Abraham Flexner's Legacy: A Magnificent Beneficence to American Medical Education and Clinical Chemistry

The general status of American medicine at the beginning of this century cannot be described except in what appear to be hyperbolic, dramatic terms. In 1910, American medicine suffered an earthquake so devastating that its aftershock still reverberates today. After the appearance of the "Flexner Report"—Bulletin Number Four commissioned by the Carnegie Foundation for the Advancement of Teaching, entitled Medical Education in the United States and Canada (1)—medicine on this continent would never be the same. Not only was the publication an exposé of disgraceful practices and gaps then prevalent in our medical education system, but also, happily for us, it provided constructive models and initiatives for correcting these deficiencies. Among other things, it opened wide the doors to the science and technology of clinical chemistry in the laboratories of medical schools and of hospitals, along with research in and teaching of biochemistry. Above all, the report catalyzed the rate of change that lifted American medicine to today's premier position. Here I will briefly examine that iconoclastic document, the implementation of its recommendations, and its modest author, Abraham Flexner (1866–1959).

Abraham Flexner's career preceding the issuing of this report had two facets that were astonishing, if not incredible: He had been a high school teacher for 19 years and held a baccalaureate in classics (Greek and Latin), with scant training in science and none in medicine. Further, despite this background, he joined and won the backing of two highly influential philanthropic groups dedicated to education, sponsored by Andrew Carnegie and John D. Rockefeller. After the appearance of the Flexner Report, huge sums of money were spent by Rockefeller's group, the General Education Board, which stimulated development of model systems for medical education. This meant financing the construction of new buildings and supporting full-time faculty with emphasis on laboratory sciences, including clinical chemistry.

What was the status of clinical chemistry when Flexner appeared on the medical scene? Practical quantitative chemical analysis of blood did not exist. Swedish-born Otto Folin (1867–1934), Chair of the Department of Biochemistry in the Harvard Medical School, had just initiated his pioneer studies of nitrogen metabolites in blood; and the Norwegian, Ivar Christian Bang (1869–1918), was also examining a few blood analytes in ultramicro volumes. Folin had, since 1904, published several articles of quantitative data on urinary constituents, while tackling the long, arduous task of introducing colorimetric methods for analyzing body fluid metabolites. This was in the era preceding the definition, development, and marketing of purified chemicals; pure water preparation; consensus standards; volumetric glassware; and industrial instrumentation oriented to the clinical laboratory. Qualitative testing of urine was practiced universally, and much related literature existed. Tools for phlebotomy were so complex and ill-defined that human blood sampling was deterred. The Journal of Biological Chemistry had been founded by Christian Herter in 1905, and the American Society of Biological Chemists was formed the following year—both institutions heavily oriented toward clinical applications. In 1908, in a lecture to the Harvey Society, Folin pointed out that the time was ripe to apply the new field of physiological chemistry to the multiplicity of potential practical problems embodied by hospital patients. Only a few hospitals and medical schools, however, were positioned to respond and a vast contrast existed between these and most of the other such institutions in America. The focus of biochemistry and of progress in medicine was in Europe, with Germany at the forefront.

The Flexner Report: Some Findings and Recommendations

In 1908, when Henry S. Pritchett, President of the recently established Carnegie Foundation for the Advancement of Teaching located in New York City, asked Abraham Flexner to make a study of American medical schools for the foundation, Flexner had just published his first book, The American College, which severely criticized some of the current educational practices, and had aroused Pritchett's interest. Low in funds, Flexner accepted the offer but pointed out that he was not to be confused with his brother, Simon Flexner, Director of the Rockefeller Institute for Medical Research; that he was not himself a medical man; and that he had never set foot inside a medical school. Pritchett replied that he wanted an educator's viewpoint, not a practitioner's.

Abraham Flexner began his survey in December 1908. He approached the task in three ways—he read everything handy on the subject of medical education in America and Europe; he conferred with representatives of the American Medical Association (AMA) in Chicago, and then reviewed reports by its Council on Medical Education (N.P. Colwell, who wrote the reports, would later make many inspection trips with
Flexner); and he went to his alma mater, Johns Hopkins University, to talk with the medical school faculty Welch, Halsted, Mall, Abel, Howell, and others. Flexner considered the medical school at Johns Hopkins to be a model displaying some of the best features of the European schools in England, France, and Germany.

In less than a year, Flexner had visited each of the 155 medical schools then extant (US, 150; Canada, 5). In visiting these schools he followed no fixed method of procedure and never used a questionnaire. Obviously he took copious notes, and meticulously recorded them for the final report. He sent his findings to the heads of the medical schools visited for correction of misstatements. The heads cooperated, perhaps because they thought Andrew Carnegie would give their schools gifts as he had done for the medical school in Atlanta.

Highlights of the specific topics covered by each visit, and the corresponding conclusions and recommendations were as follows:

**Admission requirements for students.** In all states and provinces outside the South, medical schools admitted students on the basis of a high school diploma or its “equivalent.” Only a few exceptions to this requirement existed, notably Johns Hopkins University (4-year college degree) and 15 (mostly private) schools that required one or more college years; 6 additional schools were on the verge of using this requirement. Because of its German-like medical school system, Johns Hopkins was, in almost all respects, the model school in most of the categories examined by Flexner. Harvard University required 3 years of college, but 60 of the 62 medical students admitted had the full 4-year degree. Yale admitted students with 2 or more years of college preparation.

With some exceptions, throughout the South requirements were so slipshod that entry was possible with less than a high school education; some were admitted directly from “grammar” schools. For example, Flexner’s hometown of Louisville, KY, had three medical schools in 1910; the largest of these—indeed, the largest medical school in America—the University of Louisville, admitted 600 students with a high school education or less. In the North, the situation was only marginally better. Chicago, for example, had 14 medical schools (and 4 postgraduate schools), many of which flouted the state law requiring the 4-year high school or “equivalent” basis for admission.

The Flexner Report recommended that all medical schools outside the South require at least 2 years of college education for admission. In the South, admissions standards were to be raised to accommodate high school graduates, until it was feasible to demand more education. Premedical training would be expected to prepare medical students in such sciences as chemistry, biology, and physics that, even where available, would require extra maturity in the individual student.

Flexner proposed that, given the medical needs in the general population, the number of medical schools be drastically reduced to 31 in the US, with an average enrollment of 300 students and a graduating class of <70. The annual national output of graduates would be about 2000. At capacity the 31 schools could produce 3500 new physicians annually, enough to satisfy the needs for a generation or two. However, supporting this number of schools meant closing 119 of the then-existing institutions. Within the decade after the report, 80 schools shut their doors. What an awakening in American medicine!

**University-based medical schools and academic status of faculty.** In 1910, most medical schools in America were proprietary (owned privately by a person or group; commercial, for profit). The relationship of medical colleges to universities ran the gamut—from titular only, through affiliation and noncommittal annexation, up to full university control in the best, mostly private, cases. The report argued that the universities should almost exclusively run the medical colleges, and that the professor’s rank in the medical schools should be the same as any other university department’s and with the same pay scale. Professors should not depend on private practice as a source of income, but should be permitted to serve as consultants within the boundaries set for all academia. And, professors should be chosen primarily on the basis of their training, experience, and skills in teaching and research—not because of seniority or administrative adeptness.

**Financial support of medical schools.** Of the 155 medical schools examined, 120 (77.4%) had no subsidies from endowments or public funds to meet operating expenses. Tuition fees alone provided income to pay salaries to faculty and personnel, operate plant facilities, maintain and construct buildings, finance library resources and museums, and provide laboratory support for coursework. In proprietary schools, however, most of the money was paid to the faculty so that the other needs were neglected—with sad consequences for the students. Even then, the faculty was merely part-time, and its major source of income came from private practice. Flexner stated:

> There are in the United States and Canada 56 schools whose total annual available resources are below $10,000 each.—so small a sum that the endeavor to do anything substantial with it is of course absolutely futile; a fact which is usually made an excuse for doing nothing at all, not even washing the windows, sweeping the floor, or providing disinfectant for the dissecting room. There is not even a shred of justification for their continuance: for even if there were need of several thousand dollars annually, the wretched contribution made by these poverty-stricken schools could well be spared.

The privately endowed schools such as Johns Hopkins and a few others provided the financial necessities for their medical schools, as we shall describe. The state-supported schools, though more munificent than proprietary schools, were prone to use faculty whose income was supplemented with that of private practice; indeed, there was little choice to do otherwise. The report recommended that only about 40% of operating expenses be derived from tuition fees, with the rest to be appropriated from other sources that would continually increase as a share of the costs.
Needs of a 4-year school. For the first 2 years of the curriculum, much emphasis was placed on the laboratory sciences related to clinical practices such as anatomy, physiology, pharmacology, pathology, bacteriology, and chemistry. Unfortunately, most of these experiences for the students were not hands-on, but didactic—lectures, demonstrations, group activities, textbook—or nonexistent. Contact with patients was minimal. The second 2 years involved clinical practices such as surgery, obstetrics, dispensary services, and diagnosis and treatment of disease. Also included were specialties such as pediatrics and ophthalmology. Most schools had arrangements, often very limited, with local hospital and dispensary services, and consequently provided limited faculty and opportunities for student involvement. The result was an overabundant production of ill-trained graduates, who were a plain menace to society, hardly better than charlatans and quacks. Of the 155 medical schools in America, 82 were university departments, whether actual or so-called; 27 of these had nominal or affiliated departments that the universities did not control or support financially.

The Flexner Report urged that universities completely control medical training, so that laboratories could be provided, and properly equipped and staffed, for the first 2 years of the curriculum. Universities were also urged to control hospitals and dispensaries, or to make arrangements for control of the medical aspects of such institutions as were already available. Teachers of clinical (patient-oriented) sciences were to hold professorial rank, and serve full-time as the rest of the faculty did. This recommendation would be one of the most difficult and costly to fulfill.

State boards of medical examiners; licensure. Most medical schools, particularly the proprietary ones, drilled students parrot-fashion on the questions they had to answer to become state-licensed practitioners. Despite the fact that licensure was a powerful tool for weeding out poorly trained applicants, the boards were flawed. To overcome the deficiencies, Flexner recommended that each board should (a) draw its membership from the best elements of the medical profession, (b) be armed with authority and the machinery to institute practical examinations, (c) refuse recognition to unfit schools, (d) insist on preliminary standards for admission to medical schools, and (e) be adequately funded to carry out its functions.

Miscellaneous studies and recommendations.

The Flexner Report devoted specific attention to the medical education of women and blacks and made recommendations too detailed to be covered in this article. The report appeared at a time before women could vote, and post-Civil War bigotry and abuse of civil rights were rampant. Expansions in domestic democracy would follow the two World Wars yet to be fought. Also reviewed in the report but not discussed here were medical sects in the US and the place of postgraduate medical schools.

Once the report was published, Flexner wrote (4):

It produced an immediate and profound sensation, “making the front page,” as we say nowadays. The medical profession and the faculties of the medical schools, as well as the state board of examiners, were absolutely flabbergasted by the pitiless exposure. We were threatened with lawsuits, and in one instance actually sued for libel for $150,000. I received anonymous letters warning me that I should be shot if I showed myself in Chicago, whereupon I went there to make a speech before a meeting called by the Council on Medical Education and returned unharmed.

Clinical Laboratories, Clinical Chemistry, Biochemistry, and Clinical Chemists

Readers should be aware that many recommendations made by the Flexner Report had already been addressed by the Council on Education of the AMA and by the Association of American Medical Colleges. Had the rate of progress been sufficiently rapid there would hardly have been a need for this special study. Flexner’s mentor, Henry S. Pritchett, President of the Carnegie Foundation and former President of the Massachusetts Institute of Technology, stated (1):

...The requirements of medical education have enormously increased. The laboratory has come to furnish alike to the physician and to the surgeon a new means for diagnosing and combating disease. The education of the medical practitioner under these changed conditions makes entirely different demands in respect to both preliminary and professional training.

To improve the relation of medical education to general education, the facts about current medical education and the medical schools had to be studied and understood. This is the study that was authorized and funded by the Carnegie Foundation in November 1908, and the Flexner Report was the first result of that action. “No effort has been spared to procure accurate and detailed information as to the facilities, resources, and methods of instruction of the medical schools” (1). Every detail stated was checked with the data of the AMA and the records of the Association of American Medical Colleges.

Who taught chemistry in the medical schools of 1910? Who taught biochemistry and clinical chemistry? When Otto Folin, America’s first great pioneer in clinical chemistry, received his doctorate in 1898, after pursuing an extra period of European training in physiological chemistry, he could find no job available in a medical school in America (2). His first research opportunity came at a mental hospital (McLean, Waverley, MA) only because its director, Edward Cowles, had a far-sighted vision of establishing a clinical research center for studying mental disease via neuropsychology, chemistry, and psychology. In the US, biochemistry (physiological chemistry) was newborn as a science, whereas in Europe it was already well-established by the physiologists (2, 3). Only R.H. Chittenden, America’s first biochemist (in the Sheffield Scientific School, New Haven, CT), taught biochemistry to the medical students of Yale. In the US, physiologists such as Loeb, Bowditch, and Abel were pushing for recognition of the new field. Once Folin and younger biochemists of note such as Van Slyke, Benedict, and Myers began training graduate students, these PhDs often became department heads at major...
medical schools around America. The early biochemistry was clinically oriented, as would be expected for medical schools, and quantitative clinical chemistry began. Blood analysis was launched with Folin's publications of 1912, and by Bang in Europe. America would lead the way in modern clinical chemistry applications, and later in instrumental development.

At the time of the Flexner Report, however, laboratories for clinical chemistry were either nonexistent or markedly underdeveloped. The often sophisticated qualitative analysis of urine and other body fluids was creating a thirst for the potential of quantitative blood analysis. An era of intensive metabolic, pharmacologic, and nutritional studies in biochemistry began that stimulated the use of blood chemistry in the diagnosis and monitoring of diseases. Teaching biochemistry required graduate training and research in chemistry, as well as courses at the undergraduate level. For this reason, nonphysician doctorates in biochemistry for the most part became the traditional professors and chairs of biochemistry departments in American medical schools. Most of the early biochemists and most of the publications in the Journal of Biological Chemistry were devoted to clinical chemistry.

Flexner specifically used the terms "clinical chemist" and "clinical chemistry," in the 1910 Report. Of university hospital laboratories he wrote (1):

To suffice for clinical investigation the laboratory staff must be so extended as to place, at the immediate service of the clinician, the experimental pathologist, experimental physiologist, and clinical chemist in position to bring all the resources of their several departments to bear on the solution of concrete clinical problems. Of these branches, experimental pathology and physiology have already won recognition; the next step in progress seems to lie in the field of clinical chemistry, thus far quite undeveloped in America.

A Brief Look at Abraham Flexner (4)

Abraham, the sixth of nine Flexner children, was born in 1866 in Louisville, KY. Though poor financially, his parents emphasized education and learning. Abraham Flexner's public education was heavy in the classics. He enjoyed the stimulating experience of his 2-year "part-time" job, at age 15, in the local library: 45 hours per week, at $16 per month. The money helped relieve the family budget after Flexner's father died in 1882, when Abraham was 16.

In 1884, Abraham's oldest brother, a pharmacist and now family breadwinner, sent him to Johns Hopkins University. The University, founded in 1876, was comparable to the better European ones because of its endowments, graduate school, distinguished faculty, and enterprising president, Daniel C. Gilman. Flexner, calculating that he had enough funds ($1000) for only two years, majored in the classics. By doubling up classes and working hard with no social frills, he completed the baccalaureate course work in two years at age 19. The experience at Johns Hopkins would be critical in Flexner's future. Gilman had started the medical school, in which pathology was made a nucleus of the curriculum, with William W. Welch as professor of pathology and dean of the medical school. This was the model that Flexner would later use in his survey for the Carnegie Foundation.

After graduation, Flexner returned to Louisville, where he fortunately got a job teaching classics in the public high school. Four years later a unique opportunity came for him to establish his own school, "Mr. Flexner's School," a college-preparatory high school for the well-to-do. The school was very successful, and its graduates were praised, particularly by Harvard president, Charles W. Eliot, for the quality of its applicants for admission.

In 1905, at age 39, Flexner decided to change careers. Though fond of teaching, he wanted "... to influence in some measure the life of my time in so far as that can be done through education." And so, after 15 years of operation, Flexner's School was closed. Flexner then studied psychology and philosophy at Harvard for about a year, with a pause to learn some brain anatomy at the Rockefeller Institute. In the summer of 1906, the Flexners (Abraham, wife, and first of two daughters) sailed for Europe, and settled in Berlin to continue Abraham's studies and incidentally to examine the educational system. In Heidelberg during the summer of 1907, he wrote his first book, The American College, which so caught Henry Pritchett's eye and launched his new career with the Carnegie Foundation.

Insofar as having a solid influence on American education, Flexner's career unfolded in three ways: (a) in 1908–12 with the Carnegie Foundation for the Advancement of Teaching in New York City, (b) in 1913–28 with the General Education Board in New York City, and (c) in 1930–39 with the Institute for Advanced Study in Princeton, NJ; later, in his "retirement" years, Flexner wrote four books and served as a consultant. It was in the first two stages of his career, 1908–28, that Flexner made his lasting impact on medical education and clinical chemistry. In the first stage, by precisely defining the problems, logical solutions could be offered. However, the problems could not be resolved without actual financial assistance to selected universities to serve as examples for others; such
assistance was the mission of the General Education Board.

While Flexner was still working at the Carnegie Foundation, Frederick T. Gates, an adviser to John D. Rockefeller, and head of the General Education Board, asked Flexner what he would do to reorganize medical education in America if he had a million dollars to spend. Flexner replied that he would give it to Welch at Johns Hopkins for the purpose of creating full-time faculty in the clinical branches. With permission from the Carnegie Foundation, Flexner spent 3 weeks in Baltimore discussing the matter with Welch and his colleagues. Reorganization on a full-time “university basis” was proposed for the medical, surgical, obstetrical, and pediatric clinics at an estimated cost of $1.5 million. On the basis of Flexner’s recommendations, the Board made this appropriation in 1913. The faculty assembled by Welch gave up lucrative private practices to accept clinical professorships. This reform, in one form or another, spread slowly throughout America and was a major factor in bringing American medicine to the forefront.

Much more money would be needed to help the medical schools bring their clinical branches under university control. After he had served on the General Education Board for several years, Flexner prepared a four-page memorandum asking Rockefeller to provide $50 million to stimulate the conversion of the medical branches as proposed in the Flexner Report. Although reluctant to commit the full amount of the proposal, Rockefeller eventually gave almost all of it.

Readers should be aware that improving university control of the medical branches (specialties, departments) and of hospitals, involved new laboratories for clinical chemistry and their staffing with faculty for teaching and research. Before Flexner began any projects, he first educated himself about the needs through conferences and communications. Obviously only a few selected universities could be chosen for endowment, but these could serve as models or stimuli for the others.

In 1920, Flexner and the General Education Board became intimately involved with the then-small University of Rochester. Flexner’s meetings with George Eastman resulted in Eastman and the Board each providing $5 million toward the creation of the new medical school. The endowment grew to $44 million, with Eastman continuing to contribute generously.2

Washington University in St. Louis was granted half the sum it needed to get full-time clinical teaching, the rest to be matched from its own efforts at raising endowment funds. Yale was supported once it obtained medical control of and the right to appoint the entire clinical staff at the New Haven Hospital. Efforts made at the University of Chicago were less successful and are described in Flexner’s book, Universities, published in 1930 by Oxford University Press.

The General Education Board provided the University of Iowa, the first state institution so chosen, a grant of $2.5 million on a matching basis to build a new medical school and to reorganize its faculty. The Iowans responded vigorously and generously to more than match this grant. The Vanderbilt University Medical School was completely reconstructed after the board provided an initial gift of $4 million, and followed with additional monetary gifts. The South thereby came into possession of one of the best medical schools in the US. Flexner’s brother Bernard later endowed Vanderbilt with a lectureship named for Abraham Flexner.

“... [In] less than 10 years—between 1919 and 1928—operating with less than fifty million dollars, the General Education Board had, directly and indirectly, added half a billion dollars or more to the resources and endowment of American medical education” (4). This amounts to $8 billion in current monetary terms. Flexner noted that the medical schools that topped did so without any pressure from the Board—which only used strategy in education, not pressure.

Flexner held that top-flight men should be selected to head medical schools and to teach specialties and that they should be trained adequately—abroad, if necessary, although World War I halted this practice. He advised President Lowell of Harvard to avoid picking department heads by seniority; consequently, David Edsall became dean and Harvey Cushing became professor of surgery in 1912. To create a department of neurology, Flexner advised Edsall to send a good man abroad. Edsall sent Stanley Cobb to Europe, and the General Education Board provided financial help for Cobb to create a department of neurology at Harvard. Flexner helped get a private grant to bring an outstanding ophthalmologist to JHU. Herbert S. Gasser, sent abroad to study pharmacology, returned as Professor of Physiology at Cornell, before succeeding

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1 Equal to about $800 million in recent dollars.

2 Walter Bloor, Folin’s first graduate student at Harvard, became chair and founder of the Department of Biochemistry and Pharmacology; he trained future biochemists and clinical chemists and was an honorary member of the AACC after its founding in 1948.
Fig. 3. May 1939 ceremony laying the cornerstone for Fuld Hall, the first building of the Institute for Advanced Study, Princeton, NJ (left to right): A. B. Houghton, Board of Trustees; C. Lavinia Bamberger, sister of the Institute’s founders; Albert Einstein, Institute’s faculty member since 1933; unidentified woman; Abraham Flexner, Director of the Institute; J. R. Hardin, Board of Trustees; unidentified man; Harold Dodds, President of Princeton University. Photograph through the courtesy of the Archives, Institute for Advanced Study.

Simon Flexner as Director of the Rockefeller Institute for Medical Research in 1935.

After 15 years service on the General Education Board, Abraham Flexner retired in 1928. Through his long devotion to medical education and consequently to the laboratory sciences, the Board had exerted lasting influence on 60 to 70 medical schools. At age 62, however, this was only a pause in Flexner’s long career. He remained active until his death in 1959, at age 92.

By his emphasis on the use of laboratory sciences in the training of medical students and in teaching medical specialties, Flexner helped create the milieu for the rapid growth of quantitative clinical blood chemistry under the pioneering leadership of Folin, Van Slyke, Wu, Denis, Benedict, Myers, Bloor, and others; belatedly, we express our thanks for the legacy he left us. Even more, this lay ex-high school teacher awakened American medicine to rise to greatness and thereby was an enduring benefactor of humankind.

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References

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