*

Napoleon's Surgeon

When the French Revolution began in 1789, French surgery, including military surgery, was at a low ebb. Hygiene was virtually absent. This was the state when Dominique-Jean Larrey (1766-1842) of Beaudéan began his military career, which covered the entire Napoleonic Age[20]*.*

In 1792 he became a major with the Rhine army. There he became convinced that better organization was needed to serve the wounded. One idea he had was to save the wounded and dying in the fields by building a cart, which he called "a flying ambulance" and which combined speed with safety and comfort. In 1797, he described his ambulance, including the personnel to accompany it. The ambulance was to be equipped with dressing-barrows, instruments, and bandages. His ambulance became a great success, and he weas ordered to return to Paris to arrange ambulances for the entire army[118].

Four Continental Pioneers

During the 18th century in central Europe, Surgery, *by Lorenz Heister (1683-1758) of Frankfurt, was the most important influence on surgery, where it appeared in German, English, French, Italian, Dutch, and Latin*[10,20]. *A well-educated student of languages and the humanities at the University of Hardewyk in Holland, he then went to Amsterdam to study with outstanding surgeons and anatomists. He was appointed chief surgeon of the Army of the Netherlands, where he gained great experience in wound management. After the publication of his book on surgery, he was appointed Professor of Anatomy and Surgery at the University of Helmstadt, where he remained for 38 years. He introduced to Germany a new type of surgeon, one that was highly educated, in contrast to the previously unlettered, craft-trained, and ignorant practitioners*[119,120]. *Although he advocated simplicity in operations, he improved some surgical instruments and invented some of his own, such as the trepan for removing tonsils. In* Chirurgie *he enhanced surgical standards by his systemization of the subject. The book contained beautiful copper etchings, showing operations step by step. Heister was among the first cancer surgeons and the first to describe appendicitis. "It is necessary", he wrote (1752), "for a surgeon to have complete, or at least very good, knowledge in anatomy as well as in medicine, so that he has enough judgment and understanding to study all the causes and circumstances, and to draw his conclusions from them"*[120].

Antonio Scarpa (1752-1832) has been called Italy's sole contributor to surgery at the end of the 18th century[18,121]. *His operation for clubfoot is still used in principle today. An able scholar, superb illustrator, brilliant anatomist, and skillful surgeon, he himself illustrated his* Results of Observations and Experience on the Principal Maladies of the Eyes. *Energetic and ambitious, he was despised by some and held in fear by others, but he is memorialized in the*

many anatomic structures that bear his name. He understood thoroughly the indispensability of a comprehensive knowledge of anatomy and physiology in the practice of surgery. His tireless study bore many fruits, among which were the structure of the eye and inner ear.

In 1804, he compiled a classic monograph on the forms and diagnosis of arterial aneurysms[122]*. According to Matas, Scarpa's observations were so convincing that the treatment remained "an immutable and unshaken principle in surgery from the time it was first enunciated by that remarkable surgeon over one hundred years ago to the present time"*[121]*. Not, in fact, until Matas developed his procedure of endoaneurysmorrhaphy, was the "law laid down by Scarpa" successfully challenged. Despite the challenge to Scarpa's surgical interpretations and conclusions, his anatomic and pathologic observations remain unquestioned today.*

Balthasar Salinus, a barber-surgeon, was physician to Queen Christina of Sweden and was the first to practice any significant surgery in that country. Because internists were scarce in Sweden, medicine was practiced by barber-surgeons until the 18th century. After apprenticeship in that guild, those who wished undertook theoretical studies at Uppsala or Lund and went abroad for further education.

Olof Acrel (1717-1806), known as the "father of Swedish surgery", learned surgery from an able barber-surgeon, Gerhard Boltenhagen, son of a field surgeon[21]*. He traveled to Göttingen to study under Albrecht von Haller, a pioneer in physiology and experimental medicine who also covered surgery. He returned to Sweden and in 1752 established the first general hospital there. Acrel's treatise,* Surgical Events, *a combined handbook and casebook, described operations and instruments in detail and initiated a new native school of surgery. The Acrel Medal is still awarded by the Swedish Surgical Association for outstanding achievement.*

Surgery in the Age of Revolutions

The Western World witnessed remarkable innovations during the late 18th and early 19th centuries.

The Great Scots

Surgical education and research at the University of Edinburgh, called the world's medical center in 1800, were started by John Monro (1670-1740) and were

continued by his family[10,18,19]*. Educated in Leyden along with Herman Boerhaave (1668-1738), he gained much experience as an army surgeon in Holland and Ireland. In 1715, according to his son, he sewed together a patient's severed windpipe and punctured esophagus. His son, Alexander (known as* primus*) (1697-1767), became the first professor of anatomy of the new medical faculty at Edinburgh. The publication of* The Anatomy of the Human Bones *lifted his reputation, and students flocked to him for study. In 1729 a hospital was opened in Edinburgh, later to become the renowned Royal Infirmary. Monro, wrote Oliver Goldsmith (himself a physician), "brought his science to the highest possible perfection".*

Monro's son, Alexander secundus *(1733-1817) carried on his father's work. Educated in London under William Hunter, and in Berlin, where he studied with Johann Friedrich Meckel, Alexander, the son, published* Observations on the Structure and Functions of the Nervous System *(1783), in which he presented the discovery of the connection between the heart's ventricles, called the* foramen Monroi.

The Bells

*The first Scottish surgeon to assemble surgical knowledge into an encyclopedia (*System of Surgery, *1784)*[18]*, Benjamin Bell was also the first in Britain to advocate radical operation for cancer of the breast according to the technique of Petit in Paris.*

John Bell (1763-1820), of a different family, carried on a feud with the dean, who was also a professor of medicine, that caused him to turn against official medicine[20]*. Nevertheless, he persuaded his colleagues to question several so-called clinical truths. He showed, for example, that a burst aneurysm could be sewn, and he fought for "primary" healing without pus formation. Perhaps his greatest contribution was his battle for good training in surgical anatomy. He opened his own school of anatomy and earned the title of "the father of surgical anatomy".*

After John Hunter

Well trained in anatomy and pathology, and with an elementary knowledge of physiology, the English and Scottish surgeons of the early 19th century were also technically refined. Because physicians were beginning to keep better patient notes and to classify them better than previously, they were learning more from expe-

rience and thus improved their diagnoses. With its inspiration from England, surgery of the first three quarters of the 19th century was predominantly British, whereas the last quarter was largely German.

Among John Hunter's first disciples were John Abernethy (1764-1831), whose colorful language added appeal to his special learning[94]*. He became a professor of surgery and anatomy at the College of Surgeons and chief surgeon at Saint Bartholomew's. To his students he emphasized anatomy.*

Another student of Hunter, Henry Cline (1750-1827), became a surgeon at Saint Thomas' Hospital and was interested in teaching[94]*. Still another student of Hunter's was Edward Jenner (1749-1823), who became Hunter's personal assistant but returned home to Berkeley after obtaining his degree to become a country doctor and pursue his hobbies of ornithology and botany. Jenner noted that some people in his home district allowed themselves to be infected by cowpox and that they never caught smallpox, although a rash developed on their hands.*

His mentor, Hunter, encouraged him to try an experiment, and on May 14, 1796, he did so by injecting into a young boy cowpox pus from a dairymaid[94]*. Six weeks later, when Jenner injected him with smallpox, his slight illness from the first injection made him no worse. The Royal Society rejected Jenner's report of this experiment, and even when Jenner published further evidence of his claim in 1798 in* An Inquiry into the Causes and Effects of the Variolae Vaccinae, *it did not receive immediate acceptance. Although severely criticized at first for his "unethical" experiment, Jenner later became world famous after the appearance of his report of 23 successful vaccinations.*

Interestingly, the unlikely early stimulus for experimentation with inoculation was a rigid Congregational cleric, Cotton Mather (1663-1728), who had heard from his African slaves that those who carried the scars of smallpox were the ones who could care for those infected[123]*. He persuaded Zabdiel Boylston (1697-1766), a surgeon in Muddy River, Massachusetts, to experiment with inoculation. Because Boylston himself had smallpox scars, he inoculated his son with pus from an active pock, after which his son became mildly ill and recovered. Thereafter, Boylston performed many other inoculations and published his observations in 1726*[124] *and 1727*[125]*. Those who had been inoculated were immune when the next epidemic occurred, but inoculation caused some deaths, and Boylston was severely criticized. He was later vindicated, however, and when Edward Jenner's safer method of inoculation was introduced to North America in 1801, this "vaccination" was accepted because of Boylston's success with direct inoculation.*

Another leading surgeon among Hunter's disciples was Astley Paston Cooper (1768-1841)[126]*. As as student at Edinburgh, he was not very scholarly, but then he traveled to London, where he became a surgical aide to Henry Cline at Guy's Hospital (an institution that had been donated by a penitent swindler). He became intrigued by Hunter's lectures and constant experimentation. After successfully removing a large atheroma (cyst) from the head of George IV (with alcohol the only anesthetic), he became Sir Astley Cooper. His greatest contribution,* Treatise on Hernia, *formed the basis for modern hernia surgery*[127]*. His name remains in* fascia cremasterica Cooperi *and* ligamentum Cooperi, *as well as in the tissue threads holding up the mammary glands.*

Cooper's most famous case was in a man admitted to Guy's hospital with abdominal pain[126]*. When he found a pulsating tumor inside, he promptly diagnosed an iliac aneurysm, ballooning above and below the left Poupart's ligament. Although no one had ever operated under such circumstances before, Cooper realized that the aneurysm would soon burst and the patient would bleed to death. Indeed, he made the decision to operate after the aneurysm began to bleed. After first testing his procedure on a cadaver in the autopsy room, he operated on the patient, ligating the abdominal aorta just above the bifurcation, and although the patient died 40 hours later, Cooper showed that this kind of operation was possible. It was performed subsequently by several surgeons without success, and in 1923 was successfully completed by Rudolf Matas*[128]*.*

Now pathology entered a new phase in which the basic causes of diseases were being sought. The doctrine of unbalanced body fluids was being abandoned because it did not explain tumors, aneurysms, and many other conditions. Physicians were handicapped, however, in their search for this new knowledge because they were ignorant of the cell, the building block in the human organism.

A detailed publication by Matthias Schleiden (1804-1881) in Germany about how plants are built of cells inspired a friend, Theodor Schwann (1810-1882), to make similar studies of animal tissues[10]*. Schwann, who had discovered the enzyme pepsin, confirmed that Schleiden's findings also applied to animals. His observation that nerves are imbedded in an insulating substance —the sheath of "neurilemma" (Schwann's cells)— formed the basis of modern cellular pathology, further developed by Rudolf Virchow (1821-1902).*

Virchow's studies led him to microbiology but had little use for bacteriology, an attitude that led him into controversies with other scientists. He did not accept, for example, Koch's epoch-making presentation in 1882 of the causes of tuberculo-

sis[10]. *He became a member of Parliament, and his progressive ideas almost led him into a duel with the Iron Chancellor, Bismarck.*

Physiology

A number of early physiologists had considerable influence on developments in surgery. Albrecht von Haller (1708-1777), considered to be the founder of experimental physiology, clarified the connection between the nerves and muscles. His eight-volume Elementa Physiologiae Corporis Humana[10,18,19] *collected all the physiology of his day. François Magendie (1783-1855), a professor of medicine in Paris, traced the paths of nerve impulses from the spinal cord and investigated drugs like morphine*[19]. *One of Magendie's students, Claude Bernard (1813-1878), had a profound influence on surgery (Fig. 22). A shy playwright at first, he was dissuaded by critics from continuing in that field, and he turned to physiology. His major contribution, a view that surgeons did not readily accept, was that, to function normally, an organ required a constant environment. About the inner chemical environment or "homeostasis", Bernard wrote that the free, independent life requires the stability of the internal environment and that the mechanism providing it maintains all the conditions in the internal environment that are necessary for the components' life*[27]. *His finding of the importance of keeping the body's fluids and electrolytes in proper balance was indispensable to the advancement of surgery. Bernard also studied blood vessels and regulation by vasomotor nerves.*

Triumph over Pain

The extraordinary progress made in surgery during the late 19th century can be traced, in considerable measure, to the relief from pain. From antiquity to the Middle Ages, hashish, mandrake, alcohol, and opium were the main analgesics[129]. *Many herbs, berries, barks, roots, and flower seeds and blossoms were used to effect loss of consciousness. For the pain of operations, mandragora, poppy, henbane, and hemp were used.*

Early literature contains references to various preparations for the relief of pain. In Homer's Odyssey[42], *Helen, Zeus's daughter, used a preparation, probably of opium dissolved in wine, to alleviate pain and sleep off grief. In the* Iliad[42], *Patroclus applied an astringent, anodyne, to relieve pain from Eurypylus's wound. Before operating, the famous Greek physician Dioscorides, in the first century*

A.D., applied to his patients the root of the mandragora plant boiled in wine. Galen, too, used mandragora to desensitize and paralyze the patient. Mandragora also was used to moderate the agony inflicted on the condemned. Matthew, Mark, and John described the potion that Jesus refused at his crucifixion as gall, myrrh, or hyssop mixed with wine or vinegar. According to Keys[129]*, important evidence of Paracelsus as the founder of anesthesia is found in his reference to "sweet vitriol", a distilled mixture of sulphuric acid with alcohol, which was not called ether until it was so named by Frobenius in 1730. Paracelsus had noted that it caused chickens to fall asleep and awaken later without harm, and he therefore recommended "sweet vitriol" as an anodyne that relieves pain. It was Oliver Wendell Holmes who, in a letter of November 21, 1846, to Morton, proposed the terms* anaesthesia *for the state of insensibility produced by ether and* anesthetic *for the agent*[129].

Heinrich von Pfolspeundt, originally a barber, in his Bundth-Ertznei *(1460), recommended the use of a soporific sponge as an anesthetic; the sponge was soaked in opium and mandragora and placed over the patient's nose "until he sleeps"*[106]*. Karl Sudhoff had found a recipe for the "soporific sponge" in a ninth-century Monte Cassino* codex*, and Henry Sigerist found such a recipe in Bamberg's ninth-century* Antidotarium[10]*. Possibly an earlier reference to the soporific sponge appeared in the* Antidotarium *of Nicolas of Salerno, believed to have lived in the 12th century*[129]*. Theodoric reported that Hugo of Lucca prepared a soporific sponge of opium, hemlock, henbane, mandragora, wild ivy, and the seed of a salad plant, which apparently produced anesthesia for surgical procedures. That soporific draughts were accepted before operations is evidenced by various literary references, including that related by Dioneo in Boccaccio's* Decameron *(14th century)*[130]*, in which a patient drank a potion that caused him to sleep for whatever interval was necessary to complete the operation.*

In the United States in the early 19th century, use of ether and nitrous oxide was progressing. Interestingly the use of these gases in anesthesia was promoted by their inhalation for pleasure at "laughing-gas parties". A young chemistry student, William E. Clarke, a participant in these sessions, used ether anesthesia in what was considered to be its first recorded use, for a tooth extraction in January 1842, in Rochester, New York[129]*. On March 30, 1842, in Georgia, Crawford W. Long, who had witnessed "ether frolics" at the University of Pennsylvania, used ether as an anesthetic before removing a small tumor from his patient, James M. Venable. He did not, however, publicize this event, and it was not until December 1849 that he*

described this experience in the Southern Medical and Surgical Journal[131].

Three years earlier, in the Boston Medical and Surgical Journal, Bigelow and Warren had reported the work of dentist William Thomas Green Morton (1819-1868), who had pursued the matter of anesthetization[132]. After much experimentation and following the suggestion of one of his teachers, Dr. Charles A. Jackson, to use pure sulphuric ether, Dr. Morton successfully performed a tooth extraction after inducing his patient to inhale the ether. Morton next asked Dr. John C. Warren to try the anesthetic during some operation, and that was done on October 16, 1846, when the patient, Gilbert Abbott, inhaled the vapor from Morton's new anesthesia apparatus, before Dr. Warren removed a tumor from the patient's jaw (Fig. 23). Whereas Warren considered it an obligation to introduce to other surgeons and hospitals this valuable innovation, Morton wished to keep the matter a secret and to obtain an exclusive patent for its use. Warren decided that, without a full knowledge of the apparatus and the agent, he could not ethically publicize its use, a position that prompted Morton not to keep his method a secret[133].

Surgery in the United States

Surgery in this country has played a highly significant role in the advancement of medical knowledge, training, and research, particularly since the turn of this century. Since the history of surgery in the United States has been well recounted by a number of others[123,134-137], it is neither necessary nor appropriate to detail this development here. Moreover, one of our former Presidents, David C. Sabiston, Jr., in his Presidential address before this body 16 years ago, presented a fascinating account, in his usual scholastic manner, of the major contributions to surgery from the South[138].

In accordance with this perspective of surgery, however, there are certain characteristics, qualities, and observations concerning the development of our specialty in this country that deserve consideration for several reasons. For one thing, this period of surgical development took place within a relatively brief interval, less than a century, and with accelerating rapidity. For another, it has largely, if not uniquely, been achieved by American surgeons.

To be sure, much of the underlying basis for some of these developments was begun in Europe, especially in the earlier period. These include antisepsis and asep-

sis following Lord Lister's doctrine; establishment of medical school faculties and university teaching hospitals, originally developed by physicians and surgeons who obtained their training in Europe, with the establishment of specialized disciplines both in basic medical science and clinical activities; and great expansion of animal research laboratories in surgery.

One of the most important developments in surgery that is uniquely American in concept and implementation is the residency training program that was initiated by Halsted at Johns Hopkins Hospital[139]*. To some extent, this was based on his observations of the methods of training surgeons in Austria and Germany, where surgery had been greatly advanced. He noted, however, that because the Oberartz, or Chief Resident, often remained in this position until he was chosen to head a Department of Surgery, sometimes as long as 10 years, only a few surgeons could be trained. Accordingly, he modified the program to provide for the Chief Resident to serve for only 2 to 3 years. So successful was this concept that it was ultimately standardized for the nation. Along with this development, and to a large extent stimulated by its success, there were established national qualifying boards and committees for accrediting the residency training programs and for certifying surgeons who had completed such training. It is not insignificant that none of these developments was initiated or supported by the government.*

The rapid progress or ascent of surgery, as so eloquently expressed by the Wangensteens in the title of their book, The Rise of Surgery[140]*, that has taken place in the latter part of the last century, and especially in the past four or five decades, was initiated by two important discoveries, one of European origin and the other of American origin. The former was the doctrine of antisepsis and asepsis, first propounded by Semmelweis (1847)*[141] *and Lister (1865)*[142,143]*, based on the works of Pasteur*[144] *and Koch*[145]*, and the latter was general anesthesia with ether by Crawford Long of Georgia (1842) and William Thomas Green Morton (1846) of Massachusetts.*

With these developments, surgery was significantly altered from its century-old status of an emergency high-risk character to a more deliberate elective nature. It now became possible for surgeons to pursue technical innovations for the treatment of a wide variety of lesions and diseases and to develop more meticulous surgical techniques with greatest regard for tissue in wound management and repairs. Accordingly, surgery gained greater respect both in the medical and lay communities.

Another important contribution of American surgery was the development of thoracic surgery, largely as a consequence of tracheal insufflation, first used by

Matas[146,147] *and subsequently simplified and perfected by Samuel Meltzer and John Auer*[148]. *This development obviated the cumbersome efforts of Sauerbruch (1904) to use a negative pressure cabinet for thoracic operations. Its great significance may be better appreciated when it is realized that it was the key that opened the door to surgical methods of treatment of mediastinal tumors, bronchiectasis, and other diseases of the lung, including particularly cancer and congenital and acquired cardiovascular diseases with open-heart surgery.*

Perhaps no other branch of medicine has enjoyed the striking advances that have occurred in surgery, not only technically but also from the conceptual and cognitive points of view, and indeed in the objectives[149]. *Before the turn of this century, indeed, as already indicated, the objective was largely extirpation of the diseased tissue or organ and urgent care of the wounded, with reconstruction of the tissue, whereas surgery has since focused on preservation or restoration of function, as well as cure of the underlying disease. As so well expressed by the Wangensteens in the subtitle of their book,* The Rise of Surgery, *surgery advanced "From Empiric Craft to Scientific Discipline"*[140].

Surgery has also branched into a number of subspecialties. Although ophthalmology had begun to develop much earlier, most of the other surgical subspecialties, such as urology, obstetrics, and gynecology, began being organized shortly before the turn of the century. Neurosurgery, orthopedics, and plastic surgery followed, stimulated by developments during and after World Wars I and II.

Contributing to the exciting surgical advances, the rise of ancillary services included:

(1) induction of anesthesia, which, although as indicated previously, was introduced about the mid-19th century by Long and Morton, has since been refined both pharmacologically and technically, including the mechanical ventilation of the lungs;

(2) chemotherapy, particularly the use of antibiotics for the control of infection;

(3) blood transfusion, with the discovery of four blood groups by Landsteiner and Moss and the introduction of citrate as an anticoagulant, which made the procedure safe and readily available through blood banks, along with individual blood components for specific deficiencies;

(4) more precise diagnostic methods and procedures, including x-ray (following its discovery by Roentgen in 1895), along with angiography with use of radiopaque substances to visualize circulatory diseases and various cardiovascular organ func-

tions and abnormalities, and more recently computed axial tomography (CAT) scan, positron emission tomography (PET), ultrasound, and magnetic resonance imaging (MRI);

(5) intermittent or continuous monitoring of various vital signs, gases, and cardiovascular functions; and

(6) heparin as an effective anticoagulant to prevent thrombus formation and to permit maintenance of prolonged circulation with the heart-lung machine.

The Impact of Socioeconomic Forces

The unprecedented and unforeseen changes in medicine since the turn of the century, while greatly extending our longevity and the quality of life, have also seriously complicated the delivery of health services, have altered the traditional physician-patient relationship, and have created thorny problems for patients, physicians, and the public[150]*. Prominent themes during the past several decades have included cost-benefit analysis, cost containment, HMOs, PRSOs, health-care accessibility, national health programs, alternate delivery systems, Medicare payments, malpractice insurance, voluntary accreditation, quality assurance, medical ethics (including the controversial active euthanasia and fetal tissue research), scientific misconduct, and an accelerating, indeed alarming increase in governmental regulations. In the words of Eli Ginzberg, "... the earlier untrammeled freedom of the profession to determine how, where, and for how long patients would be treated is being circumscribed by new rules, regulations, and protocols"*[151].

The vigorous campaign waged by animalists against medical research, involving sensationalism, false information, terrorism, and intimidation, has adversely influenced some segments of society and has swayed some members of Congress[152]*. These actions have cost research institutions millions of dollars, have curtailed or completely halted some valuable research programs, and have discouraged some promising young candidates from entering research. The total effect on medical research, which is the source of new medical knowledge, has been devastating.*

Physicians are becoming increasingly disenchanted, many are leaving the profession, and fewer of the best and brightest are applying to medical school. The source of their displeasure? Medical practice no longer brings a sense of satisfaction; it is simply not worth the personal frustration and financial investment. Physicians are no longer permitted to decide how to take care of their patients on the basis of their medical knowledge and training. Now third-party payers, the go-

vernment, and various and sundry committees of self-designated "experts" dictate hospital admission policies, diagnostic studies, type of treatment, and length of hospital stay. Many of these so-called "experts" have never even studied medicine or practiced a day in their lives, and some who have are unfamiliar with the nuances of a particular case.

In this connection, Sir Raymond Hoffenberg, while President of the Royal College of Physicians, published in 1986 the Rock Carling Lectureship entitled Clinical Freedom[153], *in which he analyzed the "winds of change" in medicine both in Great Britain, where a state medical service was established more than four decades ago, and in the United States, and stated that "on balance, despite our recruitment to a State-run service, we have retained a substantial degree of clinical autonomy, perhaps —one might venture— somewhat more than our colleagues in America who are less overtly subject to government control"*[153]. *He stated further that "a 'decline in clinical freedom' has taken place, and is still taking place, to a greater extent in their commercialized and competitive system than in our nationalized, bureaucratic, and more tightly controlled NHS"*[153]. *To support this belief, he quoted Dr. George Silver as follows: "... the British doctor, discontented as he or she may be with the inadequacy of the financial rewards of practice in the UK, or dissatisfied with the shabby and inadequate facilities in many places in which medical work is performed, is still largely free and untrammelled in the practice of medicine, ... (whereas) American physicians ... are pinioned by regulations and controls far beyond ... colleagues in most other countries"*[154].

The cost of a medical education in time and money is considerable, and the expense of starting a medical practice and of malpractice insurance is exorbitant. The increasing litigiousness of our society has exerted additional pressure on physicians, many of whom believe that they must practice defensive medicine. Yet they also feel they are in a no-win situation: If they order certain tests as a defense against a malpractice suit, they will be accused of increasing the patient's costs unnecessarily; if they do not order the tests, they will be accused of being negligent or incompetent. The general decline in esteem of the profession also contributes to the exodus from medicine. If this trend continues, the efforts of those who profess to "reform" the profession will be self-defeating, because the quality of health care and its accessibility, which the so-called reformists are clamoring to solve, assuredly will decline notably.

The extraordinary progress made in medicine during the past century is in serious jeopardy today[155]. *The intrusion of extramedical elements also has dis-*

turbed the physician-patient relationship, which is so crucial to effective health care. Despite the remarkable wonders of modern medicine, the patient remains the center of medical practice, and the physician-patient relationship is still the most critical element in effective health delivery. Anything that interferes with that is a self-defeating obstacle. One of the most important challenges of the future, therefore, is to restore the confidence of the public in the integrity and dedication of the medical profession and to revive the trust of individual patients in their physicians.

A troubling trend is the decline in support for medical research during the past decade or so. A negative impact of the cost-containment hysteria associated with reduction of the budget deficit is the creation of an unstable environment within the research community. The loss of promising young medical science investigators is particularly critical because the continued integrity of the nation's medical research enterprise depends largely on the availability of a pool of talented researchers, and that pool is now being depleted.

All of the wondrous medical advances that have been so briefly touched on in this presentation rest on research. It would seem unnecessary to emphasize its seminal need and its adequate support, as well as its strong protection against a minority of zealous, aggressive, and often irrational groups dedicated to its elimination. Research remains our most important and, indeed, our only means of solving the remaining problems in medicine and thus of further improving the health of the people. Indeed, the valuable advances presented here clearly establish the validity of that concept.

Cost Containment

As surgical research yielded greater and more dramatic advances, such as open-heart surgery, transplantation, and mechanical cardiac assistors, it became costlier. These "medical miracles" excited the public, who began demanding their benefits, but balked at paying for them. Other fruits of technologic development, such as imaging, met with similar public reaction. The rising cost led the government to underwrite part of the health-care program, and as critics and the press focused increasingly on accelerated costs, medical practice became the subject of inquiry. The government intruded, presumably to control costs, but its methods proved not only ineffective, but cumbersome and obstructive. The resulting constraints limited the extension and quality of surgery, for the surgeon's quest is no longer determined by the intellectual capabilities of surgeons, but by external fac-

tors — government and quality-assurance criteria. Despite these constraints, however, the quality of surgery has remained high.

Cognitive and Noncognitive Medicine

It became popular in recent years to divide medicine into cognitive and noncognitive disciplines — a throwback to the schism between medicine and surgery in the Dark Ages, when use of the hands was demeaned and the status of surgery, and indeed of all medicine, declined significantly. But the labeling of surgery as a noncognitive discipline is fallacious and totally unsupported by its history and achievements. To suggest that surgeons are merely noncerebrating technicians is to ignore their native intelligence, education, rigorous training, and performance. The history of surgery is replete with scholarship, and with innovative and highly creative activities, all highly cognitive endeavors, as well as with invention of instruments and new operative techniques and procedures. Any surgeon worth his salt arrives at a judgment regarding operative treatment on the basis of his own knowledge of the basic sciences and clinical medicine. Indeed, the training of a surgeon is equally as intense and is usually longer than that in other disciplines. Such an investment, with its personal and financial sacrifices, was apparently ignored by the advocates of the RBRVS formula.

Moreover, every development in surgery is based on cognitive phenomena and is preceded by careful reasoning and carefully designed investigations. Consider the surgical treatment of congenital cardiac malformations, aneurysms, stroke, coronary artery disease, and organ transplantation. Were these and other life-saving operations developed by those in so-called cognitive disciplines — or by practicing surgeons?

One of the most highly publicized reports regarding the new terminology and criteria for payment originated at Harvard, where, owing to its widely held perceptions as a scholarly institution, one would not expect vogue words to be used loosely and imprecisely[156,157]*. The play that the sensational results of this study received in the public press led to calls for "restructuring" of medical fees according to a "resource-based relative-value (RBRV) scale", that is, measurement of "relative levels of resource input expended when physicians produce services and procedures", which is "a function of the physician's work input, the opportunity cost of specialty training, and the relative practice costs for each specialty"*[157]*. The language is hopelessly vague and jargonish. Hsaio and coauthors*[157] *concluded that*

"Invasive procedures are typically compensated at more than double the rate of evaluation -and- management services, when both consume the same resource inputs" and that "the average family practitioner could receive 60 percent more revenue from Medicare", whereas "the average ophthalmologist and thoracic and cardiovascular surgeon could receive 40 to 50 percent less in revenues from Medicare".

The formula used to obtain their results "assumed work input to consist of time; mental effort; *knowledge, and judgment, and diagnostic acumen; technical skill; physical effort; and psychological stress"*[156]*. The idea of quantitating many of these qualitative factors is mind boggling, but it was apparently attempted with impunity. The authors concede that mental effort, technical skill, and stress are virtually impossible to measure objectively, so they blithely relied on "subjective judgments of the physicians who perform particular procedures". Interestingly, of the six authors of the Special Report, only one was a medical doctor (not a practicing surgeon) and was therefore familiar with what is involved in the daily work of a physician. The final statement in the article by Hsaio and coworkers*[156] *was almost a self-fulfilling prophecy: "This study indicates that resource-based relative values could serve as a rational foundation for compensating physicians according to the work and effort they exert in performing services".*

Had the Harvard group that divided medical practice into "cognitive" and "noncognitive" been too lazy to consult a dictionary or had they been unable to understand the lexical entries, they could have consulted the University's English Department for an explanation of the correct definitions of these terms. "Cognitive" is from the Latin cognitivus, *meaning "of or pertaining to knowledge". By that definition, if surgery is a noncognitive discipline, surgeons have no knowledge—presumably only technical skills. In earlier times, when barber-surgeons were unlettered, perhaps the term may have been applicable, but certainly not today. Because of the patent absurdity of this artificial division on the basis of intellectual involvement, because of the weakness of the arguments, and because of the failure to substantiate the arguments with valid evidence, the dichotomy of "cognitive" and "noncognitive" has now been dropped, only to be supplanted by the equally unacceptable and imprecise "procedural" and "nonprocedural". But some damage was unfairly done to the image of surgery and surgeons.*

The folly and fallacy of the new terminology and criteria proposed largely by nonpractitioners and adopted by bureaucrats to gauge the monetary value of various kinds of health services deserves exposure. So do the inanity of the new lexicon

and the infirmity of the thinking that underlies it. This is the same kind of mentality that introduced such dehumanizing terms as "consumer" for "patient" and "provider" for "physician"[158]*. "No factor has tarnished the public perception of the profession more than its flagrant commercialisation", wrote Sir Raymond Hoffenberg. "In a society in which doctors are seen as 'providers' of marketable health-care products to 'consumers' or 'clients', their standing in the community is assumed to warrant no more recognition or respect than that of other purveyors of essential goods"*[153]*. This public perception has been enhanced by the importunate hawking of medicine and solicitation of patients on television and in other news media as though they were, indeed, advertising a "product".*

The volume of "reforms" proposed by self-named health-care experts is exceeded only by their almost universal inexperience in the actual practice of medicine. If surgery were a purely technical skill, requiring no knowledge of the basic and clinical sciences, it would hardly take 10 or more years for licensure and certification. How many sugeons do you know who, when the patient is on the operating table and an unexpected finding occurs, call in a "cognitive" practitioner to advise him how to proceed? The new nomenclature is only the most recent manifestation of the attempt to devalue and demean surgery, ostensibly in the interest of cost containment.

The foregoing surgical perspective attests to the impressive, durable contributions of surgeons throughout medical recorded history. But it also documents their periodic censure and denigration as noncerebral, insensitive, avaricious, and even venal technicians. In the Babylonian, Indian, Egyptian, and Classical Greek eras, surgeons were esteemed as educated professionals, but during the Roman and later Medieval periods, physicians were discouraged from using their hands in caring for patients by sacrodotal and other factors previously described. The consequence was a separation of medicine from surgery. This arbitrary division has recurred in various forms ever since, to the detriment of both branches of medicine. As T. Clifford Allbutt[45] *has so aptly stated: "From Greece and medieval Italy we have to bring home the lesson that our division of Medicine into medicine and surgery had its root not in nature, nor even in natural artifice, but in clerical feudal and humanistic conceits". Interestingly, when these efforts at estrangement have succeeded, the status of medicine in general has declined, whereas when the two branches worked together harmoniously, the entire profession flourished, made remarkable progress, and thus served humanity better.*

It deserves emphasizing that in every period of history, surgeons of keen intel-

lect and high purpose, by observing and recording their astute clinical and experimental observations, have helped build the estimable body of medical as well as surgical knowledge available today. Reaching beyond the manual procedure of operating, they have probed the anatomy, physiology, and biochemistry of the human body and the changes that occur as a consequence of disease or injury, to develop better methods of diagnosis, treatment, and prevention. Despite the impediments imposed on early surgeons, giants like Paracelsus, Paré, and Hunter, all barber-surgeons, refused to succumb and instead engaged their inquiring minds in investigations that uncovered important concepts. The results of their inquiries not only improved surgery but also enriched all of medicine. Thus, tradition testifies to the fact that regardless of the barriers or the resistance, surgery will prevail in time. The reason is clear: surgeons have always made practical contributions, and in time society not only appreciates those services but also demands them.

To the criticism, and sometimes even the humiliation, directed to them, surgeons have responded in a constructive way by trying to improve the education, performance, and ethics of their colleagues. Thus, they have erected exacting training requirements, licensing and certification regulations, and high ethical precepts for their profession. These measures have lifted surgery from its status as the craft that some, in earlier times, and a few with dangerously powerful influence are now trying to assign it, to its current position as a respected healing science.

Today we are faced with new impositions inimical to the optimal delivery of our services—factors that threaten to erode the future of surgery. The ever-mounting government restrictions and intrusion into every decision regarding patient care; the anti-intellectual and antiscience attitude, characterized by the antagonism of groups like the animal rights zealots; the menace of malpractice litigation; and the consistent diminution in funding for research —all have a deleterious effect on our profession by diverting our attention from our primary concern— our patients. Some hospitals today spend as much as $2 million each year on quality assurance activities imposed on them, without observing any improvement occurring in patient health care.

In the face of these and other hostile forces, however, I continue to be optimistic about the future of surgery, and that optimism is reinforced by my recollection of the dauntless spirit of our predecessors—their unquenchable curiosity, their dogged determination, their indomitable courage in opening audacious new frontiers, their basic meliorism, and their innate desire to alleviate human suffering. I see all these qualities in my colleagues gathered here today, and I feel a surge of great

pride in being a member of such an honorable, dedicated, and productive group. You have added luster to the mantle of surgery and will, I know, pass on to the next generation of surgeons the intrepid spirit that has always distinguished our profession. Thank you, and may the future bring you only the best that life has to offer.

REFERENCES

1. Daremberg C. Histoire des sciences médicales, contenant l'anatomie, la physiologie, la médicine, la chirurgie, et les doctrines de pathologie générales. Paris: Baillière, 1870.

2. Haeser H. Lehrbuch der Geschichte der Medicin und der epidemischen Krankheiten. 3 Volumes, Jena: Hermann Dufft, 1875-1882.

3. Haeser H. Übersicht der Gschichte der Chirurgie. Stuttgart: Verlag von Ferdinand Enke, 1879.

4. Withington ET. Medical History From the Earliest Times, A Popular History of the Healing Art. London: Scientific Press, 1894.

5. Billings JS. The history and literature of surgery. In Dennis FS, ed. System of Surgery, Volume 1. Philadelphia: Lea Brothers & Co., 1895.

6. Neuberger M. History of Medicine. 2 Volumes. Translated by Playfair E. London: Oxford University Press, 1910-1925.

7. Sudhoff K. Beiträge zur Geschichte der Chirurgie im Mittelalter, graphische und textliche Untersuchungen in mittelalterlichen Handschriften, 2 Volumes. Leipzig: Barth, 1914-1918.

8. Buck AH. The growth of medicine from the earliest times to about 1800. New Haven: Yale University Press, 1917.

9. Meyer-Steineg T, Sudhoff K. Geschichte der Medizin im Überblick mit Abbildungen. Jena: Fischer, 1921.

10. Garrison FH. An Introduction to the History of Medicine, 4th ed. Philadelphia: WB Saunders Company, 1929.

11. Camac CNB. Imhotep to Harvey; Backgrounds of Medical History. New York: Hoeber, 1931.

12. Shryock RH. The Development of Modern Medicine; An Interpretation of the Social and Scientific Factors Involved. Philadelphia: University of Pennsylvania Press; London: H. Milford, Oxford, 1936.

13. Clendening L. Source Book of Medical History. New York: Hoeber, 1942.

14. Leonardo RA. History of Surgery. New York: Froben Press, 1943.

15. Singer C. A Short History of Medicine. Oxford: Clarendon Press, 1944.

16. Guthrie D. A History of Medicine. Philadelphia: JB Lippincott, 1946.

17. Castiglioni A. A History of Medicine. Edited and translated by Krumbhaar EB. New York: Alfred A. Knopf, 1941.

18. Mettler CC. History of Medicine. Philadelphia: The Blakiston Company, 1947.

19. Major RH Jr. A History of Medicine. 2 Volumes. Springfield: Charles C Thomas, 1954.

20. Zimmerman LM, Veith I. Great Ideas in the History of Surgery. Baltimore: Williams & Wilkins, 1961.

21. Meade RH. An Introduction to the History of General Surgery. Philadelphia: WB Saunders, 1968.

22. Lyons AS, Petrucelli RJ III. Medicine: An Illustrated History. New York: Harry N. Abrams, 1978.

23. Jastrow M Jr. The medicine of the Babylonians and Assyrians. Proc R Soc Med 1913-14; (Pt. 2): 109-176.

24. Dawson WR. The beginnings, Egypt and Assyria. Clio Medica, Volume 1. New York: Hoeber, 1930.

25. Contenau G. La Médicine en Assyrie et en Babylonie. Paris: Maloine, 1938.

26. Gordon BL. Medicine Throughout Antiquity. Philadelphia: FA Davis, 1949.

27. Bender GA. Great Moments in Medicine. Detroit: Northwood Institute Press, 1966.

28. Wells HG. The Outline of History. Garden City: Doubleday, 1971, pp 134-155.

29. David AR. The Making of the Past. The Egyptian Kingdoms. Belgium: Elsevier, 1975.

30. History of Egypt. In *The New Encyclopaedia Britannica, 15th ed. Chicago: Encyclopaedia Britannica, 1979, Vol. 6, pp 460-501.*

31. History of Mesopotamia and Iraq. In *The New Encyclopaedia Britannica, 15th ed. Chicago: Encyclopaedia Britannica, Inc., 1979, Vol. 11, pp 963-1001.*

32. Parker G. The World: An Illustrated History. New York: Harper & Row, 1986, pp 43-55.

33. Fagan B. New Treasures of the Past. New York: Barrons, 1987, pp 52-84.

34. Breasted JH. The Edwin Smith Surgical Papyrus. 2 Volumes. Chicago: University of Chicago Press, 1930.

35. Ranke H. Medicine and Surgery in Ancient Egypt. Studies in the History of Sciences. Philadelphia: University of Pennsylvania Press, 1941.

36. El-Gammal SY. Ancient Egyptian medical papyri. Hamdard 1990; 33: 58-70.

37. Hurry JB. Imhotep, the Vizier and Physician of King Zoser. Oxford: Humphrey Milford, 1926.

38. Harper RF. The Code of Hammurabi, King of Babylon About 2250 BC, 2nd ed. Chicago: University of Chicago Press, 1904.

39. Edwards C. The Hammurabi Code. London, 1921.

40. Kunja Lal B. The Sushruta Samhitā. Calcutta: JN Bose, 1907.

41. Zimmer HR. Hindu Medicine. Baltimore: Johns Hopkins Press, 1948.

42. Homer. The Iliad of Homer. Translated by Lattimore R. Chicago: University of Chicago Press, 1951. The Odyssey of Homer. Lattimore R, trans. New York: Harper & Row Publishers, 1965.

43. Adams FR, trans. The Genuine Works of Hippocrates. 2 Volumes. New York: William Wood & Co., 1849.

44. Chadwick J, Mann WN. The Medical Works of Hippocrates. Springfield: Charles C Thomas, 1950.

45. Allbutt TC. The Historical Relations of Medicine and Surgery to the End of the Sixteenth Century. London: Macmillan, 1905, p 11.

46. Brock AJ. Greek Medicine: Extracts of Medical Writers from Hippocrates to Galen. London: JM Dent, 1929.

47. Green RM. A Translation of Galen's Hygiene. Springfield: Charles C Thomas, 1951.

48. May MT, trans. Galen: On the Usefulness of the Parts of the Body. 2 Volumes, Ithaca: Cornell University Press, 1968.

49. Sarton G. Galen of Pergamon. Lawrence: University of Kansas Press, 1954.

50. Bostock J, Riley HT. The Natural History of Pliny. 5 Volumes. London: Bohn, 1856, pp 374-377.

51. Celsus AC. De medicina. Latin text with English. Spencer WG, trans. 3 Volumes. Loeb Classical Library. Cambridge: Harvard University Press; London: W. Heineman, 1948-1953.

52. Galen. Galeni pergameni omnia quae extant, in Latinum Sermonem Conversa. Basel: Frohen, 1562.

53. Galen. On the Natural Faculties. With English translation. Translated by Brock AJ. London: William Heinemann, 1916.

54. Galen. Über die Krankhaften Geschwülste (zwischen 169 und 180 n. Chr.), übersetzt und eingeleitet von Dr. Paul Richter (Klassiker der Medizin. Sudhoff K, ed). Leipzig: JA Barth, 1913.

55. Harvey W. Exercitatis anatomica de motu cordis et sanguinis in animalibus. Frankfurt: Wilhelm Fitzer, 1628.

56. Bussemaker UC, Daremberg C, eds and trans. Oeuvres d'Oribase. 6 Volumes. Paris, 1851-1876.

57. Soranus. Sorani Gynaeciorum libri IV. De signis fractuarum. De fasciis. Vita Hippocratis secundum Soranum. Ilberg J, ed. Leipzig, 1927.

58. "Tetrabiblon", the first eight of the sixteen books, were first published at Venice in 1534 as "Aetius Amideni librorum medicinalium tomus primus, primi scilicet libri octo nonc primum in lucem editi". Cited by Mettler[18], p 187.

59. Michler M. Die alexandrinischen Chirurgen. Eine Sammlung u. Auswertung ihrer Fragmente. Die hellenistische Chirurgie Teil I. Wiesbaden: F. Steiner, 1968. Cited by de Moulin[82], p 394.

60. Paulus of Aegina. The seven books of Paulus Aegineta. 3 Volumes. Translated by Adams F. London: Sydenham Society, 1844-1847.

61. Bliquez LJ. Two lists of Greek surgical instruments and the state of surgery in Byzantine times. In *Scarborough J, ed. Dumbarton Oaks Papers: Symposium on Byzantine Medicine. Washington: Dumbarton Oaks Research Library and Collection, 1984, pp 187-194.*

62. Miller TS. Byzantine hospitals. In Scarborough J, ed. Dumbarton Oaks Papers: Symposium on Byzantine Medicine. Washington: Dumbarton Oaks Research Library and Collection, 1984, pp 53-63.

63. Whipple AO. Role of the Nestorians as the connecting link between Greek and Arabic medicine. Ann Med Hist 1936; 8:313.

64. de Chauliac G. La Grande Chirurgie. Nicaise E, ed. Paris: F. Alcan, 1890.

65. Ranking GSA. The life and works of Rhazes (Abu Bakr Muhammad ben Zakaruja ar-Razi). International Congress of Medicine, Section 23. Hist Med 1914; 17: 237.

66. Rhazes. A Treatise on the Small Pox and Measles. Translated by Greenhill A. London: Sydenham Society, 1848.

67. Avicenna. The Canon (Al-Qanum). Cited in Lyons and Petrucelli[22], p 310.

68. Albucasis. La chirurgie d'Albucasis. Translated by Leclerc L. Paris: Ballière, 1861.

69. Avenzoar. Altersir. Cited by Major[19].

70. Friedenwald H. Moses Maimonides the physician. Bull Inst Hist Med 1935; 3:555.

71. Carstens HR. The history of hospitals, with special reference to some of the world's oldest institutions. Ann Intern Med 1937; 10:670-682.

72. Dixon P. Barbarian Europe. New York: EP Dutton, 1970.

73. Alexander of Tralles. Alexander von Tralles. Puschmann T, trans. Vienna: Braumüller, 1878.

74. Gerlitt J. Cosmas and Damian, the patron saints of physicians. Ciba Symposium 1939; 1:118-121.

75. Farmer DH. The Oxford Dictionary of Saints. Oxford: Clarendon Press, 1978.

76. Zimmerman LM. Cosmas and Damian, patron saints of surgery. Am J Surg 1936; 33:160-168.

77. Danilevicius Z. SS. Cosmas and Damian: the patron saints of medicine in art. JAMA 1967; 201:1021-1025.

78. The school of Salernum. Regimen sanitatis Salerni. Translated by Harington J. London: John Holme and John, 1607. Reprinted: Ente Provinciale per il Turismo, Salerno, 1966.

79. The School of Salernum, Regimen Sanitatis Salernitanum. English version by John Harrington. New York: Paul B. Hoeber, 1920.

80. Singer C, Singer D. The origin of the Medical School of Salerno, the first university, an attempted reconstruction. In *Essays on the history of medicine presented to Karl Sudhoff. Zurich, 1924: 121-138.*

81. Kristeller PO. The School of Salerno; its development and its contribution to the history of learning. Bull Hist Med 1945; 17: 138-194.

82. Theodoric. The surgery of Theodoric. Translated by Campbell E, Colton J. New York: Appleton-Century-Crofts, Vol. 1, 1955; Vol. 2, 1960.

83. William of Salicet. Chirurgie de Guillaume de Salicet, achevée en 1275. Pifteau P, trans. Toulouse: Imprimerie Saint-Cyprien, 1898.

84. Arnold of Villanova. Regimen Sanitatis Salernitanum a Magistro Arnaldo de Villa Nova Catalano veracites expositum. Louvain, 1480.

85. Lanfranc. Chirurgia magna. London: T. Marshe, 1565.

86. Sudhoff K. Ein chirurgisches manual des Jean Pitard. Sudhoffs Arch f Gesch d Med 1908-09; 2:189.

87. Pagel J. Eine bisher unveröffentliche lateinushe Version der Chirurgie der Pantegni. Latin text only. Langenbecks Arch klin Chir 1906; 81:733-786.

88. Roger of Salerno. Cyrurgia Rogerii, 1170. Cited by Major[19].

89. Yperman J. La chirurgie de Maître Jehan Yperman (1260?-1310?), Livres I et II. De Mets A, trans. Paris: Editions Hippocrate, 1936.

90. Yperman J. De 'Cyrurgie' van meester Jan Yperman. Ed in Dutch by van EC Leersum after Mss in Brussels, Cambridge, Ghent and London. Leiden: AW Sijthoff, 1912.

91. Lanfranc. Cited by Zimmerman and Veith[20].

92. De Mondeville H. Chirurgie de Maître Henri de Mondeville. Translated by Nicaise E. Paris: Ancienne Librairie Germer. Ballière, 1893.

93. De Moulin D. A History of Surgery with Emphasis on the Netherlands. Dordrecht: Martinus Nijhoff Publishers, 1988.

94. Graham H. Surgeons All. New York: Philosophical Library, Inc, 1957.

95. John of Arderne. Treatises of Fistula in Ano, Haemorrhoids and Clysters. Power D, ed. London: Kegan Paul, Trench, Trübner & Co., 1910.

96. Benivieri A. De abditis nonnullis ac mirandis morborum et sanationum causis. Translated by Singer C. Springfield: Charles C Thomas, 1954.

97. Singer C. A Short History of Anatomy From the Greeks to Harvey. New York: Dover Publications, 1957.

98. Anathomia of Mondino da Luzzi. In Fasciculo di medicina, Venice, 1493. With an introduction by Charles Singer. Florence: R. Lier & Co., 1925.

99. Vesalius A. De humani corporis fabrica. Basileae: Ioannis Oporini, 1543.

100. Schwartz G, Bishop PW, eds. Moments of Discovery. The Development of Modern Science, Vol. 2, New York: Basic Books, 1958, p 520.

101. Bishop WJ. The Early History of Surgery. London: Robert Hale Limited, 1960.

102. Cope Z. The history of the Royal College of Surgeons of England. Springfield: Charles C Thomas, 1959.

103. Paracelsus. From Mason ML. Basel—1527 (Paracelsian Surgery). Quarterly Bulletin, Northwestern University Medical School 1956; 30 (3).

104. Paré A. Oeuvres completes d'Ambroise Paré. 3. Volumes. Malgaigne J-F, ed. Paris: J-B Balliè-re, 1840.

105. DeBakey ME. History—the torch that illuminates: lessons from military medicine. President's Address delivered at the Uniformed Services University of the Health Sciences Surgical Associates Day, April 6, 1990, Bethesda, Maryland.

106. von Pfolspeundt H. Buch der Bundth-Ertzney. Haeser H, Middledorpf A, eds. Berlin: George Reimer, 1868.

107. Hieronymus Fabricius ab Aquapendente. Oeuvres chirurgicales de Hierosme Fabrice de Aquapendente. Lyon: Jean Antoine Huguetan, 1670.

108. Clowes W. A Profitable and Necessarie Booke of Observations, for All Those That Are Burned With the Flame of Gun Powder. London: Edw Bollifant for Thomas Dawson, 1596. With introduction general and medical by Starnes DT, Leake CD. New York: Scholar's Fascimiles and Reprints, 1945.

109. Wiseman R. Eight Surgical Treatises, 6th ed. 2 Volumes. London, 1734.

110. Longmore T. Richard Wiseman, Surgeon and Sergeant-Surgeon to Charles II, A Biographical Study. London: Longmans, Green & Co., 1891.

111. Platt WB. Fabricius Guilhelmus Hildanus: the father of German surgery. Bull Johns Hopkins Hosp 1905; 16:7.

112. Schaefer RJ. Wilhelm Fabricius von Hilden, Sein Leben und seine Verdienste um die Chirurgie. Studie aus der Geschichte der Chirurgie, Heft 13. Breslau: JU Kerns Verlag, 1904.

113. Cheselden W. The Anatomy of the Human body. London; C. Hitch and R. Dodsley, 1756.

114. Cope Z. William Cheselden. London: E & S Livingstone, Ltd, 1953.

115. Hunter W. The Anatomy of the Gravid Uterus. Birmingham, 1774.

116. Hunte J. A Treatise on the Blood, Inflammations, and Gun-Shot Wounds, by the Late John Hunter, to Which Is Prefixed "A Short Account of the Author's Life" by his Brother-In-Law, Everard Home. London: George Nichol, 1794.

117. Haeger K. The Illustrated History of Surgery. New York: Bell Publishing, 1988.

118. Larrey D-J. Memoirs of Military Surgery and Campaigns of the French Armies. 2 Volumes. Translated by Hall RW. Baltimore: Joseph Cushing, 1814.

119. Heister L. D. Lavrentii Heisters Chirurgie. Nurnberg: Johann Hoffmann, 1731.

120. Heister L. A General System of Surgery, in Three Parts, Containing the Doctrine and Management of Wounds by Laurence Heister, 6th ed. London: W. Innis & J. Richardson et al., 1757.

121. DeBakey ME. Foreword. In Monti A, Antonio Scarpa in Scientific History and His Role in the Fortunes of the University of Pavia. Translated by Loria FL. New York: Vigo Press, 1957.

122. Scarpa A. 'Sull' aneurisma. Riflessioni ed osservazioni anatomicochirurgiche; in folio con 10 tavole in rame incise dall' Anderloni. Pavia: Bolzani, 1804.

123. Moore F. Surgery. In Bowers JZ, Purcell EF, eds. Advances in American Medicine: Essays at the Bicentennial. 2 Volumes. New York: Josiah Macy Jr., 1976.

124. Boylston Z. An Historical Account of the Small Pox Inoculated in New England Upon All Sorts of Persons, Whites, Blacks, and All Ages and Constitutions. With Some Account of the Nature of the Infection in the Effects on Human Bodies. With Some Short Directions to the Unexperienced in the Method of Practice, 1st ed, corr. London: n.p., 1726; reprinted Boston: S. Gerrish, 1730.

125. Boylston Z. An Historical Account of the Small Pox Inoculated in New England Upon All Sorts of Persons, Whites, Blacks and of All Ages and Constitutions. With Some Account of the Nature of the Infections in the Natural and Inoculated Way, and Their Different Effects on Human Bodies. With Some Short Directions to the Unexperienced in the Method of Practice, 2nd ed. Boston & Salem: Hancock, 1727.

126. Borck RC. The Life and Work of Astley Cooper. Edinburgh: E & S Livingstone, Ltd, 1952.

127. Cooper A. The Anatomy and Surgical Treatment of Inguinal and Congenital Hernia. Part I. London, 1804.

128. Matas R. Ligation of the abdominal aorta. Ann Surg 1925; 81: 457-464.

129. Keys TE. The History of Surgical Anesthesia. New York: Schuman's, 1945.

130. Boccaccio. Il Decamerone. Volume 1. Giornata Quarta, Novella Decima. Firenze: Adriano Salani, 1928.

131. Long CW. An account of the first use of sulphuric ether by inhalation as an anaesthetic in surgical operations. South Med Surg J 1949; 5: 705-713.

132. Warren JC. Inhalation of ethereal vapor for the prevention of pain in surgical operations. Boston Med Surg J 1846; 35:375-379.

133. Bigelow HJ. Insensibility during surgical operations produced by inhalations. Boston Med Surg J 1846; 35:309-317.

134. Dennis FS. The achievements of American surgery. Med Record 1892; 42:637-648.

135. Packard FR. History of Medicine in the United States. New York: PB Hoeber, 1931.

136. Shryock RH. Medicine and Society in America, 1660-1860. New York: NY University Press, 1960.

137. Whipple AO. The Evolution of Surgery in the United States. Springfield: Charles C Thomas, 1963.

138. Sabiston DC Jr. Presidential address: major contributions to surgery from the south. Ann Surg 1975; 181:487-507.

139. Carter BN. The fruition of Halsted's concept of surgical training. Surgery 1952; 32:518-527.

140. Wangensteen OH, Wangensteen SD. The Rise of Surgery. From Empiric Craft to Scientific Discipline. Minneapolis: University of Minnesota, 1978.

141. Semmelweis IP. Die Aetiologic, der Begriff und die Prophylaxis der Kindbettfeibers. Budapest and Vienna, 1861.

142. Lister J. On a new method of treating compound fracture, abscess, etc., with observations on the conditions of suppuration. Lancet 1867; i:326, 357, 387, 507; ii:95.

143. Lister J. The Collected Papers of Joseph, Baron Lister. 2 Volumes. Oxford: Clarendon Press, 1909.

144. Pasteur L. Mémoires sur les corpuscles organisés qui existent dans l'atmosphère. Examen de la doctrine des générations spontanées. Ann de Chim et Phys 1862; 64:5-110.

145. Koch R. Etiology of anthrax; etiology of tuberculosis. M. Classics 1938; 2:715-880.

146. Matas R. Intralaryngeal insufflation for the relief of acute surgical pneumothorax. Its history and methods with a description of the latest devices for this purpose. JAMA 1900; 34:1468-1473.

147. Matas R. On the management of acute traumatic pneumothorax. Ann Surg 1899; 29:409-434.

148. Meltzer SJ, Auer J. Continuous respiration without respiratory movements. J Exp Med 1909; 11:622-625.

149. DeBakey ME. The future of surgery. Ann Surg 1963; 158:778-784.

150. DeBakey ME, DeBakey L. The ethics and economics of high-technology medicine. Compr Ther 1983; 9:6-16.

151. Ginzberg E. The destabilization of health care. N Engl J Med 1986; 315:757-761.

152. DeBakey ME. Holding human health hostage. J Invest Surg 1988; 1:81-84.

153. Hoffenberg R. Clinical freedom, The Rock Carling Fellowship, 1986. London: Nuffield Provincial Hospitals Trust, 1987.

154. Silver G. Discordant priorities. Lancet 1987; i:1195.

155. DeBakey ME. The development of vascular surgery. Am J Surg 1979; 137:697-738.

156. Hsaio WC, Braun P, Yntema D, Becker ER. Estimating physicians work for a resource-based relative-value scale. N Engl J Med 1988; 319:835-841.

157. Hsaio WC, Braun P, Dunn D, Becker ER, DeNicola M, Ketcham TR. Results and policy implications of the resource-based relative-value study. N Engl J Med 1988; 319:881-888.

158. Hanlon CR. The science and humanism program. Bull Am Coll Surg 1990; 75:42-44.