POLICY

American medical education at a crossroads

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New medical-education models in which research plays a modest role could engender a two-tiered educational system, cause a reduction in the physician-scientist pipeline, and diminish the translation of biomedical advances.

In 1908, education reformer Abraham Flexner posited that a robust research program—an essential component of a modern medical education—was absent from U.S. medical schools. This omission was considered a critical weakness because "science and the scientific or intelligent practice of medicine employ … exactly the same technique" and because the presence of ongoing research kept both the preclinical and clinical medical school faculty current on advances in biomedical science (*1*). Flexner also noted that a medical school should be part of a research university that assumes responsibility for the standards of the school and provides adequate support for both its research and clinical missions. The construct became the standard for U.S. medical schools for more than a century and supported discoveries that have changed the face of medicine.

Over the past two decades, in response to the acute need for primary care physicians, a shortage of physicians in many specialties, and the common belief that a medical school enhances the economics of a community, new medical schools have opened across the United States: 17 allopathic and 19 osteopathic schools. This growth has been accompanied by a shift toward new models of medical education in which research plays a minimal role. In addition to creating a two-tiered system of medical education, a reduction in emphasis on research threatens the quality of education received by our future biomedical workforce as well as the pipeline of physician-scientists—important consequences that have received little attention.

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SCIENCE SHIFT

The shift in the research enterprises of America's medical schools can be assessed objectively by the size of a medical school's portfolio of research and training grants from the U.S. National Institutes of Health (NIH) (Table 1). These data indicate that the amount of NIH research funding to U.S. medical schools has fallen over the past decade (Table 1; http://report.nih.gov/award/index.cfm). Although there was a small decrease in NIH funding to medical-school programs in the upper third (in terms of research dollars received) when adjusted for inflation, the decrease in the lower third was substantial. This decrease resulted in large part from the creation of new medical schools that either do not prioritize NIH-funded research or have been unable to compete for scarce NIH dollars. The mean NIH funding for the 41 medical schools in the lower tertile was $11,173,312, whereas the mean funding received by the 16 schools that opened since 2002 was $845,134. A substantial decrease in NIH-funded research has also been seen in colleges of osteopathic medicine. In 1994, 67% of colleges of osteopathic medicine supported NIH-sponsored research, whereas only 32% did so in 2013. Here, too, the change resulted in large part from the opening of 19 new schools that lacked research programs, including the first for-profit school. Thus, an increasing proportion of today's U.S. medical school graduates matriculate from programs that provide them with instruction from a community of educators who conduct little or no clinical or translational research. We are cognizant of the fact that research funding might also be obtained from other sources, such as the National Science Foundation, the Patient-Centered Outcomes Research Institute (www.pcori.org), state and local agencies, philanthropies, and

Table 1. Grant funding comparison: U.S. medical schools (2004 to 2013 by tertile ranking). Shown are the mean numbers of NIH awards and funding dollars (actual and adjusted) for all U.S. medical schools by tertile. Rankings are based on the number of NIH awards received in 2004 and 2013.

Category	2004		2013		*P* value[3]
	Mean	SD*	Mean	SD	
Awards[1]					
Upper	483.7	197.4	458.8	216.0	0.58
Middle	158.1	52.0	100.7	45.7	<0.0001
Lower	32.3	18.8	13.4	11.4	<0.0001
Funding (U.S. $)					
Upper	200.85	89.72	189.78	94.43	0.58
Middle	58.17	22.01	39.30	18.91	<0.001
Lower	12.90	8.74	5.72	5.94	<0.001
Adjusted funding[2]					
Upper	247.05	110.36	189.78	94.42	0.0107
Middle	71.54	27.08	39.30	18.91	<0.001
Lower	15.87	10.75	5.72	5.94	<0.001

1. (i) 2004 awards by tertile: upper (*n*=41) [range, 991 to 243]; middle (*n*=41) [range, 240 to 84]; lower (*n*=41), [range, 68 to 2]. (ii) 2013 awards by tertile: upper (*n*=46) [range, 1024 to 196]; middle (*n*=46) [range, 193 to 37]; lower (*n*=47) [range, 34 to 0].
2. Adjusted funding in U.S. dollars: Actual 2004 dollars of funding increased 23% to account for Consumer Price Index adjustment for inflation (U.S. Bureau of Labor Statistics) between 2004 and 2013.
3. Number of awards and mean funding of schools for each tertile were compared between 2004 and 2013 using a Student's *t*-test for independent samples. [Source: NIH awards by location and organization: http://report.nih.gov/award/index.cfm]
*SD, standard deviation

for-profit entities (for example, industry). Nevertheless, research grants from these other sources also are awarded predominantly to schools whose faculty members are most successful in obtaining NIH funds (*2*, *3*).

Many of the new U.S. medical schools share features in addition to the absence of an NIH portfolio: They are not partnered with major research universities; they have a small basic science faculty; and in many cases, their students take clerkships solely in community hospitals rather than in research-oriented quaternary care hospitals. For example, in 2013, the average number of basic science faculty members at U.S. medical schools that opened since 1993 (46.5) was substantially lower than the average number of basic science faculty at U.S. medical schools that had opened prior to 1993 (142) (www.aamc.org/data/facultyroster/reports/367218/usmsf13.html).

Because class size is, in general, smaller at newer medical schools than at established schools, we calculated the ratio of the size of the basic science faculty to the 2013 enrollment of the first-year class. The mean ratio for established schools was 0.88 (range 0.28 to 3.3), whereas the ratio for new schools was 0.62 (0.07 to 1.4). Although the ranges are large, the highest and lowest ratios, in addition to the means, reveal that students at established medical schools have a greater opportunity for contact with a basic science faculty member compared with students at new schools. Similarly, colleges of osteopathic medicine that were accredited since 1994 had on average half the number of basic science faculty as those accredited before 1994 (*4*).

The data used to calculate the number of basic science faculty at U.S. allopathic medical schools was derived from the AAMC Faculty Administration Management online user system. Faculty members were identified as basic or clinical on the basis of the departments in which they had primary appointments. Therefore, we did not capture the number of physician-scientists at each medical school if their primary appointment was in a clinical department. However, in 1994, all but 11 U.S. allopathic medical schools were associated through ownership or contract with a quaternary research-oriented hospital. Among the allopathic schools that have opened since 1994, only four have a relationship with a research-oriented hospital. Thus, the presence or lack of a relationship with a research-oriented hospital provides a subjective surrogate marker for the opportunity students have to interact with physician-scientists or clinician-investigators (*5*).

It is not surprising that many of the new medical schools do not, or cannot, support basic, translational, or clinical research. The 2013 NIH budget was 21.9 percent below its 2003 level when adjusted for inflation (*6*); further, pharmaceutical companies have reduced their support for early-stage academic research (*7*), changes in reimbursement policies make it problematic to support research with clinical revenues, and proposed cuts to direct and indirect graduate medical-education payments from Medicare threaten funding for residents and teaching faculty. Without question, omitting research improves the finances of a school of medicine. Indeed, a 2011 report from the Association of American Osteopathic Colleges demonstrated that a medical school achieves a positive margin when it does not have to support basic or translational research or a research-oriented clinical program (*4*).

Recognizing the financial opportunities afforded by this new model of medical education, there is the very real threat that, at a time of decreased NIH funding and decreased undergraduate enrollments, some medical schools or their parent universities will meet their budgetary goals by decreasing their support for medical research. This transformation will shrink the size of the medical school faculty and bring about divesting of research-oriented hospitals, thereby increasing the number of medical schools without a research focus.

Proponents of this new model of medical education argue that students who intend to pursue a career in primary care do not require hands-on exposure to laboratory-based translational research, clinical research focused on the complex array of diseases found in research-oriented hospitals, or research on clinical outcomes, comparative effectiveness, or healthcare delivery systems (*8*, *9*). Indeed, several new medical schools—for example, Texas Tech School of Medicine has a three-year family-medicine accelerated track—have opted to shorten the medical school curriculum in order to decrease the cost of a medical education for students who are committed to pursuing a career in primary care medicine, a change that substantially reduces opportunities for students to conduct a research project. These proponents also posit that clinical clerkships in community hospitals and outpatient facilities are more relevant to today's physician because patient care has moved increasingly to the outpatient setting, and studies have shown that students in community clerkships score well on standardized tests. (*10*) The realization that academic medical centers of the future might resemble large critical-care hospitals rather than those that treat a wide spectrum of diseases has provided further support for focusing medical training in community hospitals and outpatient settings rather than in a traditional academic medical center.

These arguments are problematic. Just as clinical medicine is best taught in close proximity to the patient, the most effective means by which a student can learn the complexities of clinical and translational science is through exposure to research and to physician-scientists. Indeed, the Liaison Committee on Medical Education (www.lcme.org) now requires that medical students be introduced to the basic scientific and ethical principles of clinical and translational research, including the ways in which such research is conducted, analyzed, discussed with patients, and applied to patient care. Therefore, students must obtain some of their clinical education in an environment in which both attending physicians and trainees explore, at the bedside and in conferences, how clinicians can take advantage of the bidirectional highway of translational science to inform clinical decision-making and improve care for an individual or group of patients. The focus on patient care makes understanding translational research equally important for students who plan to pursue primary care and those who plan to train in a subspecialty. A century ago, Flexner pointed out that the primary care physician should have a broader—not a narrower—education because he "has only himself to rely on: he cannot in every pinch hail specialist, expert, and nurse." But a more recent reason for educating students in the translational sciences is that its T3 and T4 components will be most successful with an informed physician workforce.

One could argue that our concern about the potential creation of a two-tiered system of medical education is elitist and biased by our own personal experiences. We would, however, argue just the opposite. A two-tiered system would actually foster the very medical elitism that most physicians dislike. As department chairs, we viewed medical education in the United States as generally comparable across a broad spectrum of schools: A top student from a Midwestern land grant university had the same opportunity to attain a competitive postgraduate training position as a top student from an Ivy League medical school. However, in a medical education system in which only some schools support programs in clinical and translational research, the most competitive programs and disciplines likely will select from the pool of applicants matriculating from research-oriented medical schools. Many competitive programs and disciplines (for example, otorhinolaryngology, orthopedic surgery, and dermatology) already require that candidates participate in research during their 4 years in medical school. A student who attends a non–research intensive medical school and thus has little or no exposure to research or to physician-scientist mentors will have far fewer postgraduate training options. Furthermore, exposure to research during medical school strongly influences a student's decision to pursue a research career; thus, an increase in the number of medical students with limited exposure to the excitement of modern medical science will result in an even steeper decline in the physician-scientist workforce (*6*).

MODERN MEDICINE

Medicine today differs greatly from that in the time of Flexner. The fields of genomics, proteomics, and metabolomics are changing our understanding of the biology of disease and shaping personalized treatment strategies. Clinical decision-making is becoming increasingly dependent on the use of bioinformatics, comparative effectiveness and outcomes research, and clinical trial results—which means that medical students must learn to amass, synthesize, critique, and apply new scientific data to patient care. For example, advising a patient about his or her "genetic analysis" requires an understanding of the promise and limitations of genome sequence analysis, epigenetics, and phenotype expression. How we train students to interpret and use these data, both in the short term and over a lifetime of learning, will have a major impact on their clinical capabilities.

The need to attain a positive margin in both the clinical and research enterprises has clearly led both new and established medical schools to redefine their educational models and priorities. This exercise is both healthy and necessary. But we appear to be heading inextricably toward a medical education system in which some schools expose their students to modern biomedical research and a cadre of physician-scientist educators while other schools train their students with exclusively practitioners as role models.

Several steps must be taken to ensure that these changes do not have unintended consequences. First, academic organizations and regulatory bodies must recognize the need to objectively evaluate these new models of medical education in a timely manner in order to determine whether they are in the best interest of students and their patients. This will undoubtedly require the creation of assessment and evaluation tools that are far more discriminating than standard board examinations and that can provide both formative and summative assessments. Medical schools must invest in information technology platforms that enable them to track student outcomes not just in the context of their medical education but also during residencies and subsequent practice. Second, as Flexner noted, universities "must realize that medical education is a serious and costly venture." A school of medicine is a public trust, and universities—large and small—must be held accountable for the quality of the medical education they provide. Regulatory authorities and university stakeholders need to rigorously evaluate new policies that decrease support for medical education or biomedical research.

Third, legislative bodies and the general public must be educated regarding the value inherent in a scientifically based education as well as its costs and recognize that continued cuts in NIH funding will have dire consequences for medical education and thus patient care. The NIH, in turn, needs to enhance its support for new physician-scientists in order to ensure that there will be an adequate supply of instructors and mentors to train the next generation of medical students. Because the transition from K08 to RO1 grants is a common bottleneck for early-career investigators (*6*), reintroduction of the R29 or "first awards" might be a good starting point. Furthermore, just as the Institutional Development Award (IDeA) program broadens the geographical distribution of NIH funding by increasing the competitiveness of investigators located in states with historically low funding levels, opportunities must also be enhanced for investigators and translational programs at medical schools that have historically smaller NIH portfolios. Because NIH funding for research is a zero-sum game, funds must be redistributed to these new programs. And finally, we must use the investigative and evaluative skills developed through innovations in the clinical and translational sciences to ensure that while new models of undergraduate medical education may be "innovative" or "different," they educate highly competent physicians and assiduously avoid the creation of a group of physicians who are unable to apply modern scientific advances to the practice of medicine for the benefit of their patients.

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