In tracing the life of this distinguished American neuro-surgeon, one must travel back to the year 1638, when his first American ancestor, Mathew, landed in Hingham, Massachusetts. Thus Cushing arose from typical New England doctor-folk. His great-grandfather, David Cushing, had practised medicine in Berkshire County, Massachusetts. His grandfather, after graduating from the Berkshire Medical College in 1824, moved west in search of a less vigorous climate and settled in Cleveland, Ohio. His father, Henry Kirke Cushing, graduated in medicine from the University of Pennsylvania, returned to Cleveland, and in time was elected to the chair of obstetrics and gynaecology at the University of the Western Reserve. After his return to Cleveland, he married Betsy Williams of that city. The Williams family had migrated also from Connecticut at a time when Cleveland was only a village. It was the good fortune of Henry and Betsy Cushing to raise a large family and, as was the case of Osler, Harvey Cushing was one of nine children.

Of his boyhood, one may gain but a glimpse—Harvey accompanying his distinguished father to the Case Library. Here his father would enter the corner of the library (which was wired off and barred to all but those privileged physicians who possessed keys) to bury himself in the latest copy of the London Lancet. From this association, it seems fair to surmise that Cushing can thank environment as well as inheritance for the impulse that eventually sent him into a career of scholastic medicine. Following his preliminary education in Cleveland, Ohio, he went to Yale College, bringing with him a fine inheritance of family tradition in medicine. Here, however, Cushing was merely a typical undergraduate who gained prowess as a baseball player, resulting in his letter, and later leading to his choice of captain of the team. It was here that he became imbued with the spirit of team-play, and the vigor which he demonstrated on the playing field is reflected in his later life at the Peter Bent Brigham Hospital in Boston, where many a distinguished surgeon of today can remember being startled out of a daydream while holding a retractor in the operating room, by the sudden exclamation: "Eyes on the ball."
As regards scholastic ability, Cushing developed slowly. His academic record at Yale College and later Harvard Medical School was undistinguished. It was not until he reached the clinic that his genius became apparent.

From Yale, Cushing graduated in due course and entered Harvard Medical School, following the example of his elder brother, Edward. He graduated in 1895, receiving the degrees of Master of Arts and Doctor of Medicine. A review of his grades at the Harvard School is of some interest for the C-minus in Clinical Surgery is a sharp contrast to the eleven A's and three B's.

Once again, following the example of his brother, he entered the Massachusetts General Hospital as surgical interne, where he became attached to the newly established south wing. It is interesting to quote from Cushing's description of the surgery of his internship days: "A good deal of it, to be sure, when looking back appears old-fashioned and we were misled in many ways. We operated too much by the clock; cases were insufficiently studied before operation; our fracture dressings were so neat and laboriously made we would hesitate to take them down to see if all was well beneath. Such minor operations as were recommended were largely orthopaedic in nature, and though the skull might often be trephined for fractures, I saw as a hospital interne in surgery, only one operation that I remember for an organic lesion of the brain."

At the hospital his industry and his beautiful records illustrated by his own drawings set him aside as an unusual character. Here he became interested in early X-ray work, then first beginning to be used in cases of broken bones. Here, records were kept on special charts, drawn by Cushing, of the progress of patients during anaesthesia, records which today are looked upon as one of the earliest attempts to set down in visual form the progress of a patient during a surgical operation.

From Boston, Cushing went to Baltimore in the autumn of 1896 as assistant on the staff of William Stewart Halsted. The shift from Boston surgery of that day where speed of operation was still considered advisable and even used as a gauge of ability, to the painstaking, slow, and gentle methods of Halsted was an everlasting inspiration to the pupil, Cushing. He often told the story himself that, coming from Boston wher a complete breast procedure was accomplished in twenty-eight minutes, he saw with misgivings a four and one-half hour operation for the same undertaking. How horrified he was when told not to dress the wound for ten days! Recalling the wounds he had previously studied, he remarked to himself, "I may not see the wound, but I shall smell it!" When in ten days the wound was dressed and found perfectly healed, his skepticism disappeared.
The Johns Hopkins Hospital, then in its first decade of existence, was an ideal place for a young man with insight and enthusiasm. The creators of that great institution were still its leaders and young enough to fire their chosen assistants with their own spirit—among these were Osler, Halsted, Welsh, Mall, Abel, Howell and Kelly.

Those were the days when the wards of a hospital were filled with typhoid fever. Cushing himself has described how he and the resident in medicine would take turns sitting by the bed of a typhoid patient, hoping to operate within an hour after perforation of the small intestine. A patient with a gunshot wound of the cervical spine with cord damage came under his care. Fortunately the patient gradually recovered and Cushing spent hours charting the return of sensation and motor function. Also, on this patient, he helped make some of the earliest X-rays used on this continent.

He was on the wards morning, noon and night working on his patients and seeing that they were looked after by nurses, junior internes and orderlies. He was interested in the smallest of details pertaining to the comfort and care of his patients. It would be quite characteristic of him to interrupt and instruct an orderly giving an enema. His medical reading was stimulated by problems that his patients presented. He learned to sketch, and his drawings added greatly to his records and histories, making them stand out above the average.

In Baltimore, Cushing was much influenced by William Halsted, from whom he learned the importance of the experimental method and of detailed records of all observations in clinic and laboratory, and that gentleness in handling of tissues with a minimal loss of blood was far more significant in the success of surgery than speed, or even manual dexterity. The ritualistic handling of silk suture, the slow, painstaking, delicate dissection of tissue which characterized Cushing's operative work was the art of William Halsted.

This training in general surgery prepared him in the best possible way to become the brilliant, pioneering father of neurosurgery and an inspiring teacher. Before him in the field of brain surgery little success had followed operation; after him many pupils were able, at home and abroad, to speedily extend his leadership and to make neurosurgery safe in the hands of many.

In Baltimore, too, began the friendship for William Osler that was an important stimulus in the clinical and literary development of Harvey Cushing, the latter to culminate in the splendid Life of Sir William Osler, published in 1925. Certain qualities in Cushing's writing and certain cordial mannerisms betray the influence which Osler must
have exerted. Indeed, Cushing lived for some time at No. 3 West Franklin Street, next door to the Osler house.

Wilder Penfield, referring to Cushing's relations with Osler and Halsted, states: "It was easier for me to see in Cushing the imprint of his masters because of the fact that I was a medical student under Osler at Oxford and under Halsted at Hopkins. It is a common experience for all of us to see in a son an unexpected trick of manner, or attitude that recalls his father. In a similar way, to see Cushing walk down the corridor of a hospital with his arm over the shoulder of a young man was sometimes for me to see Osler in the same attitude. To see Cushing at the bedside pondering on an abstract principle which lay beyond the immediate clinical problem and beyond the understanding of the patient, was sometimes to recall Halsted, 'The Professor,' in his wards at Hopkins."

During his first years in Baltimore, Cushing's interest in Roentgen-ray photography was unabated and he was responsible for the first roentgenograms made at Johns Hopkins.

Cushing's superiors at Hopkins thus recognized a man who worked unusually hard and more efficiently than average; a man who with average mentality and health set his course for the top and never became side-tracked or allowed his pace to slacken.

In 1900, Cushing's interest had turned toward the field of the nervous system and he went abroad for a year of study, crossing the ocean on the same boat and in the same cabin with Osler and Thomas McCrae.

The dominant figure in neurosurgery at this time was Victor Horsley and it was with the view of studying under his guidance that Cushing directed his footsteps toward London. Here he was doomed to disappointment in that Horsley had become so taken up with a large consulting practice, with the development of his general surgical service, as well as with matters relating to professional politics, that most of his work was done at odd hours at his home. Consequently, the young surgeon, with vague talk of returning for more work later, drifted to France, and finally to Switzerland, where, in Berne, he spent a most engrossing year in Kroenecker's laboratory.

Kocher suggested that he study the physiological relationships of intracranial tension. As a result of the work Cushing pointed out, along with other things, that the systemic blood pressure rises as the result of dangerous increase in intracranial pressure. In the spring, he started south and continued the work on intracranial tension in the physiological laboratory of Professor Mosso in Turin.

While traveling in Italy, Cushing picked up, in Pavin, a clinical
model of Riva-Rocci's blood pressure apparatus with an inflatable armlet, which he adopted for use in all his subsequent surgical procedures.

His wanderings eventually brought him once more to England, and it was his good fortune to come under the influence of Sir Charles Sherrington of Liverpool. In discussing his short acquaintance with Cushing, Sherrington writes:

"... It is just forty years since I had the pleasure of meeting him. He called on me at the Physiological Laboratory and then prolonged his stay with us to some eight months. He was already interested in cerebral surgery, and joined with enthusiasm in the experimental work going forward in the Laboratory upon the brain of the anthropoid apes. The day following a final experiment would find him early in the laboratory, devoting himself to making a series of drawings of the undissected brain, showing its surface markings, blood vessels, etc., appropriately coloured, providing a valued addition to the maps of the previous day. His drawings were beautifully executed and the Royal College of Surgeons preserves at least one of them now...."

Thus equipped, Cushing returned to Baltimore and petitioned for a post as neurosurgeon in the clinic. Dr. Halsted was staggered by the proposal, feeling that there was no possible source of livelihood in neurological surgery, since even the great Horsely did not limit himself to any such specialty. Orthopedic surgery was suggested. However, for young Cushing it was to be neurological surgery—he had hitched his wagon to a star.

He thus set out to create a special field in surgery, that of neurosurgery. Cerebral surgery was at this time in its infancy; it was still the day of mallet and chisel for entrance; of wound drainage and imperfect closure—cerebral fungus and infection as an almost inevitable consequence of most interventions for tumour. Most of the cranial operations at the beginning were miserable failures. After long hours of heart-breaking effort he would have to face the fact of the patient's death. A more easily quenched spirit would have taken "no" for an answer and concluded that Dr. Halsted was right—that this was not a field for specialization.

Gradually, however, successes began to appear. He applied Halsted's use of interrupted fine silk sutures and demonstrated that suture lines in the scalp would heal, even in the face of intracranial pressure and tension on the suture line, when closure was made with a deep and superficial layer of fine silk. When this principle was established, he was able to operate on cases and to escape the previous staggering mortality rate from cerebral fungus and infection. He had reached the point when the medical profession could be told that an exposure for brain tumour was reasonably safe.

Possibilities of removing brain tumours were becoming apparent.
Patients were saved who had been facing certain death, and others who had resigned themselves to unrelievable pain were cured. His fame spread and sufferers from neurological ailments began to flock to him.

In these earlier days of neurosurgery, time was no element with him, if it were of advantage to the patient, and three to five hours at the operating table were usual for major procedures, whereas in unusually difficult operations seven or eight hours might be consumed. One must not be mislead, however, into thinking that Dr. Cushing was a slow operator. When haste could be made, he made it, and woe to the assistant who might be caught napping "out in right field" as he used to say. Likewise, in an emergency from a severe hemorrhage, his courage, resourcefulness, and quick action sometimes meant life or death.

Patients were often left on the operating table several hours, all night, or longer if it was thought that movement might be detrimental. Special nurses were secured at his own expense if the patient could not afford them. Always his last act before leaving the hospital for his home was to pay a final visit to the patient. These special cares were not without results and the mortality for operations upon the nervous system was reduced to the lowest figure in history.

From 1901 to 1913 Cushing remained in Baltimore. He dominated the experimental work of the Hunterian Laboratory and developed a splendid teaching course in surgical anatomy, using animals as subjects. Throughout this time, as always, his chief preoccupation was the physiology which lay beneath clinical manifestations. He began two chief lines of laboratory investigation: first, the physiology of cerebrospinal fluid and, second, the physiology of the pituitary body.

In 1901 he delivered a lecture in Philadelphia at the early age of 32. This lecture was entitled "Some Experimental and Clinical Observations Concerning States of Increased Intracranial Tension." It was based on experimental work that he had done under Kocher in Berne. The lecture was followed two years later, in 1903, by a paper entitled "On Routine Determinations of Arterial Tension in Operating Room and Clinic," read at the Boston Medical Library. This paper marks the beginning of blood pressure determinations in this country. Cushing was now launched on his remarkable career as a formal lecturer and deliverer of orations.

In 1902 he married Katherine Stone Cromwell of Cleveland, whom he had known from childhood.

William Osler’s departure to Oxford took place in 1905 and at this time seemed to be a great loss to Cushing. However, by now he was well started in his bibliophilic adventures and perhaps was really bene-
fitted by the independence of thought and action which this separation enforced.

The various publications, degrees, and honors which we associate with Cushing during this pre-war period are too numerous to list and it is sufficient to say that he became at this early age an international figure in the realms of Neurology, Clinical Surgery, Physiology and Ophthalmology.

In spite of all these responsibilities, there was time for his favorite game of tennis, which he played with the vigour and enthusiasm so characteristic of his operative work. Also, there were frequent discussions with the devoted members of his house staff, and it was these informal meetings, plus his weekly rounds on patients with other than neurologic disorders, and the care of his own neurologic patients which permitted him to be the major influence for many years to come, on pupils whose interest lay in the field of general surgery.

In 1912, Cushing accepted a call to Boston, where he became Professor of Surgery at Harvard and Surgeon-in-Chief to the Peter Bent Brigham Hospital. This hospital, though not quite completed, was formally opened in April 1913 with addresses by Professor Collins Warren and Sir William Osler, then Regius Professor of Medicine at Oxford.

The Great War was soon at hand and Cushing threw himself into the struggle before the United States declared war, serving with distinction in the British Expeditionary Force. He accompanied the Harvard Ambulance unit to France in 1915 and became surgical director of the United States Base Hospital, No. 5. His great abilities soon led to his removal from this hospital group, of which he was the organizer and peace-time director, to become the senior consultant in neurosurgery of the American Expeditionary Force.

During these experiences his tremendous labors under the severe physical strain of forward conditions brought comfort and life to many an injured soldier, but his unsparing devotion to the task eventually undermined his health and left him a victim of peripheral neuritis for the remainder of his life. It has been said that at the Battle of Passchendaele he operated for sixteen hours a day.

All through this period of immense physical strain his publications continued. His contributions to the care of intracranial war wounds formed the basis for proper methods in this field. On the backs of X-ray reports and temperature charts Cushing kept his monumental war diary, which finally totalled over a million words, and in 1936 appeared in book form bearing the title "From a Surgeon's Journal."

An excerpt from this book gives a brief account of the death of Osler's son:
"Thursday, August 30th, 1917.

"Last Sunday came a letter from Lady Osler telling me that Revere was somewhere near St. Julien and how dreadful it would be should he be brought in to me with a head wound, and yet how thankful they would be. I answered immediately, asking her to wire me the number of his unit so that I could try to locate him among the millions. Rather used up, I was preparing to turn in at 10 last night, when came the shocking message:

"‘Sir Wm. Osler’s son seriously wounded. Can Major Cushing come immediately?’

"The C. O. let me have an ambulance and in pouring rain we reached Dosingham in about half an hour. It could not have been much worse, though there was a bare chance—one traversing through the upper abdomen, another penetrating the chest above the heart, two others in the thigh, fortunately without a fracture. . . . The abdomen was opened about midnight. There had been bleeding from two holes—in the upper colon and the mesenteric vessels. His condition remained unaltered, and about seven this morning the world lost this fine boy, as it does many others every day.

"We saw him buried in the early morning. A soggy Flanders field beside a little oak grove—an overcast, windy, autumnal day—the long row of wooden crosses—the new ditches half full of water being dug by Chinese coolies wearing tin helmets—the boy wrapped in an army blanket and covered by a weather-worn Union Jack, carried on their shoulders by four slipping stretcher-bearers. A strange scene—the great-great-grandson of Paul Revere under a British flag, and awaiting him a group of some six or eight American Army medical officers—saddened with the thoughts of his father. Happily it was fairly dry at the end of the trench, and some green branches were thrown in for him to lie on. The Padre recited the usual service—the bugler gave the ‘Last Post’—and we went about our duties."

During this war experience there were several trips to England and each time the long-desired visits with Osler. One of these occasions was shortly before Revere Osler’s death and though the imminence of disaster seemed in the very air, the comfort and happiness of all guests present was overwhelming.

For his great works in France Cushing was honored by his own country with the award of the Distinguished Service Medal, by great Britain by the Order of the Companion of the Bath, and by France with the position, officer of the Legion of Honor.

After the war he became re-established in Boston and his labors in neurosurgery took on their final form. His interest in general surgery lagged, for there was no time for it. Assistants flocked to his side to work in neurology and neurosurgery and the output of their work and influence is world-wide. In the midst of all this William Osler died
and at the request of Lady Osler, Cushing took up the writing of a biography.

It was a labor of love, but it was accomplished with the same tools and vigor that surrounded all Harvey Cushing's work. First, every possible source of information was gathered in and digested, the smallest references in daily newspapers were consulted, and from this background the great two-volume biography appeared.

The story is told of how his home was filled with copies of the London Times, covering the period that Osler spent in England. Each copy was scanned for some item of news having to do with Osler. Having come across some such item as: "Osler attended such and such a medical meeting," he would then write to men, whose names were also mentioned as attending, asking for further information. In this way he built up the second volume of Osler's Biography, a tiring and probably never-ending task for most men.

With characteristic foresight he dedicated the "Life of Sir William Osler." "To medical students, in the hope that something of Osler's spirit may be conveyed to those of a generation that has not known him; and particularly to those in America, lest it be forgotten who it was that made it possible for them to work at the bedside in the wards."

A noteworthy feature of the biography is the manner in which Cushing removed himself from the picture so that only those who had themselves been behind the scene could perceive how often he was an unnamed actor on the stage. This book was awarded the Pulitzer Prize as the best biographical writing of 1925, a lasting tribute to the scholarly attainment of the biographer.

During the period devoted to this enormous task an incessant routine was adopted. He worked in the early morning at home, arriving at the hospital at ten or eleven, where he was apt to plunge into a major operation at once. For from three to six hours he would operate with the utmost concentration, never lifting his eyes from the operative field. When the operation was over, he withdrew to a tiny dressing-room, where a faithful orderly prepared him tea and toast and where he dictated full notes of the operation and made one or more drawings of the operative field with the deft, quick hand of the artist. Then followed incessant correspondence, dressings, rounds with his resident surgeon and a little time in the pathology laboratory. Some days he wore his operating uniform till evening.

In 1926, he published his well-known work on the classifications of gliomas. The year, however, was marred by the death of his son William, who was killed in an accident at Yale.

On the occasion of his sixtieth birthday in 1929 his pupils dedicated
to him a collection of their writings. This special number in honor of his birthday emphasized his qualities as a teacher. The eighty-two papers were contributed by men then holding some of the most important medical and surgical positions, not only in the United States but in Europe. The contributions, besides dealing with the field of neurology and neurologic surgery, ranged over the entire field of medicine, including historical essays as well as experimental and clinical observations. The impact of Cushing's character and abilities is nowhere better pictured than in this affectionate tribute.

At a meeting of the Neurological Congress held in Berne in the autumn of 1931 Cushing won new honors. It was the first time after the war of 1914-18 that neurologists from Germany, France and England, as well as other countries of the world, had found it possible to have a joint meeting and it proved to be one that was little marred by politics or the old animosities of war. A surprise had been arranged in the form of two honorary degrees, one for Harvey Cushing and the other for Sir Charles Sherrington. Neither recipient had been previously informed of the honor, and it required considerable diplomacy to ensure their presence at the meeting without revealing the reason for having them prompt in arrival. Professor Asher, in conferring the honor upon Cushing, spoke as follows:

"Harvey Cushing, when you first came to Berne, thirty-one years ago, Hugo Kroenecker and I saw in you the future master of neurological surgery. You have more than lived up to our expectations, for in your field you have no peer. We are proud to think that some, at least, of your inspiration came from the Laboratory of Physiology at Berne and we are even more proud to welcome you as a member of our University."

Rounding out twenty busy years at Harvard, Cushing, in 1932, published the famous work "Intracranial Tumours," describing two thousand verified cases from his service. In this year he was able to report a mortality rate of only five per cent. These operative results eclipsed anything he had before achieved.

The hospital regulations set by himself and Henry Christian automatically retires the professional members of the Brigham Hospital staff at the age of 63, and this by custom is accompanied by resignation from the Medical School appointment. In 1932, the date of retirement arrived, set by himself. It came at a time when Cushing was working as never before, though bothered with peripheral vascular disease and the signs and symptoms of gastric ulcer. The transition from his tremendously active life was great, but he made it abruptly, and surgery was given up. He refused the repeated requests of the Brigham Hospital Trustees to remain in service as Surgeon-in-Chief, and attempts were soon made to entice him to many places, though it was hoped that he would stay in Boston and work on his collection of Brain Tumours.
He remained at the hospital for another year, however, and worked in uncomfortable quarters, for he insisted that his successor occupy immediately the quarters set aside for the Surgeon-in-Chief.

Retiring at the age of 64 years, he was invited to the newly created Stirling Professorship in Neurology at Yale. Here he was offered an active post, and to a man in the full vigor of his years, this opportunity and his natural devotion to his Alma Mater turned his footsteps away from Boston and Harvard.

With Dr. Louise Eisenhardt he set to work to organize a brain tumour registry which has brought together in New Haven most of the tumours of the nervous system that are known today. Without the burden of formal teaching, Dr. Cushing was able to work at his books and historical essays, and to attend pathological conferences.

In the autumn of 1934, he gave the foundation address in neurosurgery at the opening of the Montreal Neurological Institute, where his name has been inscribed in the Hall of Fame.

On April 8th, 1938, his seventieth birthday was celebrated at New Haven by pupils and admirers from all over the continent. The Yale Journal of Biology and Medicine published a special Cushing number containing papers read by his former pupils at a special meeting of the Harvey Cushing Society.

In June 1939 the Corporation of Yale University set aside a capital sum from the Sterling funds for a substantial extension of the Library of the School of Medicine, one wing which would serve for the expanding needs of the general medical library and another which was planned to receive Cushing's incomparable collection of books and manuscripts. A committee for the new medical library was immediately appointed, and Cushing was an active member. He was eager, among other things, that the library should be entered from the first floor so that students would, as it were, "fall" into the library without having to climb steps. He desired in the second place that the history library be made as attractive and accessible as the general library. He also hoped that the library should be conveniently situated, if possible at the centre of gravity of the school, so that distance would offer no obstacle to its use. However, with the threat of war in the offing, there inevitably followed a period of uncertainty about such an undertaking. On Saturday, September 30th, Cushing was informed that the University had decided to go forward with the plan at once. The war had greatly upset Cushing's peace of mind and this good news was therefore especially pleasing to him.

Four days later, on October 4th, Dr. Cushing developed the signs and symptoms of a coronary occlusion. The night before, when lifting a large volume of Vesalius from the floor, he had a premonitory twinge
of pain. Death followed early on the morning of October 7th. Two weeks previously he had remarked to Mrs. Cushing: "This war is getting me—it seems to have upset my digestion." Perhaps we may surmise now that he meant his heart. He could not plunge into this struggle as he had into the first World War.

Thus Cushing passed away, a world figure whose contributions to the literature of medicine gave him a rank as perhaps the foremost physician of his time.


Perhaps one of the most valuable and striking of his characteristics was the ability to attract and to afford inspiration to those indebted to him for their interest and their beginning in his chosen field of surgery. His imprint on many students, assistants and associates will be permanent, and his name will be always associated with surgery of the nervous system.

Cushing was never conceited or boastful of his reputation as an author. This may be easily illustrated by quoting from a letter in which he replied to a request from a friend for a copy of his complete bibliography:

"You will remember how horrified Osler was, shortly before his end, to receive a published list of his bibliography. I have much the same feeling about my own past papers, many of which were written only because I was pushed into contributing something for a medical meeting here and there. As a matter of fact, I think you have all the papers bound from 1920 to 1933, and of those written before and since that time, the less said the better."

His insatiable curiosity was one of his outstanding qualities and one which constantly led him to intellectual pursuits, often quite unassociated with his professional career. Such a curiosity certainly played a rôle in his acquisition of a great medical library. Take, for example, a book given him by a friend or a grateful patient—as soon as he had it, he had to know who had owned it before his hands touched it, then all about the author, and all about the printer.

Cushing took chief pride in being a clinician. He once said with deep feeling, when he suspected that the laboratory side of medicine was becoming over-emphasized,
"We have instruments of precision in increasing numbers with which we and our hospital assistants, at untold expense, make tests and take observations, the vast majority of which are but supplementary to, and as nothing compared with, the careful study of the patient by a keen observer using his eyes, ears, fingers and a few simple aids."

He was looked upon as a great teacher and here indeed lay one of his greatest gifts to posterity, for no master has had a more devoted group of pupils, who so obviously have followed the footsteps of their master. His method of teaching was simple. It was the apprenticeship system, and since Cushing was a man of few words, it was largely a teaching through example. He never demanded greater labors of his pupils than he set for himself.

Honors were showered deservedly on Cushing in recognition of his outstanding merit in many fields, as have been received by few, if any, other surgeons. Degrees, fellowships, titles and honorary memberships were awarded him in widely scattered areas of the universe and a recent investigation has revealed that at least 101 various awards were attained.

In brief summary, we will remember Cushing as a surgeon who placed neurology in itself upon a scientific footing, who created in America the field of neurological surgery. We will remember his remarkable case histories, his gifts as draftsman and artist, his skill in making patients spiritually as well as physically comfortable. From the scientific standpoint we will remember his pioneer use of X-ray, his introduction into America of blood pressure determination, his studies on the pituitary and upon cerebro-spinal fluid, his great clinical monograph on meningiomas. One recalls his unshaken belief in the university as a place of learning, his faith in democratic institutions which prompted his heroic services during the World War; again, one remembers his fondness for students, his gay wit, his loyalties, his celebrated "Life of Sir William Osler."

Like Osler, Cushing was a real friend to man. Let us continue to think of both as men who enriched medicine and proved that great men of science are true benefactors to all mankind.

**BIBLIOGRAPHY**

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Low Back and Sciatic Pain

By C. D. Keeley, '41

The medical and surgical aspects of backache are far too extensive to be considered comprehensively within the scope of any one paper. Therefore, I shall limit my discussion to some of the causes and the treatment of the more common and important forms of backache which are met with in the general practice of medicine.

The patient with intractable low back and sciatic pain has always been a problem to the physician. Lumbago and sciatica are ancient conditions. Hippocrates is known to have advised the use of actual cautery in the treatment of patients afflicted with these conditions. Even with the more advanced scientific methods of investigation and treatment now available low back and sciatic pain are still responsible for a tremendous economic loss each year, therefore accurate diagnosis of the condition and proper treatment of the patient are important. The possible causes or contributing factors of low back and sciatic pain may be classified as in any other problem, in several ways. In order to make this paper as explicit as possible, the following simple classification will be used:

Classification

I. Congenital
   1. Skeletal anomalies
      a. Tropism
      b. Spondylolisthesis
      c. Sacralization
      d. Spina bifida occulta
      e. Post-dislocation of 5th Lumbar vertebra

II. Acquired
   1. Traumatic
      a. Intraspinal:
         1. Ruptured nucleus pulposum
         2. Hypertrophy of ligamentum flava
         3. Fracture of vertebra
      b. Extradural:
         1. Injury or strain of soft parts of lower back—"Sciatic radiation of purely reflex origin" of Steindler
         2. Imperfect joint mechanism of the lower limbs:
            a. flat feet
            b. varus deformities due to rickets
            c. unreduced congenital dislocation of the hip
            d. fractures of bones of lower limb
      c. Postural defects
2. *Inflammatory*

   a. Acute:
      1. Sciatic neuritis—alone or as a part of multiple neuritis
      2. Lumbago—a true myositis
      3. T.B.
      4. Syphilis
      5. Typhoid
      6. Osteomyelitis

   b. Chronic:
      1. Arthritis of spine

3. *Neoplastic*

   a. Benign:
      1. Hypertrophy of ligamentum flavum
      2. Neurofibroma of Sciatic Nerve or Spinal Cord
      3. Meningioma

   b. Malignant:
      1. Primary
         a. Glioma
         b. Sarcomas
      2. Secondary
         a. Breast
         b. Prostate
         c. Kidney


   **Note:** Gynecological causes have purposely been avoided.

   From the above simple but cumbersome classification the extent of the subject is evident. Therefore, I shall only attempt to discuss briefly the more common conditions producing low back and sciatic pain.

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**CONGENITAL**

**Congenital Anomalies**

Congenital anomalies per se should not be the cause of pain and discomfort, but may predispose to injury and strain. An example of this is sacralization, where the enlarged processes of the fifth lumbar vertebra are united to the sacrum, in which case a pseudarthrosis is present. Solid union would mean added strength, while fibrous union with a false joint predisposes to strain.

**Posterior dislocation of fifth lumbar vertebra**

Posterior dislocation of the fifth lumbar vertebra on the sacrum takes place with greater frequency when the anterior type of facet is present. The fifth lumbar nerve is the largest and passes through the smallest intervertebral foramen between the fifth lumbar vertebra and the sacrum; therefore, a relatively slight disturbance of the articular
relationship can cause compression of this important part of the sciatic nerve, causing local pain as well as pain referred down the course of the sciatic nerve. This lesion may also be classified under trauma and on occasion may be combined with fracture to give a fracture dislocation.

ACQUIRED

Ruptured nucleus pulposus

Ruptured nucleus pulposus is usually traumatic in origin and Walsh of the Mayo Clinic believes that many of these cases are the result of several injuries rather than of only one severe injury. He also points out that trauma may injure several structures in the lower back and that the removal of only one of the sources of the pain will not completely relieve the patient. It is of note that hypertrophy of the ligamenta flava was found in 155 of the last 175 cases of posterior protrusion of the intervertebral disc reported at the Mayo Clinic.

The intervertebral disc is composed of a central hydrostatic ball-bearing mass, the nucleus pulposus, which is surrounded by interlacing fibrous bands, the annulus fibrosus, which in turn is firmly attached to the cartilage plate of the vertebral body. By trauma the nucleus may be forced out of its position, usually in a backward direction through the weakest part of the annulus fibrosus. Here it may impinge on the spinal cord. Protrusions tend to occur at the regions of greatest curvature of the spinal column. This appears to be indirect evidence of the traumatic nature of the process, since it is at these portions of the spinal column that mechanical stress and strain is greatest in heavy lifting and pushing.

Of 10,000 cases of low back and sciatic pain encountered at the Mayo Clinic in the last three years, in only 300 cases was it possible to arrive at a diagnosis of probable protruded intervertebral discs—270 of these were solitary. In 30 cases, multiple protrusions had occurred and in some instances two or more discs had protruded. Of the protrusions found at operation, 30 were at the third lumbar interspace, 140 at the fourth lumbar interspace and 139 at the fifth lumbar interspace. Sex incidence was interesting in that there were 226 males among these patients and only 74 females, which is probably due to the greater liability of trauma in the male.

Intermittence of symptoms which is quite characteristic of the syndrome was present in 81 per cent of a reported series of cases. Unilateral pain was the most common symptom reported but a few had bilateral pain. Pain was increased by sneezing, straining or flexing the head on the neck in over half of the cases. Nocturnal pain occurred in 21 per cent of the cases. Paraesthesia in the fourth or fifth lumbar or sacral dermatomes developed in nearly half of these cases. The most important neurological signs were: positive Lasègue’s sign, the presence
of sciatic tenderness, the diminution or absence of Achilles tendon reflex, decrease or loss of the hamstring reflexes and muscular weakness, atrophy or sensory loss. In most cases obliteration of the normal lumbar curve was noted and movements of the back, particularly hyper-extension, were limited and painful.

Spinal fluid in 66 per cent of the cases had a protein concentration of 40 mgm. or more but 34 per cent had less than 40 mgm. per cent. Therefore, although an abnormally high protein level is of diagnostic value, a normal spinal fluid protein does not exclude the condition.

Radiological examination should be carried out in all suspected cases in order to accurately localize the lesion. Lipiodal has been most used as a contrast medium but air injection similar to encephalography is being used considerably more at present because of possible harmful effects of the lipiodal on nervous tissue and the necessity of laminectomy for its removal. Chamberlain and Young of Philadelphia have used oxygen routinely for over a year because it is absorbed faster and produces less reaction. They suggest that since the gaseous contrast media are readily absorbed, spinal canal visualization may now be carried out in those patients whose symptoms and neurologic findings did not formerly warrant such an investigation.

Removal of the protruded portion of the intervertebral disc by means of a laminectomy has continued to give satisfactory results, 90 per cent of the patients are relieved immediately and dramatically. Walker suggests that after removal of the protruded part, some type of lumbosacral fusion be employed, especially in the patient who is going to lead an active life. Reference must again be made to the fact that since other injuries may have been suffered in the lower back region in addition to the intervertebral disc, single operations do not always give complete relief. Ober has reported two cases of fasciotomy which graphically illustrate this point. After relief had been obtained for a time, subsequent operations revealed protruded intervertebral discs.

_Hypertrophied ligamentum flavum_

Hypertrophied ligamentum flavum is nearly always associated with ruptured nucleus pulposus. The hypertrophy is thought to be the result of repeated minimal trauma. This condition produces bilateral symptoms in the large majority of cases. The roentgenological findings are characterized in the lateral view by a broad, rounded indentation on the posterior aspect of the lipiodal column between contiguous laminae. In the anterior or prone plate there may be a unilateral but usually a bilateral broad indentation of the lipiodal or air column. Symptoms and treatment are similar to those of protruded intervertebral disc.
Soft tissue injury with sciatic radiation

Steindler believes it should be anticipated that a large percentage of low back pain is due to injuries of the soft tissues. He believes that there is a large group of cases of low back pain (30 per cent) in which sciatic radiation has nothing whatever to do with direct irritation either of the nerve trunk or of its roots but that it is purely a reflex phenomenon which follows and does not precede the low back pain. The application of Head's law of referred pain, “Pain in a part of low sensibility in close central connection with a part of high sensibility is felt in the latter region,” may be of use in determining the exact origin of the trouble. Based upon this Steindler has described the “trigger points” which are merely areas located on the lower back over definite anatomical structures. When pressure is applied over these localized areas, pain with sciatic radiation is produced or exaggerated. Upon the injection of this point or points with novocaine, the local pain as well as the sciatic radiation at once disappear and the leg signs become negative. Steindler has listed six of these so-called trigger points naming the syndrome from each:

1. Sacrospinalis syndrome—pressure point at posterior superior or inferior iliac spine.
2. Lumbosacral syndrome—pressure at lumbosacral junction.
3. Gluteal syndrome—pressure point at gluteus maximus insertion.
4. Transversosacral syndrome—pressure point at transversosacral articulation.
5. Tensor fasciae latae syndrome—pressure point at lateral border of fascia and iliotibial band (positive Ober's sign).
6. Myofascial syndrome—vague tenderness along the sacrospinalis muscle and its fascial sheath.

Success of treatment in these soft tissue cases depends on the success or failure of immobilizing the injured part whether externally by plaster cast or strapping, or internally by fixation or even in the elimination of a painful joint by resection. The beneficial result obtained in the successful Ober's operation is due to the elimination of the tensor fasciae latae syndrome, by resecting the fascia lata.

Imperfect joint mechanism of lower limb

In many instances, back pain is due to faulty joint mechanism of the lower limb. Especially in the acute foot strain (flat-foot) there is a stretching of the ligaments of the long arch of the foot with pain which is often referred up the leg to the posterior part of the knee and lower back.

Healed fractures of the tibia and fibula, with poor alignment of the bones result in alteration in the plane of the ankle joint from the horizontal; the weight of the body no longer falls perpendicularly upon the arch of the foot, producing strain at the ankle, the knee and even in the back. Also inequality in the length of the limbs due to shortening
from fractures may cause pain, particularly in later years, through the production of a lumbar scoliosis and traumatic arthritis.

Postural defects

Lack of postural tone is a common cause of chronic low backache. The patient stands with the head and shoulders forward and down, the abdomen relaxed and the pelvis rotated forward. There is often a degree of flat-foot present. In the presence of such relaxed musculature the ligaments alone offer support and static strain follows. Treatment and correction can be accomplished by use of braces, corsets and remedial exercises.

Acute

Low back pain of infectious origin must always be considered. In this group the more common lesions are infectious arthritis, spondylitis deformans, myofascitis, fibrositis, "typhoid spine" and T.B. of the sacro-iliac joint. Gonococcal arthritis is frequently localized in the lumbo-sacral joint and may even cause an infectious spondylitis of all the vertebral joints.

Sciatic neuritis alone or as a part of multiple neuritis occasionally occurs but is rare. Treatment consists of immobilization and application of heat or cold.

Lumbago is considered to be an inflammatory affection of the lumbar muscles, "a myositis," frequently following exposure to wet and cold. It is acute and of short duration. Recurrent "lumbago" is a symptom only, the cause being mechanical or arthritic.

Chronic

Chronic arthritis is the most frequent cause of continued back pain in people over 35 years of age. This is the form of backache which is usually classified under spondylitis or chronic arthritis and acute exacerbations may occur from time to time. Under this group the "facet syndrome" described by Ghormely which is an arthritic condition of the facets may be placed.

The most troublesome arthritis associated with low back pain and sciatic radiation is the osteohypertrophic type in which the intervertebral foramina are narrowed to such an extent that they impinge upon the roots of the nerves. A radicular type of pain which is usually sharp and may be burning or gnawing but rarely aching, is produced. Remarkable cures or remissions have been reported after tonsillectomy (foci of infection) but now chronic infective arthritis is noted for its tendency towards spontaneous remissions, therefore, a week's rest might have accomplished the same results as the elimination of the foci.

Benign

Benign tumours of the cord and surrounding structures are rare but do occur. Neurofibroma of the sciatic nerve proper may give rise
to symptoms referable to its distribution, and to the lower back as in Von Recklinghausen’s disease. Meningioma of the cord causing pressure may give rise to symptoms similar to those of ruptured nucleus pulposus.

Malignant

Secondary tumours such as metastasis of breast cancer in the female and prostatic cancer in the male involving the pelvis and spinal cord are very likely causes of low back pain. It is of note here that tumours of the thoracic or even the cervical region of the spinal column may sometimes give rise to sciatic pain. Treatment in these cases is palliative x-radiation or alcohol injection for relief of the intractable pain.

PSYCHOGENIC FACTORS

Backache with or without sciatic radiation is one of the most common symptoms of the psychoneurotic. Undoubtedly, some patients with backache are malingerers who recover with settlement of their compensation claims. The complaint of backache by a young married woman may on analysis be found to spring from sexual incompatibility or from fear of pregnancy. In these cases, the symptom is a defence mechanism, built up either consciously or subconsciously, but until its psychological background is fully discussed and explained, physical therapeutic measures will be largely ineffective.

These patients are not malingerers but constitutionally inadequate persons who shrink from responsibility by hiding behind a functional complaint. The physician who considers psychic factors unimportant and neglects to take them into account will do so to his sorrow.

SUMMARY AND CONCLUSIONS

The more common causes of low back and sciatic pain have been discussed and some treatment outlined.

The gynecological causes of low back pain have been avoided purposely.

Notwithstanding the fact that each year some new cause of low back and sciatic pain is described, it is well to remember that the older and more common causes should be thought of and eliminated first in the differential diagnosis of any given case.

BIBLIOGRAPHY

Haematuria in Pregnancy
With Report of a Case

By John G. Stapleton, B.A., '41

Haematuria is a common symptom, indicative of such a large number of generalized and urinary tract diseases that its investigation calls for a very painstaking study of the patient. Even with the greatest care, one is sometimes unable to demonstrate a cause, as in the case presented herein.

The association of haematuria with pregnancy appears to be rather uncommon, and this paper offers a brief discussion of the syndrome, and the report of a case. As a background for consideration of the subject of haematuria the following simple classification is presented:

**CAUSES OF HAEMATURIA**

I. PRE-RENAL CAUSES
2. Infections
   (a) Infectious fevers: typhoid, malaria, smallpox, scarlet fever.
   (b) Adjacent local infections: appendicitis, pelvic abscess, perinephritis.
3. Toxic conditions—pregnancy toxaemias, drugs: cantharides, turpentine, urotropin, sulfapyridine.
4. Endocrine disturbances—vicarious menstruation.

II. RENAL CAUSES
1. Tuberculosis.
3. Renal calculus.
4. Inflammatory and Necrotic changes: acute glomerulonephritis, embolic glomerulonephritis, focal nephritis, malignant nephrosclerosis.
7. Essential haematuria (Vide infra).

III. POST-RENAL CAUSES
1. Upper tract—stone, stricture, tumour.
2. Mid-tract (bladder)—stone, tumours, ulcer, infections, diverticulum, parasites (Bilharzia, Filaria bancrofti).
3. Lower tract—posterior urethral infections, stricture, foreign bodies, trauma, hypertrophy of prostate, carcinoma of prostate.

The following review of the literature on the subject of haematuria in association with pregnancy was suggested by an encounter with Mrs. M. B., a patient on the Gynecological service of the Victoria Hospital, London. She presented herself with a gross haematuria of one month's duration, associated with a six and a half month's pregnancy. She had absolutely no complaints. (Complete history and physical examination below.) The published information on the subject of haematuria in association with pregnancy was investigated. In 1920 Dattin presented a series of 20 cases collected from the world's literature during the previous 80 years. None of these were sufficiently investigated according to modern urologic standards and contribute nothing to our study. The literature during the last twenty years proved to be rather meager. Quigley, in 1921, presented a case of gross haematuria occurring in the later months of pregnancy, which cleared up after the pregnancy. This patient had many signs of toxaemia—elevated blood pressure, oedema, pruritus and nausea. Three weeks post-partum the urine was microscopically and chemically free of blood; the haematuria was considered a result of toxaemia. The importance of haematuria as an early symptom of pregnancy toxaemia has been emphasized by Becker, and more recently by DeLee.

Swanson, in 1929, presented a case of haematuria associated with a pregnancy hydronephrosis as the only demonstrable pathology. He suggests passive congestion and increased permeability of the capillaries of the kidney pelvis as the cause of the haematuria. The patient was a para VI who had had intermittent painless haematuria of varying degree during the later months of her last three pregnancies. There are several other references in the literature to haematuria in pregnancy hydronephrosis. Most of these papers are in foreign language journals and we are uncertain as to the extent to which they have been investigated. One would expect to encounter more frequent cases of haematuria from this cause if it were very important, since hydronephrosis is so extremely common.

Albanese presents a series of cases with haematuria in pregnancy due to an acute flare-up of a previous chronic nephritis. These should not be difficult to diagnose.

Morris, in 1935, presented a paper on Haematuria as a complication of pregnancy in which he reviewed 30 cases which he had seen himself. These cases turned up in 154 urologic consultations in pregnant women having urinary tract complaints; i.e., in 20%. They comprised 18 cases of gross haematuria and 12 cases of microscopic haematuria. From these figures it is evident that haematuria in preg-
nancy cannot be considered the rarity which the paucity of the literature on the subject might suggest. Morris analyzes his series of cases very carefully and gives an interesting summary of his findings. His 30 patients averaged 27 years in age; 16 were primiparae; the average time of onset was 4½ months. He found cystitis in all 30 cases. Seventeen had definite renal pain. There was a pyelitis in 22 cases (20 of which were bilateral) and definite hydronephrosis in 10 cases. A number of other lesions were found: pyonephrosis (2), ptosis (9), megaloureter (11), ureteral calculus (2), ureteritis (2). These findings illustrate the necessity for thorough investigation of all cases by a competent urologist. It is interesting to note that one or more significant pathological lesions were found in all the above cases. That this is not always the case will be shown below. Urologists have long reserved the term “essential haematuria” for such cases, in which no pathology can be demonstrated ante-mortem. It is significant, however, that as the technique of urological investigation has progressed the number of “essential haematurias” has become fewer and fewer, until there is a widespread tendency today to abandon the term. However, as Wilbur and Priestley point out, there is a small group of cases where the term may properly be applied. The diagnosis should not be made until careful urologic and general investigation has eliminated all the other causes in the classification of haematuria. The remaining cases are, clinically, haematurias without demonstrable cause, despite the most painstaking investigation. Pathologically they are caused (Wilbur and Priestley) by minor lesions in the renal papillae, namely:

(a) Dilatation of blood vessels (so-called varices of the renal papilla).
(b) Interstitial haemorrhage.
(c) Mild chronic inflammation (“papillitis”).
(d) Fibrosis.

The main causes of haematuria with pregnancy as determined from a survey of the literature on the subject seems to be:

(1) Toxaemia (of the pre-eclamptic type).
(2) Hydronephrosis.
(3) Acute exacerbation of previous chronic nephritis.
(4) Pyelitis.
(5) Vicarious menstruation (due to endocrine disturbance).
(6) Essential haematuria.

CASE HISTORY

Mrs. M. B., aged 24, white, para IV, gravida V, was admitted to hospital on October 7th, 1940, with a history of gross haematuria for one month, without any bladder symptoms or any pain in the costovertebral region. Blood is present in all specimens of urine, uniformly
mixed throughout. Outside of a certain uneasiness because of the haematuria, she felt perfectly well, and had not suffered any particular limitation of activity because of her haematuria. She was 6½ months pregnant on admission, and had had four previous pregnancies, the second of which ended in a stillbirth. Her last previous pregnancy ended one year ago, and was accompanied by a gross haematuria which began in the third month and cleared up one month post-partum. (Microscopic examination not done.) There was approximately 10 months free of haematuria, followed by the development of gross bleeding during the sixth month of the present pregnancy. She states that the urine is redder this time than before, and that small clots have been passed.

The patient was very thoroughly investigated both as to history and physical condition. She denied having taken any type of medicine or drugs; she had had no signs or symptoms of any toxaemia; she had never had backache, costovertebral tenderness, dysuria or frequency. She ate a well-balanced diet. Physical examination revealed a well-developed, moderately well-nourished young woman in no apparent discomfort. There was no costovertebral tenderness or spasm. There was no evidence of any systemic disease.

**Catheter urine:** albumin 4 plus, sugar negative, 100-200 red cells and 50-75 pus cells per high-power field, no casts.

**Haematology:** Haemoglobin 72%, red cells 3,530,000, white cells 12,250, coagulation time 10 minutes, bleeding time 1 minute, clot retraction normal.

**Blood Chemistry:** N.P.N. 24.6, creatinine 1.0, calcium 10.0, phosphorus 4.3, vitamin C 0.36 mg. per cent.

**Other Data:** Blood pressure 110/0. B.M.R. plus 4 per cent.

**Cystoscopy, October 12, 1940:** Bladder mucosa was normal. Several clots were present in the bladder. Urine from the right ureteral orifice was slightly cloudy, but not blood-tinged. Urine from the left ureter showed gross blood. Ureteral catheters were passed up to both pelves without difficulty. Specimens of urine were collected from each side and retrograde pyelograms were done. These gave good visualization of the pelves and calyces and showed no suggestion of abnormality.

**Urine report:** left—numerous red blood cells, no pus, no bacteria.

right—no blood cells, no pus.

Cultures gave no growth from either side.

This patient was presented at Surgical Staff Conference at Victoria Hospital as a case of bleeding from the left kidney, cause undetermined. In the absence of any evidence of disease of the urinary tract other than the bleeding or of any general disease or toxaemia, the
consensus of opinion was that she must be labelled as an “essential haematuria.” It was felt that she could safely be allowed to carry on with her pregnancy, under careful supervision, and supported by adequate doses of iron and vitamins. She was discharged after about two weeks in hospital.

The patient re-entered the hospital on December 25th, 1940, and was delivered of a normal full-term infant weighing 7 lbs. 2 ozs. Gross haematuria disappeared in seven days. At the time of her discharge, on January 9th, 1941, mother and child were both in good health and only on microscopic examination could a few red cells be found in the urine.

**SUMMARY**

1. Haematuria is caused by a multitude of conditions, both general and local, in the urinary tract.

2. The term “essential haematuria” is properly applied to certain cases of haematuria caused by minor pathological lesions in the kidney papilla, not demonstrable during life unless the kidney be excised.

3. An interesting case-record of a woman who had gross haematuria of unknown origin during two pregnancies is presented.

**BIBLIOGRAPHY**


**SUMMER DIARRHEA IN BABIES**

Casec (calcium caseinate), which is almost wholly a combination of protein and calcium, offers a quickly effective method of treating all types of diarrhea, both in bottle-fed and breast-fed infants. For the former, the carbohydrate is temporarily omitted from the 24-hour formula and replaced with 8 level tablespoonfuls of Casec. Within a day or two the diarrhea will usually be arrested, and carbohydrate in the form of Dextri-Maltose may safely be added to the formula and the Casec gradually eliminated. Three to six teaspoonfuls of a thin paste of Casec and water, given before each nursing, is well indicated for loose stools in breast-fed babies. Please send for samples to Mead Johnson & Company, Evansville, Indiana.
Medicine Among the North American Indians

By WM. LOVEGROVE '42 and RAY STUBBING '42

Of all primitive races, the North American Indian is of greatest ethnological interest. He roamed the forests of present-day Canada and the United States as a nomad and when the French reached Canada they found in him a faithful picture of Stone Age man. In his organization and racial traditions, his tribal instincts, his nomadic life, his barbaric customs and demon-filled mythology, his implements of utility and warfare, he represented a survival of prehistoric life. Yet, when the white men came they found the Indians practising medicine and surgery with a skill and knowledge equal in many respects, and superior in several, to the European practice of the day. In their knowledge of herbal remedies, the Indians were undoubtedly superior to the French physicians. They had diuretics, purges, astringents, expectorants, emetics, even emmenagogues. But it was in the field of wound treatment and fracture management that the Indian excelled. The accidents of outdoor life, combined with the demands of tribal wars, enforced a learning based upon experience. Their system of treatment was passed from generation to generation both as common knowledge in the tribe and as secrets of the medical cult and, despite the obvious shortcomings of such a method, it was surprisingly complete.

Their Concept of Disease

Primitive man, when faced with the danger of losing his life, or when in bodily pain or mental anguish, has always sought aid from some power beyond himself. Thus, there have arisen physicians and priests among all peoples. Often these offices have been combined in one. So we find that the Indian’s practise of medicine and his religious beliefs and rites were often inextricably bound. It is inevitable, then, that many diseases would be regarded as unnatural states, as a punishment from the gods or the work of evil spirits who must be foiled or propitiated. Similarly, there logically evolved two chief divisions of treatment, namely, the use of magic and the use of natural remedies (plasters, sweat baths, etc.).

According to Indian conception, disease might be the result of natural causes, in which instance it should yield to natural remedies; or it was of supernatural origin, caused either by (a) an unconscious desire—desideria innata—of the patient’s soul which must be divined by dreams or riddles; or (b) as a result of a spell cast upon the body by evil spirits or sorcerers, which must then be removed or exorcised by sacrifices, special feasts, dances, emesis, sucking the painful part,
and the like. These conceptions were held largely by the great Algonquin race, whose tribes included the Ojibways, Ottawas, Menominis, Pottawatomis, etc., scattered throughout Manitoba, Minnesota, Wisconsin, Michigan, Northern Ontario, along the Saguenay River and on the north shore of the St. Lawrence.

**Medical Organization Among the Ojibways**

The Ojibways (Chippewas), occupying Wisconsin, Minnesota and Northwestern Ontario, appear to have been best organized with regard to the profession and practice of medicine. The medicine men were tribal members of noble bearing, wide knowledge and qualities of leadership. They commanded great respect and were important in the social organization of the tribe, ranking as chiefs or next to the chiefs in authority and in the regard of the people. Only candidates of high standard were adopted as healers. Health and long life represented the greatest good to the Ojibway and he was most highly regarded who could bring aid conducive to these ends. They rewarded him not only materially, but with a firm belief in his supernatural powers and by the bestowal of tribal honours. The medicine men and women (for both were admitted to the office) were really the priests of the people, having knowledge not only of the treatment of disease but also of tribal customs, songs, traditions and laws. They were the spiritual rulers of the people. In the organization, as well as the high ranking medicine men, were “herbalists” who were members of the Midewiwin and whose remedies were secrets of the cult; and “jugglers,” or djasokids, who treated the sick by magic—the charlatans of the day.

**The Indian Medical Student**

The training of the tribal healers is a very interesting aspect of Indian medicine. To belong to the Midewiwin was a great honour and the boy or girl whose parents were willing to make the necessary payments, often involving great sacrifice of labour and wealth, was fortunate indeed. The candidate was given a name at a ceremony of admittance. A member of the Midewiwin was appointed to act as godfather and to instruct the novitiate in tribal law, rites and ceremonies of the medicine lodge. The training was carried on actively over a course of years, after which the candidate became a junior member of the medical society. As he went into practice and the demands upon his knowledge increased, he returned, paid the necessary fee, and took a post-graduate course from the older members of the medicine lodge. In this way he passed from the first degree to the second and, if an ambitious individual with aspirations of great power and authority, he was able to advance by taking further degrees. If the youth died in the midst of his training, his father or mother was allowed to take his place and to receive initiation as long as his payments had been made in full.
Diseases of the Indian

The picture we have of the Indians is as a stalwart race who lived an active, healthy life outdoors, engaged in fishing, hunting and warfare; quite free from the ills besetting ordinary mankind. The truth is that their afflictions were many and varied; the fact of their healthy survival being a criterion of the success of their therapeutics.

It is obvious, engaged as they were in active, dangerous pursuits, that wounds and fractures would be common-place. Frost-bite, too, was undoubtedly common and yet no mention is found of treatment save in one instance of successful amputation of both lower legs to prevent death from gangrene resulting from severe freezing. Infection of wounds was the exception rather than the rule in those days when bacteria were unsuspected. Diseases of the eyes, due to prolonged exposure to smoke in their houses, frequently led to blindness. Insanity was present and there is evidence to suggest that the one so afflicted came to be regarded as all-wise in the tribe. Jacques Cartier, reporting in 1536, remarked concerning insane members of the Indian encampments at Hochelaga and Stadacona.

With the exception of respiratory infections and mild forms of dysentery, the Indian was remarkably free from infectious diseases. With the arrival of Columbus, in 1492, a new era dawned for the Western Hemisphere, but the white man's coming marked the zenith of the Indian's day. There is little doubt that diseases such as measles, scarlet fever, diphtheria, smallpox, chicken-pox, typhoid, malaria and yellow fever were importations to this continent. And the first sign of the coming twilight of the race was its extreme susceptibility to these diseases. Authentic reports exist of whole tribes being wiped out by measles and smallpox after the visit of one or two white trappers or soldiers. Those Indians who were able fled in terror of the plague, leaving possessions and friends behind.

Despite the popular theory that syphilis was taken back to Europe by the sailors of Columbus, modern authoritative opinion is that neither syphilis nor tuberculosis existed in North or South America before the white man came. This opinion, held foremost by W. T. Corlett, is based upon studies of many thousands of skeletons in search of bony lesions as well as upon the reports of those who early studied Indian customs and welfare.

Surgery, Wounds, Fractures and Dislocations

The Indians led a very active life and traumatic accidents were common. Through observation and experience they developed a very effective method of treating wounds and fractures. It is agreed that their methods and results were probably superior to those of the white doctors of the time. However, their strong physique and healthy manner of uncrowded living must be evaluated in considering the results.
In the treatment of wounds, effective antiseptic solutions were not known, yet infection was not common. This was because they cleansed the wounds in running water and applied only poultices and powders, which permitted free drainage. Salves which tended to close the wounds were not used.

Large wounds were sutured with threads of sinew in bone needles, the sutures being left in place for six to eight weeks. Healing was by granulation and by placing a thin piece of bark between the outer wound edges they assured that healing would be from the bottom up. Wicks made of grass or cloth were inserted for drainage in several tribes. In most of the Indian tribes only superficial foreign bodies were sought for and removed. But the Tuscaroras performed debridement and removed deeply-placed arrow heads very skilfully.

The methods used to control bleeding are interesting. The cauterizing of wounds was widely practised and all tribes understood the use of the tourniquet for severe haemorrhage in the extremities. Wounds were sometimes packed with eagle's down or, more important, with scrapings from the inside of a fresh hide (compare with the use of muscle tissue in brain surgery). Spider webs were collected and used to stop bleeding by some.

In certain internal conditions which they were hard put to understand, Phlebotomy was practised and about "half a pan" of blood removed. Boils and abscesses were incised and free drainage permitted. Digits were amputated, possibly often for frost-bite. One tribe in the Southern States made it a practise to cut off about half of each foot of their slaves in order to prevent escape. They arranged a thick skin flap on the dorsal aspect which was then turned down over the cut surface to the sole and sutured. Routine amputation of legs was not practised in treatment by any save several tribes in South America.

There is some evidence that the North American tribes drilled holes through the skull into the cranial cavity as a form of therapy. This was probably done for severe headaches in order to allow the evil spirits imprisoned in the skull to escape. That some of these operations did not cause death is proven by the new growth of the bone around the drill holes. Some South American tribes successfully removed large pieces of skull; an operation not at all uncommon.

The presence of well-united fractures in the unearthed skeletons is testimony of the skill of the Red Man in treating broken bones. Deformed bones due to badly adjusted fractures are not common. All members of the tribe had some skill in the treatment of fractures. The broken bone fragments were set by manipulation and then held in place by various means. Splints of wood extending to the adjacent joints were put around the limbs and held in place by thongs. Several tribes
wrapped the fractured limb with wet rawhide which dried to form a hard cast. Others used thick slabs of water-soaked birch bark with similar results. Windows were cut in the splints for the purpose of treating accompanying wounds.

The replacement of dislocations was understood by the average Indian. A report exists of an Indian who replaced his own hip which he had dislocated in the forest. This was accomplished by locking the feet between two logs and manoeuvring the body, undoubtedly with much pain. This Spartan treatment was, though, to be preferred to death by starvation in the bush. The Ojibways administered a mixture of nauseating plant decoctions in order to obtain the necessary muscular relaxation for replacement.

Advanced surgical manoeuvres were of necessity restricted but it is interesting to note that drainage of empyema was successfully performed in some tribes. If a tooth were hollow, the Ojibways would heat an awl almost red hot and put it into the cavity of the tooth. Extractions were performed either by forcibly striking the tooth to loosen it or by wrapping a sinew around the tooth close to the root and jerking.

**Obstetrics**

The study and recording of Indian obstetrical practise has been difficult because of the secretiveness which prevailed at childbirth.

The Indian baby is smaller considerably than the white baby and this fact, together with the scarcity of pelvic deformities, made labour a comparatively easy procedure. The Indian mother led an active life and this, too, was favourable for easy delivery. Therefore, there was little interference during childbirth.

The methods of conducting labour were as numerous as the tribes. Each area saw a particular custom in practise and only the most widespread principles are mentioned here.

When the time for labour came the mother usually left the house and, aided by some older women, gave birth to the child by the river bank or in specially constructed lodges. If labour was prolonged they would use pressure on the abdomen and external manipulation of the fetus. Vaginal examinations were never performed. The usual position assumed by the mother was kneeling with a support above the head arranged so she could grasp it during pains.

Malposition was usually fatal. In cases prolonged for any reason, usually transverse lies, the medicine man was called. His chief contribution was the use of special chants and rituals. However, in some tribes external version was attempted and, in others, four women would pick up the mother and attempt to change the lie by swinging her in
the air. In a few areas, the woman would attempt to force delivery by crawling over a fallen tree trunk, forcing the fundus down by great pressure.

The cord was never tied until after delivery of the placenta. It is surprising to note that all the Amerinds practised Crede's method for expressing the placenta, at least 100 years before he published his procedure. The Crows and Creeks used a post padded with a blanket, which was pressed into the epigastrium. The Plains Indians tickled the woman's nose and the resultant sneezing helped to expel the placenta. The Papagos tied a buckskin thong around the cord and to the mother's foot. She applied her own traction.

After labour, the mother usually went about her work in a few hours with no apparent ill-effects. Some tribes used a tight abdominal binder and others allowed the mother a few days of rest.

Abortions were extremely uncommon before the coming of the white man. The delivery of half-breed children, averaging 1½ pounds more than a pure-bred Indian baby, was usually very difficult and this led to the development of abortion methods. Procedures varied from the insertion of slippery elm bark into the cervical canal to the midwives trampling on the pregnant abdomen. A number of herbs were used as abortifacients but, except in the Creek tribe, their effectiveness has not been proven.

Diseases of the reproductive organs were uncommon. Malignant tumours were apparently very rare. Malposition of the uterus was recognized and the Plains Indians used vaginal pessaries made of balls of twisted buffalo hair in an attempt to deal with them. Dysmenorrhoea was quite common, judging by the number of herbs used to treat this condition.

From observations of modern pure-blooded Indians it has been concluded that sepsis, eclampsia, and post-partum haemorrhage were almost unknown. Malpositions were also uncommon. Undoubtedly this explains the low infant and maternal mortality among the Indians and is the reason their crude obstetrical procedures were successful.

Special Procedures

The use of the steam bath in sweat lodges was practically universal in both the Americas. The lodge generally took the form of a small oven-shaped structure with a small door and nearly air-tight joints. It varied in construction from brick in the South to snow and ice blocks in the North.

Steam baths were used not only to treat disease but as routine health measures and following long marches or exposure. The patient sat close to a pile of heated stones and threw small amounts of cold water upon the stones to produce steam. Occasionally, water treated with
herbs was used. In addition, the body was often whipped with twigs to increase sweating and the whole procedure was followed by a cold bath to complete the treatment.

The enema was used to administer both decoctions and nutrient solutions by rectum. The apparatus consisted of a deer bladder and a hollow reed which was tied into it. The bladder was filled with the solution and the reed inserted, making a quite efficient instrument.

Inhalations were used for chest conditions. Powdered herbs were placed on hot rocks over which the patient sat, head covered with a blanket, inhaling the fumes. This treatment was also used for treating headaches.

Bleeding was practised for almost all ailments. They would make either a small wound with a sharp instrument or would scarify the skin by scraping with a flint knife. The Indians believed that an evil spirit had entered the body to cause the sickness so they would next apply suction at the bleeding point by means of a hollow long bone. A favorite practice of the "juggler" was to secret a small object in his mouth before sucking, for example, a piece of charred wood, some gravel, even a small mouse or a bird. After applying suction he would triumphantly show the object as the evil spirit drawn out of the body.

The Use of Herbs in Treatment

Probably the first account of the white man's contact with Indian medicine is given by Jacques Cartier. After arriving in Canada in 1535, Cartier's sailors fell ill with a sickness previously unknown to them. In his narrative, Cartier gives a description of the disease and leaves no doubt that it was scurvy that was afflicting his men. All treatment failed and a post-mortem of one of the dead did not aid them. By mid-February there were only three well men of his crew of 110. His narrative continues as follows:

"In such sorte did the sickness continue that there were not above three sounde men in the shippe.

"We were so oppressed and grieved with that sickness that we had lost all hope ever to see France againe, if God in His infinite mercie had not revealed a singular and excellente remedy unto us. Oure Capitayn considering oure estate one day went forthe walking, when he saw a troupe of those countrysmen coming from Stadagona, among which was Domagaia, who not passing tenne or twelve days before had been very sick with that disease. Our Capitayne seeing him whole and sound was thereat marvellous glad. He asked Domagaia how he had done to heale himself. He answered that he had taken the juice and sappe of the leaves of a certayne tree and therewith had healed hymselfe. Our Capitayne asked him if any were to be had thereabout, desiring him to show it to him. Domagaia straight sent two women to fetch
some of it whyche brought tenne or twelve branches of it and therewithal showed us the waye how to use it and that is thus: to take the barke and leaves of the said tree and boil it together, then to drink of the saide decoction one daye and the other not, and the dregges of it to be put upon his legges that is sick. The tree is in their language called Ameda. Our Capitayne presently caused some of that drinke to be made, but there was none durst taste of it, except one or two who ventured the drinking of it only to taste and prove it, the others seeing that did the like and presently recovered their health and were delyvered of that sicknesse soever.

"After this medicine was founde and proved to be true there was much strife about it that they were readie to kill one another, that a tree as bigge as any oake in France was spoyled and lapped bare." The tree was identified as a species of spruce.

This account illustrates the efficacy of some of the Red Man's methods. Consider also that 65 per cent of Indian herbs have been proven active and that cinchona, cascarasagra da, copaiba, ipecac, purshiana, sarsaparilla, jalap and guaiacum were given to us by the medicine man. Cascara sagrada is said to be the most widely used drug in the world. The others are also in daily use.

The Indian is by nature very curious. He is also a keen observer. These two characteristics, along with many centuries of trial and error methods explain his very large and useful list of drugs.

While his knowledge of anatomy and physiology were limited, he had a name for the main organs of the body and had a rough idea of their functions. The herbs were usually used for a specific purpose such as purgation, diuresis, emesis, etc. The plants were collected at certain times of the year when they were most potent. Indeed, at certain periods the medicinal properties are lacking and the plant is inert.

The plants were ground and used in the form of powders or as infusions. Usually only a single herb was employed but sometimes as many as twelve different ingredients were present in a mixture. The dose of drugs to be used was known because some herbs were very potent and too large amounts had been found to give a very severe effect.

External conditions were treated with lotions or poultices, while internal ailments were treated with medicinal tea. The herb was steeped in warm water and this taken several times a day for four days. Four is a sacred number and if there was no improvement in this period the treatment was changed. Bitter and nauseating ingredients were disguised by pleasant-tasting herbs.

Another principle still in use today was employed by the medicine
man. To be most effective, he believed the charge for the treatment must be sufficient. Also, if the sick man wished to pay an extra fee he would be shown how to make his own medicine.

Bad medicine was also made. This the Indian used to overcome his enemies. Hunting charms were employed in which an outline of the desired game was drawn on the ground and the proper medicine placed over the animal's heart. A similar procedure was employed against human enemies. Such procedures against human beings were frowned upon and punishment imposed for their performance. All agreed it was a perversion of Grand Medical Society teachings.

Even a superficial discussion of the many drugs used and the purposes for which they were used would take many pages. It is sufficient to say that in the modern Pharmacopeia there are about 60 drugs formerly used by the Indian. There are many others that have not been investigated and which may be active. It was in this branch of medicine that the North American native made his greatest contribution.

Conclusion

The practise of Indian medicine should be evaluated only by considering their stage of development as a race. The vast majority of American Indians were living in a hunting culture of the Stone Age. They were true Stone Age men as late as 1870 for their contact with the whites did not begin a true iron culture. But, as we have seen, they practised a medicine comparable with that of the Chaldeans, Hebrews and early Greeks, and with that of a period in the Middle Ages in Europe. Compared with contemporary whites, they were not to be scorned. Their treatment of empyema, wounds and fractures was equal to that of 18th century white physicians. They did not understand internal medicine and had no knowledge of the handling of the infectious diseases introduced by the white man. Their use of drugs was remarkable and they added many to the modern Pharmacopeia.

The man of mystery, the medicine man, remains obscure. He was a dignitary of the race who, because of his elusiveness, has been misunderstood and maligned. Most people of today regard him as a "witch doctor." It is true that he made use of weird costumes, superstitious rites, incantations, and practised on the basis of a demonological concept of disease. But he practised legitimate therapeutics as well as ceremonial. Consider the therapeutics of the white in the rural Midwest as late as 1890. Babies were weaned at certain times of the Zodiac; children of stunted growth were passed through holes in trees; a pan of water was placed beneath the bed to prevent night sweats; "Nanny tea," made of goat's dung, was given in eruptive fevers, etc.

To those who find pleasure in delving into the past is given the task of revealing his true character. "Four requisites were demanded
of the one who was to deal with the mysteries enshrined in the rites and ceremonies of the tribe:

First, and most important, was the recognition of the sanctity of human life.

Second, he must be a man whose words never deviate from the path of truth.

Third, he must be slow to anger.

Fourth, he must be deliberate and prudent of speech, lest by haste he should profane his trust by thoughtless utterance."

There are instances well known where these men have refused to instruct their own sons in the sacred rites because they lacked the essential requisites of character; the honor and sanctity of office was above paternal feeling. These were the prophets and priests, the Indian's Men of Mystery, termed by the European—the Medicine Men.

The closing of the day of the American Indian has arrived. His tragedy is that he stood in the westward path of Empire. Amalgamation and extinction alone await him, and with his passing go many fine qualities, a noble concept of the gods and man's relation to them, an understanding of nature and a co-operation with natural forces, a frank appreciation of man’s dependence upon something beyond his own power.

"Ho! All ye of the heavens; all ye of the air; all ye of the earth;
I bid ye all to hear me!
Into your midst has come a new life.
Consent ye, consent ye all, I implore!
Make its path smooth, then shall it travel beyond the four hills."
(Used at childbirth.)

BIBLIOGRAPHY
Some Aspects of Wound Healing

By C. Amacher, '42

Tissue repair from the patient's aspect is of great importance, be it that patient a stevedore or a sub-deb. The stevedore is righteously indignant if his viscera refuse to remain in their normal anatomical position within his body during strenuous muscular exercise. The sub-deb is no less incensed if her flawless exterior is marred to any degree.

When one assesses the value of any new technique in wound repair, he must keep in mind certain underlying principles in the healing of wounds.

1. Haemostasis

Haemorrhage must be controlled. Blood clot, sterile or infected, delays the fibrophasia which unites the wound surfaces. It must be remembered, however, that mass ligatures or heavy suture material nullify the good effect of haemostasis because they devitalize tissue.

2. Infection Must Be Eliminated

(a) Aseptic operating room technique is imperative. The patient's skin, because of sweat gland and hair follicle bacteria, cannot be completely sterilized, but preliminary cleansing with hot soap and water, followed by a chemical bactericidal solution, gives a relatively clean operative field. Exclusion of skin edges during the operation and keeping out of the wound contaminated gloves, instruments and salt solution minimize skin contaminants.

(b) Debridement and irrigations with sterile saline is an essential principle.

(c) Foreign bodies must be reduced to a minimum. Heavy ligatures and drains predispose clean tissue to infection.

(d) Bacteriostasis by Chemotherapeutic measures. The principle of oral or parenteral introduction of the salts of an azo dye containing a sulfonamide group has revolutionized the treatment of haemolytic streptococcal infections. Their bacteriostatic action allows the normal body defenses to regain control.

3. Normal Anatomical Apposition of Severed Tissues

This is easy in clean incised wounds, but it is a problem in lacerated inflamed tissues.

To accomplish and maintain apposition, mechanical means of suturing and pressure have been developed.

4. Restoration and Maintenance of Nutrition in the tissues involved in the wound.
Devitalized tissue means necrosis with subsequent infection. Maintenance of nutrition depends upon:

(a) *Preservation of blood supply* by the avoidance of mass ligation of vessels, and surrounding muscle and fascia and by the use of fine haemostats and ligatures.

(b) *Reducing trauma of:*
   1. blunt haemostats,
   2. heavy needles,
   3. heavy suturing materials.

(c) *Avoidance of wound dressings that are too tight* for the impaired circulation.

5. **Patient and wound placed at rest by**

(a) elimination of pain during the operation and post-operatively. Proper anaesthesia must be chosen as well as efficient pre-operative and post-operative sedation.

(b) support and immobilization of the repaired part until fibroplasia and repair are complete.

(c) elimination of tissue tension produced by:
   1. tight sutures,
   2. muscle spasm,
   3. distension.

The cycle is, tissue tension—pain—muscle spasm. In the abdomen, this cycle predisposes to pulmonary complications and wound disruption.

Distension in intestinal anastomosis results in tension on the suture line, often resulting in leakage with peritonitis or fistulae.

The Miller-Abbot tube, now widely used after resections, has reduced the hazard of ileus.

**Some Pathological Findings in Wound Healing**

Two of the most striking features in wound repair are:

1. fibroplasia,
2. the presence of an enormous number of neutrophiles.

Some histologists have believed that the rôle of the polymorph in wound healing is to liquefy the fibrin in the wound and pave the way for fibroblastic proliferation.

The following experiment was performed by Laurence, Pearce and Mider to determine the rôle of the neutrophile in wound healing.

A serum toxic to polymorphonuclears was prepared and injected into guinea pigs, producing experimental neutropenia. These pigs,
together with a great number of untreated controls, had artificial incisions made in their abdominal walls. A number of each group had the incisions contaminated with staphylococcus in order that healing in the presence of infection might be observed.

The gross appearance of the wounds in the treated uninfected animals did not differ from those of the untreated, uninfected guinea pigs. There was very little difference in the tensile strength of the incisions.

In judging repair, the greatest reliance was placed on the histological appearance of the healing process. There was a striking difference microscopically. The treated animals had a reduction or an absence of neutrophiles in their incisions, while the controls had enormous numbers of polymorphs present in the wounds. Fibroblastic proliferation was the same in each and on this basis repair was determined to be unaltered in the treated animals.

The infected neutropenic animals, however, demonstrated little defence against the infection, and showed cellulitis of the abdominal wall, injection of the peritoneum and a haemorrhagic discharge from the wounds. The control animals responded in the usual way with localization of the infection to form an abscess in which was found masses of leukocytes.

The polymorphonuclear leukocytes, therefore, seem to play a part in wound repair by helping to combat the spread of infection. The essential feature in wound repair is fibroplasia which is apparently independent of the neutrophilic leukocyte.

**SERUM PROTEINS AND WOUND HEALING**

Koster and Shapiro made a post-operative study of the concentrations of total protein, albumin and globulin, the albumen globulin ratio and the calculated protein oncotic pressure of the serum of 58 patients whose wounds were carefully observed.

Four groups were studied. One series of 17 cases had hernioplasties with clean wounds. The determinations were done on an average of four days after the operations. A second group of 23 had abdominal operations with clean wounds. The determinations were performed on an average of eight days post-operatively. In the cases of 16 who had abdominal wounds complicated by deep infections extending below the fascia, the determinations were done on an average of 11 days after the operations. The final group of eight had clean wounds which disrupted during convalescence, and the serum proteins were estimated eight days post-operatively. All wounds were sutured with catgut in deeper layers and with black silk in the skin.
The values for the total proteins and protein fractions in the cases of patients with clean abdominal and hernial wounds were similar to the values reported in the literature for normal human beings. On the other hand, the average values for total protein, and the albumin fraction in the cases of patients with deep infection and wound disruption were slightly but definitely lower than normal. The value for globulin remained unchanged. Whatever hypoproteinemia was present was therefore actually hypoalbuminemia. It was shown that 86 per cent of the patients with complicated wounds had serum albumin concentrations below 3.75 gms. per hundred cubic centimeters, whereas only 20 per cent of the patients with clean wounds had such low concentrations.

Since some patients with infected or disrupted wounds show normal concentrations of serum protein and albumin, while others with clean wounds may have relatively low total and albumin protein values, it is apparent that hypoproteinemia by itself is neither a necessary nor a sufficient condition for the development of wound infection or disruption. However, the facts presented by Koster and Shapiro suggest that a poor nutritional state, manifested by hypoproteinemia, may favour the development of deep infection and the disruption of clean wounds.

SUTURE MATERIALS AND SUTURING TECHNIQUE IN WOUND HEALING

Suture materials and suturing technique play a definite part in the satisfactory healing of wounds.

In many localities, the use of absorbable suture material is practiced mainly because of its excellent physical characteristics and ease of handling. The pendulum is still swinging between catgut and silk but there is a definite trend toward the wider use of non-absorbable types of sutures with particular reference to annealed stainless steel wire and a synthetic plastic suture called plastigut.

Preston has performed experiments on rats to determine the effect of sutures on wound integrity as shown by the tensile strength of the healing lesions. The tensile strength was determined mechanically by special apparatus.

This work was prompted by the observation of re-opened abdominal wounds on the operating table, where one could see the gross changes produced in living tissues by suture materials.

It was noted that the tensile strength of the abdominal wounds closed by catgut was much less than that of wounds of the same type closed by serum-proof silk and annealed steel wire. The incisions in which the wire was used were the strongest.

Swelling of the wound and stitch abscesses were common features in the closure with catgut. These complications were singularly lacking when the wire had been used. This naturally inclines one toward the
view that lack of tissue reaction and lack of gross infection about the wire suture were the factors accounting for increased tensile strength.

At the same time, the efficacy of various suturing techniques was investigated. Interrupted tight and loose big bite, interrupted tight and loose small bite, continuous tight and loose big bite, continuous tight and loose small bite types were used. It was determined that the interrupted, loose, small bite stitch produces the strongest wounds and that the continuous, tight, large bite stitch gives the poorest results. Referring back to the earlier statement that good wound-healing depends on maintenance of tissue nutrition, it is obvious that the detrimental effect of the continuous, tight, big bite sutures is the result of reduced blood supply to the wound.

The surgeon using annealed stainless steel wire finds that his speed is cut down at first because of the different handling properties of this suture. He must guard against puncture wounds to his fingers, particularly in an infected field.

A great deal of force must be applied in tying the knots. Also, he must remove all loose pieces of wire from the operating field or he may be confronted by medicolegal complications.

A new plastic suture has been developed by Bellas and his coworkers, who have claimed that it has most of the attributes of an ideal suture. The plastic material is synthetic, in contrast to catgut, which is of animal origin. Silk, in lesser degree, is also animal material and as such is susceptible to enzymatic action in the tissues. This is also the chief objection to catgut because, while the enzymatic reaction is occurring, oedema appears and free fluid collects in the tissues. Repair is hindered, and the strength of the incision is at its weakest in about seven days.

It has been proved that in certain protein-sensitive individuals the products of catgut solution induce allergic reactions. Moreover, they make a splendid culture medium for bacteria.

Linen, because of its capillarity, allows absorption and retention of tissue juices which, by stagnation, become a good medium for the development of microorganisms.

The plastic suture, called “Plastigut” by Bellas and his associates, appears to be truly a non-absorbable and non-capillary substance. These two attributes increase the likelihood of healing by first intention.

The advocates of this suture are impressed by the substantial “feel” of the material, claiming it to be equal to catgut and superior to the limpness of silk. It is prepared in sizes equivalent to the catgut sutures.
CUTANEOUS HEALING IN WOUNDS

The skin has lines of elasticity. These lines of tension were outlined by Langer, but since his observations were based on cadavers, it is possible that the physiological lines of elasticity of the various surface regions may be different in the living subject.

To illustrate the part played by lines of tension in ideal cicatrization, one has only to recall to mind the appearance of a scar in the common lower quadrant abdominal oblique incision. It will be noted that in the majority of these wounds the upper part of the scar usually has finer linear cutaneous markings than the lower part, which is frequently broadened. Observations of this type have led to the belief that the suprapubic area has transverse lines of tension rather than the oblique vertical lines of Langer.

In abdominal operations primary importance is attached to the operative field and attention is rarely paid to the direction of the incision with regard to cutaneous tension.

A further cause for this less than perfect, though perhaps adequate cutaneous healing, may lie in the “bevelled” incision. It is difficult to approximate the edges of such a wound accurately.

In the upper right abdomen, in operations on the biliary tract, vertical incisions commonly show diffuse widening. Here, however, in addition to the factor of lines of tension, we must consider the increased mobility of the upper abdominal area due to respiration. The tendency of many patients to gain weight after an operation must also be kept in mind. An increase of 10 to 30 pounds is considered sufficient to cause an increase in cutaneous tension in the upper abdominal region. Both of these factors exert force on the line of healing at a time when the maximum tensile strength of the wound has not been reached.

The adequate undercutting of cutaneous flaps often gives better healing, due to lessened cutaneous tension. This fact is borne out by observing the results of the “collar” incision of thyroidectomy. In this incision, the platysma muscle is neatly sutured in a separate plane from the line of suture of the skin, and wide undercutting of skin flaps is done to relieve cutaneous tension.

VITAMIN “C” AND WOUND HEALING

Wolffler is convinced that deficiency of vitamin C brings about tissue changes long before there is any clinical evidence of scurvy. He believes that one of the early manifestations is a deficiency of collagenous material incident to wound healing.

Human beings, unlike animals, cannot synthesize vitamin C, nor do they store this factor to any great extent. As a result, there is a constant demand for it.
The normal cevitamic acid level in the blood is placed between 0.6 and 1.5 mgms. per cent. The high level for scurvy is given as 0.35 mgms. per cent. However, this low level may be reached by a normal individual temporarily, on an inadequate vitamin C intake, without any untoward results, providing his regular diet is resumed promptly after the scurvy level is reached.

The patient with some form of chronic illness such as peptic ulcer, gall bladder disease, obstructing gastro-intestinal lesions, etc., frequently confines his diet to soft, well-cooked food almost totally lacking in vitamin C. As a result, a deficiency state develops which, though sub-clinical as far as scurvy is concerned, hampers the healing power of the tissues. These patients, coming to operation, show a very low concentration of cevitamic acid in the blood.

Wolffer believes that the patient deficient in vitamin C should receive 1 gm. of cevitamic acid daily for 10 days before any surgical procedure is attempted, and this should be continued until the wound healing is complete. It is illuminating to compare the results obtained in some operations before and after this form of therapy was used.

Wolffer treated two cases of cancer of the oesophagus, both about the same age, who were admitted in a very weakened condition. The one, prior to the use of the vitamin, underwent a gastrostomy. At this time no one had considered a cevitamic acid deficiency to have any influence upon convalescence. The patient’s wound did not heal properly and evisceration occurred on two occasions. Eventually the gastric suture line disrupted and death occurred from a spreading peritonitis.

The other patient, admitted in a far worse condition, was found to have a very low blood cevitamic acid level. For nine days pre-operatively, he was treated with cevitamic acid, and his blood was brought up to the normal level in this principle. The treatment was continued post-operatively, and the wound healed with remarkable rapidity.

The burden of proof is not thrown on these two cases alone; they are merely representative of a number that have shown good results under this treatment, and they lend considerable weight to the argument in favour of this type of therapy.

Infection, trauma incident to surgical procedure, fever and disturbance of the gastro-intestinal tract seem to be factors concerned with vitamin C metabolism, and an increased demand for the vitamin.

**Wound Healing and the Post-Operative Use of Insulin in the Non-Diabetic**

Before the isolation of insulin, it was known that the diabetic patient was singularly susceptible to the untoward effects of infective
processes and that, frequently, operative wounds in the diabetic did not heal promptly. The use of insulin in these cases now makes surgical procedure relatively safe.

There are a large number of patients who exhibit slight or moderate disturbances of carbohydrate metabolism. Surgery in these cases demonstrates a more satisfactory post-operative course if insulin is administered up to safe limits, after the operation.

Apart from the frank diabetic group, and this latter sub-clinical type, it is the contention of Gurd of Montreal that infection or trauma of any kind is likely to cause a disturbance of carbohydrate metabolism. This is particularly true of persons over the age of 40.

In the patients whose clinical history supported his hypothesis, mild hyperglycaemia was usually found, or if the blood sugar was normal, some disturbance of the sugar tolerance curve existed. Later examinations of these same patients after complete recovery proved their non-diabetic status by demonstrating normal blood sugar levels and time curves.

The use of insulin and glucose in these non-diabetic cases when wound-healing was delayed seemed to speed up the tardy healing.

Although many cases in point might be cited, the one reported by Bazin in 1924 is perhaps the most excellent in support of Gurd's theory.

On October 14, 1924, a woman, age 47, was admitted to the hospital. In August, she had suffered an abrasion on the dorsum of her right foot. This became infected, the skin sloughed off over an area of four to five inches. A Thiersch graft was employed without any result other than that the donor area became ulcerated. All general and special examinations were negative, and at no time was there glycosuria.

Two months after admission, a fasting blood sugar was taken and showed 161 mgms. per cent. Her diet was regulated and her blood sugar fell well into the normal range of 80 to 120 mgms. Her ulcers immediately started to heal, and she was discharged in about 20 days. On a succeeding admission in 1931, she was absolutely proven to be non-diabetic. Both her fasting blood sugar and sugar tolerance curve were normal.

Gurd has presented numerous cases of this type and all have been definitely helped by the use of insulin.

This therapy, however, should be undertaken only in a hospital so that the patient can be carefully observed as to clinical state and blood sugar estimations.

The preferred treatment in these patients is five units of unmodified
insulin every eight hours, with blood sugar studies before, and usually after, the insulin has been administered.

**SUMMARY**

1. The underlying principles of wound healing are: haemostasis, elimination of infection, normal apposition of severed tissues, restoration of tissue nutrition, rest for the patient and the wound.

2. Neutrophilic leukocytes are only important as defenders in suppuration during wound healing. Fibroplasia is the essential feature of healing.

3. Poor nutritional states, of which hypoproteinemia is a manifestation, may favour both the development of deep infection and the disruption of clean wounds.

4. Two types of suture material seem to be especially efficacious in wound healing:
   1. annealed stainless steel wire,
   2. a synthetic plastic suture, "Plastigut."

5. Cutaneous healing is speeded if—
   1. the lines of tension of the skin are followed,
   2. the "beveled" incision is avoided,
   3. the skin is adequately undercut.

6. The administration of cevitamic acid seems to be a great aid in wound healing in patients deficient in vitamin C.

7. Wound healing frequently seems to be speeded up in persons suffering from infected wounds and trauma, particularly in those over 40 years of age, if insulin is administered post-operatively, up to the limits of tolerance.

**BIBLIOGRAPHY**

In the first issue of Volume 11 an appeal was made to the graduates to support THE JOURNAL more faithfully than they had previously. The response has been encouraging but there is considerable room for improvement. This year THE JOURNAL staff have attempted to cut all expenses to the bone and yet tried to turn out a good JOURNAL. Present indications show that the debt is going to be cut almost in half when the books are closed for the year. If the subscribers will only co-operate, we can clean up the debt in one more year.

The Editor wishes to thank all those who co-operated so heartily in producing this volume of THE JOURNAL. If such a spirit continues to prevail, THE JOURNAL will improve continually in the future.
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