

Personalized medical education: Reappraising clinician-scientist training

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Revitalizing the Oslerian ideal of the clinician-scientist-teacher may help in the training of the next generation of translational researchers.

William Osler's ideal of the clinician-scientist-teacher not only set standards for medical education on both sides of the Atlantic more than a century ago, it also holds solutions for the training of the next generation of translational researchers today. Having pioneered modern bedside teaching in Canada and the United States in the late 1800s, Osler was appointed Regius Professor of Medicine at the University of Oxford in 1905. Upon his arrival from Johns Hopkins to Oxford, he discovered that, in England, research and preclinical medical education in universities were dissociated from clinical practice and postgraduate training in hospitals. Because Osler was convinced that future advances in medical education and patient care would come from research, he challenged the English medical establishment to integrate research into medical education and patient care under the auspices of a university professor: "The Professor has three duties—to see that the patients are well treated, to investigate disease, and to teach students and nurses" (1). He argued that great scientific discoveries came from "the pursuit of knowledge for its own sake" and that already in the early 20th century, the hallmark of such discoveries was their translatability into practical applications (1). Thus, the enduring challenge in modern medicine is not only scientific innovation but also translation of scientific discoveries into new therapies for the benefit of humanity.

THE CHALLENGES OF A JOINT CLINICIAN-SCIENTIST TRAINING PROGRAM

Today, the challenges identified by Osler are particularly acute in the training of clinician-scientists—clinically qualified physicians sub-

stantially engaged in scientific research. Clinician-scientists can achieve the research skills necessary to engage in cutting-edge science through a variety of educational pathways. Joint MD-PhD programs are widely used in Canada and the United States but are rare in the UK and continental Europe, where medical students and postgraduate trainees (residents) follow various functionally equivalent training pathways in the pursuit of a clinician-scientist career. These range from extensive involvement in research projects and completion of masters-level research degrees during medical training to dedicated research fellowships and clinician-scientist development training after graduation from medical school.

Regardless of country and training pathway, trainees invested in developing both clinical and research expertise face daunting challenges. Because of the increased complexity of modern science and patient care, students in joint MD-PhD programs in North America and their functional equivalents around the world take up to 8 years to complete both degrees. This results in high risks for students, as some drop out during their training—for example, up to 27% of MD-PhD matriculants in the United States (2). Those aspiring clinician-scientists without financial support who persevere must endure mounting student debt and a poor work-life balance. When new clinician-scientists eventually start their independent research careers, they do not get to enjoy a grace period of time, money, and energy necessary to develop new ideas because they are immediately caught up in the race to publish, the struggle to survive from grant to grant, and the ever increasing demands of maintaining medical accreditation.

To add further complexity, obtaining both an MD and PhD does not necessarily a clinician-scientist make. Medical and research degrees differ markedly because they are predicated on fundamentally different approaches. Whereas medical education seeks to provide a platform to teach students to enhance patient benefit while minimizing clinical risk,

research degrees aim to attain the same goal through taking scientific risks. Integrated exposure to these dichotomous (but complementary) ways of thinking is lacking because students pursue medical and research degrees in separated blocks of time. Students spend too much of their time learning at the bench during their scientific research training rather than conducting clinical research or practicing clinical skills at the patient's bedside. The reality is that time for research in medical school is sparse, so that medical students on clinical rotations are often pushed into becoming passive observers of, rather than active participants in, the cutting-edge scientific process. This is further compounded by the growing schism between clinical and research departments in medical schools and postgraduate training programs (3). Many medical school laboratories that previously focused on clinical teaching and clinical investigations have moved out of hospitals to purpose-built institutes and research centers that focus on basic sciences. It is thus not surprising that, increasingly, clinician-scientists struggle to capitalize on their clinical and research expertise to perform innovative translational research.

Despite the creation and spread of joint MD-PhD degrees in North America in the 1960s, the above-mentioned challenges have adversely affected the ability of clinician-scientists to innovate. This is best illustrated by the training pathways of Nobel Laureates in Physiology or Medicine, the Nobel Prize being a robust marker of scientific innovation. By examining the biographies of 210 Nobel Laureates in Physiology or Medicine awarded since 1901 and posted on the Nobel Prize website (4), we found a steady decline in the proportion of clinician-scientists awarded the Nobel Prize in Physiology or Medicine (Fig. 1). Clinician-scientists accounted for 73% of Nobel Laureates in Physiology or Medicine from 1901 to 1960; from 1961 to 2015, their proportion dropped to 42%. In contrast, the proportion of Nobel Laureates in Physiology or Medicine who are nonclinically trained scientists has increased from 27% in 1901–1960 to 58% in 1961–2015. The shift in predominant career pathways of Nobel Laureates in Physiology or Medicine from clinician-scientists to nonclinically trained scientists in part reflects the shift of the most awarded areas from human diseases until 1960 to basic molecular biology and genetics after 1960. The downside of this shift is that most basic science discoveries have yet to be translated into therapies and improved patient care,

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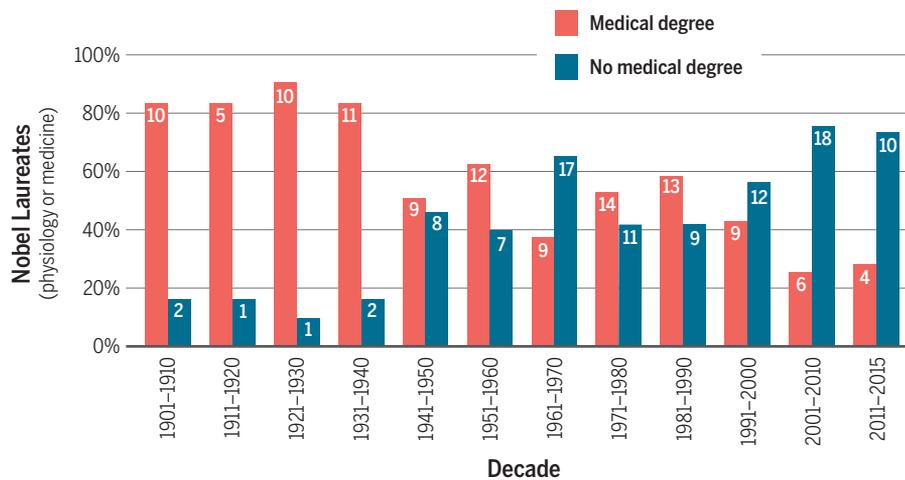


Fig. 1. The greatest prize of all. Shown are Nobel Laureates in Physiology or Medicine by medical degree, 1901–2015. A steady decline in the proportion of clinician-scientists awarded the Nobel Prize in Physiology or Medicine has led to a shift in predominant career pathways of Nobel Laureates in Physiology or Medicine from clinician-scientists to nonclinically trained scientists. Bars indicate proportions; figures in the bars indicate absolute numbers. A Nobel Prize was not awarded in 1915–1918, 1921, 1925, or 1940–1942. [Source: Biographies of Nobel Laureates on the Nobel Prize website (4).]

whereas the burden of chronic disease associated with the 21st century's aging population is escalating.

INTEGRATION OF CLINICAL AND RESEARCH EDUCATION

After a crisis in the numbers of clinician-scientists in the UK in the early 2000s, government, industry, medical research charities, and universities recognized the need to strengthen clinical research and innovation in the National Health Service (NHS) for the benefit of patients. To achieve this, a wide group of stakeholders chaired by Mark Walport, then director of the Wellcome Trust, set out to modernize medical careers in the UK (5), and the government created the National Institute for Health Research (NIHR) (6). Within this framework, Oxford academic and healthcare partners established the Oxford University Clinical Academic Graduate School (OUCAGS) (7), which is aimed at better integrating the exposure to clinical practice, research, and teaching as advocated by Osler. In addition to traditional masters and doctoral programs for aspiring clinician-scientists, OUCAGS offers new NIHR-funded training pathways based on Walport's recommendations: academic clinical fellowships allowing trainees to undertake 25% research and 75% clinical training over 3 to 4 years, usually, to develop a proposal for a doctorate; and clinical lectureships allowing trainees to undertake 50% research and 50% clinical training

over 4 years, usually, to conduct postdoctoral research and teaching. The faculty and trainees are particularly enthusiastic about these new pathways because they attempt to bridge the organizational divide between the university and the hospital and enable trainees to develop and pursue their own line of research. Moreover, funding for academic clinical fellowship and clinical lectureship posts comes predominantly from NIHR, reflecting the societal importance of translational clinical research.

Although the implementation of NIHR and OUCAGS has helped to narrow the gap between clinician and scientist, it has highlighted the pressing need to develop more integrated, dynamic, and flexible clinician-scientist training programs that span the entire continuum of undergraduate and postgraduate education and training. We believe that to achieve this, we need to revitalize the Oslerian ideal of the clinician-scientist-teacher. First, the integration of clinical training and exposure to research needs to be strengthened. Second, teaching and mentorship need to be equal partners with research and patient care. Third, scientifically innovative translational research for patient benefit needs to become the *raison d'être* of clinician-scientist training and careers. It is time for a seismic shift in the way the next generation of clinician-scientists is educated.

Exposure to and involvement in clinical translational research throughout medical school and postgraduate specialty training is

a key tenet. Trainees interested in a clinician-scientist career should be given an opportunity to undertake a simultaneous parallel research path during medical school and residency. Protected time would be given to pursue short research projects relevant to curricular modules of interest throughout the medical school course. For example, a student learning the fundamentals of cardiology in the classroom or at the bedside could take a short detour from their "standard" medical course to pursue a research project in that field. The duration of dedicated research project time would need to be flexible (such as 2 to 6 months) to accommodate project goals and demands. This would facilitate the introduction and consolidation of core medical principles while contributing to cutting-edge science.

Trainees would be expected to devise a personalized curriculum to enable them to weave research in and out of the regular medical school and residency curriculum. In so doing, contextual knowledge and real-world experiences (clinical and scientific) would be married through a problem-solving based approach. Time allotted to the acquisition of core medical knowledge, bedside apprenticeship, and research training would be dependent on competency-based outcomes and not restricted to time-fixed rotations. The duration of research exposure throughout the degree course would vary according to the trainees' needs and interests, with the candidate potentially being awarded a higher research degree (such as MSc or PhD) arising from their scientific contributions. This system would provide a distinct platform to arm the emerging clinician-scientist with the skills needed to be adequately trained in providing an excellent clinical service at the bedside while taking scientific risks at the bench for the betterment of patient care.

VALUE OF TEACHING AND MENTORSHIP

Critical to the success of such a system would be close mentorship of trainees by dedicated, established clinician-scientists, similar to the Oslerian ideal. The personalized nature of the proposed training program would require the close guidance and regular critical appraisal of a trainee's performance from an assigned mentor, who would oversee their clinical and research activities. Enthusiastic clinical researchers from a range of specialties would supervise research projects while interacting regularly with the trainee's mentor to discuss progress and to mobilize support. The

time-intensive nature of such an “apprenticeship” would necessarily limit the number of trainees selected on a competitive basis to pursue this path (less than 10% of a medical school class because of mentorship and resource limitations). Further, institutions would be expected to protect the time of talented clinician-scientist educators and mentors so that they may engage adequately with clinician-scientist candidates. The stale but pervasive view that educators are failed clinicians or scientists requires dismantling, and the integral role of teaching as part of clinician-scientist training demands resurrection. The means by which institutions evaluate “academic contribution” needs careful reconsideration.

IMPORTANCE OF INNOVATION AND TRANSLATION

Scientifically innovative translational research for patient benefit needs to become the *raison d'être* of clinician-scientist training and careers. To achieve this goal, clinician-scientist training needs to be recalibrated from molding the brightest clinicians into basic scientists to training clinicians to translate basic science discoveries into health benefits for local and global patient communities. Therefore, it would be important to maximize involvement of trainees in clinical and research organizations that are funded by taxpayers to focus on impactful translational research. For example, institutions with Clinical and Translational Science Awards (CTSAs) in the United States and Biomedical Research Centres (BRCs) in the UK could offer prime environments and partial resources for clinician-scientist training. Given that some of the greatest health benefits can be achieved at

the level of health systems and global populations, clinician-scientist programs would also need to include medical humanities, social sciences, public health policy, health services research, and leadership and management training to change suboptimal health systems and social structures.

Last, government and society as a whole need to encourage and recognize impactful translational research. Funders of health research should encourage translational research by basing funding awards on the impact of the research on patients rather than according to academic outputs. For example, the current Research Excellence Framework exercise in the UK seeks to allocate 20% of taxpayers' funding in medicine and all other academic disciplines to universities on the basis of the societal and economic impact of their research. It is also important for society to raise the profile of translational research and recognize achievements of clinician-scientists. Prestigious scientific awards and prizes need to better balance recognition of innovative scientific discovery with impactful translational research leading to substantial clinical benefit. Translational medicine has evolved sufficiently as a discipline to warrant a high-profile award analogous to the Fields Medal or Nobel Prize.

CONCLUSIONS

We are at a critical juncture in the field of medicine and scientific discovery, where the burden of chronic disease is escalating and the translational impact of research is falling further behind. By strengthening the integration between clinical training and exposure to research, enhancing the value of teaching and mentorship, and encouraging scientific inno-

vation and translation for patient benefit, the next generation of clinician-scientists will be better poised to overcome the medical challenges of this century. In so doing, we stand to benefit from the humanistic value of their research, which would be deserving of the most prestigious of scientific awards.

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