ORIGINAL CONTRIBUTION

Welch, Sedgwick, and the Hopkins Model of Hygiene

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William H. Welch and William T. Sedgwick, two of the founding fathers of American public health, were both early generation “Hopkins Men.” Sedgwick was part of the first group of graduate students to attend Johns Hopkins University, and Welch was part of the initial faculty at the University’s medical school. While they never worked together as colleagues at Hopkins, both became interested in the exciting new discoveries of the microbial nature of human disease and developed similar public health programs based on this information. Sedgwick expanded upon these investigations in the new sanitary science program at MIT, where academic public health first emerged in the United States following Sedgwick’s appointment in 1883. Welch, who had been exposed to European research in microbiology, promoted microbial research in pathology in Baltimore in 1884. His laboratory-based investigations expanded until they led to the formation of the country’s first school of public health in 1916. Thus, a “Hopkins Model” for hygiene and public health emerged from the efforts of both Welch and Sedgwick.

The title of this paper makes reference to one specific site in which hygiene and public health figured prominently at the turn-of-the-century. Admittedly, it is a reference that may be difficult to find in the historical literature [1]. Nevertheless, as I will argue, a “Hopkins Model” for both conducting research in public health, hygiene, and sanitary science (all of which were synonymous terms during this time) and for the institution-building in this important arena of health care did exist and was a critical factor in elevating the American medical establishment in the understanding of the bacteriological nature of human infectious disease.

Of course, William H. Welch and William T. Sedgwick had different roles in the development of the “Hopkins Model of Hygiene,” since Welch became a faculty member in 1884 at Johns Hopkins University to found a department of pathology for the planned medical school and hospital in Baltimore. By the time he had arrived alongside the Chesapeake’s shoreline, Sedgwick had already completed his doctoral degree in physiology at Hopkins (1881), working under H. Newell Martin, and he also completed a two-year stint as an “associate in the Biological Laboratory” in 1883, before relocating in Boston at the Massachusetts Institute of Technology.

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Thus, the two were not direct colleagues or collaborators at Johns Hopkins. What they did share was the important experience of being at Johns Hopkins during its formative years as the great "experiment" in the development of a new and modern university [2]. Although it was ostensibly patterned after universities and scientific institutes in Germany and England, in practice Johns Hopkins emerged as a unique university in the United States, one that soon served as the model for other American colleges and universities interested in adding science to their curricula (Harvard, Princeton, Pennsylvania) and for many new colleges and universities that emerged at the turn-of-the-century (Clark University, University of Chicago, Stanford University). Beginning in 1876, Johns Hopkins offered this country's first actual graduate training in the humanities and the sciences, based now on training students how to conduct original research projects and to write original research publications. The impact of this new model was particularly striking in the sciences where American scholars were enabled, for the first time, to pursue advanced degrees on this side of the Atlantic. In addition, and according to the will establishing the new university, the school set its sights toward the foundation of a hospital (1889) and a medical school, finally opened in 1893, a school that became this country's first modern medical school, requiring pre-medical training for its applicants and science training for its matriculates. The new academic agenda meant that the university would struggle in the early years to attract enough students to remain viable, since physicians could train more quickly and cheaply elsewhere. However, Johns Hopkins eventually served as the model for the reforms recommended in the Flexner Report of 1910, the critical document that served as the catalyst to place medical training for physicians on a new footing in the United States.

Such was the exciting setting in which Welch and Sedgwick found themselves when they arrived in Baltimore. The university opened its doors with an internationally trained and recognized faculty. It soon attracted America's best and brightest, and scholars from throughout the world traveled through Baltimore to observe the new institution and to spend time within its new seminars and laboratories.

WILLIAM HENRY WELCH

William Henry Welch (1850-1934) was born into a prominent and privileged New England family, rich with a medical heritage and with an orientation toward the learned life [3]. Maybe because so many of his family members were involved in the practice of medicine, the young Welch may have decided to rebel by pursuing classics as an alternative. However, after graduating in that subject from Yale in 1870, he could not find employment in the field. In actual fact, he was not a stellar classicist, which may explain his dismal career prospects. Instead of his chosen field, he opted to pursue the family vocation, medicine, first studying chemistry at Yale's Sheffield School in 1871 and then entering the College of Physicians and Surgeons in New York City, where he completed his medical degree in 1875. Soon realizing the deficiencies of his American medical education, Welch traveled to Europe where he remained for almost two years, wandering from physiological laboratory to pathological institute and working with such impressive scientists as Friedrich Daniel von Recklinghausen, Wilhelm Waldeyer, Moritz Wagner, Karl Ludwig, Karl Leuckart, and Julius Cohnheim. When he arrived back in New York, he immediately
applied his European experiences, establishing the first pathology laboratory in the United States at Bellevue Hospital in 1878. He remained in New York until 1884, when the job he had hoped for at the new university and medical school in Baltimore called him. But before taking up permanent residency at Johns Hopkins, Welch again crossed the Atlantic, this time spending all of his time studying the new science of bacteriology [4]. Looking back on that year, Welch later remarked:

I returned from Germany, thrilled with enthusiasm, at the dawn of the new era, and with some training and capacity to use that master key forged by pathology and bacteriology, which was to unlock secrets of nature destined to transform the face of modern medicine [5].

Of course, Welch eventually was to play a critical role in the transformation of the “face of modern medicine,” but first he was set to the task of transforming American medical education. When he returned from Europe, he began laboratory work, first in Martin’s Biological Laboratory, a new building erected in 1883, but by 1886 Welch had built his own laboratory, “The Pathological,” a research institution immediately adjacent to the emerging hospital in Baltimore. Welch combined the pathological anatomy of Rudolph Virchow, the experimental pathology of Cohnheim, and the bacteriology of Robert Koch to create a new American laboratory setting for the study of infectious disease [6]. Here he investigated not only pathological cases, but he was soon examining hog cholera, the pneumococcus of lobar pneumonia, diphtheria, and a new bacillus, *Bacillus welchii*, the infamous “gas bacilli.” When the hospital opened in 1889 and then the medical school finally greeted its first class of students in 1893, Welch was drawn away from laboratory science and toward administration, agreeing to serve as the medical school’s initial dean (1893). His administrative career at Johns Hopkins was to continue, as he was also the first dean of the new School of Hygiene and Public Health (1916) and inaugural chair of the new Institute for the History of Medicine (1925). Reflecting back on this career, he inadvertently provided a parallel between his own contributions to medicine and the development of medicine within the United States.

[The] development of scientific medicine in this country during the last four decades has been the great improvement in medical education, with the accompanying creation of laboratories for instruction and research [7].

His comments, made on the occasion of his eightieth birthday in 1930, were characteristically modest. Thus he did not underscore his own individual contributions to providing the new model of medical education for physicians in the United States, although these developments were largely due to Welch’s influence.

**WILLIAM T. SEDGWICK**

William Sedgwick’s family background was opposite to that of Welch [8]. Born into extremely modest means in New England, Sedgwick lacked a strong familial influence on his career. But he was a good student and, from the beginning of his academic career, he sought a medical path. He graduated from Yale’s Sheffield School in 1877, with an area of specialty in chemistry, a common specialty for those interested to pursue a medical career. When he entered medical school, however, he was sorely disappointed with the type of education that was then available, particularly noting the lack of any exposure to the innovative European work in surgery. When a graduate fellowship to the new Johns Hopkins University was available, he decided to pursue academic science one more year. With his close friend, E.B. Wil-
son, who was to achieve fame later as America’s leading cytologist, Sedgwick moved to Baltimore in 1879, where he was soon bitten by the laboratory bug he discovered there. Working closely with the physiologist Martin, he completed his doctoral degree in 1881, stayed on two more years as an associate in biology, and accepted a position in biology at MIT in 1883, the first biology position offered at the heretofore exclusively technical school. Beginning in the new Department of Biology, which he soon renamed the Department of Biology and Public Health, Sedgwick discovered the new excitement and the joys of bacteriology and sanitary engineering, passions that consumed the remainder of his professional career. Consequently, his one-time goal of a medical degree had been replaced by the allure of investigating microbial disease agents.

Known affectionately by his students as “The Chief,” Sedgwick soon helped to establish the Lawrence Experimental Station in 1886, where he successfully studied and remedied an outbreak of typhoid fever in the Merrimack River valley. His work near the cities of Lowell and Lawrence was one of the first and most complete demonstrations in the United States of the importance of separating domestic water sources from water used for waste purposes, leading to a national water purification movement. The importance of this work led MIT to build a new laboratory for him in 1899 in Boston. He then was equipped with the best sanitary laboratory facilities in the country, now named the Sanitary Research Laboratory and Sewage Experiment Station which he directed beginning in 1902. From this date until his untimely death in 1921, Sedgwick set himself to the task of developing the institutional framework for sanitary science, culminating in the country’s first school of public health, the combined MIT-Harvard School of Public Health in 1913. In all, he trained almost 400 engineers, graduates students, and physicians in bacteriology and its application to publish health issues [9]. It is also important to stress that Sedgwick and his wife had a modest vacation home in Maine, immediately adjacent to John D. Rockefeller’s estate. Rockefeller was later to provide critical funds after the First World War for the schools of public health at both Harvard (where the joint program with MIT eventually settled) and Johns Hopkins, most probably due to Sedgwick’s encouragement [10].

When both Welch and Sedgwick began their schooling, scientific education in the United States was in exceedingly poor condition [11]. Only at Yale’s Sheffield School or Harvard’s Lawrence Scientific School was any advanced science education offered. In addition, following the disastrous Civil War, many American political and educational leaders clearly understood the critical need of the country to develop a scientific tradition. Rapid industrialization and this country’s first real industrial revolution in the 1870s and 1880s created new-found wealth for many, but they also spawned pressing social and environmental problems that demanded new methods of thinking and new creative solutions to solve. It was into this arena that the experiment with science at Johns Hopkins began.

Despite these problems and the well-known deficiencies of American science, the end of the nineteenth century was not a depressing time, especially for those working within the scientific and medical communities. In many ways, there was an exciting vitality in the United States, with almost unparalleled opportunities for those who were poised to take advantage of them. In addition, the materialistic improvements of the Victorian era and the scientific advancements of the nineteenth century, led to the conviction of many Americans that they were living in a privileged era. Sedgwick clearly illustrated this attitude in
Benson: Welch, Sedgwick, and the Hopkins model of hygiene

a lecture he presented early in the twentieth century.

Those of us who were born in the middle of the last century have been sufficiently fortunate for we have witnessed the conquest of Darwinism, and the theory of evolution, the rise of anthropology, and the rise and victories of the germ theory of disease. Think of it for a moment! The theory of gravitation, the theory of evolution, and the theory of infection! What a privilege to have lived while these were debated and finally accepted as the basal theories of science. [12]

But the new theories were not the only aspects of science that offered exciting changes for its practitioners. The late nineteenth century marked the initial emergence and complete development of laboratory science in the United States. Thus, Welch and Sedgwick were among the first Americans to be exposed to the new laboratory methods of science, pioneered in Europe, and to the enormously successful laboratory approaches as they were applied to the pressing problems of science. Quickly, both applied these methods to research into the nature of infectious disease and to teaching within the new and exciting field of bacteriology. Furthermore, it is not too difficult to appreciate Sedgwick's enthusiasm about the advancements in understanding about infectious disease, an enthusiasm shared by the more phlegmatic Welch, given the rapid advancements in understanding the role microorganisms played in disease. Pasteur's microbial work was done in the 1870s; Koch identified the bacillus for anthrax in 1876, tuberculosis in 1882 and cholera in 1883; typhoid was isolated in 1880; and Klebs and Loefler identified the germ-agent for diphtheria in 1884. Almost matching the speed of these developments, public health measures were enacted for water purification and sewage treatment; soon antitoxin appeared for diphtheria. And the impact of these measures was remarkable. Between 1880 and 1925, life expectancy in the United States increased by 17 years, an astounding increase of 40 percent [13]! Even more impressively, many of the most virulent diseases of the nineteenth century, including typhoid, cholera, and diphtheria, all but disappeared by the third decade of the twentieth century.

Credit for these vast improvements in public health can be easily and accurately attributed to the “Hopkins Model of Hygiene” and to Sedgwick and Welch. Through “The Pathological” at Johns Hopkins, the graduate programs of both schools (MIT's program was transferred to Harvard in 1922), much of what Americans knew about bacteriology and public health was gathered. Welch's most active personal participation as a laboratory scientist was between the years 1889 and 1892, when he directed his attention to cholera, diphtheria, and pneumonia. But the research tradition at “The Pathological” continued long after Welch moved into administration, leading ultimately to the formation of the School of Hygiene and Public Health in 1916, a school for which he provided direction. On the other hand, Sedgwick continued his scientific work throughout his long and distinguished career, investigating mainly water-borne disease, especially typhoid, and developing an acute understanding of the biology of microbes. His work was not narrowly medical in the sense that Welch’s was; instead, he sought to develop methods to treat water sources to eliminate the microbes for disease, and he attempted to uncover methods to manage waste materials to eliminate the microbes for disease, and he attempted to uncover methods to manage waste materials to eliminate their deleterious effects on urban environments. Thus, Sedgwick helped to define public health approaches to the treatment and eradication of disease.
But the “Hopkins Model” of Welch and Sedgwick was not restricted to their careful laboratory investigations of microbes. In fact, “Hopkins” may be used as an epithet to describe a unique style of those who attended and worked at Johns Hopkins, thereby becoming infected with the “Hopkins” approach [14]. For example, there has always been a deep appreciation for the history of science among those who attended Johns Hopkins. Not surprisingly, Sedgwick taught the first course in the history of science at MIT and he co-authored the earliest American work in the history of science in 1917 [15]. Similarly, Welch’s lectures and public lectures were inoculated with historical remarks about science and medicine, a characteristic that was formally recognized when he was asked to serve as the first chair of the Institute of the History of Medicine in 1925, the nation’s first such academic setting for the history of science.

Second, both men were also deeply committed to women’s education, a concern that was vociferously debated at the turn-of-the-century, but adopted, albeit on a limited scale, at both Hopkins and MIT. Sedgwick’s position on women’s education may have been influenced by his lifelong relationship with Ellen Swallow, MIT’s first professor of home economics and one of Sedgwick’s colleagues at the Lawrence Experimental Station and one who shared his interest in sanitary engineering. The source of Welch’s open-minded attitude toward women is much more difficult to understand, since he was a life-long bachelor and did not keep the company of women on a regular basis. But he may have become influenced by the wealthy Hopkins benefactor Mary Garrett, a philanthropist who almost single-handedly funded the new medical school in Baltimore on the condition that it admit women. Welch was the dean.

Third, both men also had similar teaching styles, again a style associated with Hopkins. Neither gave too direct instruction to students and neither supervised student work in the laboratory too intrusively, but both worked alongside their students in a “if they watch they will learn” manner. And this was highly effective, not just to inculcate proper scientific practice, but in fomenting the idea of egalitarianism within the laboratory. As a result, both Welch and Sedgwick were revered as teachers, colleagues, and lifelong compatriots. Fourth, both Welch and Sedgwick were engaging speakers, erudite conversationalists, and well-read scholars, again characteristics of the turn-of-the-century “Hopkins Man.” Finally both believed in the value of learning for its own sake while, at the same time, arguing for the application of science to practical problems. Hence, much of the work done in both laboratories was in basic science; at the same time, the titles “public health,” “hygiene,” and “sanitary science” spoke to the practical orientation of both men.

In summary, it is difficult to underestimate the impact that William Welch and William Sedgwick had on the development of bacteriology in the United States and on the formation of public health in this country. Both were charter members of the Society of American Bacteriology (the parent organization of the American Society for Microbiology), both served as president of the organization (actually, they served as president, appropriately enough, sequentially), and both were initial directors or deans of the first schools of public health in the United States. Moreover, it is a truism to state that of those trained in the United States in bacteriology, sanitary science, and public health between 1890 and 1930, essentially all were directly or indirectly taught by either Welch or Sedgwick. Thus, in a meaningful sense, the two quintessential “Hopkins Men” provided the actual mold from which the “Hopkins Model of Hygiene” was cast [16].
NOTES

1. While I would certainly like to take credit for the title of the paper, it rightly belongs to the organizers of the symposium of the American Society of Microbiology, Rivers Singleton and William Summers, who invited me to participate by requesting a paper on this precise topic.

2. **Hugh Hawkins, Pioneer: A History of the Johns Hopkins University, 1874-1889. Ithaca: Cornell University Press; 1960.** For more information concerning the biology department, see the articles in the special section of the American Zoologist dedicated to the history of the department in Baltimore, Volume 27, 1987.

3. There are numerous biographical sources on Welch but, remarkably, few detail his considerable contributions in public health and bacteriology. Nevertheless, the wide scope of his erudition is clear from the many treatments of his life. See Brieger, G.H. Welch, William Henry. In: Gillispie, C.C., ed. *Dictionary of Scientific Biography.* New York: Charles Scribners’ Sons; 1971, Volume 16, pp. 248-250; Cohen, B. Comments on the relation of Dr. Welch to the rise of microbiology in America. Bull. Hist. Med. 24:319-324, 1950; Flexner, S. William Henry Welch (1850-1934). Nat. Acad. Sci. Biogr. Mem. 22:215-222, 1943; Flexner, S. and Flexner, J.T. *William Henry Welch and the Heroic Age of American Medicine.* New York: Viking Press; 1941; Freeburg, V.O. ed. *William Henry Welch at Eighty.* New York: Milbank Memorial Fund; 1930. Garrison, F.H. In Memoriam: William Henry Welch (1850-1934). Sci. Month. 38:579-582, 1934; Shyrock, R.H. Dr. Welch and medical history. Bull. Hist. Med. 24:325-332, 1950 (the entire volume of this Bulletin is dedicated to Welch); Temkin, O. The European background of young Dr. Welch. Bull. Hist. Med. 24:308-318, 1950.

4. Owsei Temkin details Welch’s experiences in Europe in his article, “The European Background...”

5. Freeburg, V.O. *William Henry Welch,* p. 39.

6. Flexner, S. *William Henry Welch,* p. 218.

7. Freeburg, V.O. *William Henry Welch,* p. 39.

8. Given his critical position in the American sanitation movement, it is surprising that there is little contemporary biographical information about Sedgwick. Among the historical documents, see Anon., “Sedgwick, William Thompson,” *The National Cyclopedia of American Biography.* New York: James T. White, Co. 13:290-91, 1906; J.A.T., “Sedgwick, William Thompson,” *Dictionary of American Biography.* New York: Charles Scribners’ Sons; 16:552-53, 1935; Jordan, E.O., Whipple, G.C. and Winslow, C.-E.A. *A Pioneer of Public Health: William Thompson Sedgwick.* New Haven: Yale University Press; 1924; Tobey, J.A. *Riders of the Plague: The Story of the Conquest of Disease.* New York: Charles Scribners’ Sons; 1930; Whipple, G.C. The public health work of Professor Sedgwick. Science 53:171-174, 1911; and Wilson, E.B. William Thompson Sedgwick (1855-1921). Proceed. Amer. Acad. Arts. 57:512-16, 1922.

9. Jordan, E.O., Whipple, G.C., Winslow, C.-E.A. *A Pioneer of Public Health: William Thompson Sedgwick.* New Haven, Yale University Press; 1924, Appendix.

10. Although I have not seen the documentation to support my hypothesis, I am sure that Sedgwick played an important role in convincing Rockefeller to fund public health projects, beginning with the work in the Southern states in the United States attacking hookworm and typhoid. Certainly the fact that Sedgwick’s time in Maine with Rockefeller and Rockefeller’s subsequent funding of public health measures aimed at sanitation, is compelling circumstantial evidence.

11. Benson, K.R. *From Museum Research to Laboratory Research: The Transformation of Natural History into Academic Biology.* In: Rainier, R., Benson, K.R., and Mainschein, J., eds. *The American Development of Biology.* Philadelphia: University of Pennsylvania Press; 1988, pp 49-83.

12. Jordan, E.O., Whipple, G.C., Winslow, C.-E.A. *A Pioneer of Public Health: William Thompson Sedgwick.* New Haven, Yale University Press; 1924, p. 48.

13. Freeburg, V.O. *William Henry Welch,* p. 116.

14. This designation was also used in the special edition of the American Zoologist from 1987. In addition, a similar argument for a “Hopkins” approach to science is in: Maeinschein, J. In: *Transforming Traditions: American Biology, 1880-1915.* Baltimore: Johns Hopkins University Press; 1991.

15. Sedgwick, W.T. and Tyler, H.W. *A Short History of Science.* New York: Macmillan; 1917.

16. As mentioned earlier in this paper, it a remarkable coincidence that neither Welch or Sedgwick has received a recent historical assessment of their work in public health or sanitation. This is made all the more remarkable since both men figured so prominently in the formation of professional public
health programs in the United States and since Sedgwick published the initial American text in sanitary science (Principles of Sanitary Science, 1902). Both names are mentioned in overviews of public health, in particular the work of George Rosen and John Duffy; nevertheless, both beg for more historical attention.