NEUROSURGERY AT WAR

The following is the presidential address of John Slater given at the September 2005 annual meeting of the Western Neurosurgical Society.

Two years ago, when I learned that I would be given the responsibility of the presidential address, I began to think of a topic for this meeting. We were at war in Afghanistan and, since then, in Iraq. I had been a U.S. Army reservist neurosurgeon during the Vietnam war. One-third of the neurosurgeons attending this meeting of the Western Neurosurgical Society were neurosurgeons in one or another of our recent wars. The topic of Neurosurgery At War seemed obvious.

James Goodrich, a neurosurgeon in the Bronx wrote, "It has often been said that the two oldest living professions are prostitution and neurosurgery". Quoting from Dr. Goodrich, "I would assume that the ancient warrior realized very early that it was easiest to annihilate or at least slow down his opponent with a blow to the head. Therefore, the concept of head injury remains as ancient as the powers of solicitation by the opposite sex". .

You are all aware of ancient doctors performing trephinations. This slide shows a list of some of the oldest sites where skulls with trephinations have been found. The list is not complete, as archaeologists occasionally find trephined skulls in new, unexpected places. Archaeologists have literally found thousands of skulls with evidence of surgical trephination. More than 1500 of these skulls show evidence of healing, which is certainly an indication that the patient lived. Some of these skulls show multiple trephined openings, again strongly suggesting that the patient lived. The most interesting to me are the ones that show a
skull fracture, a trephined area of the skull and healing of the bone. Therefore we know the diagnosis, the treatment and that the patient lived. Some of the unearthed skulls from Peru have cranioplasties with shells being used as cranioplasty material or sometimes silver or sometimes gold replacing the trephined opening. Some of these show bone healing tightly around the foreign body. The earliest writings about trephinations are found in Egyptian papyri, which were written about 2500 to 3000 B.C. and discovered by Edwin Smith. These case reports were organized by Diagnosis and Treatment and even definition of terms which are included in these Smith translations. For instance, the papyri describe linear fractures, smashes which were comminuted, depressed and compound fractures. The doctor on call, then determined one of three verdicts: Verdict One - an ailment I will treat, Verdict Two - an ailment with which I will contend, and Verdict Three - an ailment not to be treated. You can further translate that as "I wouldn't touch him with a ten foot pole".

These amazing papers describe head posture and skin color. One case describes a gaping head wound with comminuted fracture and rupture of the meningeal membranes to reveal the brain surface, which was compared to the surface of cooling molten copper. This is the first time we know of when words indicating brain, meninges and CSF were used.
In Greco Roman times, Paulus diagnosed a fracture by tapping on the skull with a stick. "When the resulting sound was that of a broken pot", he diagnosed a fracture. His sixth book which deals with surgery, describes his drill for trephination. This was the first drill that had arresting projections to prevent the drill from penetrating the interior of the skull. He used a drill with a flat instrument called a meningophalanx that protected the dura.

Hippocrates, who lived from 460 B.C. to 377 B.C., systematically described head injuries and categorized them as fractures, contusions of bone, compressed fractures, depressions or indentations with or without fractures. The clinical history was emphasized. Specifically, doctors were to inquire if the patient was confused, if he became giddy, if he fell down. If one is in doubt about a fracture, the injured man was asked to chew a piece of wood and to state whether he observes a cracking sound in his bone. Hippocrates then went on to explain that when a concussion is caused by a blow, the victim loses speech and cannot hear. Because of Hippocrates choice of words, concussion was diagnosed if the patient lost speech for many centuries afterwards. You and I can think of other reasons why the patient might lose speech but evidently Hippocrates was so revered that this overly simplistic and inaccurate idea prevailed.

Hippocrates described seizures occurring opposite the side of injury. He advocated cauterization of bone with a red hot iron. He recommended trephination very frequently, except for depressed skull fractures. There was no explanation.

There are two references to brain injuries in the bible. The wife of Joel slew the Canaanite general Sisera "by driving a metal tent stake through his temple" while he slept. Then there was the case of Goliath who was rendered unconscious by a stone which sunk into his forehead. Goliath was wearing a helmet. The helmet did not extend low enough to protect his forehead. Drs. Armanda and Poffenbarger have noted similar problems with current U.S. Army helmets. Abulcasis was born near Cordoba where he lived all his life. He obtained his surgical steel from Toledo.

In the Medieval period, Roger of Salerno recommended finger palpation to detect fractures. "If the wound is small, it should be enlarged unless bleeding or other complications prevent." Again quoting from Roger, "the trephine should be cautiously applied close to the fracture fissure on each side and as many perforations made as necessary. Then, with a chisel, a cut is made from one hole to another so that the opening reaches from end to end of the fissure and exudation can escape. The exudation should be carefully cleaned away. Strips of the finest linen are then inserted by means of a feather between the skull and the brain. After introducing a fold of linen between the bone and the dura, the injured bone should be removed."
Another Medieval surgeon, Theodoric, believed and wrote advocating wound healing by primary intention. His teachings were rejected for about 700 years.
In the 14th century, Guid Sholiac was the first to remove successfully a part of the brain damaged by injury.

Giovanni DeVago, 1460 to 1525, counteracted the poisonous effects of salt peter, which he knew was an ingredient of gun powder, by cleaning the bed of the wound with boiling elder oil. There are other interesting surgeons in the Middle Ages but certainly the most noteworthy in the 1500s was Ambrose Pare'. Pare' had no university education and yet wrote twenty-six books on medicine. He was apprentice to a barber surgeon at age thirteen. He became surgeon to four of France's kings and was admitted to the College of Surgeons as Master Surgeon. Pare' described his own experiences as a "fresh water surgeon" with the French army when it marched into Northern Italy. Following the advice of Giovanni DeVago, he applied, without fail, this boiling oil even though it would cause the wounded man extreme pain. Quoting Pare', "I wished to know first how to apply it, how the other surgeons did their first dressings which was to apply the oil as boiling as possible. So I took heart to do as they did. Finally, my oil was exhausted and I was forced instead to apply a digestive made of egg yolk, rose oil and turpentine. That night I could not sleep easily, thinking that by failure of cauterizing I would find the wounded in whom I had failed to put the oil, dead of poisoning. This made me get up early in

the morning to visit them. There, beyond my hope, I found those on whom I had used the digestive medication feeling little pain in their wounds without inflammation and swelling. They had rested well through the night. The others on whom I had used the oil, I found feverish with great pain, swelling and inflammation around their wounds. Then I resolved never again, to so cruelly burn the poor soldiers wounded by gunshot."

In 1600, Richard Wiseman worked as a military surgeon in the English, Spanish and Dutch armies. He removed epidural hematomas and advised incising the dura to evacuate subdural hematomas. He published a book and several surgical treatises on 600 patients he had personally treated. Many of these patients had head injuries inflicted by halberds, swords and axes, and also gunshot wounds. He described contra coup injuries and he knew that membranes are sensitive, whereas the brain substance is not. He explains that gunshots beat pieces of skull into the brain and, therefore, may be determined mortal. However, if the bullet penetrated no further than the dura mater it is curable.
Because of the many wars during the 17th century, the treatment of head injuries underwent many changes. Informed consent was sometimes necessary. "The learned and well disclosed surgeon should tell the patient and point out the dangers of the operation. The surgeon should immediately make a statement in which he depicts the danger to the patient, to the patient' s life, to avoid stupid gossip by laymen".

There is an oft repeated story of the first successful graft cranioplasty. It is a very interesting story although some details have been questioned. The story was reported in 1668 by Job Janszoon von Neekerem, a surgeon in Amsterdam. The account describes an injury to a nobleman in Moscow who had received a sword wound to the head. The blow not only denuded the scalp but removed a section of the cranium. The repair of the defect was performed using an unusual graft. The surgeon filled the skull opening with the bone from the cranium of a dead dog. The nobleman was restored to complete health. He exalted joyously telling his friends and acquaintances of his miraculous recovery. The nobleman's worries were far from over. Church officials heard of this treatment. The church officials felt that a Christian's head was too pure to be implanted with the bone of a dog. Therefore, the nobleman was denied entry into any Russian church as long as the dog bone remained in the nobleman's head. The nobleman therefore ordered the surgeon to remove the graft. The surgeon, however, was helpless because the K9 bone had firmly united with the human cranium. The nobleman therefore left Russia.

Purcival Pott (1713 to 1788) was one of the first to recognize that it was the neurologic status and not the skull fracture that determined whether the surgical intervention was indicated. "The symptoms that arise from the head injury are not due to the fracture of the skull but due to the injury of the brain".

In the 19th century, two Army surgeons distinguished themselves. Baron Larry was a favorite of Napoleon. Larry advocated trephining the skull in cases of depressed fracture. On the British side, George Guthrie wrote beautifully of his experiences with head injuries. He advocated surgery for extradural hemorrhage and for epidural abscess.

Between the American Revolution and the American Civil War, there were over 100 wars involving gunshot wounds to the head. Although considerable advances had been made, several authors point out that some of these lessons seem to have to be relearned with each successive conflict. That seemed to be the case in World War I and in World War 11. It also seemed to me from that it was my experience -,-Vietnam as well.

Hennen wrote clearly about phantom limb pain. He noted pupillary changes in head injuries. He was writing about the peninsular war, that is the war in Spain and Portugal, occurring from 1809 to 1814. It was noted that head injuries were uncommon in military hospitals because the soldier injured in the head usually died on the battlefield.

In the American Civil War, three million men went to war. Hundreds of thousands of graves resulted. It is estimated that 360,000 Union soldiers and 258,000 Confederate soldiers were killed. Diseases caused roughly twice as many deaths as wounds. Twenty-five percent of the Union deaths from disease, were from typhoid fever. Ether, which was invented in 1846 by Crawford Long, was available. Chloroform, which was invented by Morton in 1848, was also available. Chloroform was preferred because it was rapid and nonflammable.
The Civil War surgeon was advised to care for the closed head injury patient by putting the patient in a supine position with his head lowered to increase blood supply to the brain. The patient was wrapped in blankets and hot water bottles. Local inflammants, i.e., nitrogen mustard, was used on the extremities to stimulate circulation. In addition, some soldiers had treatments with leeches, cupping, enemas and prophylactic bleeding. The mortality rate of penetrating wounds of the head was 82% compared with 100% mortality rate given by one surgeon in the Crimean War.

Surgical care took place in appalling circumstances. Keen gave the following description. "Our hands were, as a rule, as clean as those of a gentleman but were never disinfected. The patient's skin was similarly clean or cleansed but not disinfected. Our instruments, from germ-gathering velvet lined cases, were laid out on a table and not disinfected. If they needed a little sharpening, I have seen them stropped on the boot or even on the sole of the boot. If an instrument fell to the floor, it was swished in a basin of unsterilized water and plunged into the wound without disinfection."

In the period between 1900 and World War 1, Ernest von Bergman was a professor of surgery and a practicing neurosurgeon. He was born in Latvia and raised and trained in Russia. He was a professor of surgery in both Russia and Prussia. He was a military surgeon in the Prussia versus Austria war, also the Franco-Prussian war, also the Russo-Turkish conflict. He was the first to measure cerebrovenous pressure. He advocated Listerian principles of antisepsis. He recommended, in 1880, complete exploration and primary closure of an open head wound to be done at the nearest field hospital. If that is impossible, he recommended debridement and packing of the wound with transfer of the patient to a larger hospital as soon as possible. Those principles were ignored by most surgeons up to and including the first couple of years of World War 1.

Keen, who many of you know from Keen's Point, was born in 1837 in Philadelphia. He graduated valedictorian of his class from Brown University and entered Jefferson University Medical School in Philadelphia. The Civil War began during his first year in medical school and Keen became temporary surgeon to the 5th Massachusetts Regiment. He and his regiment were in the first battle of Bull Run and he was appalled by the ignorance of his fellow surgeons. After his term of enlistment, Keen returned to Jefferson Medical School which he describes as "seven professors, one demonstrator and that is all. No library, no hospital, no patients for a student to examine, no ward classes, no microscopes". After graduation, he was back in the Army where he was recruited by S. Weir Mitchell to participate in the study and treatment of soldiers with disorders of the nervous system. Mitchell had persuaded Surgeon General William A. Hammond to create a hospital for the diagnosis of soldiers with diseases affecting the nervous system. This hospital treated "at one time 80 epileptics, every kind of nerve wound,

palsy's, singular chorea's and stump disorders". I would add to that, the doctors at this hospital also described phantom limb pain and causalgia.

Keen's later accomplishments included: One - operating on the first brain tumor in America. The patient was improved and lived for fifteen years after surgery. Two - the first to perform ventricular taps at Keen's Point. Three - the first surgeon to perform a cholecystectomy. Four - in 1893 Keen operated on a sarcoma of the roof of the mouth of President Grover Cleveland. The surgery was done secretly on the president' s yacht, which was anchored in New York Harbor. Most of the left maxilla was removed, along with portions of the palate. A second operation was performed two weeks later. Two years later a prosthesis was made. The entire matter was kept secret until 1917, years after Cleveland's death. The fifth thing that Keen is noted for is that he consulted in 1921 on Franklin Delano Roosevelt, who, as you may know, developed polio that year.

World War I brought on the advent of Seventy Day Brain Surgeons. Head injuries were more common in World War I than in previous wars. That was because trench warfare exposed the upper part of the body, especially the head. Furthermore, helmets were not used until 1915. In 1917, Army Surgeon General William Gorgess, learned that about 15% of the casualties on the western front sustained intracranial injuries. He therefore established a brain surgery ubsection to the Committee on Ophthalmology. Post cards were sent out to experts around the country asking for the names of individuals who had training or practice in neurosurgery.
It was determined that 300 brain surgeons were needed. The post cards yielded approximately 350 neurosurgical volunteers but many of them had inadequate training. Therefore, several military neurosurgical courses were organized. The courses were taught by Charles Frasier in Philadelphia, Dean Lewis in Chicago, Elsberg in New York and Ernie Saks in St. Louis. These courses were typically seventy days long and, therefore, the term Seventy Day Brain Surgeons became popular. I have heard that some residencies now take longer.
World War I is, of course, noteworthy because of the efforts of Harvey Cushing. Cushing was Professor of Surgery at Harvard Medical School in 1912. Doctors in the French Army had suggested, in December of 1914, that American universities rotate units to France to help care for the great number of injured patients. Cushing and the Peter Bent Brigham Unit sailed for Europe in April of 1915 for a three month rotation. It is of interest to me that this adventure by Cushing and the staff of the Peter Bent Brigham was financed by the trustees of the Peter Bent Brigham Hospital and several wealthy individuals. Cushing was in Europe for approximately five weeks. On the way home, he traveled through the bodies and wreckage of the recently sunken Lusitania. Over the next two years, he tried to prepare himself and this country for our entry into World War I.

The U.S. entered the war in April 1917 and Cushing arrived in Europe in May. Not long after his arrival, he was attached to the British Casualty Station in Provan Belgium approximately nine miles from the battlefield in Upray. That summer, the British line moved forward three miles, at a cost of 90,000 lives. Cushing describes the awful situation of trying to operate on the casualties.

Cushing recommended stereoscopic x-rays as part of the preop evaluation of the patient.
We were certainly using those in the Vietnam era. He preferred local anesthesia to ether. Often the awake patient would be encouraged to cough in order to expel blood clots, foreign bodies, etc. A magnet was helpful in removing bullets and shrapnel. Cushing criticized the Little Jack Homers of the surgical profession. The Little Jack Homers used their fingers for exploration of the wound tract. Instead, he advocated a red rubber catheter and mild suction to extract foreign bodies. Dakins Dichloramine T and eucalyptus oil was used to irrigate the wound tract and the

dural surface. Cushing's original surgical mortality for penetrating wounds of the brain was 54%. Later, it reduced to 40% and finally 28% in his last forty-five cases. On returning to Boston, Cushing wrote extensively of his experience. It is estimated that during his last twelve years in Boston, he committed to paper between 5000 and 10,000 words a day. When I read that, I questioned it but I have studied that point and believe that it is possible, although amazing to me that he could have kept up such an average. Cushing's writings were not always ppreciated. The British tried twice to court martial him for violation of censorship codes.

Thomas Edward Lawrence was known to his family as "Ned" and known to the rest of us as "Lawrence of Arabia". He was born in 1888 and died in 1935. At Jesus College Oxford, he wrote a thesis on crusader Castles. That led to his appointment as archaeologic assistant on the river Euphrates and later was assigned to the military intelligence unit in Cairo during World War 1. In 1917, he directed Arab troops in their capture of Aqaba and the Wadi Item. This culminated in his triumphal entry into Damascus. Nevertheless, Lawrence was unknown in his native land until Lowell Thomas, American journalist, toured Britain with a lavish series of lectures on Lawrence and his exploits.

Lawrence loved fast moving motorcycles. He was driving a Bro Superior motorcycle when he swerved to avoid boys on their bicycles. Lawrence sustained a skull fracture and closed head injury with coma and death in five days.

Hugh Cairns, a Rhodes scholar from Australia, studied under Cushing in Boston in 1926. He returned as Professor of Surgery at Oxford. Cairns, along with other surgeons, was called to help in the care of the famous T.E. Lawrence. There was nothing he could do. Cairns was profoundly moved by this tragedy. Cairns studied motorcycle injuries. He found that 2,279 motorcyclists and passengers had been killed during the first twenty-one months of World War II. Only seven motorcyclists were wearing helmets when injured and none of them had fatal injuries. This led to the British motorcyclists dispatch riders being required to wear helmets. In Britain, the helmets became mandatory for all motorcyclists in 1973. California adopted a helmet law in 1992.

Skipping ahead to World War II, it is all I can do to resist telling stories that Edgar Kahn told me. You see, Kahn and virtually every professor that I had in medical school and in residency, were graduates of World War II. Some of these professors had been in the Korean War also. Time does not permit me to repeat these stories now.

Skipping ,ahead to Vietnam, yours truly was just out of residency and sent to the 106 General Hospital in Yokohama, Japan. This was a 1000 bed acute hospital and I was Chief of Neurosurgery. Okay, I was the only neurosurgeon. Patients were evacuated from RVN to Japan in C 131 transport planes. These huge airplanes had patients on stretchers two or three deep. Nurses would go up and down the aisles walking between the banks of stretchers. After the planes landed at Tachikawa, Japan, patients would be transferred by helicopter to our general hospital or to another general hospital or to Camp Zama, a semi-permanent Army hospital in Japan. All of these patients had been treated in RVN. Bill Hammond, a senior member of this society, saw many of the patients at the 24th Evacuation Hospital in RVN. Our patients included back injuries, everything from sprains to that gaping wounds of the spine. I distinctly remember one patient _ that a hole in his back big enough that I thought I could put my fist into it. Compression fractures came in groups. If they were officers, they were probably in helicopters that were shot down. If they were regular GI's, they were probably in armored personnel carriers that went over a mine. The APC would be blown 20 to 40 feet in the air with almost everyone inside getting a spinal compression fracture.

Neurosurgery took care of peripheral nerve injuries. These injuries were often from Bouncing Betty mines. These mines, when triggered, would jump approximately three feet in the air and then explode. A nearby soldier might receive a dozen shrapnel wounds. Given all those wounds, the soldier might have one or more peripheral nerve injuries. The other major group of patients was head injuries. Most of them had had surgery. Infections were common in head injuries and in other wounds. You recall that rice ' , were plowed by oxen who also fertilized the area. Anyone with an open injury falling in a flooded rice field would have a wound contaminated with gram-negative bacilli. As Chief of Neurosurgery, I was called upon to treat cerebral fungus. That does not mean a fungal infection. Rather, because of increased intracranial pressure and because of an open skull wound, the brain was pushing out of the head. The protruding brain looked to Cushing and others before him like a toad stool, hence the term cerebral fungus. My residency experience in treating cerebral fungus was limited. My textbooks had been sent to the Presidio. One text by Mierowski concerning his experience in the Korean War, was available to me. What I learned from was only a little more valuable than what Pare' had learned about the treatment of head injuries with boiling elder oil. Fortunately, General George Hayes, a neurosurgeon, and Professor Henry Schwartz came through following neurosurgical patients from RVN to the VA Hospitals in the States. The treatment markedly improved after their visit.

IN SUMMARY: Although craniectomies are the oldest known surgical procedures, the specialty of neurosurgery arguably originated with the demands of World War 1. Each war brings great respect and recognition to individual neurosurgeons who have done an exemplary job in impossible situations. Each war involves neurosurgeons who are inexperienced for the tasks at hand. Each war involves relearning principals that were useful in the past but which have been forgotten.

Thank you for listening and thanks to the many authors whose work I have paraphrased and plagiarized.

A bibliography of this talk is available by writing John Slater at fax (559) 459-1368.