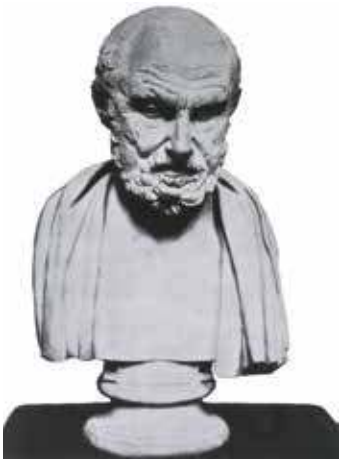

Hippocrates

Images courtesy of the National Library of Medicine.

The conversion of Galen

Avicenna

Anton Van Leeuwenhoek

Editorial

Alpha Omega Alpha and scholarship

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Scholarship has long been and continues to be an important and vital responsibility for physicians. *Doctor*, from Latin *docere*, means "to teach." Physicians have a responsibility to use observation and reasoned thought to expand human knowledge and ameliorate suffering. All physicians are teachers and are called on to teach. Throughout history physicians have endeavored to learn and understand from their work with the sick and injured and taught about the science and art of medicine. It has been said that the researcher at the bench, the clinician in the ward or office, and the epidemiologist in the field are all making "experiments." We are, therefore, all scholars in medicine and health.

Research may be defined as careful or diligent search, studious inquiry or examination, or the collecting of information about a particular subject. Many physicians equate scholarship with biomedical research, even though it has been estimated that only about two percent of physicians are directly involved in basic research. Medicine and patient care have been dramatically improved by these physicians through their scholarship in biomedical research, its applications and translations, and publications.

I believe that all physicians do research every day in the care of patients, and that we also have an obligation to participate in active scholarship. Clinicians carefully evaluate the patient's history, perform a thorough examination, develop a hypothesis based on the clinical findings, and then gather data and information to support or reject their hypotheses. They then make informed decisions and act to make a dianosis, predict prognosis, and determine treatment. They often study the medical and scientific literature to learn about their patient's illness and other diagnostic possibilities and to find current diagnostic and therapeutic best practices. They implement a clinical plan, inform and teach the patient and staff, and then record the information in the medical record. Physicians observe, discover, study, interpret, and teach. This is scholarly activity by every physician.

Here is one contemporary example of a physician scholar. In the 1970s, Dr. Joel Weisman, an osteopathic family practitioner practicing in Southern California, began to see young men with shingles, Kaposi sarcoma, and lymphoma-like illnesses. In 1980, he cared for a number of gay men with a puzzling constellation of symptoms, including weight loss, lymphadenopathy, fever, rashes, low WBCs, and fungal infections that appeared to be immunological in origin. Some of the patients also had pneumonia. Weisman consulted with Dr. Michael Gottlieb, who diagnosed these and other similar patients as having biopsy-proven pneumocystis pneumonia. Weisman then took the next step in scholarship. He published a description of five cases, a case series, in the Centers for Disease Control June 4, 1981, *Morbidity and Mortality Weekly Report*.[1] This case series report is recognized as the first scholarly publication describing AIDS. Dr. Weisman's clinical observations, reflection, and clinical reasoning in the care of his patients was followed up with a crucial step: publication of his case series. This starting point led to the application of epidemiologic, social, and biomedical research that has taught us much about HIV and AIDS.

Ignaz Semmelweis

Edward Jenner

John Snow

Robert Koch

Scholarship in medicine

Scholarship and experimentation in medicine has a long history. Plato defined science as " the discovery of things as they really are" based on observation and reasoned thought. In Babylon in the second millennium BCE, the concepts of symptoms, physical examination, diagnosis, etiology, prognosis, treatments, and traditional herbal practices based on empirical observations and the use of logic were taught. The literature in medical compendia defined the purpose of medicine to cure diseases of the sick, protect the healthy, and prolong life. Although their concepts were based on the preconceived notion of the imbalance of body elements and humours, among the achievements of medicine of the time were the isolation of some patients with infectious diseases, performance of surgical interventions, food prohibitions, and the treatment of patients with herbal medicine, acupuncture, massage, and other remedies.

Hippocrates observed and described the clubbing of the fingers in lung and cyanotic heart disease, the Hippocratic facies, and other physical manifestations of diseases. He categorized illness as acute, chronic, endemic, and epidemic. He was the first chest surgeon to operate for thoracic empyema.

Galen was a great surgeon performing many complex surgeries who wrote extensively on anatomy based on his human dissections.

Avicenna wrote *The Canon of Medicine* (1025) and *The Book of Healing* (1027). At this time books, mostly religious and some medical texts, were hand written and copied. Gutenberg's invention of the printing press and movable type in 1455 led to the rapid rise of science and medicine.

Many other medical scholars followed and contributed by cataloging their observations and experiences. William Harvey in seventeenth century described the circulatory system, by deducing that the presence of valves in veins and their absence in arteries determined the direction of blood flow, as well as the necessity for pulmonary circulation to oxygenate the blood and the heart as the pump to maintain circulation.

Developments in pharmacology and technology led to other important medical discoveries. In 1676 using the new technology of the microscope Anton van Leeuwenhoek first observed bacteria and microorganisms. In 1842 anesthesia, both nitrous oxide and ether, was used for dental extractions and surgeries. In 1847 Ignaz Semmelweis dramatically reduced the death rate of mothers by requiring physicians to clean their hands before assisting in childbirth. Joseph Lister in 1865 proved the principles of antisepsis in the treatment of wounds by using phenol/carbolic acid to sterilize surfaces before surgery and promoted handwashing and wearing gloves to further maintain asepsis. Louis Pasteur linked microorganisms with disease and developed the process of pasteurization.

During the 1854 cholera outbreak in London, John Snow documented the location of each of his cases with a "dot map" that showed a definite cluster around Broad Street. After learning through interviews that most of his patients drank water from the Broad Street pump, he caused the pump handle to be removed, ending the outbreak. Snow is now considered the

William Osler. Courtesy of the National Library of Medicine.

founder of the science of epidemiology. He published his findings in a letter to the editor of the *Medical Times and Gazette*.[2]

In 1796, Dr. Edward Jenner, after learning that milkmaids were usually immune to smallpox, hypothesized that previous exposure to cowpox protected them from the more severe disease. Jenner tested the hypothesis by inoculating an eight-year-old boy with pus from a cowpox blister. After the boy recovered from the mild case of cowpox he acquired, Jenner inoculated him repeatedly with pus from smallpox blisters; the child never developed smallpox. Jenner continued his research and finally published his findings on 23 cases.[3] The results spread through Europe and beyond; vaccination became widely accepted as a safe means to prevent smallpox.

Dr. Robert Koch is considered the founder of modern bacteriology. He identified the causative bacterial agents for anthrax, cholera, and tuberculosis, successfully culturing organisms obtained from patients treated in the examination room next to his laboratory, staining the cultured organisms, and observing them under the microscope. While many authorities of the time believed that tuberculosis was a hereditary disease, Koch believed it was an infection caused by a bacteria. He confirmed the crucial stepwise tests: mycobacterium was present in all cases of tuberculosis, the organism could be isolated and grown in healthy guinea pigs, the isolated and cultured organism caused tuberculosis when inoculated into healthy guinea pigs, and the recovered organism from the diseased guinea pigs was the same as the organism cultured from the original diseased patient. These are now referred to as Koch's postulates. He published papers on each of these infectious diseases and won the Nobel Prize in Medicine in 1905.

Sir William Osler is an example of a great clinician scholar. He was not a research scientist, but his scholarly work at the turn of the nineteenth to twentieth centuries transformed clinical medicine and medical education. Osler firmly believed in the scientific basis of medicine and he worked to disseminate the research and discoveries of others. Osler's clinical practice, keen observations, teaching, lecturing, and writing made major contributions to medical education. *Osler's The Principles and Practice of Medicine*, published in 1892 was for decades the seminal textbook of modern medical practice. Osler made many other contributions to medical education and practice, including requiring that medical students participate in bedside teaching with direct care of patients, establishing the first residency training program for physicians, creating one of the first organized educational journal clubs, founding of the Association of American Physicians, and establishing the Johns Hopkins University School of Medicine. He emphasized and taught students and physicians to, "listen to your patient, he is telling you the diagnosis." His participation in the creation and development of the Johns Hopkins School of Medicine was pivotal in the 1910 Flexner Carnegie Foundation Report that revolutionized medical schools and medical education in the United States.[4]

The twentieth century produced amazing research and scholarship in medicine, science, engineering, technology, health, and patient care, fueled by research in many areas of science and engineering. The National Institutes of Health (NIH) was established in 1930; its subsequent research role began in 1937. In 1946, the NIH became the engine for biomedical research with government support and funding. While not all of the discoveries related to medical science and medicine were made by physicians, physicians adapted and applied the discoveries to patient care and actively taught about the new discoveries and their clinical applications. The following table summarizes some of the highlights of progress, discovery, and application of advances in the science of medicine and health in the twentieth century.

Standing out from among the many advances in scholarship

Twentieth-Century Research and Scholarship in Medicine	
Aspirin	1828
Clean water, safe food, electricity, education	1900–1950
Discovery of blood groups	1901
Endoscopy	1901–1923
X-Rays	1902
Flexner Report on Medical Education	1910
Vitamins A, B, C, D, E, K (vital nutrients not made endogenously by humans)	1913 on
Electrocardiogram	1914
Vaccines DPT Influenza Yellow fever Polio Measles, mumps, rubella Hepatitis A and B Pneumonia Eradication of smallpox	 1920s 1945 1937 1955 1971 1980s–1990s 1977 1980
Discovery of insulin	1922
Control of infectious diseases Discovery of sulfa Discovery of penicillin Other antibiotics	 1930s 1928
Flame photometer (electrolyte measurements)	1936
Cardiac catheterization	1941
Modern randomized controlled trial	1948
Framington Heart Study	1948–present
Radioimmunoassay to measure peptides	1950s
Open heart surgery	1952
DNA structure	1953
Diagnostic ultrasound	1954
Kidney transplant	1956
Contraception	1960s
Computer assisted tomography (CT)	1970s
Magnetic resonance imaging (MRI)	1971
Angioplasty	1974
AIDS epidemic	1981
Reduction in mortality from heart attacks and strokes	1969–

in medicine during the twentieth century is the development of the Randomized Controlled Trial (RCT), now accepted as the "gold standard" for acquiring scientific evidence to evaluate therapeutics in medicine. Another pivotal research project was an observational study, the Framingham Heart Study, begun in 1948.[5] It had been established by then that cardiovascular disease, including heart attacks and stokes, was a rising epidemic. The debate about high blood pressure ranged between two positions: One group hypothesized that the aging vascular system became stiff and required a higher blood pressure to adequately provide circulation. Another group believed that hypertension contributed to heart disease and stroke by exposing the vessels to increased vascular pressure.

The National Heart Institute at NIH in collaboration with Boston University advanced a hypothesis that the development of cardiac disease was influenced by lifestyle and family history. The group devised a long-term observational study to identify potential factors for heart disease in a large cohort of people originally without evident heart disease in Framingham, Massachusetts. They enrolled 5,209 men and women between thirty and sixty-two years of age and observed them over many years to elucidate the differences between those who developed heart disease and those who did not. Participants were given extensive physical examinations and lifestyle interviews, with follow-up every two years for a medical history, physical examination, and laboratory tests. There have now been more than a 1,000 publications on this population. The Framingham Study demonstrated the association of cigarette smoking as a cardiovascular risk factor in the 1960s. Subsequently other major cardiovascular risk factors were identified, including high blood pressure, elevated cholesterol, physical inactivity, and others.

Perhaps the next most significant achievement of twentieth-century research has been the Human Genome Project, which was initiated in 1990 by the Department of Energy and NIH to sequence the human genome. Three non-physician scientists led the projects to sequence the human genome, James Watson and Francis Collins at the NIH and J. Craig Venter at the private company Celera. The human genome was sequenced and the results published in 2000 and 2001 and has now greatly advanced our understanding of human biology and medicine.[6]

"Scholarship Reconsidered"

In 1990, Ernest Boyer from the Carnegie Foundation for the Advancement of Teaching published his seminal report,

Scholarship Reconsidered: Priorities of the Professoriate, in which he advocated for expansion of the traditional and widely accepted definition of scholarship and research.[7] He focused primarily on scholarship for faculty of traditional colleges and universities, particularly their roles and responsibilities in a milieu in which scholarship was equated with traditional research and the scholarship of discovery. Boyer's model of scholarship has subsequently been widely adopted in many academic institutions and medical schools. I believe it is directly applicable to the scholarly and scholarship responsibilities of physicians in their multiple professional roles and functions, including the care of patients. It also directly relates to the physician's fundamental responsibility for continued learning. Boyer's model is also based on the concept that "Theory surely leads to practice. But practice also leads to theory."[7p16] He noted, "Surely, scholarship means engaging in original research. But the work of the scholar also means stepping back from one's investigation, looking for connections, building bridges between theory and practice, and communicating one's knowledge effectively to students."[7p16] He then presented his concepts of the types of scholarship.

The Scholarship of Discovery

For many, scholarship means engaging in original research in biomedical sciences, humanities, social sciences, epidemiology, and translational research that advances knowledge.

He quoted William Bowen, former president of Princeton University, who said that scholarly research "reflects our pressing, irrepressible need as human beings to confront the unknown and to see understanding for its own sake. It is tied inextricably to the freedom to think freshly, to see propositions of every kind in ever-changing light. And it celebrates the special exhilaration that comes from a new idea."[7p17] And a quote from Lewis Thomas on major medical breakthroughs in the twentieth century: "It was basic science of a very high order, storing up a great mass of interesting knowledge for its own sake, creating, so to speak, a bank of information, ready for drawing on when the time for intelligent use arrived."[7p18] Scholarship of Discovery is usually documented in peer-review publications of original research.

The Scholarship of Integration

This represents scholars who give meaning to isolated facts, putting them in perspective and context by integration. It involves the synthesis of information and the making of connections across disciplines, across topics within a discipline, or across time, illuminating data in a revealing way to bring new insights. It means interpretation into larger intellectual patterns to learn "What do the findings *mean*?"[7p19] It is scholarship that is interdisciplinary, interpretive, and integrative. It naturally leads to the next category, scholarship of application and engagement.

The Scholarship of Application and Engagement

This gets at the question, "How can knowledge be responsibly applied to consequential problems? How can knowledge be useful and helpful to physicians, patients, and society?"[7p21] How to connect knowledge and theory to practice? It is the scholarship of service. Scholarly service both applies and contributes to human knowledge, resulting in the application of knowledge and skills in medical practice, including diagnosis, serving patients, shaping public or institutional policy, providing leadership, demonstrating professionalism, and serving society. Scholarly service often involves presentations at professional or community meetings, case reports, case series articles, and sharing information in diverse ways.

The Scholarship of Teaching

We in medicine have an obligation to teach what we know. As Aristotle said, "Teaching is the highest form of understanding." Most of us can attest that we also learn from having to teach and from the process of teaching. Teaching contributes to the continuity of knowledge and stimulates creativity and curiosity. It actively promotes and contributes to scholarship. Physicians have many opportunities to teach, from bedside or clinic rounds, to patient consultations, to journal clubs, to organized teaching conferences, to mentoring of other physicians and students. Teaching promotes a spirit of inquiry and scholarship.

Scholarship in medicine today

Many medical schools have developed a Mentored Scholarly Activity requirement for medical students. The term "scholarly" is used purposefully, recognizing that some students will choose to do bench or clinical research for their project, but many are more interested in scholarship in the humanities, arts, social sciences, epidemiology, public policy, and other areas.

The Accreditation Council for Graduate Medical Education (ACGME) established a requirement for each resident to demonstrate acceptable scholarly activity to complete his or her training.[8] They explain that for residents to pursue scholarly activities, they not only need to work and learn in a culture that values and nurtures scholarship, but also need to learn specific skills, such as transforming an idea into a research question (experimental, descriptive or observational), choosing an appropriate study design, determining what instrumentation to use, preparing for data collection, management and

analysis, ethical conduct of research, and the rules and regulations governing human subjects research. ACGME and their RRCs have adopted the Boyer concepts of scholarly activity. The responsibility for establishing and maintaining an environment of inquiry and scholarship rests with the faculty, and an active research component must be included within each program. Both faculty and residents must participate actively in scholarly activity. Scholarly activity is a common program requirement for accreditation by the Accreditation Councilor for Graduate Medical Education.[9] Scholarship is defined as one of the following:

- The scholarship of discovery, as evidenced by peer-reviewed funding or publication of original research in peer-reviewed journals.
- The scholarship of dissemination, as evidenced by review articles or chapters in textbooks.
- The scholarship of application, as evidenced by the publication or presentation a local, regional, or national professional and scientific meetings, for example, case reports or clinical series.
- Active participation of the teaching staff (including residents) in clinical discussions, rounds, journal club, and research conferences in a manner that promotes a spirit of inquiry and scholarship; offering of guidance and technical support, e.g., research design, statistical analysis, for residents involved in research; and provision of support for resident participation as appropriate in scholarly activities.[10]

All physicians need to pursue scholarship that "promotes a spirit of inquiry and scholarship." I encourage physicians to write about their observations and experiences and submit their work for publication. While many physicians are not good writers, all have some experience writing personal statements and essays, as well as clinical histories. Unfortunately, many of us have developed nonclinical "writing apraxia," a common condition in which the physician has no problem talking about complex topics, but can't write cogently about them. It is a poorly understood but common condition. The idea that your writing must be perfect results in not writing at all. But writing well can be learned, and we all need to learn to do it, and do it better. It is an important part of scholarship. We need to overcome writing apraxia because we need to share our observations and experiences with the medical profession. Remember Dr. Weisman's five cases and the difference his observations and publication made in the recognition of a new disease, HIV and AIDS.

Alpha Omega Alpha (ΑΩΑ) has long been an advocate and supporter of scholarship. We provide more than three-quarters of a million dollars per year for programs and awards that are mostly to support scholarship. These include: Four Robert J. Glaser ΑΩΑ Distinguished Teacher Awards; about 50 ΑΩΑ Medical Student Research Fellowship Awards; Edward D. Harris ΑΩΑ Professionalism Awards and support of national meetings on medical professionalism; ΑΩΑ Medical Student Service Leadership Awards; about sixty ΑΩΑ Visiting Professors; ΑΩΑ Clinical Faculty Awards; ΑΩΑ Postgraduate Awards for resident and fellow scholarly projects; and ΑΩΑ medical student awards for essays and poetry. ΑΩΑ also publishes the society's journal, *The Pharos,* a peer-reviewed means to publish articles other than biomedical research and related to health and medicine.

I encourage all of us in medicine to rethink scholarship and I urge all of us to more actively pursue scholarly work in our practices, communities, and societies. I also hope to promote a keen "spirit of inquiry and scholarship" in our profession.

References

1. Gottlieb MD, Schanker HM, Fan PT, Saxon A, Weisman JD, Pozalski I. Pneumocystis pneumonia—Los Angeles. Morbidity and Mortality Weekly Report; 1981 Jun 4.

2. Johnson S. The Ghost Map: The Story of London's Most Terrifying Epidemic—and Hos It Changed Science, Cities, and the Modern World. New York: Riverside Books; 2006.

3. Riedel S. Edward Jenner and the history of small pox and vaccination. Proc (Bayl Univ Med Cent) 2005; 18: 21–25.

4. Flexner A. Medical Education in the United States and Canada. Carnegie Foundation for the Advancement of Teaching; 1910. Available at: http://www.carnegiefoundation.org/sites/default/files/elibrary/Carnegie_Flexner_Report.pdf.

5. Kannel WB, Dawber TR, Kagan A, Revotskie N, Stokes J 3rd. Factors of risk in the development of coronary heart disease—six year follow-up experience. The Framingham Study. Ann Intern Med 1961; 55: 33–50.

6. Collins FS, Green ED Guttmacher AE, Guyer MS. A Vision for the future of genomics research. nature 2003; 422: 835–47.

7. Boyer EL. Scholarship Reconsidere3d: Priorities of the Professoriate. Princeton (NJ): Princeton University Press; 1990.

8. Schultz HF. Research during internal medicine residency training: meeting the challenge of the Residency Review Committee. Ann Intern Med 1996; 124: 340–42.

9. Accreditation Council for Graduate Medical Education. Residency program training requirements. http://www.acgme.org/acgmeweb/Portals/0/PFAssets/2013-PR-FAQ-PIF/140_internal_medicine_07012013.pdf.

10. Grady EC, Roise A, Barr D, et al. Defining scholarly activity in graduate medical education. J Grad Med Ed 2012: 558–61.