III. SURGERY YESTERDAY AND TODAY

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Seminar
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Man left his Anthropoid cousins some two million years ago. The cleavage was not abrupt. It is difficult to estimate just how long it was before the divorce was complete, but the most ancient remains of man date back only to about 350,000 years B. C., and it would seem that man has existed as man, for not much more than half a million years. Half a million years ago man began an endless struggle against disease. Since the last glacier retreated man has had to fight for health, and the first weapon in the hands of the first surgeon was a flint.

Trepanning the skull for the release of demons is the earliest surgical operation of which any evidence remains. The flint knife was used for this operation. The belief of demoniacal possession was perhaps one of the first concepts of man. The treatment for demons imprisoned in the bony vault of the skull was a perfectly rational one. Skulls have outlasted skeletons and borne mute witness to what was done aeons before the dawn of civilization. It is hardly possible that the surgeons who undertook this hazardous operation did not know of many other lesser surgical procedures, but evidence of what has been done to human flesh moulders rapidly. Bones remain, and enough Neolithic bones of arms and legs have been found to show that Neolithic man suffered from broken limbs just as often as from demoniacal possession. The old bones have told their story of the trepanning of skulls. They have taught us, too, that something was done to assist the healing of fractures. Exactly what methods were used in setting the fractures and splinting them we do not know, but we can legitimately guess.

To assist this guessing we seek instruction from the still-living primitive people who have preserved minor surgical technics since they came into existence. We may surmise that their methods of treating broken bones were known to Neolithic man. Some of them probably were, but it can never be proven.

At least two existing races treat fractures in ways which may have been known to Neolithic man. American Indians have long used bark splints. The native surgeons of Southern Australia for some centuries have been encasing broken legs and arms in soft clay which sets hard.

As to the surgery that Neolithic man directed at parts other than bones or skulls there is no evidence at all. We can see from the now existing primitive tribes first of all how wounds were treated. An instinctive treatment, popular amongst all sorts of primitive races, is to apply the leaves of trees or plants. A leaf or a cobweb and an incantation was as far as most primitive peoples went in the treatment of wounds. In one or two existing tribes, however, definite attempts at wound surgery have been recorded by modern observers. It is likely that one or more of these methods were known to Neolithic man.

Next comes the art of bleeding and the kindred practices of cupping, leeching, and scarifying. All these methods of bleeding were direct attacks on pains, either as pains or as manifestations of demoniacal activity. It seems reasonable to suppose that the fact that such bleedings did not always succeed in allaying pain or in curing disease directed the thoughts of primitive surgeons to other methods of approaching the same problems. One line of thought must have led to the Amazon's amputations-wholesale removal of the affected part complete with demons; another led

to the cautery. If the demon could not be removed by bleeding, then it might possibly be driven away by heat, or perhaps counter-irritation,

There is one operation which has a well-established history of some six thousand years. The operation of circumcision was practiced about 4000 B. C.

It is quite clear that surgery was in the beginning an attack on disease in exactly the same way as it is today. The Neolithic surgeon had no knowledge of pathology and not much more of anatomy. His instruments were crude, but his ideas were sound. His belief in demons was the only one possible in his time, and his attack on intracranial invaders was just as direct as the modern surgeon's approach to a brain tumor. The cupping and bleeding that his immediate descendents practiced were just as logical. After half a million years we have discarded the demons, but in the explanation of disease we still invoke certain concepts which will probably amuse surgical posterity much less than half a million days hence. In the same way ritual mutilations of men and women were an undoubted prostitution of surgery, but even so they had more social significance than a gastro-enterostomy will ever attain. Surgery was born of a queer muddle of demonology, tribal ritual, and social necessity, but in the earliest civilizations it developed rapidly into a lusty infant art.

Over many thousands of years, man slowly became civilized and rather more slowly his surgeons followed suit. Southwest Asia was the first home of civilization. The Sumerians by 5000B. C. were organizing an ordered civilization in Babylon and over the whole delta of the Tigris and Euphrates in Sumer and Akkad. It was in Babylon itself, not quite 2250 years B. C. that the great law-giver Hammurabi drew up his code. In it he regulated,

among innumerable other things, the exact fee that a surgeon was to receive for certain operations. The variation in fees according to the social status of the patient has persisted to this day.

The first woman doctor to receive historical note was the goddess Tefurt, who compounded medicine for the Great God Ra. She gave him a headache, but the Goddess Isis gave him some medicine which contained Berry-of-the-Poppy Plant. This is one of the earliest uses of opium for pain.

The Egyptian practice of mummification allowed for the acquisition of a certain degree of anatomical knowledge, although it was quite limited.

Before mysticism destroyed it, Egyptian surgery inspired many peoples, but the surgery practiced in China seems to have resembled it more closely than that of any other country. Then China went the way of Egypt and remained at a surgical standstill for a longer time.

The first record of anesthesia is that of giving a patient a toxic drink so that he became unconscious, remaining so for as long as three days.

Surgery attained a remarkable development in ancient India. Knowledge of the early Aryan surgery was gained from three sacred books, since many of the oldest surgical and medical books were not produced until a little later. These early surgical books are remarkable for their comprehensiveness and systematic arrangement. They describe how surgery was of primary importance because of injuries sustained in wars between the gods and demons, these injuries having to be dealt with long before the art of medicine was needed to cure fevers and general diseases which were unknown at that time. The qualities of character and temperament necessary in one who is to be a surgeon are given in detail with the whole involved ritual of initiation. The need for anatomical knowledge, and the fact that this could only be obtained by careful dissection of the human cadaver, are stressed. A

clear-cut and logical classification of operations mentions eight general types: incising, excising, scraping, puncturing, searching or probing, secreting fluids, and suturing. One hundred and twenty-five surgical instruments are minutely described and indications for their use outlined. The insistence on a correct training is remarkable; there is a section describing how an apprentice may try his hand on ingenious models.

It is difficult to assess the extent to which the great civilizations were dependent upon each other's culture. It is easier to estimate the degree of surgical development attained in different countries, leaving on one side the vexed question as to whether such culture was borrowed or arose independently.

Old China never had any real system of surgery, nor had Japan. Of the Babylonians we know little except that they practiced surgery in a fairly advanced form and that to them credit must be given for freeing surgery from the trammels of religion, at least for a time. Surgery in Egypt and to an even greater extent in India, reached heights which only the Greeks equalled, and only our own civilization has bettered. Indian surgeons advanced far beyond their Egyptian contemporaries, but in medicine in general, therapeutics, and in hygiene, Egypt and India must have ranked equal. The decline and fall of surgery followed almost the same line in the two countries. Over-specilization was the first step in the decline. The age-old bands between medicine and religion were tightened, The priests invoked their gods and made incantations and myths obscure true surgery in order that their own authority might be enhanced. Surgery was no longer a profession or an art but was allowed to become a menial trade.

There was once a chief of Thessaly who fought in the Trojan Wars. He

was born in 13 B. C. and was named Asklepios; the Romans knew him later as Aesculapius. Myths and legends began to gather around this Thessalian chief. It was obvious that no mortal could have performed such miraculous cures. He was deemed a god and the son of gods.

Temples of Asklepios were first built in the eighth and early seventh centuries B. C.; over three hundred were built. Those who practiced surgery and medicine in the temples were known as Asklepiadae. In the course of time the priests devoted themselves more and more to the pruely religious side of their work, and a school of lay assistants, or secular Asklepiadae, grew up and took over the medical and surgical treatment of patients. These laymen must have been brought up in Greek schools of philosophy and logic--they achieved more in a few years than the superstitious priests had achieved in centuries.

Inevitably medical schools arose; the first of these was in Cnidos, a Lacedaemonian colony in Asiatic Doris. The school was probably founded about the seventh century B. C. Magic and superstition were discarded. There was an accurate observation and systematic description of facts relating to disease.

There was founded a rival school on the island of Cos about a hundred years later. Here the patient was regarded as more important than his symptoms or disease.

At least two of the major works of Cos were written by Hippocrates. He was born in 460 B. C., son of a lay Asklepiad, was a pupil and later a teacher in the school of Cos. He and his fellows brought to the existing culture a clearer insight and a broader rationalism. They never distinguished between medicine and surgery but practiced both as integral parts of a

single liberal art. Hippocrates died in 370 B. C. and for four hundred years after his death his teachings were followed.

The first Greek surgeons in Rome were probably charlatans and adventurers, but because they were Greek were given to look after the all-important gladiators and gymnasts. Gradually Greek medicine and surgery came to be taken more seriously.

The next man of great importance was Galen who was born in 131 A. D. and went to Rome in 162. His medical and surgical works influenced every act and thought of unborn generations of surgeons. Much of Galen's surgery was learned on the battered bodies of gladiators. He was a genius, a born physiologist, a brilliant exponent of experimental methods, and a first class anatomist, but not another Hippocrates. He was the Dictator, while Hippocrates was the Father of Medicine.

Roman surgery never quite reached the Hippocratic heights. Bitter sectarianism which characterized much of the Roman surgical practice did nothing to advance the science. Army medical service probably had its beginning here because the health of the conquering legions was of primary impertance.

Hippocrates made a liberal art of surgery. Galen tried to make it a dogmatic science and the misinterpretation of later compilers, who had neither the vision of one nor the genius of the other, made it a pseudo-scientific mixture of every art and every science from black magic to botony. Philosophy and reason were the only things excluded from this bad mixture. Hippocrates had erected the science of medicine on a foundation of accurately observed facts while Galen with his well-meant attempts at a mathematical systematization placed only on a foundation of pure reason made the science a burden of doctrine and dogma. The coming of the

barbians simply marked the final fading out of surgery which had begun to grow dim five centuries before.

Throughout this long dark period of surgery which followed, only the Moslem Empire knew and practiced something of a true surgery, and their Empire like others before it was destined to crumble soon. It did crumble, but it left behind a legacy of translations and a compilation of medical and surgical works which were to pave the way for a surgical Renaissance.

It was noted that during this period harp strings were used to suture abdominal wounds. Linen which had previously been used and was found to have rotted was replaced by pig's bristles. These are some of the earliest materials used as sutures that have been recorded.

Galen was the one who touched nothing that he did not ornament with his learning and injure with his theories, and who first laid down the dictum that "surgery is only a mode of treatment."[1] Then in the time that followed, the surgeon was treated as an inferior being. According to the Pope bloodshed was incompatible with the divine mission so any surgical procedures that involved bloodshed were relegated to men unlilely to be afflicted with divine missions, such as barbers, bathkeepers, executioners, mountebanks, and the like.

Monasteries had as one of their purposes "to help sick brethren,"[2] so gradually their medical duties took precedence over their religious ones.

A medical school was established at Salerno in about 1070 A. D. It was the first institution in Europe to bear any resemblance to a university. It gave to Europe nothing original except perhaps its legends. But Salerno did perform great service. It held such of the old Greek traditions that it had. With them it mingled all the culture of Arabia and the Greek and Roman teachings which the Moslem ratiocination had twisted

a little. A Greek, a Latin , an Arab, and a Jew each contributed something, and a Moor plagiarized them all. Salerno took these things and savored them with a naive common sense and a kindly sympathy, adapting all the learning of the East to fit the needs of awakening Europe. Salerno was the model after which the Universities of Bologna, Naples, and Montpellier were founded and were gaining strength.

Roger Frugardi a surgeon of Salerno through his teachings and writings came to be known as one of the founders of modern surgery. One of his pupils, Roland, produced a book which added information to the one written by Roger's friend. At Salerno, Bologna and other centers this book was annotated by different surgeons and finally in 1270 there was written at Salerno a volume by Roger, Roland, and the Four Masters, whose names are unknown. This volume for generations was regarded as the most authoritative surgical work in existence.

Roger, Roland, and the Four Masters were succeeded by other surgeons who followed their teachings and assisted in placing surgery on a firm foundation again. Most of these surgeons travelled from country to country, learning their craft from the famous surgeons at the Universities of Bologna, Padua, Montpellier, and so on. Their practical experience was gained in the wars, and then, as now, it was a good school for budding surgeons.

Lanfrank was the founder of French surgery, but not by choice. He wrote two books which later became surgical classics. One of Lanfrank's contemporaries, Henri de Mondeville, wrote a description of an ideal surgeon; this description has never been bettered. The first quality of a good surgeon is boldness tempered with enough wisdom to avoid undertaking a really dangerous operation unless he is certain that it is the only way to avoid a greater danger. "The surgeon's hands should be well-shaped with

long, delicate, and supple fingers, which should not tremble. A cure should always be promised to the patient, but parents or some trusted friend should be told if there is any danger. The surgeon should refuse as far as possible all difficult cases and never interfere with desperate ones. He may give advice to the poor for the love of God only, but the rich should be made to pay well."[3]

It was in the thirteenth century that surgery began to come to life again in Europe. The hospitals of St. Bartholomew and St. Thomas were coming into existence in London. So in England there were hospitals, physicians, and apothecaries. Surgeons had yet to appear, but the barbers, who undertook what surgery there was were quietly creating a guild to protect their own interests, a guild which was to have considerable influence upon the rise of surgery in England.

Guy de Chauliac was born at the end of the thirteenth century. In the middle of the fourteenth century he became known as the Prince of Surgeons, the greatest authority on surgery in Europe at that time. He is remembered for hisinsistence upon details of surgical after-care. Guy de Chauliac perserved his position as a leading surgical authority for some two hundred years, until, in fact, his most famous countryman Ambroise Paré, displaced him from it.

Then came the Black Death, or bubonic plague. The population of the earth was reduced by a quarter in the space of a few years. The Black Death shocked the ecclesiastical and lay authorities out of their comparative indifference to the public health. A guild of barbers was adapted as a sort of rough and ready public health service. So it was that the ranks of barbers were swelled by the inclusion of surgeons and apothecaries. The barbers and surgeons began to draw apart again and became two separate

groups.

The fourteenth century saw the medieval period drawing to its close and the Renaissance being ushered in throughout all of the Western world. In this century lived the first three Englishmen to contribute anything at all to the art of surgery. The three of them all bearing the name of John, at varying periods in the fourteenth century made their individual contributions to surgery.

The first of them, John of Gaddesden, was more of a physician than a surgeon. John of Arderne was more of a surgeon than a physician. John of Mirfield was neither a physician nor a surgeon, but rather a priestly bibliophile.

John of Gaddesden was primarily a doctor of physic but dabbled in surgery, and according to one authority was quite prepared, if paid for it, to act as dentist, chiropidist, and even delousing attendent to his patients. The work which made John of Gaddesden famous was the "Rosa Anglica." As the rose has five petals, so the Rosa had five parts, dealing respectively with fevers, injuries, general hygiene, diet, and materia medica and treatment by drugs.

John of Arderne was the first English surgeon worthy to be classed with the men who were recreating surgery in Europe. He was born in 1307 A. D. After a long apprenticeship to military surgery in the Hundred Year's War, he went to Newark, then a great center of trade and an occaisional meeting place for the English Parliament. There he practiced surgery from A. D. 1349 to 1370, devoting much of his attention to the surgical cure of fistulae--openings through the skin made by accident or disease and forming abnormal communications with some internal organ. He was a bold surgeon and in his writings had two great merits. He describes in

detail every step of the operations he practiced, and in considering the results of his treatment he records his failures as carefully as he did his successes. His writings included works on the care of the eyes, on bleeding, on sinuses and fistulae of the anus, on plants and their uses, on clysters and enemata. John of Arderne's most important contribution to surgery was the operation for the cure of anal fistula, a condition that most of his predecessors regarded as incurable. He was also a shrewd diagnostician.

John of Mirfield wrote two treatises which he thought would benefit his fellows. These works contained little that was original. He simply tried to present what he had thought good and worthy of quotation from the works of many well known medical and surgical authorities.

These three men, different though they were in their outlook on life and in their practice, had one quality in common. Each in his own way helped to make the fourteenth century a starting point from which surgery in England was to arise and flourish. The start was a late one but from that century onwards England was to advance the art and science of surgery as much as, if not more than, the many older empires had done.

In spite of the pleas of John of Mirfield and many others more eminent than he, surgery was becoming more and more widely separated from medicine, and the belief that it was an inferior art was held almost everywhere. The great universities coming into existence from the twelfth century on had well established faculties of medicine, but from none of them could a special degree in surgery be obtained. Licenses to practice surgery were granted very occaisionally from the universities, but usually with the provision that they should not practice medicine. Since they were debarred from a university education and with their art regarded

generally as more of a trade than a profession, surgeons in London, in Paris, and in a few other great centers bonded together to protect themselves and their profession, and evolved an educational system of their own.

The College of Saint Côme in Paris came into being as a loosely constituted guild early in the thirteenth century. The objects of this French confraternity were to promote good fellowship and to help distressed brethren. A young would-be surgeon was first of all an apprentice attached to a master of the College. In due course he became a Bachelor, at which stage the payment of a fee of one franc admitted him to membership of the College. After a period of study the Bachelor paid a fee of twelve gold crowns, took the Hippocratic oath, and became a Licentiate. He could then practice surgery in Paris or its environs. Four years later, if deemed competent, the Licentiate might become a Master and himself take apprentices.

In 1421 the first act regulating the practice of surgery in England was passed. Parliament enacted that the King's Council should have the authority to legislate by ordinance against unqualified practitioners of either medicine or surgery. However not much was done to enforce this enactment. Then the physicians formed a society which entered into an alliance with the fellowship of surgeons, with the idea of restoring the old unity. An exact and detailed constitution for the joint college was drawn up, and was approved by the mayor and aldermen of London in 1423. The college ceased to exist after two or three years, but it did show that physicians and surgeons could cooperate--if only for a short time--and, by exercising the powers it had been granted for dealing with ignorant and unqualified practitioners, it so upset the barbers who practiced

surgery that they were forced to seek a fresh confirmation of the power to practice surgery unmolested which had first been granted them in 1415.

The physicians went on about the same as usual but the surgeons reorganized their Guild. Then the barbers became a more important civic body and were granted a charter of incorporation. They tended to wounds, hurts, bruises,and other ailments, and bleeding and drawing teeth.

In 1511 an act was passed which forbade any person in the City of London to practice as either a physician or surgeon unless he had first beenlicinsed to do so by the Bishop of London or the Dean of St. Paul's. Instead of increasing their prestige this licinsing system had the opposite effect and the surgeons fell very low in popular esteem. This disrepute of surgery caused the surgeons to lean upon and associate themselves more and more closely with the Barbers' Company. This union of practice was recognized statutorily by the passing of a formal Act of Parliament in 1540 incorporating the two companies.

The men who had achieved the formation of the Barber-Surgeon's Co. did not imagine that a statutory union of the two companies would immediately give reality to the ideals for which they had striven. They wanted to raise the status of the profession, and so they proceeded to organize a course of systematic teaching for all who practiced surgery. Regulations were drawn up with regard to the supervision and examination of apprentices. At the same time an effort was made to diminish the number of quacks. This failed except in some districts where surgeons were also justices of the peace.

Thomas Vicary, surgeon to the King, was particularly interested in the teaching of anatomy. He wrote for the benefit of the apprentice students "Aprofitable Treatise of the Anatomie of Man's Body." This was

an elementary text book, and in the preface the author outlined the qualities which he thought a surgeon should possess. These were that he should be learned, expert, ingenious, and well-mannered.

Vesalius founded modern anatomy. He challenged the thousand year old teachings of Galen by actually dissecting human bodies; consequently his morality was as much in doubt as his sanity. The University, with shrewd foresight, decided that dissection of the human body was both lawful and moral, and slowly the truth of Vesalius's observations was established.

Vicary believed that a surgeon should know the principles of medicine as well as those of surgery, and also that he should know anatomy, and be reasonably well versed in Philosophy, Grammar, Logic, and Rhetoric. This standard of education was not to be achieved within the lifetime of Vicary.

In England the Barber-Surgeon's Company was in the process of creating a corporate surgery. In Italy Vesalius was founding a true anatomy. France was advancing a pure surgery. Germain Colot, a Frenchman, studied the methods of certain wandering Italian lithotomists and perfected the technic of the operation of lithotomy.

Ambroise Paré was so impressed by the skill and dexterity of Colot that after he had served his apprenticeship with a barber-surgeon, he went to Paris to try to perfect himself in the art of surgery. Paré discovered and taught a new method of treatment of gunshot wounds. He used a salve rather than cauterizing with boiling oil, then he covered the wound with a simple dressing. Trusses for the support of ruptures had long been used, but Paré improved and popularized them. He introduced a form of massage and he linked up the symptom of dysuria with enlargement of the prostate gland which may cause it. He was also the first to suggest

that syphilis might affect the walls of arteries and allow them to swell and dilate into aneurysms. In midwifery, in cases in which the child presented by breech, it was his revival of podalic version that made the procedure popular again. For cases of severe bleeding from the womb he artifically induced labor to start.

Paré's second great advancement, the first being the abandonment of boiling oil and of the cautery, was the way in which he made safe and practicable again the amputation of limbs. This he did by reintroducing the use of the ligature to tie bleeding blood vessels and so stop hemorrhage. Each advance that Paré made was in the direction of a rational simplicity and a reasonable cleanliness.

Thomas Gale, a contemporary of Paré's made no appreciable advancement of pure surgery, but he did help in his own country in raising the standards of surgical practice and improving the education and character of the barber-surgeon's appfentices.

William Clowes (born in 1540) was probably the greatest of the Elizabethan surgeons. Neither Gale nor Clowes ever achieved the eminence of Paré, but, like him they helped to make their colleagues and their successors realize that surgery was essentially a simple art, which would not be advanced by confining it to the Latin tongue or by regarding it as a mystery and shrouding it in secrecy.

A human body was publicly dissected for the first time in many hundred's of years in Venice in 1308. At first there was an outcry against the sacrilegious immorality of such a proceeding. In the course of years however, the practice became adopted and remarkably elaborated. Public dissection of a criminal was attended by dignitaries of Church and State, professors of the university, physicians and surgeons, and merchants

adopted in treating fractures and dislocations, amputating limbs and breasts, and so on. He illustrated the application of an amazing variety of bandages, and among them the many-tailed bandage which bears his name and is still in use.

With the gradual rise of surgery it was inevitable that more and more interest should be taken in anatomy on which surgery is founded, particularly after the impetus that had been given to anatomical study by Vesalius.

By the end of the sixteenth century the anatomists had begun to impress upon surgeons the impertance of a knowledge of the structure of the human body. The function of different structures and different organs had been the subject of speculation, and very occaisonal experiment, since the time of Hippocrates.

William Harvey, born in 1578, proved the fact of the circulation of the blood. His most important contributions were the two major changes in thought and method which Harvey brought about by his system of experiment, observation, and long-continued investigation by the process of trial and error, and his method of applying simple yet fundamental quantitative measurements to a problem in physiology. From this time up to the present day these interdependent principles of investigation have been at the base of every advance in medicine and surgery.

Harvey lived long enough to see his theory of the circulation of the blood generally accepted. He had taught physicians why their ointments and inunctions would affect theinternal organs of the body, and why a local infection could give rise to symptoms which affected the whole body. He had taught surgeons the rational use of the ligature. More important still he had taught generations of students that speculation

alone was valueless; that advances in knowledge would result only from patient experiment, patient measurement, and patient application of the method of trial and error; and that the facts--if they were facts and if there were enough of them--would always speak for themselves.

Up to the end of the seventeenth century surgery was the surgery of war. Civil ailments such as cataract of the eye, stone in the bladder, wryneck, and so on, were left to the itinerant quacks. Then the two oldest hospitals, St. Bartholomew's and St. Thomas, began to expand their accommodations and appoint to their staffs young surgeons instead of aged war veterans. These men did the things they were taught, but with so many patients in the hospitals they inevitably found some suffering from the civil ailments mentioned above. Operations for these conditions had not been taught them, but they went ahead anyway and achieved increasing success. Young men began to go direct to the surgeons of the two hospitals rather than apprentice themselves to the Barber-Surgeon's Company.

The Governors of St. Thomas officially recognized the system of teaching which had grown up rather haphazardly, and began to regulate it so far as their own hospital was concerned. In this way despite the opposition of the Barber-Surgeon's Company, great medical schools came into being.

William Cheselden was the most outstanding figure in English surgery during the first half of the eighteenth century. The operation for lateral lithotomy established Cheselden's reputation. Then France recognized his greatness and he was made a Corresponding Member of the Royal Academy of Sciences of Paris, and was the first foreigner to be elected to the French Royal Academy of Surgery on its establishment in 1732. He operated successfully upon a child of thirteen for congenital cataracts, then describe the operation of iridectomy.

Percival Pott, born in 1715, quickly succeeded Cheselden. He wrote

on such conditions as ruptures, eye disorders, head injuries due to violence, fracture and dislocations. He was the first to describe accurately curvature of the spine due to tuberculous caries and leav~~causing~~ some degree of paralysis; this condition is now called Pott's Disease. He also wrote a book dealing with industrial medicine. He tried in all of his works to achieve simplicity by a rational classification based on anatomy.

William Cheselden and Percival Pott raised the prestige of surgeons to a point where they could rank almost, if not quite, equal with physicians. They did this directly, by their work in the Surgeon's Company and by helping to raise the standard of surgical education, and indirectly, by example. At this time there was a natural tendency for physicians and surgeons to work in greater amity, for in eighteenth century England there was a plague which threatened both their houses. The divided ranks of physicians and surgeons were faced, on all sides, by a monstrous army of quacks and mountebanks. In self-defense physicians and surgeons drew together. At this time eye work, bone-setting, and dentistry were almost entirely in the hands of quacks.

William Hunter, born in 1718, obtained his studies in medicine and surgery, first at Edinburgh and later in London. He had excelled as a teacher and as an anatomist. He made two great contributions to surgery, one direct and one indirect. He revolutionized the teaching of anatomy and surgery, and set up a model school which was only displaced when the modern hospital schools of medicine arose--and he brought to London, and trained and educated, his younger brother, John.

John Hunter founded the sciences of experimental and surgical pathology. He found surgery little more than a trade. Harvey had pointed out a method of simple investigation, which a few of his successors were

following. Cheselden and others had raised the standards of craftsmanship in surgery, and the prestige of surgeons. John Hunter showed that there were processes of disease which could be studied just as Harvey had studied the processes of nature, and that only by investigating the changes due to disease in the light of a knowledge of the functions of normal tissues and organs could surgery by properly applied. He provided the surgical pathology which was to weld Cheselden's craftsmanship and Harvey's physiology into a single instrument, which could be applied scientifically to the relief and cure of disease. Hunter made it clear that structure is always an expression of function, and abnormalities are due to retarded or arrested development, or to misuse or malfunction. He showed how much a study of the lower animals could contribute to the study of man, how the physiological activities of lower forms of life are but simplifications of those same activities in higher forms. His contributions to embryology, biology, anatony, physiology, pathology, surgery, dentistry, and medicine, were legion and were all arrived at by the same route, patient observation, then painstaking inquiry. These methods he taught to his pupils, and he founded a tradition and a school of thought which were to be the mainsprings of surgical advance.

John Hunter's pupils became the leaders of the next generation of surgeons. By their efforts teaching was centered around the great hospitals with their wealth of clinical material.

Philip Syng Physick, born in 1768, was John Hunter's favorite American pupil. Though he studied in London, he qualified in Edinburgh, and returned to Philadelphia. He made innumerable advances in surgical technics, devising and modifying instruments and splints. He was an excellent anatomist. He experimented for several years with different ligature materials, trying to find some substance that would be absorbed and

not need to be sloughed out; buckstring, Frenck kid, and animal gut were among the ligatures he tried. Among his contributions were a wire snare which was used in removing tonsils, a splint for fractured thighs, another for injured elbows, and a cannula which could be introduced through a trephine hole to drain off an excess of fluid from the brain. He was the first full professor of surgery at the University of Pennsylvania.

Many of Hunter's students became famous surgeons, but a general practitioner, Edward Jenner, was perhaps the most distinguished of them all. Dr. Edward Jenner in introducing vaccination for the prevention of smallpox made one of the greatest single contributions any one man has ever made to medicine.

Quacks went out of the picture about this time, Harvey and Hunter had pointed the way to knowledge. Philip Syng Physick and John Syng Dorsey were creating a school in direct line of descent from Hunter in America. In London, William Blizard, Henry Cline, and John Abernathy had carried the Hunterian teachings to their different hospitals, and with John Gunning had seen the old Surgeon's Company become a Royal College, firmly established on rational lines and a worthy custodian of the greatest single collection of pathological and anatomical specimens in the world. These men were among the early pupils of John Hunter. Following close behind them were younger men, pupils of an older but still inspiring John Hunter. Perhaps the most distinguished of them was Astley Paston Cooper, and contemporary with him were two brothers, John and Charles Bell, the first of a series of great surgeons who took origin from the fast-growing school of Edinburgh.

Astley Cooper, born in 1768, was the best-known surgeon on London at a time when London was the greatest surgical center in the world. He

had been the first to ligate the abdominal aorta successfully, and the first to amputate a leg at the hip joint. His greatest contribution to surgery was in his lecturing.

Benjamin Bell was the most successful surgeon in Scotland, and he made a number of minor improvements in technic, notably by using long flaps in amputating and by reducing the instruments employed for different operations to a minimum. Two books were published by him. The first was a "System of Surgery", which was important in that it was the first attempt by a British surgeon to bring together in one volume the whole practice of surgery in a loosely systematized form. The second was on gonorrhea and syphilis and was published in 1793. In this work Benjamin Bell demonstrated clearly that gonorrhea and syphilis are two entirely different diseases.

John Bell was born in Edinburgh in 1763. Two causes which he did much to advance were the "doctrine of anastomosing arteries" and the "doctrine of adhesion". The first one was one of John Hunter's teachings carried to its logical conclusion and was applied particularly to saving limbs in which the main artery had been injured by gunshot or other wounds, and which not long before would have been incontinently amputated. The second doctrine was a renewed attack upon the healing by second intention, after suppuration, of operation and other wounds. Bell wrote that suppuration would be prevented in almost every case if after operation the surgeon saw to it that the wounded parts were laid so cleanly and neatly in contact with each other that they would adhere. The operative words, in both senses, are "cleanly" and"neatly", and to most surgeons of that time they represented an unnecessary, and almost effeminate, refinement of the orthodox two-fisted butchery.

Charles Bell was eleven years younger than his brother John. While still a student he published in 1798 his "System of Dissections", with thirty large plates, all his own and all works of art. A year later he was elected a member of the College of Surgeons of Edinburgh, and began to assist his brother in lecturing and dissecting. Upon his brother's suggestion, Charles went to London and was welcomed, not as an anatomist or surgeon, but as the artist responsible for the illustrations in his book. Artists and anatomists came to study under him. He made many wax models of normal and diseased organs. In 1807 he printed "Idea of a New Anatomy of the Brain" which clearly demonstrated that there were two sets of nerves, motor and sensory. Bell was the creator of modern clinical neurology. Bell's palsy gets its name from the incidence of a patient being brought to Bell with a paralysis of one side of her face.

In the advancement of surgery, Scotland had now taken the lead from London, just as surely as London had wrested it from Paris a hundred years previously.

Scotland was the next country to take the lead in surgical history with Robert Liston and James Syme as the two principal leaders.

Liston was born in Scotland in 1794. His main contributions were in the field of Orthopedics. He insisted that a fracture of the femoral neck should be properly set, and the limb should be splinted and kept immobile long enough for bony union to take place. He described what he considered the best splint for this purpose, and, although it was devised by a French surgeon, this particular splint is still known as the "long Liston". Liston perfected the technic and rapidity of amputations, thereby reducing the suffering of his patients.

James Syme published in 1831 his "Principles of Surgery." The principles

were few and simple. The most important one was the principle underlying all conservative surgery. Its most obvious application was in the substitution of excision of diseased joints for amputation of limbs, but Syme applied it to every operation he undertook, saving and conserving always the maximem of healthy tissue compatible with entire removal of diseased structures.

Surgery had been advancing slowly but steadily through the long eighteenth century and the early part of the nineteenth century. Difficulties had been gradually overcome. One problem after another was solved. The art was tending to become a science, and a moderately respectable one. More and more young men were attracted to surgery as a career. Their increasing numbers rapidly made more urgent one of the problems which had never been solved. Surgery was based on a knowledge of anatomy. The teaching of anatomy demanded a continual supply of bodies, or subjects for dissection. Corpses had to be carved that lives might be saved! A few subjects were legally available for dissection, but the legitimate demand was always greater than the legal supply. Resurrectionists came into being and grave robbing became a profitable prusuit to supply bodies for dissections that were done unlawfully. In 1832 the Anatomy Act was passed regulating schools of anatomy of England and Scotland. Two hundred resurrectionists were out of work, and the supply of bodies for the teaching of anatomy was legally assured.

In 1833 Boyer, a French surgeon made the statement that surgery seemed to have attained the highest degree of perfection of which it was capable. These surgeons could not know that chemists and microscopists would throw casually to the surgeons truths which would alter the face of surgery, and break down for ever the two great barriers within the limits they imposed.

He and his fellows, and all their predecessors, had worked within those limits. Pain and sepsis straitly marked the narrow path that the surgeons trod.

The pain that patients suffered beneath the knife can hardly be guessed at, but the way in which it affected a few of the men who wielded that knife is known. Their agony of mind may reflect in some small degree their patients' physical sufferings. All that could be done about it was to increase the operating speed. This was the only method they knew of attacking the problem, and Liston brought this method as near to perfection as was humanly possible.

Sepsis was the other angel of death barring the further progress of surgery. About the year 1800, of every two patients subjected to operation one died.

Pain and sepsis worked hand in hand to bring surgery to a full stop. For fear of pain patients delayed operation till such resistance to infection as they might have had was almost gone. For fear of sepsis and the hospital contagion those who might have resisted both delayed operation even longer, till when at length they did submit to the surgeon, the pain and shock of the operation killed them. Surgeons were as conscious of these twin terrors as their patients. They only undertook the well tried operations, for it was unthinkable to submit men to procedures which might mean deathif no certainty of relief in the event of recovery from the operation could be promised them. So surgery had resolved itself into a rut of rapid excisions. Cataracts were removed, limbs and breast were amputated, tumors were cut away, stones were taken from the bladder, aneurysms were ligated, and ruptures cured. Little else could be attempted; opening of the abdominal cavity was done only as a desperate last resort. In his day and generation Boyer was right. Surgery could advance no further till the

two great barriers were overthrown. Both had existed since the history of mankind began.

From the dawn of civilization attempts had been made to control or at least deaden pain. Magical incantations were used for a thousand years to render patients less conscious of the pain of an operation, and strange deities were invoked on their behalf. For another thousand years, in civilizations less mystical and more crudely practical, the victim was tied down with ropes and instructed to commend himself to God and bear his sufferings beneath the surgeon's knife with such fortitude as he could command. It is no small wonder that the most famous and most sought-after surgeons were those who handled their knives with the greatest speed and dexterity.

Queer concoctions to relieve pain were used by the most primitive peoples. Unhappily, they rarely produced complete unconsciousness, except in doses which were lethal. The same literally fatal objection applied also to a method of producing unconsciousness used by the Roman surgeons. The great carotid arteries in the neck, which supply blood to the brain, were forcibly compressed against the bony parts of the spinal column. This diminished the blood supply to the brain and certainly caused inconsciousness, but also did irretrievable damage to the brain in many cases, so that if the patient recovered at all, he might be paralysed or otherwise disabled for life. This method was soon abandoned and the surgeons did their best with the few pain-deadening drugs of which they had knowledge. A technic based on the same principle of diminishing the blood supply to the brain, but with less disasterous results, was that of opening an artery in the wrist and bleeding the patient to unconsciousness. Another Roman practice was to give various drugs in wine to those who were suffering.

Humphry Davy published in 1800 the results of his work on nitrous

oxide, which soon became known as "laughing gas." Little attention was paid to Davy's work.

Shortly after this a man by the name of Horace Wells of Massachusetts began to use Davy's "laughing gas" in dentistry. A death resulted in the use of this gas; Wells gave up his practice and committed suicide. William Morton, partner of Wells, was also using nitrous oxide, but he abandoned its use after Wells' unfortunate experience. However Morton still sought anxiously for some means of abolishing pain. While practicing dentistry in Boston, Morton was studying medicine at Harvard, and there he met Dr. Charles Jackson who told Morton of what he had noticed at a so-called ether jag party. The medical students inhaled small quantities of the vapor of sulphuric ether. They became mildly intoxicated and they seemed to be quite insensible to any pain. Morton first tried this vapor on a dog, then on himself, and next on a patient, with desirable results.

About two weeks later Morton obtained permission from Dr. Warren, the senior surgeon of the Massachusetts General Hospital to try the ether on a patient who was to have a tumor removed. A large crowd of students and doctors arrived to watch the operation. Dr. Warren and the assistant surgeon arrived and for the first time in history waited for the man who had promised to make the patient insensible. Surgeons all over the world have been doing this ever since. The patient was oblivious to all pain during the entire operation.

Actually Dr. Long of Athens, Georgia was the first man to use ether as an anesthetic. He did this in 1842, but as news was slow to travel William Morton, thanks to his public demonstration in 1846 received the credit for the discovery.

James Young Simpson was the first to realize that chloroform was

better and stronger than ether. The first public demonstration of the new anesthetic was in 1847. Chloroform as compared to ether, was more agreeable to take, less expensive, more easily portable, and, most important of all, it required no special form of inhaler. The battle against pain was half over. The war with public opinion promptly started.

Even with the use of anesthetics, the deaths from operations was still high, because the hospitals were crowded and infections were spread easily and quickly. Without knowing the reasons for so many deaths, Simpson was on the right lines when he pleaded for larger and more airy hospitals. He wanted big new hospitals in the country so that the dread-ful over-crowding in the town hospitals would be avoided.

Simpson became the best known surgeon in the world and during the last few years of his life he saw the first crumblings of the other great barrier, sepsis.

Joseph Lister was born in 1827 in London. He had resolved to become a great surgeon and study under Robert Liston, but Liston died about the time Lister entered medical school. His father had done a great deal of work in perfecting microscopical lenses. During all his medical studies Joseph Lister maintained his interest in the microscopy his father had taught him. By the age of twenty-five he published two important papers in the Quarterly Journal of Microscopical Science.

Shortly after this Lister went to Edinburgh to study and work under James Syme who was recognized as the first surgeon in Europe. He acted as Syme's house-surgeon and lectured to students. He was interested as much in pathology as in pure surgery. He obtained a professorship of surgery at Glasgow and was later appointed to the hospital staff of the Glasgow Infirmary, this giving him an opportunity to take his students

into the hospital and teach them at the bedside.

It was only then that Lister realized fully the limitations of his art. All his patients were operated upon by himself or one of his house surgeons. The right operations were done at the right time. Chloroform was carefully given so that there was no need to rush through an operation. Yet after twelve months' work the results were appalling. It seemed that for every life saved in the theater one was lost in the wards. The patients would be well for a day or two after operation then gangrene would set in, or blood poisoning occurred, both with fatal results. If they escaped those scourges, they might die of erysipelas which swept through the wards in recurrent epidemics. The figures could be juggled and looked at from different angles, but they always told Lister the same thing. Before the discovery of anesthesia two out of every three patients subjected to operation died. After the advent of ether and chloroform one out of every three died. Things were better than they had been, but not much better.

Oliver Wendall Holmes, Professor of Anatomy and Physiology in Dartmouth College at Hanover, master of polished fiction, recognized primarily for his writings, won the fight for the recognition of puerperal fever as a contagious disease by telling rhetoric firmly based on demonstrable facts and figures. It was again by startling figures that he ended the long fight he had waged, by showing how the contagion could be prevented.

The Hungarian whose triumph of prevention Holmes flourished in the face of his critics was Ignaz Philipp Semmelweis, and assistant obstetrician in a Viemna hospital. He demolished each and every fallacious idea that arose as to the reasons for the spread of puerperal fever among the obstetrical patients, some of whom were attended by students who had come directly from the dissecting rooms. But for some time Semmelweis had no theory of

his own to offer. Then some time later he instructed all of the students to rinse their hands in a simple solution of chloride of lime before delivering, examining, or in any way touching a patient. After following this practice for two years, the mortality rate in the maternity ward was only 1.28%, wheras before it had been about 15%.

Lister knew of the work of Semmelweis, and knew of the crusade for its recognition that Oliver Wendell Holmes had led, but he did not grasp its significance for surgery. Lister knew that there was something associated with the air that caused putrefaction. Pasteur told him what it was. Lister read everything Pasteur wrote on the subject. He learnt that the micro-organisms causing putrefaction could be carried on particles of dust floating in the atmosphere. They could be destroyed by heat, or filtered from the air by tightly packed cotton-wool. It was the application of Pasteur's principles to the healing of wounds and to surgical technic that made Lister so famous. He sterilized his ligatures and instruments and prepared the patient's skin before operating.

Whereas comment always centered about the speed with which surgeons operated, in the case of Lister's operations it was the speed with which his patients recovered that excited discussion.

Lister made surgery safe for patients. He had banished sepsis from hospital wards. Long before he died he had opened up new fields of surgical endeavour. Since his death surgery had advanced steadily, but it may be truly said that every advance has been dependent in more or less degree upon his genius--genius which enabled him to link the word of a French chemist with an experiment in sewage control to effect a revolution in every department of the surgical art.

It has been said that there are only two periods in the history of

surgery--before Lister and after Lister. The first of these periods began when the world was very young, the second not thirty years ago. Yet in the last thirty years more has been achieved than in the thirty thousand years before them. But through all the conflicting changes and counter-changes the trends of advancement are clear. They date from, and depend on, the discoveries of anesthesia and antisepsis.

Fewer and fewer patients were being subjected to the old operations, but more and more patients were being treated by new operations, which antisepsis had made possible. Previously surgery had saved a proportion of lives at the expense of innumerable limbs. Now it was saving innumerable lives at the cost of only an occaisional limb.

Many of the surgeons at this time said that the abdomen, the chest, and the brain would be forever shut from the intrusion of the wise and humane surgeon. Lister's laborious but certain proof of the correctmess of Pasteur's germ theory, and his slow evolution of a preventive antisepsis based on that theory formed a key which would unlock each and all of the body cavities.

The great Rudolf Virchow, Lister's most distinguished contemporary solidly established the conception of cellular pathology. Advances in pathology led to advances in diagnosis and in treatment. The three chief props of the old surgery, aneurysms, amputations, and bleeding, crumbled and disappeared, shattered by the weight of pathology and physiology on which a new surgery was being based. This new surgery became possible when Listerism was carried to its logical conclusion and antisepsis became asepsis, a change which took place in Lister's own lifetime.

Ernst von Bergmann of Berlin was another of the leaders in the evolution of asepsis. He and his assistant, Schimmelbusch, by the end of the last century had developed steam pressure sterilizers, in which all the cloths,

towels, bandages, and dressings to be used at operation could be freed completely from bacteria, and they elaborated a ritual use of antiseptics to ensure that no organisms could gain access to an operaing wound. William Stewart Halsted, professor of surgery in the Johns Hopkins University, added one of the final touches when in 1890 he had bronze casts made of his own hands. On these casts the first surgical gloves were moulded. Being made of rubber they could be completely sterilized, being thin, they did not interefere with his delicacy of touch. Masks of gauze, which were first used at Charing Cross Hospital in 1900 by Dr. William Hunter, completed the equipment for asepsis. Since then there have been refinements of technic and a slow standardization of aseptic procedures, but the fundamental principles, which Lister laid down, remain unaltered.

But of all the new diagnostic aids that were rapidly coming into use the most unexpected and the most valuable was the one to which Lister referred in his presidential address to the British Association in 1895--the Roentgen ray.

Antisepsis freed surgery from the last of its shackles. Roentgen rays and other aids to diagnosis showed what scope there was for this new-found freedom. One by one the forbidden organs came within reach of the surgeon's knife. Surgery, like medicine, began to embrace so wide a field that the individual could till but a small corner of it. Specialism began. Specialists in the past were all general surgeons with particular interests. Specialism as we know it today only became necessary or even possible towards the end of the last century. With the specialists there came also the consultants, men who did but little operating themselves, yet had a vast experience of diagnosis, based usually on a long training in pathology. The consultant was generally a man who was far better fitted to advise his colleagues what

operations to perform than he was to perform them himself. In this sense the first surgical consultant, proper, in this country was Sir James Paget.

Then there began the early growth of different specialities. The old specialities were given a new lease of life by Listerism, and new specialities arose as if by magic.

Ophthalmology is one of the oldest specialities. Hammurabi, laying down his code in 2250 B. C., legislated specifically for operation on the eye. A speciality as old as ophthalmology is that of plastic surgery. It was practiced by the ancient Hindoo surgeons.

Older than either of these specialities is that of midwifery, which had no real existence, however, till antisepsis changed Cesarean section from a last-minute attempt to extract a live child from a dying mother to an operation which would almost always save the lives of both mother and child. Then in the last half of the ninteenth century midwives divided their art into the twin specialities of obstetrics and gynecology.

The speciality of laryngology was created in 1854. Otology, the speciality concerned with diseases of the ear, and laryngology were soon linked together, and watched with interest the rise of rhinology, the study of diseases of the nose, the youngest branch of the triple speciality otorhinolaryngology.

Specialization has inevitable disadvantages, but the many specialities into which surgery has been divided would not be surviving, and indeed flourishing, today if they had not justified themselves with their accomplishments. The great empires of more than a thousand years ago saw their surgery decay not because their surgeons specialized but because their specialists achieved nothing.

Lister's work not only gave new life to all the older specialities but

created entirely new specialities, by giving the lie direct to the age-old doctrine of the forbidden cavities. Antisepsis allowed surgeons to explore with impunity the regions which many surgeons had called taboo--the abdomen, the chest, the skull, and the joints.

By the end of the ninteenth century there were few organs left in the abdomen which had not been attacked by surgeons. All these early operations were for the most part excisions--removal of the appendix, or of part of a rib, part of a nerve within the skull, part of the intestine or stomach, part of the ligaments or bones making up a joint. Reconstructive surgery was to come later, but already four new specialities were being rapidly defined. Many surgeons were devoting themselves to the surgical treatment of conditions affecting abdominal organs. Another school of surgeons was concentrating on diseases of banes and joints. A smaller group were tentatively exploring the surgery of the brain and spinal cord and the nervous system generally. By the beginning of this century there were specialists in each of these three fields, and one or two men in different parts of the world were laying the foundations of the newest speciality--thoracic surgery, the surgery of the heart and lungs and other structures in the chest.

The French surgeons of this period were among the first to realize that so far as the surgery of the abdominal organs was concerned further specialization was necessary.

Victor Horsley was the greatest early exponent in this country of neurosurgery. He and Macewen of Glasgow and Reckmas Godler were among the first surgeons to operate on the brain. In 1887 Horsley removed a tumor from the spinal cord for the first time. He also mapped out different areas of the brain controlling different functions, and tracts of nerve

fibers leading from the brain to the spinal cord, and he standardized the operative approaches to the central nervous system. The surgery of the skull, which began when primitive man made the first trepan hole, is now but a part of the approach to the brain within the skull. The freshly flaked flint has been displaced by an electrically driven saw. The opening of the skull is no longer an end in itself but only a means to an end.

The modern surgery of bones and joints is compounded of parts of the old and the new surgery. Since prehistoric times fractures have been sustained and have had to be repaired. In this sense manipulative orthopedics is as old as it can be. Operative orthopedics, however, is a development which Lister made possible and to which he made several personal contributions.

Anesthesia and antisepsis allowed theorthopedists to correct surgically bony as well as muscular and tendinous deformities, and in 1880 William Macewen of Glasgow did the first deliberately planned bone grafting operation. Now it may be said that the scope of orthopedics has widened to include the treatment not only of accidents, but also of any disease which may directly affect the locomotor system of the body. Bone and muscle are the twin raw materials of the orthopedist's art, and the emphasis now is always on prevention rather than on the correction of deformity and crippling. Bone grafts and tendon transplants are of more interest today than the most cunning mechanical contrivance for the support of deformity, which, unless congenital, always represents an orthopedic failure.

Whether there ever will develop from the joint activities of surgeons and psychiatrists a pure surgery of the intellect and emotions it is impossible to tell. One thing is certain, neurosurgery is advancing fast enough to defy all prophecy, and, however unlikely it may seem, there is abare possibility that the surgeons of a hundred years hence may make super-

men of us all, unless they fall beneath a dictator's spell and are given to solve the much simpler problem of making morons of the most of us.

Surgery has had as many false prophets as any other human activity. The most recent of them was one of the greatest British surgeons of this country, the late Lord Moynihan. Only five years ago Moynihan said: "The craft of surgery has in truth nearly reached its limit in respect both of range and of safety." [4] Five brief years have seen surgery extend its range without impairing its safety, and the limits of surgical endeavour are still far from being reached. Even the immediate future cannot be forecast with any certainty, but it is perhaps possible to discern some sort of a pattern in prospect into which all the innumerable surgical specialities can be roughly fitted.

Modern anesthesia has been advancing steadily since the last decade of the last century. All the anesthetics are constantly being improved. Each has advantages and disadvantages, which must be assessed from the point of view of the individual patient and the operation he is to undergo. The death rate for any one anesthetic is so nearly infinitesimal that attempts to bring it ever nearer to a hypothetically possible vanishing point become more and more difficult. The drugs used are becoming more potent yet less dangerous. The apparatus involved in their administration is approximating ever more nearly to the fool-proof. These changes will be recorded from time to time in the medical press, but they will excite no general interest. What will reach the headlines will be the next major advance in anesthesia. This may not happen for many years, but when it does come anesthetists may be the first members of the medical profession to boast a death rate of exactly nil per thousand.

Aseptic methods have been improving gradually ever since they were introduced. In recent years weaknesses in three links of the chain of

asepsis have been evident. Attention has been concentrated on them simply because all the other integral parts of the ritual have been perfected, and so by comparison these three defects have been relatively magnified.

The problem of sterilization of catgut still remains because still a dozen or more deaths occur from tetanus conveyed by catgut.

The second problem lies in protecting the patient from organisms in the surgeon's nose and throat. Masks of all shapes and varieties have been in use since the early part of this century. A recent investigation of no less that sixty different masks from hospitals throught the United States showed that none of them were completely efficient under all circumstances.

The third difficulty is presented by the air itself. The use of the carbolic spray was abandoned because the organisms in the air were relatively few and it was distressing to both patient and surgeon. The first step was the process of air-conditioning and air-filtration. Then formaldehyde vapour was used but not for very long. The next and most recent advance is one that may generally be adopted in the next ten yeats or so . It consists in irradiating the theater by means of a battery of ultra-violet lamps suspended directly over the operating table. The surgeon and his theatre staff have to protect their eyes and skin from the rays and the patient, too, has to be protected in some measure, but the effects of this method have been remarkable. In the first place almost complete sterility of the air is insured. In the second place this artificial sunshine has a healing effect upon the wounds. Healing is more rapid and the general health of the patient is more quickly restored than was the case before the introduction of this technic at Duke University in Durham, North Carolina.

It seems, then, that the risks associated with anesthesia and with the

possibility of infection at operation may perhaps disappear in the future. There must always be some operative shock, but this too has been appreciably lessened by improvements in anesthesia and in operative technic, Surgery is one of the few modern activities in which speed is neither necessary nor desirable; there are a few exceptions, however. Careful and gentle handling of all tissues, ligature step by step of even the smallest bloodvessels, careful and accurate excision or correction, and exact apposition and suture of divided structures are the ideals aimed at--and their achievement is not compatible with operative speed and surgical showmanship.

The pre-operative extension of surgical care has been increasing continuously for several years and will continue to do so. Complete post-operative care is being approached in every department of surgery and its advancement will continue.

The remaining part of this paper will be devoted to the modern operating room division of the hospital and its personnel.

The operating room is really the center of surgical treatment. The majority of surgical patients in the hospital are either being prepared for operation or are being cared for after operation. While the operation is usually the more dramatic part of the treatment, preoperative preparation and postoperative care may be equally as important as the operation. The patient is in the operating room for an hour or so, but the preoperative and comvalescing periods may be a question of days or weeks, or longer. What is done in the operating room may affect the patient's life, health, and happiness. For this reason every facility is used to save time and effort during the operation and reduce the risk as far as possible. This is accomplished ~~but~~ also by taking every aseptic precaution possible in

the operating room, and having the necessary supplies, instruments, and equipment ready. This can best be accomplished by the working out of various routines, which, if not entirely satisfactory for each operation, would at least serve as a working basis from which to build. While every case may vary to some extent, and different surgeons have individual technics, basic routines can be developed and changes made according to the individual requirements. Certain general supplies and instruments will be required for a group of operations.

The operating room should, as far as possible, be isolated, so that patients of the hospital may not be disturbed by sounds from it nor annoyed by the odor of the anesthetics.

To facilitate thorough cleansing, everything in and about the operating room should be plain, simple, and of such material and construction as will bear repeated washings and scrubbings.

The operating room should not be so large as to require unnecessary walking, and yet should not be so small as to interfere with a perfect aseptic technic.

Daylight is preferable in the operating room and is obtained in one of two ways; either by a skylight or by having the entire north wall of the operating room made of glass. The artificial illumination used for lighting the operative field should be electric. The pre-requisites for a good operating room light are: 1. Good light, 2. Minimum amount of heat, 3. Absence of glare, 4. Ease of adjustability without contamination of operative field, 5. Absence of shadows, and 6. Emergency light in the hood. General lighting is obtained by ceiling or wall lights. There are also small lights for illuminating the operative field when it is deep and difficult of access.

The ventilation should be indirect. Heating should be by steam or hot water system. A cloth covering should be made for the radiators to prevent

dust from collecting on them as the heat waves will float the dust around the room. The temperature of the operating room should be about eighty degrees Farenheit.

Each room is a separate unit and requires standard equipment and supplies. When the operating division is large enough, with sufficient rooms, certain types of operations are assigned to particular rooms. This will make the arranging of the rooms easier and assembling of certain supplies smoother, as particular routines can be developed for this room.

Considerable thought and planning enter into the satisfactory construction of an operating division. Waste space should be avoided to eliminate unnecessary expense, and convenient arrangement of the rooms should be considered in relation to supply and sterilization rooms, anesthetizing rooms, and the elevators. Aconvenient arrangement saves unnecessary steps and loss of time.

There should be two scrub-up rooms, one for nurses and one for doctors. Supplies of scrub iniforms, caps and masks are kept in each scrub room. The sdrub-up basin should be fairly large. The water should be fed preferably by a spray above the bowl. The temperature and flow of the water should be regulated by a knee or foot pedal. The soap should be fed by a foot dispenser. Sterile brushes and orange sticks should be close at hand on a convenient shelf in an antiseptic solution or sterile jar. The antiseptics that are used after scrubbing up ahould be accessible. If alcohol is used it should be placed in a dispenser operated by a foot peddle. The gown and glove table is placed conveniently in the operating room.

The operating table should be so placed in the operating room that the best daylight is on the operative field. If daylight cannot be used, the table should be placed so as to have the artificial light thrown directly into the wound. The arrangement of the operating table will vary with the

different operations. Every one of the operating room personnel should be thoroughly familiar with the particular operating table in use, so that at a moment's notice each will know which wheel or lever to turn or pull to obtain the position the surgeon desires.

Two or three tables are needed for the instruments. One called the Mayo table, is adjustable in height and is so arranged that it may be pushed directly over the patient. The second table is fairly large and is used for the reserve supply of instruments, dressings, etc. There may be a third table called the suture table, placed close to the reserve table. Some hospitals do not have this suture table, but put the sutures on the reserve table.

Behind the operator and his assistant is placed a basin of Bichloride of Mercury solution, 1 - 10,000 strength. There is also a double basin standard next to the reserve table; one basin is used for washing instruments and the other for hot lap sponges. There are also about three discard basins on the floor used for soiled sponges, etc.

The place of the anesthetist is at the head of the table. He is usually seated on an adjustable stool so that at no time is his head above the shield. He has a small table beside him with his supplies, stethescope, airway, mask, anesthetic sheet, etc. For local anesthesia an extra small table is set up with the necessary supplies and then removed immediately after anesthesia has been administered.

If the surgeon or his assistants are short and the table is high, footbenches of several heights are provided.

Wheel stretchers are used to carry patients to and from the surgery. This stretcher has a mattress covered with a rubber sheet; over this is a plain sheet and then there is a small pillow. The patient is covered with

a sheet and blanket.

Some hospitals have a separate room in which the patient is anesthetized before being brought into the operating room, and in which certain preliminary preparations are carried out. The advantages of this, particularly if the patient is fairly well awake, are that he does not come in contact with the apparent confusion in the operating room before he goes to sleep, and does not see the startling array of tables and instruments, and the parade of strange-looking figures. Time may also be saved by inducing anesthesia in this room while the fimal arrangements are being made in the operating room. One disadvantage on the use of such a room for anesthetizing the patient is the need of moving the patient and the anesthetic machine together into the operating room.

There should be a nurse assigned to the anesthetizing to aid the anesthetist, make whatever preliminary preparations are needed, and watch the patient who may be frightened or who may be partially under the effects of the preliminary medication.

Ordinarily the patient is returned to his room as promptly as possible, but some hospitals prefer to keep him on the division for a time, therefore a room is provided into which the patient can be moved and kept while waiting for or receiving a blood transfusion or glucose, or other form of treatment or observation before he can be safely transferred to his room.

The nurse spends a considerable part of her time in the workroom in carrying out various duties. The folding of gauze into sponges and pads, the wrapping of material and equipment, and the cleaning and oiling of instruments may all be done in this room. The room should be well lighted, and ventilated, with adequate tables and chairs to permit carrying out the work conveniently and comfortably.

The sterilization room should adjoin the workroom. It is here that the large number of supplies for the next day or week are sterilized. The sterilizers are larger and seperate from those adjoining the operating rooms. The sterile supply storage room should be seperate from both the workroom and the general storage room, so that there can be no possible chance of confusion in regard to sterile or nonsterile articles.

The operating room force is responsible for the various supplies, including the preparation of gauze for sponges and dressings, their wrapping, sterilization, and proper storing; also the proper assembling, wrapping, and sterilization of special equipment, such as glucose equipment, so that it is always ready for emergency use. The instruments for each operation, or part of them, may by selected by the nurse or interne according to the list supplied, but the sterilization is the duty of the nurse. The wrapping and sterilization of gowns, gloves, drapes, and sutures is also the duty of the nurse, and the preparation of the various solutions is done in the operating division.

To save space, equipment, and time, sterilization of supplies for the entire hospital is done in the operating division. The needed supplies are then sent to the various dressing rooms on the different divisions.

A good supply of prepared and sterile articles are kept labeled, dated, and in their proper places in the operating rooms, ready for use at any time. The supplies are checked each day to be sure the necessary afticles are on hand. Once a week the old supplies are removed and resterilized.

The danger of known or unknown contamination of the supplies and the operative field is lessened or prevented by rigid observation of certain ~~of certain~~ rules. The operating room itself, that is, the walls, cabinets, and other large articles, are kept immaculately clean. Following certain operations, particularly those of infectious cases, the furniture, walls,

floor are washed with lysol solution.

The various rules to follow and precautions to take are as follows:

Complete sterilization of instruments, sutures, gloves, sponges, drapes, and any other articles to be used in the operation.

Proper precautions in putting on gowns and gloves after adequate preparation of the hands and arms.

Careful preparation of the operating field and adequate draping.

Prevention of contamination of the wound and sterile field by prevention of contamination through the air.

Strict observation to prevent breaks in technic.

Prevention of perspiration dropping from the faces of the operating team.

While the general principles of operating room procedures are the same in all hospitals, there is much variance in minor details of method and technic. Many hospitals have perfected methods which yield splendid results so far as they themselves are concerned, although these may be entirely unsuited to other hospitals doing a different class of work, differently managed, or differently situated. Each institution must, to a certain extent, develop methods suited to its special requirements, but it may gain much by studying the methods successfully followed in other institutions. Even in various operating rooms of a surgery department, technic varies slightly according to the preference of the surgeon, or the character of the work.

A surprisingly large force is necessary in the operating room because one must remember that there are numerous details not seen by the casual obaerver such as--cutting of gauze, folding and preparation of dry goods, cleansing and care of instruments, cleansing of operating rooms, etc. The

personnel of an operating room having one hundred and fifty surgical beds with three major and three minor operating rooms should consist of: a supervising nurse, four graduate nurses, six student nurses, two orderlies, and three trained workers.

All but the student nurses are permanent members of the operating room personnel. The student nurses come to the operating room for instruction during the second year of their training, before their maternity work. The operating room training lasts about three months. There should be a definite rotation, usually two nurses coming on and the same number going off this service each month.

In the operating room, where "each works for all and all work for the patient," there must be discipline, team work and morale. To maintain discipline in the operatin room, each and every one must know his or her exact rank, position, and duties, The supervisor is in charge; in her absence the responsibilities rest with the senior graduate, the junior graduate, etc., in the order named, In this way everyone clearly understands his or her rand and position. There never is any question about who must take orders.

The work of the operating room nurse is strenous; the nerve strain is great; the hours may be long and irregular, therefore the nurse who specializes in this work must be physically strong. She must be alert, must have self-control and must not lose her head. The reaction time of an operating room nurse must be short. This nurse must be an individual who can think logically--who can plan her work beforehand, and who can do it consistently and methodically. Last, and most important, she must be rigidly conscientious, since so much of her work, particularly the sterilization, etc., is done without the supervision of the surgeon. She must have an aseptic conscience which will not allow her to take a single chance which might later cost a patient's life.

Footnote References

1. Flack, Issac Harvey, "The Story of Surgery"
Dudley, Doran and Co., Inc., New York, 1939.

2. Ibid.

3. Ibid.

4. Ibid.