# 5 Strategies to Facilitate the Development of Physician-Scientists during Undergraduate and Postgraduate Medical Education

**Keywords:** Research; Medical Education; Physician-Scientist; Training

**Mimi Deng[1], Leonardo Martin Calderon[2], Ricarda M. Konder[3], Portia Tang[4]**

[1]Faculty of Medicine, University of Ottawa, Ontario, Canada
[2]Faculty of Medicine, University of Ottawa, Ontario, Canada
[3]Faculty of Medicine, Dalhousie University, Nova Scotia, Canada
[4]Faculty of Medicine, Queen's University, Ontario, Canada

## ABSTRACT

In the last decade, there has been a discrepancy between the increasing recognition for research involvement in medical training and the stagnation in the number physician-scientists. Health research funding cutbacks, inadequate mentorship, heavy schedules, and unfamiliarity with scientific methodology are obstacles that limit research interest amongst junior medical learners and cause attrition of promising physician-scientists in training. This article outlines five strategies to promote and facilitate the development of physician-scientists: (1) partnerships between healthcare and academia, (2) increasing admission to MD/PhD and Clinical Investigator programs, (3) establishing fundamentals of scientific thinking, (4) long-term research mentorship, and (5) facilitating knowledge translation.

## RÉSUMÉ

Au cours de la dernière décennie, il y a eu un écart entre la reconnaissance croissante de l'implication de la recherche dans la formation médicale et la stagnation du nombre de médecins-scientifiques. Les coupures de financement pour la recherche dans le domaine de la santé, le mentorat inadéquat, les horaires chargés et la méconnaissance de la méthodologie scientifique sont tous des obstacles qui limitent l'intérêt des jeunes étudiants en médecine pour la recherche et provoquent l'attrition de médecins scientifiques prometteurs. Cet article présente cinq stratégies visant à promouvoir et à faciliter le développement de médecins scientifiques : (1) partenariats entre le secteur des soins de santé et le monde universitaire, (2) augmenter l'admission aux programmes MD/PhD de formation en médecine ainsi qu'aux programmes de formation en recherche clinique, (3) établir les bases de la pensée scientifique, (4) assurer un mentorat en recherche à long terme, et (5) faciliter l'application des connaissances.

## INTRODUCTION

Research engagement by medical trainees is beneficial for both professional development and quality of patient care (1, 2), whether it's developing skills in analytical thinking and communication or staying on the forefront of best practice. Consequently, Scholar is one of the Canadian Medical Education Directives for Specialists (CanMEDS) roles (3). Early and positive research exposure is critical to inspiring the development of physician-scientists. Given

their unique skillset at the intersection of clinical discovery and application, physician-scientists are often catalysts for knowledge translation (4). Despite this understanding, the total number of physician-scientists engaged in research has stagnated in the past decade (5).

In 2014, 1.5% of all practicing physicians in the United States reported research as their primary activity, compared to 5% in 1987, even though the number of MD/PhD and Clinician Investigator Program (CIP) positions has been increasing (6). This trend can be attributed to research becoming a predominantly MD/PhD engagement and decreasing in popularity amongst MDs. Research resources are already limited for MD/PhD and CIP programs, and funding allocation favours already established investigators (7). In 2015, the Canadian Institutes of Health Research announced the phasing out of the Clinician Scientist Training Awards, equivalent to $1.8 million CAD that has traditionally been awarded to more than 100 MD/PhD students in training (8, 9). In addition, the technologies and expertise conducive to innovation are often inaccessible outside of large academic centres, thus geographically restricting the types of research projects that can be conducted. As the aging physician-scientist population wind down their careers and shift into retirement or clinical practice exclusively, the incoming generation is lacking mentors to guide them in navigating the complexities of the physician-scientist identity (7). In other words, the absence of robust and comprehensive support systems can force the students' hand in forfeiting a career in research. In particular, the transition between clinical or post-doctoral fellowship and starting an independent research position is especially vulnerable to attrition (10).

From the medical student's perspective, the duality of physician-scientist may be losing its appeal for logistical and personal reasons. Competency in both medical practice and scientific research comes at the cost of a substantially prolonged education. By the time physician-scientists become hospital staff or chief investigators, their medical school colleagues will have already seen years of clinical practice. Furthermore, engaging in research on top of a dense medical curriculum (among other obligations) is challenging and can be discordant with the current movement towards work-life balance in the healthcare profession (11). Aside from the fear of burnout, students may be hesitant to commit heavily to research given the plethora of non-academic endeavours, such as involvement in health policy and advocacy, international health, and social accountability, which may be of interest. Compounded with an emphasis on developing clinician skills as the primary objective of medical education, it comes as no surprise that research has fallen out of favour.

A 2010 cross-sectional survey on the attitudes of Canadian medical students towards research revealed that although the majority (76%) of medical students are interested in research, prominent barriers include time, availability of research mentors, and lack of formal teaching on scientific methodology (12). Herein, we outline five strategies to promote the development of physician-scientists in undergraduate and postgraduate medical education programs.

## 1. REMOVING RESEARCH AND EDUCATIONAL SILOS

The first step in introducing students to the multidisciplinary teamwork behind innovation involves removing silos between healthcare and academia. In Germany, the government has created six new health centres in biomedicine as part of the nation's largest scientific organization (13). The Helmoholtz Association – Research for Grand Challenges comprises 18 educational and health institutions that work together to tackle environmental and common health concerns, including diabetes, cancer, dementia, infectious disease, cardiovascular disease, and lung disease (14). Many American universities have successfully integrated universities and hospitals through the Flexner model (15). Conceived by the educational reformist, Abraham Flexner, this model recommends the affiliation of hospitals with medical universities to ensure a strong research focus behind healthcare decision-making. A notable example of the Flexner model is John Hopkins University School of Medicine and John Hopkins Hospital and Health System, known collectively as Johns Hopkins Hospital (JHM). JHM is an integrated health enterprise that brings together scientists and physicians across six academic and community hospitals, four suburban healthcare and surgical centres, and 39 outpatient sites (16). The University of Ottawa Heart Institute's affiliation with the University of Ottawa and The Ottawa Hospital enables provision of specialized cardiovascular education, research, and patient care (17). Partnership between healthcare and academia yields opportunities in knowledge

translation that inspire the next generation of clinician-scientists (15).

## 2. SUPPORTING MD/PHD AND CIP PROGRAMS

One of the most salient examples of training physician-scientists is the MD/PhD program offered at 15 of 17 medical schools across Canada, with the number of successful MD/PhD applicants ranging from three to 10 depending on the school (18). According to a recent survey of the Canadian MD/PhD program alumni, 53% had been principal investigators on at least one recent funded project and 44% have dedicated at least half of their time to research. The postgraduate equivalent to the MD/PhD program is the CIP program, which enables residents to pursue formal research training within a Royal College-accredited program. Many CIP graduates obtain academic appointment with protected time for research after completing residency, with 39% receiving external award funding (19). MD/PhD and CIP programs are effective at producing competent and motivated clinician-scientists. There is merit in increasing the number of MD/PhD and CIP spots in medical school and residency, respectively, with a focus on professional and financial support in critical periods of transition.

## 3. TEACHING THE FUNDAMENTALS OF SCIENTIFIC METHODOLOGY

One of the barriers to medical student engagement in research is the lack of structured education surrounding scientific methodology and statistical analysis (12). The University of Tennessee Health Science Center and Vanderbilt University have a unique National Institutes of Health-sponsored Medical Student Research Fellowship (MSRF) program that offers lectures in scientific methods alongside research involvement (20). A longitudinal study following 1000 students enrolled over 25 years found that there was significantly more interest in academic careers amongst MSRF alumni, compared to students who did not attend the program. In addition, one-third of MSRF graduates reported that research was a significant part of their post-residency careers (20). Similarly, the Professional Student Mentored Research Fellowship (PSMRF) program at the University of Kentucky College of Medicine begins their longitudinal, mentored research project with an Introduction to Clinical Research course that offers: (1) core lectures on research ethics, data analysis, and manuscript review, and (2) discussion with clinician-scientists on balancing clinical and research careers, evidence-based medicine, and translational research (21). PSMRF students are 50% more productive in publishing research during medical school (21).

## 4. LONGITUDINAL RESEARCH MENTORSHIP IN MD PROGRAMS

Another solution to consider is establishing a standardized longitudinal research track for medical students involving protected research time. The University of Michigan has a program titled The Scientific Discovery Path of Excellence (22), in which medical students outside the MD/PhD program receive research guidance from faculty, which culminates in a capstone research project. Similarly, the Research in Medicine (RIM) program at Dalhousie University pairs their first-year medical students with a research mentor to begin a four-year research project from scratch, starting from developing a research question, drafting a proposal, attaining Research Ethics Board approval and conducting investigations, to manuscript writing and submission (23). RIM requirements include a research presentation in at least one academic meeting and a manuscript submission of publishable quality. These programs standardize research experience and allow students to oversee a project from inception to completion. It would be worthwhile to pilot similar research initiatives in other Canadian medical schools to introduce students to the physician-scientist identity.

## 5. EMPHASIZING KNOWLEDGE TRANSLATION

Knowledge translation describes the application of basic science research to clinical guidelines and medical technologies, or more colloquially referred to as “bench-to-bedside” research (24). As future medical professionals, medical students are well-positioned to engage in translational research as they will be able to identify the medical issues that can benefit from further work in knowledge translation. In recent years, the merit of translational research has become increasingly recognized. In 2016, a research team at Sick Kids Hospital in Toronto delineated a new cancer surveillance protocol that dramatically improves survival for patients with Li-Fraumeni syndrome, a hereditary disease associated with significant

cancer risk. Five-year survival was 89% for people who underwent surveillance compared to only 60% for those who did not (25). Another example is the amendment in dosing of hormone therapy for prostate cancer. Intermittent androgen deprivation therapy demonstrates comparable efficacy to continuous treatment, but reduced adverse events (26). Translational research instills medical trainees with the importance of research stewardship. Seeing their research endeavours manifest to improve the lives of their patients and communities can help reduce the estimated 17-year delay between scientific discovery and clinical implementation (27).

## CONCLUSION

Allowing medical trainees to gain the confidence in incorporating research into their future careers begins with positive research exposure in undergraduate medical education and residency. This can be achieved through integrated academic healthcare centres, support for MD/PhD and CIP programs, formal education on scientific methodology, longitudinal research mentorship programs, and developing competencies in knowledge translation. Despite the financial implications of the aforementioned strategies, investing in physician-scientists is worthwhile as they are in a unique position to conduct high-quality research that can greatly contribute to the medical field. The role of studentships in inciting research interest amongst junior medical learners has been well-investigated. However, further research should be performed on trajectory of research interest as clinical learners enter practice. Understanding the downstream challenges affecting budding physician-scientists will inform how research processes can be systemically improved.

## REFERENCES


1. Laidlaw A, Aiton J, Struthers J, Guild S. Developing research skills in medical students: AMEE Guide No. 69. Med Teach. 2012;34(9):e754-771.
2. Collier AC. Medical school hotline: importance of research in medical education. Hawaii J Med Public Health. 2012 Feb;71(2):53–6.
3. Frank JR, Danoff D. The CanMEDS initiative: implementing an outcomes-based framework of physician competencies. Med Teach. 2007 Sep;29(7):642–7.
4. Archer SL. The making of a physician-scientist—the process has a pattern: lessons from the lives sof Nobel laureates in medicine and physiology. European heart journal. 2007;28(4):510-4.
5. NIH RePORT - Physician Scientist Workforce Report 2014 [Internet]. [cited 2020 Jul 10]. Available from: https://report.nih.gov/Workforce/PSE/index.aspx.
6. Davila JR. The Physician-Scientist: Past Trends and Future Directions. Michigan Journal of Medicine. 2016;1(1).
7. Daniels RJ. A generation at risk: Young investigators and the future of the biomedical workforce. PNAS. 2015;112(2):313–8.
8. Webster PC. CIHR cutting MD/PhD training program. Canadian Medical Association Journal. 2015;187(12).
9. Sater L, Schwartz JS, Coupland S, Young M, Nguyen LHP. Nationwide study of publication misrepresentation in applicants to residency. Med Educ. 2015; 49: 601-11.
10. Eisen A, Eaton DC. A Model for Postdoctoral Education That Promotes Minority and Majority Success in the Biomedical Sciences[Internet]. CBE Life Sci Educ. 2017;16(4). [cited 2020 Jul 11]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5749967/
11. Fernandez Nievas IF, Thaver D. Work–Life Balance: A Different Scale for Doctors [Internet]. Front Pediatr 2015;3. [cited 2020 Jul 10]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4689844/.
12. Siemens DR, Punnen S, Wong J, Kanji N. A survey on the attitudes towards research in medical school. BMC Med Educ. 2010 Jan 22;10:4.
13. Bornstein SR, Licinio J. Improving the efficacy of translational medicine by optimally integrating health care, academia and industry. Nat Med. 2011;17(12):1567–9.
14. Groß M, Stauffacher M. Transdisciplinary Environmental Science: Problem-oriented Projects and Strategic Research Programs. Interdisciplinary Science Reviews. 2014;39(4):299–306.
15. Ebert RH. Flexner's model and the future of medical education. Acad Med. 1992 Nov;67(11):737–42.
16. Relationship Between JHU & JHM [Internet]. JHU Board of Trustees. [cited 2020 Jul 11]. Available from: https://trustees.jhu.edu/relationship-between-jhu-jhm/
17. Cardiac Translational Research Laboratory [Internet]. University of Ottawa Heart Institute. [cited 2020 Jul 11]. Available from: https://www.ottawaheart.ca/research-team/cardiac-translational-research-laboratory
18. Skinnider MA, Squair JW, Twa DDW, Ji JX, Kuzyk A, Wang X, et al. Characteristics and outcomes of Canadian MD/PhD program graduates: a cross-sectional survey. CMAJ Open. 2017 Apr 25;5(2):E308–14.
19. Hayward CP, Danoff D, Kennedy M, Lee AC, Brzezina S, Bond U. Clinician investigator training in Canada: a review. Clin Invest Med. 2011 Aug 1;34(4):E192.
20. Solomon SS, Tom SC, Pichert J, Wasserman D, Powers AC. Impact of Medical Student Research in the Development of Physician-Scientists. Journal of Investigative Medicine. 2003;51(3):149–56.
21. Areephanthu CJ, Bole R, Stratton T, Kelly TH, Starnes CP, Sawaya BP. Impact of Professional Student Mentored Research Fellowship on Medical Education and Academic Medicine Career Path. Clin Transl Sci. 2015 Oct;8(5):479–83.
22. Research Guides: Scientific Discovery Path of Excellence - An Information Resource Starter Kit: Getting Started [Internet]. Library Research Guides. [cited 2020 Jul 10] Available from: http://guides.lib.umich.edu/DiscoveryPoE.
23. RIM Mentorship [Internet]. Dalhousie University. [cited 2020 Jul 11]. Available from: https://medicine.dal.ca/research-dal-med/Faculty-staff/benefits.html
24. Bornstein SR, Licinio J. Improving the efficacy of translational medicine by optimally integrating health care, academia and industry. Nat Med. 2011;17(12):1567–9.
25. Raskind WH, Hisama FM, Bennett RL. Biochemical and imaging surveillance in Li-Fraumeni syndrome. The Lancet Oncology. 2016;1;17(11):e472.
26. Magnan S, Zarychanski R, Pilote L, Bernier L, Shemilt M, Vigneault E, et al. Intermittent vs Continuous Androgen Deprivation Therapy for Prostate Cancer: A Systematic Review and Meta-analysis. JAMA Oncol. 2015;1(9):1261–9.
27. Canadian Institutes of Health Research [Internet]. Ottawa, ON: Knowledge translation in health care: Moving from evidence to practice. [cited 2020 Jul 10].Available from: http://www.cihr-irsc.gc.ca/e/40618.html