

## LEGACIES

## A Man for All Seasons: W.W. Keen

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**WILLIAM WILLIAMS KEEN** was the catalyst for the advent of neurosurgery in the United States. He served in the Civil War and collaborated with Silas Weir Mitchell in studying injuries sustained to the nervous system. These studies culminated in the publication in 1864 of *Gunshot Wounds and Other Injuries of the Nerves and Reflex Paralysis*, which first described causalgia, reflex sympathetic dystrophy, and secondary paralysis. His most monumental accomplishment undoubtedly was being the first surgeon in the United States to successfully remove a primary brain tumor (1887) and have the patient survive for more than 30 years. As the editor of *Surgery, Its Principles and Practice*, Keen invited Harvey Cushing to write the section on surgery of the head, which propelled Cushing to international recognition and provided a foothold for the new specialty of neurosurgery. Multiple sources were reviewed to prepare this comprehensive biographical account of Keen's contributions. Emphasis is placed on those achievements that furthered the discipline of neurosurgery. Although a general surgeon, Keen had a special interest in the nervous system. He treated patients with trigeminal neuralgia, performed cortical excisions for patients with epilepsy, and devised the procedure of posterior upper cervical root sections for spasmodic torticollis. He was the first surgeon to perform and advocate ventricular punctures. He served as a consultant and surgeon to both Grover Cleveland and Franklin Delano Roosevelt. (*Neurosurgery* 50:181–190, 2002)

**Key words:** Brain tumor, Harvey Cushing, History of neurosurgery, Silas Weir Mitchell, William Williams Keen

**W**illiam Williams Keen, M.D., a colossus in the field of surgery and the newly emerging discipline of neurosurgery in the late 19th and early 20th centuries, died in 1932 at age 95. Like most other near-centenarians, he had outlived his contemporaries and most of the succeeding generation of surgeons as well, many of whom had known him and could have written of his accomplishments with a large measure of personal knowledge, affection, and devotion. That Keen in 1887 was the first in the United States to remove a primary brain tumor successfully and have the patient survive for another 30 years would be a singular accomplishment in itself. Cushing recognized the magnitude of that achievement in the introduction to his monograph on *Intracranial Tumors*:

*I would like therefore, to doff my cap to the sole survivor of the pioneers in this work, my fellow countryman, W. W. Keen, who was one of the very first (1887) successfully to localize and remove a large meningeal tumor, yet had neither bone wax, no muscle implant, no hypertonic saline at his command, no knowledge of intrapharyngeal narcosis, far less local anesthesia, no instrument of precision with which to follow the patient's condition from moment to moment, no provision for transfusion in case of need—and who simply made a sufficiently large hole in the skull, removed the exposed tumor with his finger, ligated the bleeding vessels;*

*drained the wound and in spite of a subsequent fungus cerebri, the patient with the same help Pare relied upon ultimately recovered. But both Dr. Keen and their celebrated case, the end result of which he recorded thirty years later are exceptions to all rules; neither is likely to be duplicated. (2)*

There was much more to Keen than that one historic event, however, and his remarkable career can best be epitomized by the title "The Nestor of Surgery," an eponym that was bestowed upon him when he was awarded the first honorary fellowship of the newly formed American College of Surgeons in 1913. (In Greek mythology at the time of the Trojan Wars, Nestor was the eldest warrior and counselor, the wisest of the wise.)

### THE EARLY YEARS

William Williams Keen was born on January 19, 1837, in Philadelphia, PA. Educated at Saunders Academy and Central High School, he entered Brown University and graduated in 1859 at age 22, the valedictorian of his class. He remained at Brown for an additional year to study chemistry and physics and received a master's degree in 1860. He entered Jefferson Medical College in Philadelphia in the fall of 1860. Toward the end of his first year in medical school, the Civil War erupted, and he was recommended for the position of tem-

porary surgeon to the Fifth Massachusetts Regiment. On July 21, 1860, Keen found himself thrust into the first battle of Bull Run (Fig. 1). He was appalled at the chaos of the experience, not having received a single order and discovering the general ignorance of surgeons of that period. After his term of enlistment in the army expired, he reenrolled at Jefferson and graduated in 1862. In a reminiscence, he described his student days thus: "Seven professors, one demonstrator and that is all. No laboratory, no library, no hospital, no specialties. . . no patients for students to examine, no ward classes, no microscopes" (18).

After graduation, Keen was commissioned as an acting assistant surgeon in the U.S. Army until recruited by his friend Silas Weir Mitchell (1829–1914), considered the father of American neurology, to participate in the study and treatment of soldiers with disorders of the nervous system. A man of incredible energy and versatility, Mitchell was a clinician, psychologist, and novelist. Keen had first met S.W. Mitchell in 1860, when he had been a medical student for just 3 days. He recalled someone looking through the venetian blinds of his preceptor's office who then said to him, "Doctor, don't you want to help me in some experiments on snakes?" (22). Mitchell was 8 years older than Keen and a fellow Jefferson graduate (1850), and the two remained friends and colleagues for more than 50 years, until Mitchell's death in 1914.

Mitchell had persuaded his friend Dr. William A. Hammond, then the Surgeon General of the army, to create a hospital for the investigation and diagnosis of soldiers with diseases and wounds affecting the nervous system. The U.S. Army Hospital for Diseases of the Nervous System was initially established on Christian Street in Philadelphia in May 1863; but after the terrible carnage at Gettysburg in 1864, a new facility was required, and a 400-bed institution at Turner's Lane was opened. Keen, a full-time resident surgeon, lived on the grounds of the Turner's Lane facility. Mitchell, Keen, and a third colleague, Dr. George Morehouse, were relieved of administrative responsibilities so that they could



**FIGURE 1.**  
W.W. Keen in the  
Civil War (1861).

engage in research. The workload was enormous, and after each new battle, more cases would flow in. As Mitchell later remarked, "Here at one time there were eighty epileptics, every kind of nerve wound, palsies, singular choreas and stump disorders" (33).

The detailed clinical observations and physiological correlations that were made by this trio of surgeons can be illustrated by the case of Edward Mooney, who sustained a gunshot wound to the superior cervical sympathetic ganglion at Chancellorsville in May 1863 (1). When Keen first saw Mooney, he said to himself, "You are Dalton's cat." Some years later he explained, "Those of you who are familiar with Dalton's good old text book of physiology will remember a picture of a cat whose cervical sympathetic nerve had been severed" (16). Five years later, in 1869, Horner described the familiar syndrome that bears his name (5).

In 1864, the three physicians documented their study of peripheral nerve injuries in a classic monograph, *Gunshot Wounds and Other Injuries of the Nerves* (32). This seminal publication and another entitled *Reflex Paralysis* (26) described causalgia, reflex sympathetic dystrophy, and secondary paralysis, which in World War II would be known as "primary blast injury." (Nearly 80 years after its publication, the Yale University School of Medicine reprinted *Reflex Paralysis*. In an introduction to that edition, John F. Fulton stated, "The book on gunshot wounds. . . stands as one of the great milestones in the history of American neurology and American clinical medicine.")

After the Civil War armistice, Turner's Lane hospital was disbanded, and the three young collaborators turned to other activities. Keen embarked on a grand tour of European medical centers (1864–1866) that included postgraduate study with Duchenne in Paris and with Virchow in Berlin.

## TEACHING AND PRACTICE (1866–1886)

Upon his return from studying abroad, Keen established himself in practice and concurrently began a lecture series in pathological anatomy at his alma mater. In 1866, he acquired ownership of the Philadelphia School of Anatomy, where he lectured on anatomy and operative surgery until its dissolution in 1875. In 1875, he was appointed Professor of Artistic Anatomy at the Pennsylvania Academy of Fine Arts, where occasionally he was assisted by the young Thomas Eakins as a demonstrator (Fig. 2). Eakins (1844–1916), an American painter, was and is considered one of the supreme masters of American art. In 1873, Eakins began to teach at the Philadelphia Academy of Fine Arts, where he eventually succeeded in transforming the entire course of study, particularly emphasizing 1) the scientific study of anatomy and 2) perspective. A large canvas completed in 1875, *The Gross Clinic*, has sometimes been called his masterpiece.

In 1884, Keen was appointed Professor of Surgery in the Woman's Medical College of Philadelphia, a post that he held until 1889, when he succeeded the younger Gross as Professor of Surgery at Jefferson Medical College. As a surgery teacher, Keen was said to be direct, clear, and convincing. As his reputation grew, his clinics were crowded with visiting sur-



**FIGURE 2.** W.W. Keen teaching anatomy at the Pennsylvania Academy of Fine Arts.

geons from the United States and abroad (Figs. 3 and 4). His successor at Jefferson, John Chalmers DaCosta, described him as a master surgeon:

*He always showed best when the situation was worst. Dr. Keen was always calmer, quieter, kinder, pleasanter, the worse the surgical situation was, and I never saw it get the best of him. He had a favorite expression when he would finally get hold of the situation and control the hemorrhage: "Now we have the whip-hand of it." (36)*

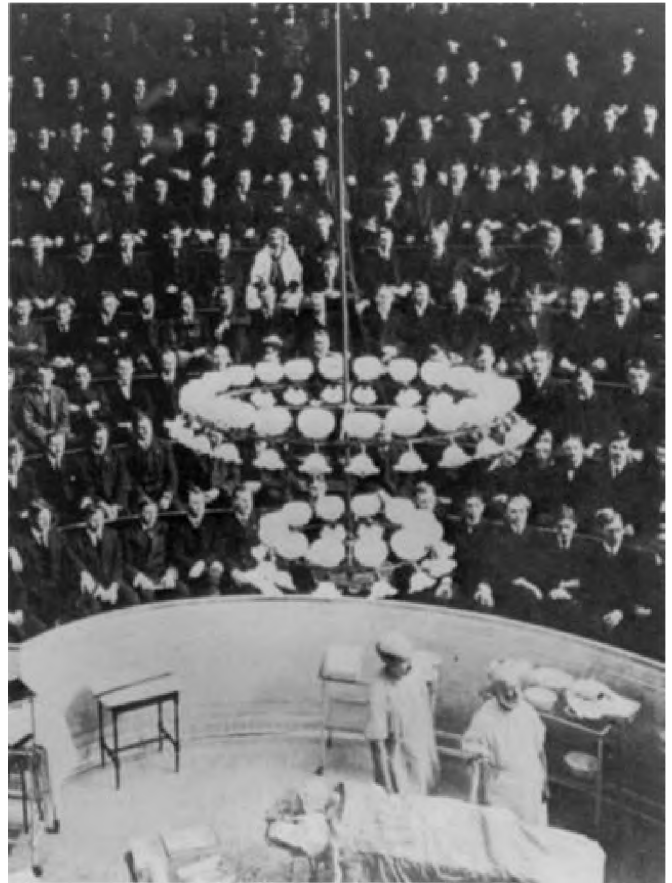
His writing during this period consisted primarily of case reports on a variety of subjects, and in 1886 he published "Stretching of the Facial Nerve" (7), an article in which he described a treatment for hemifacial spasm and a potpourri of other conditions.

#### REMOVAL OF THE FIRST PRIMARY BRAIN TUMOR IN AMERICA: DECEMBER 15, 1887

A 26-year-old carriage maker had fallen and sustained a head injury at age 3 and right-sided otitis media at age 5.



**FIGURE 3.** W.W. Keen (seated left) in the amphitheater of the Jefferson Hospital (1894). Note the ungloved, blood-stained hands.



**FIGURE 4.** W.W. Keen's "Surgical Pit" at Jefferson Medical College, Philadelphia (c. 1900).

Thereafter, his development was relatively normal, although he was described as somewhat dull and complained frequently of headaches, which increased in severity in 1884. In February 1885, he developed major seizures involving the right side, followed by postictal paresis. His seizures and headaches became more intractable and were accompanied by increasing dysphasia. A visual examination performed in June 1887 revealed a right homonymous hemianopsia as well as a large central scotomata. By the fall of 1887, he had written several letters to Keen, asking that an operation be performed.

It is useful to step back and visualize the status of intracranial surgery in the late 1880s. Ether and later chloroform anesthesia had been used for about 30 years. Lister had promulgated the use of carbolic acid spray for antisepsis in 1869, followed by the use of aseptic techniques to minimize bacterial contamination. Clinical evidence of cerebral localization was beginning to accumulate, spurred by the studies of Broca (1861), Jackson (1869), Fritsch and Hitzig (1870), and Ferrier (1873). The first brain tumor operation had been performed by Godlee in London (1884), but the patient died about 1 month later because of infection. Radiographic studies were not even conceived until Roentgen initiated them in 1895. Electrocautery, catgut sutures, and local pressure were used to control brain and scalp bleeding. Bone wax was not introduced until



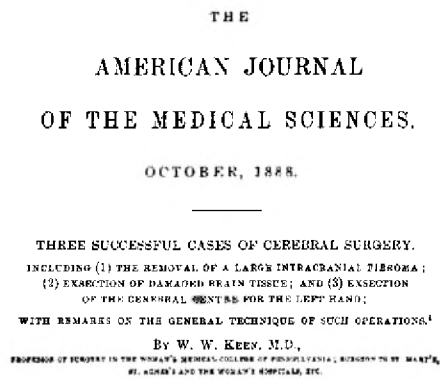
Horsley began using it in 1892, and blood transfusions were not used until the work of Crile. Electric lighting, often supplemented by a skylight in the operating room, was marginal, and no good methods for measuring or reducing increased intracranial pressure had yet been developed.

Keen performed the operative procedure at St. Mary's Hospital in Philadelphia in a room from which the carpeting had been removed and "all the woodwork and furniture as well as the floor were thoroughly scrubbed with carbolic solution" (8) (Fig. 5). Carbolic acid was sprayed throughout the operating room on the morning of surgery but not during the operation. All instruments were boiled for 2 hours. The patient's scalp was shaved, scrubbed, and covered with a wet sublimate dressing until just before surgery, when the ether and sublimate dressings were repeated. The surgeon's and assistants' hands were carefully cleansed and disinfected, but surgical gloves were not used. Open drop ether was administered.

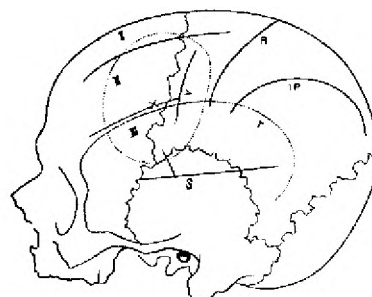
Keen was convinced that the tumor, which turned out to be a large convexity frontal fibrous meningioma (called a *fibroma*), was related to the head injury that this individual had sustained at age 3 and based his incision, a semi-elliptical flap on an old 1/4-in scar just anterior to the coronal suture above the temporal ridge (Fig. 6). With trephines in the posterior frontal region above the temporal ridge, supplemented with rongeur, an osteotomy measuring 2 1/2 x 3 in was made, beneath which the dura presented as a hard mass (Fig. 7).

*On incising the dura one-quarter inch from the edge of the bone it was found to be adherent to the subjacent mass slightly at the margins but increasingly so towards the site of the scar at the center. I therefore severed the connection all round, and was able now to enucleate the growth by the finger with but very little force, and lift it out from the underlying brain tissue and from the fossa behind the squamous portion of the temporal bone.*

Copious bleeding from the denuded white matter was controlled with catgut ligature of several veins, repeated pressure by sponges, and irrigation with hot water (115-120°F). After hemostasis, "The cavity left by the tumor had been filled by nearly one-half by the resilient brain tissue." The cavity was drained with rubber tubing and horsehair. The dura had been excised, and the bone fragments could not be replaced, so the scalp was closed with sponge over it to partially obliterate the cavity. The entire operation lasted nearly 2 hours.

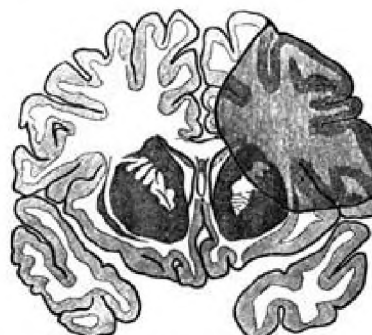


**FIGURE 5.**  
Reproduction of the title page of the article describing the first successful brain tumor removal in the United States (1888).



**FIGURE 6.**  
Diagrammatic sketch showing the location of the tumor.

Diagram of the skull showing the site of the tumor.  
S, Plots of Sphenoid; R, Plots of Radius; IP, Intercranial suture; Y, Accessory parietal suture; T, Temporal ridge; L, H, G, the first, second, and third frontal convolutions. The solid shaded line represents the tumor, the dotted line the site of the scar.



**FIGURE 7.**  
Coronal diagrammatic sketch showing the tumor.

Diagram to show the depth of the tumor in Case I. The shaded part represents the tumor. The section is from "Dalton's Topog. Anat. of the Brain," Series C, Plate VI. (Given by Dr. S. C. Wood.)

On the evening of the operation, the patient was "perfectly conscious; called me by name, aphasia somewhat marked. . . no paralysis. Slight pain." For the first week he did well, was afebrile, and had clear mental function and only intermittent drainage from the wound. Thereafter he became intermittently febrile (104.2°F) with waxing and waning of right-sided paresis and dysphasia accompanied by a watery discharge from the wound. On the eleventh postoperative day, "fearing an accumulation of pus. . . I reopened the wound with my finger to over half its extent. This disclosed a mass of tissue, somewhat discolored, swollen, soft and friable, not very vascular, resembling white brain tissue." Thereafter, the patient's brain began to herniate through the opening and adhere to the flap.

During the next 2 weeks, the brain fungus increased in size with the drainage of "limpid fluid." All drainage cleared on the thirty-seventh day after the operation, and skin grafts were placed over the fungus to complete cicatrization. Thereafter, the fungus enlarged and contracted with position, bulging when the patient lay supine and strained and becoming depressed when the patient sat and stood. The patient was discharged to his home on the eighty-fourth postoperative day, with the hemiparesis much improved.

In reflecting on his management of the case, Keen thought that the genesis of the tumor had been the head injury at age 3 followed by slow, progressive tumor growth with compliance of the surrounding brain. He was surprised that the tumor had extended into the lateral ventricle with little clinical manifestations and regretted having reopened the incision, thereby causing a long delay in healing.

The patient died in 1918, 30 years after the original surgery. In fulfillment of his promise to Keen, a postmortem study was performed (23). There was no recurrent tumor. In what had been the tumor bed, there was a "craterlike cavity" extending into the floor of the left lateral ventricle and covered superficially with a fibrous membrane. Both ventricles were enlarged, and the optic nerves and chiasm were atrophic.

## OTHER AREAS OF NEUROSURGICAL INTEREST

Neurosurgery as we now know it was initiated by Cushing in the United States and by Horsley in the United Kingdom. In the early 1890s, Cushing, then in his 20s, was a house officer at The Johns Hopkins University. Horsley, a decade older, was in London. Keen, however, was already past 50 years old and a busy, well-established general surgeon and professor. Although certain neurological disorders caught his attention, neurosurgery had arrived on the scene somewhat belatedly in his career. One major area of interest to him was the surgical treatment of trigeminal neuralgia.

Keen was an excellent anatomist and had treated several patients with tic douloureux with peripheral neurectomies. Although good initial relief was obtained, the pain recurred. Hartley (4) in 1892 and Feodor Krause (30) in 1893 had independently described an intracranial procedure for removing the Gasserian ganglion and curing the pain. Keen, who was an avid reader of medical literature, attempted the Hartley-Krause procedure in 1894 (25). The patient had undergone multiple previous procedures for control of his trigeminal neuralgia, and when the patient's cranium was opened, Keen encountered severe bleeding, which forced him to pack the wound and back off. In reoperating on the third postoperative day, although the surgery was again complicated by bleeding, successful exposure and destruction of the Gasserian ganglion were achieved with a dissector and a small spoon. During the next several years, Cushing refined the Hartley-Krause procedure, and in April 1900 Keen invited him to Philadelphia to describe his technique and results. An interesting side note is that Spiller, a neurologist who wrote a paper on tic douloureux with Keen in 1898, suggested that partial resection of the sensory trigeminal root might be just as effective as and less traumatic to the patient than total ganglionectomy (27). This prediction was realized when Spiller persuaded C.H. Frazier to perform a sensory root section for trigeminal neuralgia in 1901 (34).

Keen's other contributions to the emerging neurosurgical field include craniectomy for "microcephalus" in 1891 (12). At that time, before the development of cranial radiographs, it was impossible to distinguish microcephaly from craniosynostosis. Because the latter condition was the only one that might potentially benefit from craniectomy, the operative procedure was abandoned until the indications could better be defined. Keen also performed cortical excisions for focal epilepsy with the use of electrical stimulation for localization (10, 24).

Keen was prescient in thinking that ventricular taps might relieve hydrocephalus and increased intracranial pressure, and he was the first to perform a ventricular tap in the

modern era (9). To perform ventricular puncture safely, he proposed creating a burr hole 1¼ in above and 1¼ in behind the external auditory meatus and inserting the trochar and cannula aimed at a point 2½ in above the opposite external acoustic meatus (Keen's Point).

At the urging of his old friend and colleague S.W. Mitchell, Keen devised and performed a procedure for the treatment of spasmodic torticollis in which he essentially divided the posterior divisions of the first three cervical nerves and possibly the spinal accessory nerves. His approach served as the template for surgery for this condition thereafter (11).

Of course, Keen was a general surgeon, and his interests and writings extended beyond the surgery of the central nervous system. He was one of the first surgeons to perform a cholecystotomy (1879). In 1893, reporting on a partial resection of the liver for tumors, he wrote, "Most tumors in large portions of the liver could be removed without undo disturbance of the liver and liver tissue will regenerate and make good the loss." Keen's other areas of interest included posterior resection for cancer of the rectum, aneurysms of the abdominal aorta, laryngectomies, peripheral nerve suturing, amputations, and the diagnosis and treatment of cervical ribs.

## RELATIONSHIP OF KEEN AND CUSHING

In the late 19th century, typhoid fever was still rampant, and death from the disease as a complication of intestinal perforation and peritonitis was common. Keen was especially interested in this subject, and, when he was invited to deliver the Sixth Shattuck Lecture to the Massachusetts Medical Society in 1896, he selected the topic "Gangrene as a complication and sequel of the continued fevers, especially typhoid" (14). Together with Westcott, he wrote a monograph entitled *The Surgical Complications and Sequels of Typhoid Fever*, which was published in 1898 (28). Cushing, a young surgeon attending The Johns Hopkins University, was interested in the same subject, and in 1898 he published a paper on typhoid fever with intestinal perforations, which he sent to Keen. In a rather brisk note (January 26, 1899), Keen responded:

*My dear Dr. Cushing:*

*Thank you so much for sending me your paper on intestinal perforation. On page 25 I notice you dissent from my opinion, but I hardly think that you state it quite exactly. I certainly do advise delay till the immediate symptoms of shock have passed away, but my only statement (on pages 225-26) as to the second twelve hours is that all things considered it has been the most favorable up to this time. (3)*

Despite this slightly contentious introduction, Keen was aware of Cushing's increasing interest in surgery of the nervous system. In December 1901, Cushing, on the strong recommendation of Keen, was asked to deliver the prestigious Mutter Lecture of the College of Physicians in Philadelphia. This was Cushing's first public appearance outside the environs of Johns Hopkins, and he painstakingly rewrote the manuscript, summarizing the experimental work on the relationship between increased intracranial pressure and blood pressure that he had performed in Berne. The lecture was a great success, and a warm personal and professional relation-



ship began between one of the grandees of American surgery, then age 64, and the promising newcomer, then age 32.

Keen was quick to adopt new ideas, techniques, and instruments. He was the first surgeon in Philadelphia to embrace Listerian techniques of antisepsis, and he published an article on the use of the Gigli saw to obtain access to the brain within a year of the device's introduction (1897) (15). After Roentgen reported his discovery of x-rays to the Würzburg Society in December 1895, Keen wrote an article in *McClure's* magazine on the potential applications and possible hazards of this new process (13). This article was quickly followed by several medical publications on radiography.

In 1883, Keen began his association with the editorial board of the famous *Gray's Anatomy: Descriptive and Surgical*, and in 1887, he revised and reedited the American edition of this famous text. In 1892, he initiated *An American Textbook of Surgery for Practitioners and Students* (29), a multiauthored text of which he was the primary editor. This text was reissued in several revised editions, all of which enjoyed great popularity.

In March 1903, Keen wrote to Cushing:

*I have read with the greatest interest your paper ["On routine determination of arterial tension in the operating-room and clinic"]. . . . I should like very much to have, say, 200 to 250 words at the outside as to how to use it, i.e. the Riva-Rocci instrument, and the interpretation of the blood pressure for the new Edition of the American Textbook of Surgery.*

In 1906, Keen became the editor of a multivolume text, *Surgery, Its Principles and Practice* (17). He invited Cushing, who had just begun to devote himself primarily to neurological surgery, to contribute the section on "Surgery of the Head." Because Keen had limited Cushing's section to 80 printed pages, he was amazed to receive 800 typewritten pages with 154 illustrations. This painstaking work eventually was published in 1908 as a monograph of 273 pages. When queried on one occasion by Keen about when the manuscript could be expected, Cushing, who was working very hard, evidently sent back a somewhat tart reply. Keen was prompted to reply, "I shall feel very badly if I have been the cause of your being 'swearing mad.' I am sure when you have written the chapter and see it in print, you will be so proud of your baby that you will be 'swearing glad'" (3). When completed and published in 1908, Cushing's section created a sensation at home and abroad, establishing neurosurgery as a distinct clinical endeavor with Cushing as its clearly defined leader. Keen wrote to Cushing from Rome in November 1907:

*My dear "Cush":*

*Yrs of Nov. 7 has just reached me. No, I didn't say hard things about you if I remember rightly tho I think I expressed serious regret that I had not had the pleasure & the opportunity of reading your chapter in MS. I hope very shortly to see it in print as soon as Vol. III reaches this side. You have no idea of the troubles of an Editor when e.g. a chapter of 20 pp. (assigned) reaches him expanded to 70 & one of 80 pp to 196! . . .*

*But you may sure that any regrets are of the past & that I have no hard feelings for anyone but only delight at the*

*splendid Surgery you & the others have produced. . . . Yours as ever, Bill. (3)*

During this same period, Keen was approaching the statutory age of retirement and was so impressed by Cushing's talents that he urged Cushing to consider replacing him as Professor of Surgery at Jefferson Medical College. Cushing considered the matter for several years but eventually decided to stay at Hopkins (3). Cushing wrote to Keen on March 13, 1906:

*Dear Dr. Keen:*

*I have thought the matter over very seriously and though the offer is a most alluring one, I think it would be unwise for me to accept it. My admiration and fondness for you is such that my decision has been especially hard to make and I know nothing that could have given me greater satisfaction than the feeling that in a measure I was about to succeed one whose record almost more than any other I would like to emulate.*

On the next day, Keen replied:

*I suppose that your letter must be considered as final though I do so with a great deal of reluctance. You know how warmly I feel about you and how earnestly I desired for you to come here—so much so that I offered to resign if you would come and take my place.*

The two continued to be friends and admirers of each other's achievements. In September 1915, at a time when the prospects of the United States entering WWI on the side of the Allies were becoming inevitable, Cushing was asked by Major General W.C. Gorgas, Surgeon General of the U.S. Army, to consider organizing a Harvard surgical group that could be dispatched as a single entity to set up a base hospital in Europe, should the United States enter the war. Cushing was enthusiastic about the concept, but in replying to Gorgas (September 21, 1915) stated:

*There is one thing that I feel like emphasizing and that is the great desirability of having provision made for Base Hospitals devoted to special lines of work, where, for example, the neurological, dental, orthopedic and other special things can be well taken care. . . . All this hails back to the Mitchell, Moorehouse and Keen work in the sixties, which I suppose was one of the first similar base hospitals ever established. (3)*

During this period, Keen, who had reached the age of 80, had been called back to service by the newly formed National Research Council as one of the senior advisors in surgery, with the rank of a Major in the U.S. Army. On October 26, 1916, he called on Cushing for assistance (35) (Fig. 8):

*Dear Dr. Cushing:*

*I have been asked by the National Research Council, of which I am member, to draw up a report on "The new discoveries and their applications in the treatment of wounds in the present war". . . . I shall be very much obliged to you if you will give me from your very wide experience your view on the various matters which will naturally suggest themselves to your mind.*

Cushing answered promptly on October 28, 1916:

*Dear Dr. Keen:*

*. . . My own experience was largely limited to the treatment of cranial injuries, and it was not a particularly large*



**FIGURE 8.**  
W.W. Keen in  
World War I  
(1917).

one. I am sending you a reprint in which I have stated my feelings in the matter. . . .

The admiration, friendship, and respect that Cushing had for Keen were captured in his remarks when he presented Keen with the Bigelow medal of the Boston Surgical Society in 1922. Cushing described his old friend, then age 85, as "an institution":

*The institution to which I refer has been distinguished from the outset for its patriotism; and its first official act as long ago as 1861 was the loan to the Fifth Massachusetts Regiment, and so to the Nation, of an assistant surgeon. Soon after it came into existence, the same institution established an editorial and publishing bureau, and since the first appearance in print in 1864, of a medical classic entitled 'Gun-shot wounds and other injuries of the nerves' there has followed a series of essays, monographs and volumes of no less interest and importance. It has given to the profession a succession of teachers in anatomy and surgery in more than one school of medicine—demonstrators, lecturers, professors, and even a professor emeritus—so that its pupils have been legion.*

*When that most unpromising of all specialties, the surgery of the nervous system, needed an optimistic pioneer, it was called upon to furnish one. . . . Accordingly to you, Sir, . . . I present still another award. . . highly deserved not only for your accomplishment and services to medicine, but for that which means more than these—for that more enduring quality—your professional character. (3)*

## CONSULTANT TO PRESIDENTS

### *President Grover Cleveland (1893)*

In 1893, soon after being reelected to his second term, President Grover Cleveland discovered an ulceration in the roof of his mouth, which was determined to be a sarcoma on

the basis of a biopsy. Because the nation was in a financial crisis, Cleveland wished to keep secret the surgery that would be required. In July 1893, the surgery was performed by Drs. Bryant, Erdmann, and Keen on the presidential yacht, the *Oncida*, which was anchored in waters off New York Harbor. The intraoral procedure was performed with a special cheek retractor that Keen had brought back from Paris in 1866. Most of the left maxilla was removed, with an extension of the lesion into the maxillary sinus being excised together with a portion of the small palate. A second operation was performed approximately 2 weeks later to excise and cauterize all remaining suspicious tissue.

Approximately 2 years later, when the wound was completely healed, a permanent prosthesis was fashioned and inserted. Keen followed the patient thereafter and never found any recurrence. Cleveland died 15 years after the operation, in 1908, without evidence of local recurrence or distant metastases, and the entire matter remained secret until 1917. After a reporter uncovered the story, Keen published the definitive account (19).

### *Franklin Delano Roosevelt (1921)*

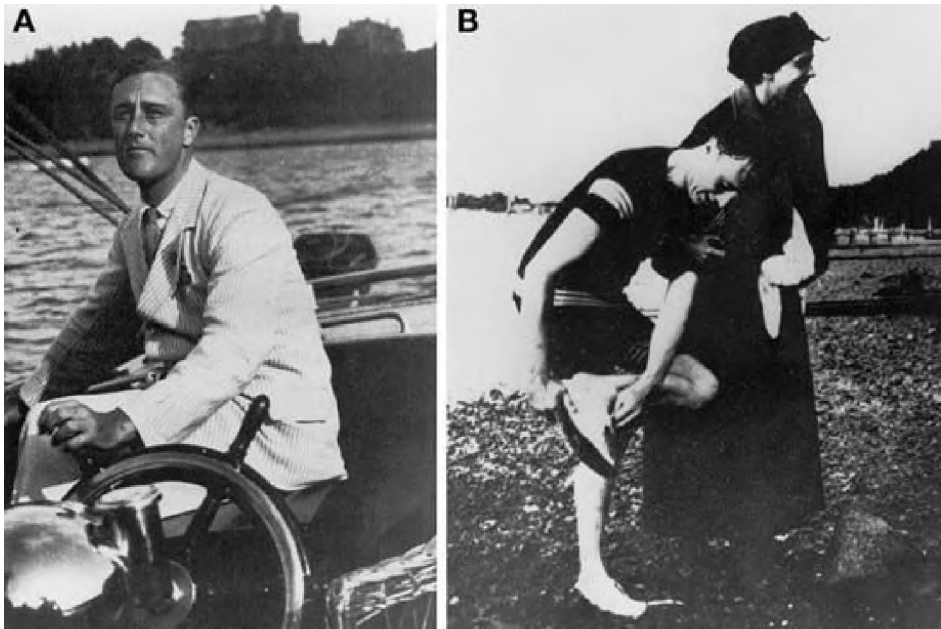
On August 10, 1921, Franklin D. Roosevelt, recently defeated as the Democratic vice-presidential candidate in the U.S. presidential election of 1920 and planning a possible campaign for Governor of New York, was beginning a summer vacation at Campobello Island in the province of New Brunswick, Canada, across the Bay of Fundy from Eastport, ME (Fig. 9). After an exhausting day of sailing, hiking, and swimming in the frigid waters of the bay, he became febrile and developed generalized fatigue accompanied by severe back and leg pain. The next morning Roosevelt could not stand and had difficulty voiding, and soon he could not move either lower extremity. Dr. Bennet, the physician in nearby Lubec, ME, was baffled and advised Roosevelt to get a second opinion. Telephone calls were placed up and down the Maine coast to the summer resorts, and Keen, then 84, was located in Bar Harbor. He agreed both to drive to Campobello Island on August 14 to see the patient and to keep the matter a secret.

Keen arrived at approximately 7:30 that Sunday morning, "a slender white bearded old man in gold spectacles." As Eleanor Roosevelt subsequently wrote, Keen

*made a most careful thorough examination. . . and thinks a clot of blood from a sudden congestion has settled in the lower spinal cord temporarily removing the power to move but not to feel. . . . [T]he doctor thinks absorption of the clot has already begun as he can move his toes on one foot a little more which is very encouraging. (31)*

Keen advised Roosevelt to get bed rest and a vigorous massage. The patient's condition worsened, however, and he developed some weakness in the hands. On August 18, Eleanor Roosevelt received a letter from Keen, who had ruminated about the case since returning to Bar Harbor. He stated that he was "inclined to believe that a blood clot might not be the cause; it was more likely a 'lesion of the spinal cord,' a more serious affliction with a much slower rate of recovery."





**FIGURE 9.** Franklin D. Roosevelt at Campobello Island, province of New Brunswick, Canada (c. 1920), sailing (A) and with Eleanor Roosevelt (B).

On hearing the news, FDR's uncle Fred Delano in New York City informally consulted several physicians, who suspected polio. Delano wrote to Eleanor Roosevelt, "Dr. Keen, all doctors seem to know. . . he is a fine old chap but he is a surgeon and not a connoisseur of this malady. I think it would be very unwise to trust to his diagnosis." Delano suggested that the Roosevelts consult with Dr. Robert Lovett, then Professor of Orthopedic Surgery at Harvard University. Keen tracked down Lovett, who was summering in Newport, RI, and Lovett agreed to go to Campobello.

On August 25, Lovett, Keen, and Bennet reexamined the patient, who now had some questionable facial paralysis, weakness of the left hand, and no movement below the waist. They agreed that the most likely diagnosis was poliomyelitis.

Keen was extremely impressed with both the Roosevelts during this most difficult time. In a letter to Eleanor Roosevelt, who had taken care of her husband day and night until a trained nurse could come from New York City, he wrote, "You have been a rare wife and have borne your heavy burden most bravely. You will surely break down if you do not have immediately relief." In a 1926 letter to FDR, Keen wrote of Eleanor, "She is one of my heroines. . . [D]on't fail to tell her so." In commenting on the couple's courage and attitude, he wrote that he had "rarely met two such brave, cheerful and delightful patients" (37).

### PERSONAL HONORS

Little has been written about the personal life of this remarkable man. His own memoirs were edited by one of his grandchildren, W.W. Keen James, in 1990 (6). Keen had deep religious convictions, remaining active in the First Baptist Church of Philadelphia and publishing dissertations on his faith: *I Believe in God and in Evolution* in 1922 (20) and *Everlasting Life* in 1924 (21). He was an ardent prohibitionist and was very active in the antivivisection movement, although he

personally had never performed any animal research. Yet, he was not a straitlaced puritan, constricted and self-righteous because of his own convictions. That he was most energetic is clear from his far-ranging activities.

Keen was described as having a quiet, unassuming manner and a disarming sense of humor. He was a most curious individual. He was quick to recognize new talent, ideas, and techniques and easily discarded old, more comfortable habits when he became convinced that innovation was required.

The untimely death of his wife in July 1886 left Keen bereft of her companionship when he was only 49 years old, after which he was solely responsible for the upbringing of his four young daughters. Mrs. Keen had been a patient of Sir William Osler, who stayed by her side during her last days, and the Keens and the Oslers were close friends during Osler's years in Philadelphia (1884–1889). Keen was rescued from despair by the one remedy that Osler prescribed under these and similar circumstances—work. And work he did for the next 46 years, until he died in June 1932 at the age of 95.

During his lifetime, Keen received numerous honors and awards. He was President of the American Surgical Association (1899), the American Medical Association (1900), the American Philosophical Society (1907–1917), and the International College of Surgeons (1920). In 1913, he was the first surgeon to receive an honorary fellowship in the newly formed American College of Surgeons. He was elected an honorary fellow of the Royal College of Surgeons of England (1900), Edinburgh, and Ireland, as well as the Legion D'Honneur of France (1923) and the Order of the Crown of Belgium (1920). He received honorary degrees from seven North American universities—Brown (1891), Northwestern (1903), Toronto (1903), Yale (1906), Pennsylvania (1919), Jefferson Medical College (1919), and Harvard (1920)—as well as four foreign institutions—Edinburgh (1905), St. Andrews (1911), Uppsala (Sweden 1907), and Paris (1923).



Keen maintained strong ties with his undergraduate college and medical schools, Brown University and Jefferson Medical College. In addition to bequests for fellowships and special awards, he served as a member of the Corporation of Brown University for 59 years, which is perhaps a record for this type of endeavor.

## CONCLUSIONS

Although Harvey Cushing established neurological surgery, especially surgery of the brain, as a distinct surgical discipline in the early 20th century, the specialty did not burst onto the scene *sui generis*. Its development required a group of disparate advances that would make operative procedures on the central nervous system acceptable in terms of mortality and morbidity. Among the more critical discoveries in the latter half of the 19th century were those of inhalation anesthesia, antisepsis, and asepsis; principles of cerebral localization by physiological and then radiographic techniques; and the abilities to control cerebral bleeding by electrocautery and to compensate for blood loss by transfusion.

Cushing himself, however, required more than these adjuncts. He needed mentors who had ventured into this unpromising territory previously to demonstrate that although the obstacles were formidable, they were not insurmountable. He required counselors to encourage his efforts and assuage his disappointments. Keen fit into this role perfectly. He both stood firmly at the pinnacle of American surgery and had a lifelong special interest in the nervous system. Keen was nearing retirement when Cushing arrived on the scene, but he recognized the potential inherent in the field of surgery of the central nervous system as well as the potential of this promising newcomer, and he was in the position to promote the advancement of both, which he did unstintingly. It is fair to say that the section on surgery of the head written by Cushing at the invitation of Keen for his 1908 textbook was the vehicle that propelled Cushing onto the national and international stage and provided the new specialty of neurosurgery with a foothold for the difficult journey ahead.

Possibly Keen and his lifetime achievements are summarized best by a quotation from Theodore Roosevelt (April 10, 1899):

*Far better it is to dare mighty things, to win glorious triumphs, even though checkered by failure, than to take rank with those poor spirits who neither enjoy much nor suffer much, because they live in the great twilight that knows not victory or defeat.*

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## COMMENTS

The authors provide a wonderful biographical vignette of W.W. Keen that is oriented to a neurosurgical audience. A reprint of this article should be in the collection of any serious student of the history of neurosurgery. Although a number of biographical articles on this pioneering American surgeon were published previously, few have dealt directly with his neurosurgical contributions. Cushing has always stolen the limelight in neurosurgery, but Keen clearly deserves credit for his early and sometimes quite heroic contributions to early neurosurgery. From his training in the Civil War to his rapid adoption of anesthesia antiseptics, and cerebral localization, it is quite clear that he was a man of enormous intellectual capacity and one who was willing to change his thinking quickly when the need arose. In addition, he was a kind and gentle person and surgeon, which is almost an oxymoron in current times. It is inconceivable today to perform brain surgery without at least a computed tomographic scanner, and most neurosurgical residents are trained with the use of image-guided computer devices. Keen took a patient with an old scar on the forehead, sterilized the scar with alcohol and carbolic acid, and put the patient to sleep with ether, then removed the meningioma with the end of his finger through a generous craniectomy. The patient lived another 30-plus years.

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Keen has always been one of my neurosurgical heroes, and this beautifully written and carefully researched article outlines his many important accomplishments and his amazing record of

leadership in American surgery. Like William MacEwen, Keen had a long, productive life, was active in many aspects of surgery, and made important, lasting contributions to the field of neurosurgery. Drs. Keen and MacEwen were among the first to use Listerian principles in surgery, and perhaps this is one of the factors that made them so successful. Keen was a great role model, a consummate surgeon, a true gentleman, a political activist, an excellent humanistic writer, and a superb teacher. It is interesting to note how well he and Dr. Cushing got along, and it is important to note that one of Cushing's first major contributions as a young faculty member was a chapter in Keen's *Surgery, Its Principles and Practice* (1).

**Edward R. Laws, Jr.**  
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1. Keen WW (ed): *Surgery, Its Principles and Practice*. Philadelphia and London, W.B. Saunders, 1906.

Rovit and Couldwell have performed a genuine service to the history of neurosurgery in rekindling interest in one of the field's earliest pioneers. In this well-written article, they identify Keen's early exercises in neurosurgery as a specialty some years before Cushing became interested in the field. Unlike Cushing, Keen did not view neurosurgery as a specialty, even though he continued to report (a total of 50) original contributions on neurosurgical subjects (1). He remained a general surgeon but to his everlasting credit recognized Cushing's pioneering efforts to concentrate on the physiology and surgery of the brain. The relationship of Keen and Cushing is described well. Especially important was Keen's invitation to Cushing to write a chapter on surgery of the head in *Surgery, Its Principles and Practice* (2), of which Keen was the editor. This exposure won Cushing wide recognition in the new field of brain surgery.

In his own right, Keen was an excellent anatomist, and this skill provided him with the practical background for his innovative surgical procedures. Yet, he was more than a practical anatomist; he was truly a scholar in the history of anatomy. His affiliation with the Philadelphia School of Anatomy probably inspired his comprehensive textbook, *The Early History of Practical Anatomy*, which was published by J.B. Lippincott in 1874. Long out of print by the turn of the 20th century, it was republished in 1905 with additional notes in *Addresses and Other Papers* (3).

**Lycurgus M. Davey**  
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