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EDITOR'S PAGE

Current Education of Physicians: Lost in Translation?

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The first warning about the endangered future of physician-scientist careers was articulated by James Wyngaarden in 1979, later director of the National Institutes of Health (NIH). He noted that the number of MD applicants for research grants from the NIH was decreasing while that of PhD applicants was rapidly rising (1). Deep concern about this problem has intensified over the past decade, resulting in a call for action by the current NIH director, Francis Collins, who in 2014 convened and charged the Physician-Scientist Workforce Working Group to examine the roots of the problem and recommend potential solutions. Its report concluded that "analysis of AMA [American Medical Association] and NIH data demonstrate continued aging over the past decade of physicians engaged in research, which presage a significant decline in the physician-scientist workforce, especially as the current cohort of senior physician-scientists retires" (2).

Many plausible causes have been proposed for the loss of interest among young physicians (MDs and MD-PhDs) in serious research careers (3). However, it now appears that the number entering that career path is less of a problem than the number dropping out. Early attrition from this career pathway has been referred to as the "leaky pipeline." Other critically important factors that have been discussed include the increasing length of training required to start an independent clinical research career (with the mean age of physicians securing a first independent NIH grant now approaching the mid-40s); the increasing indebtedness of medical school graduates (with the average for medical students graduating in 2018 ballooning to $197,000 in student loans); changes in generational priorities for work-life balance and controllable lifestyles; the continued discouragement of women from entering the physician-scientist career path, even though their potential for productive careers is at least as great as that of men (with women now representing 50% of matriculating medical students); and the increasing perception of insecurity in those jobs.

In our opinion, 1 major factor that has not been discussed is the number of consecutive years of required training of physicians that are virtually devoid of exposure to scientific thinking. Take for example the typical training path of a cardiologist. With medical school curricular reform, the period of teaching foundational sciences has been reduced from 24 months to 12 to 18 months in most schools. The rationale for this is commendable: instead of rigidly bisecting medical education into the foundational sciences years and the clinical years, as the traditional curriculum dictated for the past century, these 2 facets of education can be now fully integrated seamlessly (4). This curricular change entails early exposure of medical students to meaningful clinical experiences while they are studying basic sciences (which has been accomplished successfully), and substantively inserting the foundational sciences into the clinical years. Theoretically, this would justify shortening of the basic science curriculum by 6 to 12 months. Unfortunately, the second part of the plan has not been possible to achieve. The most recent (2019) annual surveys administered by the Association of American Medical Colleges to all medical students in the United States at the times of their matriculation and graduation now show an approximately 10% drop over the course of 4 years of medical school in the likelihood of including research during their careers (https://www.aamc.org/data/student-surveys/). In good faith, the U.S. Medical

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Licensing Examination did introduce foundational science questions into the Step 2 board examinations (which are taken at the end of medical school). Step 2 has 2 components, a clinical skills examination (which is purely that) and a clinical knowledge examination. However, at the time of this writing, the latter portion of the test includes only 1% to 3% of questions under "general principles of foundational science." This example of the failure to integrate the science of medicine into clinical training is 1 of several examples of ineffective curricular reform and is emblematic of the recurring cyclic problem of recommending but not effecting meaningful integration. Many professional educators who make recommendations about curriculum are not regularly exposed to the practical realities of clinical practice today, with its breakneck pace, intensity, and complexity, all of which are further pressurized by restricted work duty hours. Thus it is understandable that the architects of curricular reform may not have fully appreciated the impossibility of inserting meaningful scientific thinking into a busy clinical environment.

After medical school, a future cardiologist undergoes 3 years of residency in internal medicine. The practical challenges of introducing medical science into those whirlwind years are even greater than those of students in clerkships. The problem is compounded today by the virtual disappearance of physician-scientist role models from both the inpatient and outpatient arenas. In the hospital, physician-scientists have been replaced by hospitalists, who are often outstanding clinicians who provide excellent and much needed continuity of care and supervision but whose main responsibilities are ensuring efficiency and cost-effectiveness of care and teaching mostly the technical aspects of medicine to residents. Time pressures require discussions of "what" and "how" rather than "why." Following this comes a period of 2 to 3 continuous years of clinical training in a fellowship, with the same constraints on time for scientific thinking before the next opportunity research opportunity reappears. This means typically about 7 to 8 uninterrupted years of pure clinical training. As critical as this prolonged training is to develop excellent clinical specialists, it also means the current generation of trainees will not be exposed to scientific thinking during the most formative years of their careers. This problem is particularly pernicious for training the next generation of translational physician-scientists, who will no longer have a sufficient scientific background to begin to ask meaningful questions about the pathophysiology of disease, let alone understand how to identify therapeutic targets within disease-causing pathways. Moreover, it is unrealistic to expect young physicians to ever become reinspired by the excitement of a career as a physician-scientist when they have not had any exposure during their most formative years.

Thorough and intensive clinical training cannot be replaced, even for future physicians who aspire to predominantly research careers. So what can be done to keep the pilot light of interest in a research career burning during this period of intensive clinical training? First, dedicated research time during undergraduate and graduate medical education requires extramural financial support, which is conspicuously absent today. Given the massive commitment to biomedical research in the United States that is supported by industry, philanthropy, and public tax dollars (5), it is ironic that we are failing to invest in the durable cultivation of the very workforce that will be required to sustain this country's biomedical research enterprise. A notable exception has been the longstanding and highly successful support by the NIH for MD-PhD combined degree programs. Another possibility for fostering the development of translational physician-scientists during clinical training would be to incorporate elements of the NIH Intramural Translational Science Training Program into medical school and post-graduate medical training programs. The Translational Science Training Program is currently a 2-day boot camp-style course that intertwines multidisciplinary scientific content, understanding of the drug development process, clinical trial terminology, and career exploration (https://www.training.nih.gov/tstp). A similar type of approach could be adopted to research electives in medical school, residency, and fellowship to provide ongoing exposure to scientific thinking. For medical students, a meaningful period of protected time for original research under the guidance of a good faculty mentor can be introduced into the curriculum late in the third year or during the fourth year. An example of this is the required 6-month block of "protected" research time toward the end of medical school, named the Areas of Concentration program, that has been successfully implemented at Weill Cornell Medical College. Another example is the Duke medical school curriculum, wherein students learn the core basic sciences in the first year and complete core clinical clerkships in the second year. The students then devote 10 to 12 months to scholarly investigation and fulfill elective rotations in the third and fourth years. Thus, by condensing the traditionally structured training from 4 years into 3 years, the Duke medical school curriculum provides students with ample opportunity to pursue their own independent research interests. Finally, active physician-scientists must be brought back onto inpatient services for attending and teaching rounds in partnership with hospitalists, who should maintain responsibility for supervision and oversight. Not only would this kind of arrangement permit continued exposure of clerkship students and residents to the scientific underpinnings of medical practice, but it would also provide the hospitalists with the same and the physician-scientists with much needed exposure to the current realities of clinical practice. As always, we welcome your thoughts about how to train the next generation of translational scientists, either through social media (#JACC:BTS) or by e-mail (jaccbts@acc.org).

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