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The life and legacy of William T. Bovie

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Abstract

This Historian's Address, presented at the North Pacific Surgical Association 2012 meeting, held in Spokane, Washington, on November 9, 2012, briefly reviews the life and surgical contributions of the inventor William T. Bovie and his collaboration with Dr Harvey Cushing, which led to the widespread acceptance of surgical electrocautery for dissection and hemostasis.
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Since antiquity, the need to control bleeding has been an obvious priority for physicians. Over millennia, numerous strategies evolved. The Edwin Smith papyrus[1] advised placing fresh meat poultices on open wounds to assist hemostasis. In medieval times, blood loss was stanched by hot cautery. By the time of the American Civil War, speedy amputations and mass ligatures for major vascular pedicles were the order of the day. By the late 19th century, improved anesthesia, better appreciation of antisepsis, and more sophisticated knowledge of anatomy allowed Halsted and others to achieve further progress with precise clamp-and-tie hemostasis. The rise of "Halstedian technique" set the stage for increasingly complex surgical possibilities, although antibiotics, modern surgical lighting, and sophisticated retractor systems all remained decades in the future.

Despite these advances, surgical hemostasis remained problematic. Major procedures entailed clamping and individually tying large numbers of vessels, both tedious and time-consuming. When surgical fields were in deep anatomic recesses, or involved especially fragile vessels, clamp-and-tie methods daunted even the most gifted surgical technicians.

The next major advance was the discovery that high-frequency electric current could heat and desiccate targeted tissues and thereby heat-seal vessels for hemostasis. This concept became known as "electrosurgery." Today, I will briefly profile one of the pioneers in this surgical breakthrough, the biophysicist Dr William T. Bovie. Although Dr Bovie was not a physician, his name endures worldwide in surgery as a generic term for electrocautery devices, nearly a half century after his death. Most published accounts of Bovie's life have not been in mainstream general surgery journals, and most younger surgeons have little or no knowledge of Bovie the man, whose 1931 invention has allowed all of us to practice better surgery in the generations since.

Bovie was born on September 11, 1882, in Augusta, a small town in southwestern Michigan. His father was a successful general practitioner there and also managed a "gentleman's farm" near the village. On the family homestead, Bovie passed an idyllic rural boyhood. Early on, his precocious intelligence and inquisitive curiosity became apparent. Around his home were souvenirs of antique telegraphic apparatus given to Bovie's father by a friend of Samuel Morse. Young William is said to have been fascinated by these devices and their batteries, possibly a factor in his later interest in electricity.[2]

Bovie's father died in 1901, forcing Bovie to pursue his higher education with reduced financial means. He briefly attended a local business school in Kalamazoo, then

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enrolled at Albion College near his hometown, later transferring to the University of Michigan in Ann Arbor, where he received his bachelor's degree in 1905. After working for a time as a college instructor in Ohio to pay off his student debt, he undertook graduate study at the University of Missouri. While there, he met Martha Adams, whom he wed in 1909. After Bovie attained his master's degree in 1910, the couple moved to Boston, where in 1914, Bovie was awarded a Ph.D. in plant physiology from Harvard. He then took a junior faculty position at the Harvard-associated Huntington Hospital for Cancer Research. Early work there involved finding further medical applications for the "hot" new element, radium. Like many who worked with this substance before its collateral risks became fully appreciated, he reportedly sustained chronic radiation damage to his hands.[3]

Both in his school days and in subsequent research years at Harvard, Bovie was recalled as a highly talented but frequently irascible young man. Like many gifted individuals, he sometimes chafed at conventional teaching methods, and he enjoyed challenging the status quo. His fertile mind reportedly led him to often start more projects than he finished.

Basic concepts of using electricity in various ways to heat tissues for surgical applications preceded Bovie.[4] It had been learned that above a certain frequency, electricity could flow through living tissue without creating generalized muscle contractions, but the current would cause local heating of tissues at the electrical point of entry. Indeed, 5 years before Bovie's patent, an earlier patent had been granted in 1926 to William Bierman of New York City for a primitive device to heat and sever tissues, essentially an electrified pincer forceps.[5] Interestingly, although patent citations for current-generation cautery devices are often traced back to this 1926 patent in addition to the one granted to Bovie in 1931, Bierman seems to have been lost to history. In an internet search, the best reference I found was a 1940 New York census roll for one William Bierman, listed as an embalmer and undertaker! It remains uncertain whether this is the same individual as Bierman the inventor.

Despite this challenge to the primacy of his invention and the acknowledged work of several others who preceded him in this field, Bovie clearly improved on existing concepts and helped develop circuitry that would lend itself to more widespread medical applications. Unlike Bierman's earlier device, Bovie's patent grant includes diagrams that remain easily recognizable to modern surgeons as "a Bovie." In my estimation, Bovie earned his eponym!

Despite his innovations, the name of Bovie would likely be little known today if it had not been for the happy coincidence that Huntington Hospital was just down the street from the new Peter Bent Brigham Hospital, where Dr Harvey Cushing had been working for some years as surgeon-in-chief. Cushing, who trained at Johns Hopkins under Halsted, was by then a surgeon of international standing who remains rightfully remembered today as the "father of neurosurgery." (Parenthetically, my aunt Anne was a scrub nurse for Cushing.) Cushing grew up in Cleveland and was, like Bovie, a physician's son. His intriguing life story has been detailed in two excellent biographies.[6,7]

In late 1926, it was the fortuitous confluence of geographical proximity, Cushing's need for a better hemostatic strategy for an especially challenging patient, and his insight for the potential of using Bovie's device for this particular patient that put electrocautery on the road to widespread acceptance.

The idea of using an electrosurgical device as a surgical tool is said to have first come to Cushing when one of his colleagues saw a trade-show demonstration of electrosurgical desiccation of a piece of beef and jokingly asked Cushing how he thought this newfangled gizmo might work on brains! Although unintended, this may have led to a subsequent eureka moment for Cushing. A few months later, he operated on an especially difficult patient with a large parietal tumor, but severe bleeding forced Cushing to abandon his planned resection. Electrocautery must have occurred to him as a possible solution, for shortly after this failed surgery, he contacted Bovie to solicit his help for another attempt. Bovie agreed and reportedly brought his desk-sized device to the Brigham by rolling it down the street from his lab at Huntington on a hand cart. Use of the apparatus required jury-rigged modification of the Brigham's operating room wiring, but there is no historical mention of Cushing having these plans looked over by an investigational review board or ethics committee!

The reoperation, which took place on October 1, 1926, was arguably as significant a surgical event as was Morton's classic demonstration of ether anesthesia some 80 years earlier. As before, there was much local interest in this trial of Bovie's new machine. Cushing himself described a carnival atmosphere, which included the presence of numerous members of the New England Surgical Association, a surgical assistant who had to scrub out (perhaps overcome by unfamiliar "Bovie" fumes), other observers suffering from flu coughing through the procedure, and a medical student, on call as a possible "warm blood donor," who fainted![8] It was no doubt quite a spectacle, with the reserved and precise Cushing hovering over the patient while Bovie, off to the side, fiddled with the controls of his apparatus. In the end, Cushing successfully removed the lemon-sized tumor, with much improved hemostasis. The patient made a full and rapid recovery.

This initial success led to Cushing and Bovie's further collaboration in other difficult cases. Cushing valued Bovie's presence and technical assistance with the machine. Although eager to press on with its use, Cushing was not altogether comfortable with the hazards of the new approach. In a letter to a colleague,[7] Cushing wrote, "I have been having a perfectly amazing time with Bovie, who has an electro-surgical apparatus powerful enough to electrocute a mastodon, and nearly as big.…It is amazing that

either the patient, Bovie, or the operating staff survive. Since this machine that he runs for me might electrocute anybody any minute, I am trying to make hay while the sun shines, viz., while Bovie is around…tackling brain tumors that I never before thought I could possibly attack."

Although Cushing's growing experience with electrosurgery led more to success than failure, there were moments of technical excitement along the way. In one case, the current short-circuited through a metal retractor, traveled up Cushing's arm, and exited via his headlight! In recounting the matter, Cushing dryly noted that it was "unpleasant to say the least." On another memorable occasion, Cushing "Bovied" into the frontal sinus while the patient was under ether anesthetic, igniting the vapor, which "went off in a blue flame," fortunately without injury to the patient. It is written that in some future cases, the team tried to reduce explosive risks by administering the ether per rectum![9]

Cushing's overall favorable impressions of electrosurgery's potential led to his landmark case series publication in December 1928, in *Surgery, Gynecology, and Obstetrics*, the official journal of the American College of Surgeons. In this article, Bovie authored introductory comments on the underlying electrophysical principles.[9] Increasingly thereafter, electrosurgery became part of mainstream surgical practice. The shared favorable experiences of Cushing and others at regional and national meetings further solidified embrace of this new technology. Bovie, who was said to have a talent for public speaking, found himself much in demand around the country as a lecturer on the subject. He was recognized in Philadelphia with the John Scott Medal, a prestigious award for inventions and innovations that further the betterment of mankind. This honor placed Bovie in the company of such distinguished fellow recipients from this era as Marie Curie, Frederick Banting, Thomas Edison, and Guglielmo Marconi.[10]

Ironically, although Bovie was without question a brilliant man, he lacked much instinct for personal financial security. When he patented his apparatus in 1931 (US Patent No 1,813,902, which lists him as the sole inventor[11]), he conveyed his patent rights to the device's manufacturing company for $1! Later in life, he maintained that he had had no interest in reaping personal reward from his invention. In today's medical business world, Bovie would likely have become very wealthy. Sadly for Bovie and his family, things turned out otherwise. The brief professional intersection of his talents and those of Cushing was to be the high point of his career.

Toward the end of his association with Cushing, Bovie failed to gain academic tenure and took a faculty position at Northwestern University in Chicago. After Cushing was unsuccessful in securing him a dedicated research position with General Electric, Bovie moved on to Bar Harbor, Maine, taking a position at the Jackson Laboratory, a newly established cancer research facility on the Maine coast. This opportunity for Bovie came from the lab's founder and a long-time friend, Dr C.C. Little. Unfortunately, many details of Bovie's work at the Jackson facility were lost in the great Bar Harbor fire of 1947 which heavily damaged the lab and its records.

After several years in Bar Harbor, Bovie moved to Waterville, Maine, where he signed on at Colby College, a small liberal arts school, as a lecturer in social technology, the study of ways to use technology to improve society at large. This was likely a good fit for Bovie's fertile mind. In his 10 years at Colby, he was a popular campus figure, often inviting students to his expansive but cluttered Civil War–era home in a nearby town for informal discussions and dinner with the family. This 160-year-old house still stands. At his home, Bovie also indulged many other interests and hobbies, ranging from blacksmithing to plant photosynthesis to the development of microfilm and even to earthworm culture! His was truly a peripatetic mind. As might be expected from an inventor and innovator, Bovie made it a top priority to encourage his Colby students to develop the capacity to think outside the box and not to let their minds become merely "mental encyclopedias" of conventional wisdom. Not bad advice.

Unfortunately, Bovie's last years were marked by ever worsening poverty and health issues. His modest pension, combined with expenses of supporting his many interests, proved grossly insufficient for his family's overall needs. Long portly, his struggle with obesity and its effects grew steadily worse. He became a shut-in, diabetic and arthritic, his life confined to a few downstairs rooms. Neighbors helped with day-to-day needs, and local physicians are reported to have sometimes chipped in to help him make ends meet. He died on New Year's Day in 1958. Funeral expenses were reportedly borne in part by friends and neighbors. His wife outlived him by 16 years. They are buried in Maplewood Cemetery in Fairfield, Maine.[2]

A fine epitaph to the importance of Bovie's work comes at the end of the landmark 1928 Cushing and Bovie article, referenced earlier. In the final paragraph, which I paraphrase slightly, Cushing wrote, "Surgery is a conservative art. It takes to new methods reluctantly, as an old dog to new tricks. It was slow to adopt the ligature; slow to adopt the principles of antisepsis; slow to adopt the fastidious technique and painstaking haemostasis that have largely put a stop to operating by the clock. From a technical standpoint, the principles of electrosurgery are likely to be no less revolutionary."

Over the years, the primitive electrosurgery device patented by Bovie has been supplanted by far more sophisticated machines and newer technologies that rely on related principles, such as ultrasound and mechanical interactions, to achieve the focused and controlled heating of grasped tissue, which remains the essence of surgical cautery. Despite this quantum technical progress, which surgeons now take for granted, it is worth appreciating the lasting significance of Bovie's invention, as well as his idealism that a medical inventor's focus should not primarily be directed toward personal financial gain but to see the

new innovation used for the general betterment of mankind. In that regard, Bovie succeeded well. Nearly a century on from his time in the sun, today's surgeons should continue to be grateful for his life.

References

1. Zimmerman L, Veith I. Great Ideas in the History of Surgery. New York: Dover Publications; 1967.
2. Goldwyn R. Bovie: the man and the machine. Ann Plastic Surg 1979; 2:135–53.
3. Dr. William T. Bovie. In: Eminent Albionians. Albion, MI: Albion College Alumni Association; 1948.
4. O'Connor J, Bloom D. William T. Bovie and electrosurgery. Surgery 1996;119:390–6.
5. Bierman W. Method of and Means for Treating Animal Tissue to Coagulate the Same (1,586,645, July 1, 1926). Alexandria, VA: United States Patent Office; 1926.
6. Fulton JF. Harvey Cushing: A Biography. Springfield, IL: Thomas Publishing; 1946.
7. Bliss M. Harvey Cushing: A Life in Surgery. Toronto, Canada: University of Toronto Press; 2005.
8. Voorhees J, Cohen-Gadol A, Laws E, et al. Battling blood loss in neurosurgery: Harvey Cushing's embrace of electrosurgery. J. Neurosurg 2005;102:745–52.
9. Cushing H, Bovie W. Electrosurgery as an aid to the removal of intracranial tumors. Surg Gynecol Obstet 1928;47:751–84.
10. Garfield E. The John Scott Award: Philadelphia, PA. Available at: http://www.garfield.library.upenn.edu/johnscottaward.html. Accessed November 6, 2012.
11. Bovie W. Electrosurgical Apparatus (1,813,902, July 14, 1931). Alexandria, VA: United States Patent Office; 1931.