Training the next generation of Canadian Clinician-Scientists: charting a path to success

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Abstract

Clinician-scientists are physicians with training in both clinical medicine and research that enables them to occupy a unique niche as specialists in basic and translational biomedical research. While there is widespread acknowledgement of the importance of clinician-scientists in today's landscape of evidence-based medical practice, training of clinician-scientists in Canada has been on the decline, with fewer opportunities to obtain funding. With the increasing length of training and lower financial compensation, fewer medical graduates are choosing to pursue such a career. MD-PhD programs, in which trainees receive both medical and research training, have the potential to be an important tool in training the next generation of clinician-scientists; however, MD-PhD trainees in Canada face barriers that include an increase in medical school tuition and a decrease in the amount of financial support. We examined the available data on MD-PhD training in Canada and identified a lack of oversight, a lack of funding and poor mentorship as barriers experienced by MD-PhD trainees. Specific recommendations are provided to begin the process of addressing these challenges, starting with the establishment of an overseeing national body that would track long-term outcome data for MD-PhD trainees. This national body could then function to implement best practices from individual programs across the country and to provide further mentorship and support for early-career physician-scientists. MD-PhD programs have the potential to address Canada's growing shortage of clinician-scientists, and strengthening MD-PhD programs will help to effect positive change.

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The practice of medicine today is reliant more than ever before on the body of knowledge obtained through rigorous clinical trials and biomedical research. The emergence of this trend of "evidence-based medicine" has created a strong demand for clinician-scientists who are able to translate the results of research studies into practice [1]. Whereas a clinician practices medicine according to the best available evidence, a clinician-scientist pushes the boundaries of that body of evidence further. Strictly speaking, clinician-scientists are physicians who have undertaken additional research training and assume roles in academia that combine medical practice with health or basic science research [2,3].

Despite the increasing importance of the clinician-scientist in today's environment of evidence-based medical practice, the training environment of clinician-scientists in Canada, especially for MD-PhD trainees, has deteriorated significantly in recent years. Increased training length, combined with decreased availability of financial support, has meant that the clinician-scientist training pathway has become less attractive.

In this paper, we give an overview of the current situation for clinician-scientist, especially MD-PhD, training in Canada and provide some evidence-based recommendations on how the training process could be improved. These recommendations have been endorsed by both the Canadian Federation of Medical Students (CFMS), which represents more than 8,000 medical students at 14 Canadian medical schools across the country, and the Clinician Investigator Trainee Association of Canada (CITAC), which represents MD-PhD and Clinician Investigator Program (CIP) trainees in Canada. Our recommendations will be of interest to members of the Canadian Society for Clinical Investigation (CSCI) and others in Canada concerned for the future of clinician scientists.

Historical Perspective on MD-PhD Training

In 1964, in response to the increasing concern in the United States about the decline in the number of physicians with biomedical research as a component of their careers, the USA National Institutes of Health (NIH) initiated the highly competitive and prestigious Medical Scientist Training Program (MSTP) [4]. Students in the MSTP stream had both clinical and formal research components in their training, obtaining both an MD and a PhD at its conclusion.

Joint MD-PhD programs grew rapidly in the US over the following two decades, producing a steady stream of outstanding medical scientists who were leaders in both academic research and clinical practice. In 1984, the University of Toronto was the first institution in Canada to establish a MD-PhD program, followed by McGill University and the University of British Columbia in 1985. In the last 30 years, MD-PhD programs have expanded nationwide and are now offered in 14 of the 17 medical schools in the country.

In 1995, the Canadian Institutes of Health Research (CIHR) developed a MD-PhD Studentship Program grant. The last existing iteration of this grant was awarded annually to MD-PhD Program Directors and individually administered at each institution. In 2010, 52% of MD-PhD trainees (88/170) nation-wide were fully funded; however, many trainees still needed to apply for other funding sources, such as the CIHR Banting and Best Doctoral Awards or Vanier Canada Graduate Scholarships, for support [5]. In some cases, there was dedicated institutional funding available for MD-PhD trainees, although the amount of funds available was quite variable between institutions. The MD-PhD Program Grants represented 0.15% of CIHR's $1.8 billion annual operating budget in 2015 [6].

Historically, there has been little capacity to track the number of MD-PhD trainees on a national level. One study looking at enrollment in MD-PhD programs in Canada found a 53% increase in MD-PhD trainees across the country between 2002 (111 enrolled) and 2010 (170 enrolled) [5]. A report by the Royal College of Physicians and Surgeons of Canada (RCPSC) Clinician Scientist Working Group reports that a total of 234 MD-PhD trainees graduated from undergraduate medical training in a nine-year period from 2004-2013 [2].

Current State of MD-PhD Programs

Medical school tuition fees have risen dramatically over the past two decades. Canadian medical students now expect to take out loans of well over $100,000 and receive little financial support from the government [7-9]. While this trend impacts all medical students, MD-PhD trainees are disproportionately affected due to increased years of training and a delay in income earning [10]. MSTP attempts to compensate for this delay by providing MD-PhD trainees in the USA with significant scholarship support and a tuition waiver—but no such equivalent program exists in Canada [11].

A decline in the popularity of the clinician-scientist career pathway, especially in basic science, also poses a problem. Data from the USA indicated that there has been a decline in the number of clinician-scientists who hold primary appointments in a basic science department [12]. This decline in popularity, combined with the rising average age at which new clinician-scientists obtain their first major research grant (37.0

years of age in 1985 *versus* 44.3 years in 2011) [13], present a serious threat to the clinician-scientist career pathway. A study from the University of British Columbia indicated that securing salaries and funding for research were two of the key barriers for newly trained clinician-scientists [14]. Clinical faculty members typically earn more than research faculty members, largely because academic centers pay clinician -scientists less for time spent on research commitments [2,14].

Clinician-scientist training in Canada is currently in a period of turmoil. Funding for MD-PhD programs has undergone substantial change in recent years. In June of 2015, the CIHR announced the termination of the MD-PhD Program Grants starting in 2016 [15]. This move was a significant blow to clinician-scientist training in Canada, removing an important incentive for students looking to apply to MD-PhD programs in this country and potentially jeopardizing the ability of MD-PhD programs to provide longitudinal support for trainees. A number of groups questioned this sudden decision, especially in light of a shortage of clinician-scientists [6,16]. Others have pointed out that Canada currently lacks both a strategic direction and a roadmap for clinician-scientist training [17].

Impact of MD-PhD Training

There is considerable evidence from the USA showing that graduates of clinician-scientist training programs preferred to pursue a career focused on research and were approximately ten times more likely than their MD-only peers to express an intention to pursue research [12,18-20]. Data from Canadian institutions are in the process of being collected, but can be expected to be similar to those of their USA counterparts.

Perhaps unsurprisingly, trainees in clinician-scientist programs are more likely to have an interest in either pursuing research as a primary component of their career or to have research as a significant component of their clinical practice. In a survey of nearly 80,000 residents and practicing physicians who graduated from USA medical schools, respondents who had graduated from MD-PhD programs were significantly more likely to indicate they were planning on pursuing a career either "exclusively" or "significantly involved" in research (81.2%) compared with respondents who had graduated from MD-only programs (11.0%) [18].

Early interest in research amongst clinician-scientist trainees correlates with greater involvement in research during professional practice. A 2010 study on the career trajectories of former trainees in 24 USA MD-PhD programs revealed that 81% were employed in academia, research institutes or the private sector and that two-thirds reported devoting more than half of their time to research [12]. A 1991 study of 72 graduates of the Washington University MSTP program showed that 86% were employed in academic institutions, and that 83% reported spending at least 75% of their time in research [18]. These data are consistent with the observation that clinician-scientists today are both less likely to be involved in research and tend to obtain their first major research grant at a later age than in the 1980s, with the average age for first-time R01 grant holders increasing from 37 in 1985 to 44 in 2011 in the USA [21].

While it is difficult to quantify the precise impact clinician-scientists have on the process of translating research into clinical practice, it is troubling that the decline in clinician-scientists has coincided with an increase in the gap between research and clinical practice [22,23]. This trend is partially attributable to the separation of clinical and basic research. Whereas in 1970 the number of NIH grants awarded to MD investigators approximately matched the number awarded to PhD investigators, by 2005 PhD investigators received 2.5 times the number of grants that MD investigators received [21]. This reflects both a decline in the number of physicians who were engaged in research and a growth in the number of PhD investigators and the number of those investigators engaged in biomedical and clinical research. Simultaneously, while the number of clinicians increased in the past four decades, the number of clinicians involved primarily in research has remained static [21].

Recommendations on Clinician-Scientist Training

To prioritize the training of MD-PhDs and other clinician-scientists, a National Committee on Clinician-Scientist Training must be formed to mitigate barriers while enhancing and unifying training across Canada (see Figure 1). We believe that the CIHR, along with other stakeholders, is best suited to lead the creation and operation of such a national body. In the USA, the NIH currently assumes the responsibility of funding MSTP programs in addition to tracking enrollment and outcomes for MSTP trainees—although it has been pointed out that the tracking of outcomes by the NIH needs be to improved [24]. In Canada, the CIHR has an analogous mandate to "excel ... in the creation of new knowledge and its translation into improved health" [25], which aligns with the mission of training new clinician-scientist. Furthermore, CIHR already oversees scientist training awards and grants, where shared administrative resources and knowledge of implementing training and funding priorities exists. As recently as 2013, public CIHR reports have committed to leadership in scientist

training, including explicit references to clinician-scientists. The Strategy for Patient-Oriented Research external advisory committee, which included senior CIHR leadership, acknowledged that efforts "need to stabilize [Canada's] shrinking cadre of physician-scientists" [26]. Together, these factors identify CIHR as the central stakeholder for forming the national body and through their mandate, provides CIHR the operational incentive to capture political support for this initiative.

CIHR is not alone in their support of clinician-scientists and must be encouraged and supported by other stakeholders. The Association of Faculties of Medicine of Canada (AFMC) is "the voice of academic medicine in Canada" and, thus, another central stakeholder in this mission [27]. The AFMC currently collects data on Canada's MD graduates through

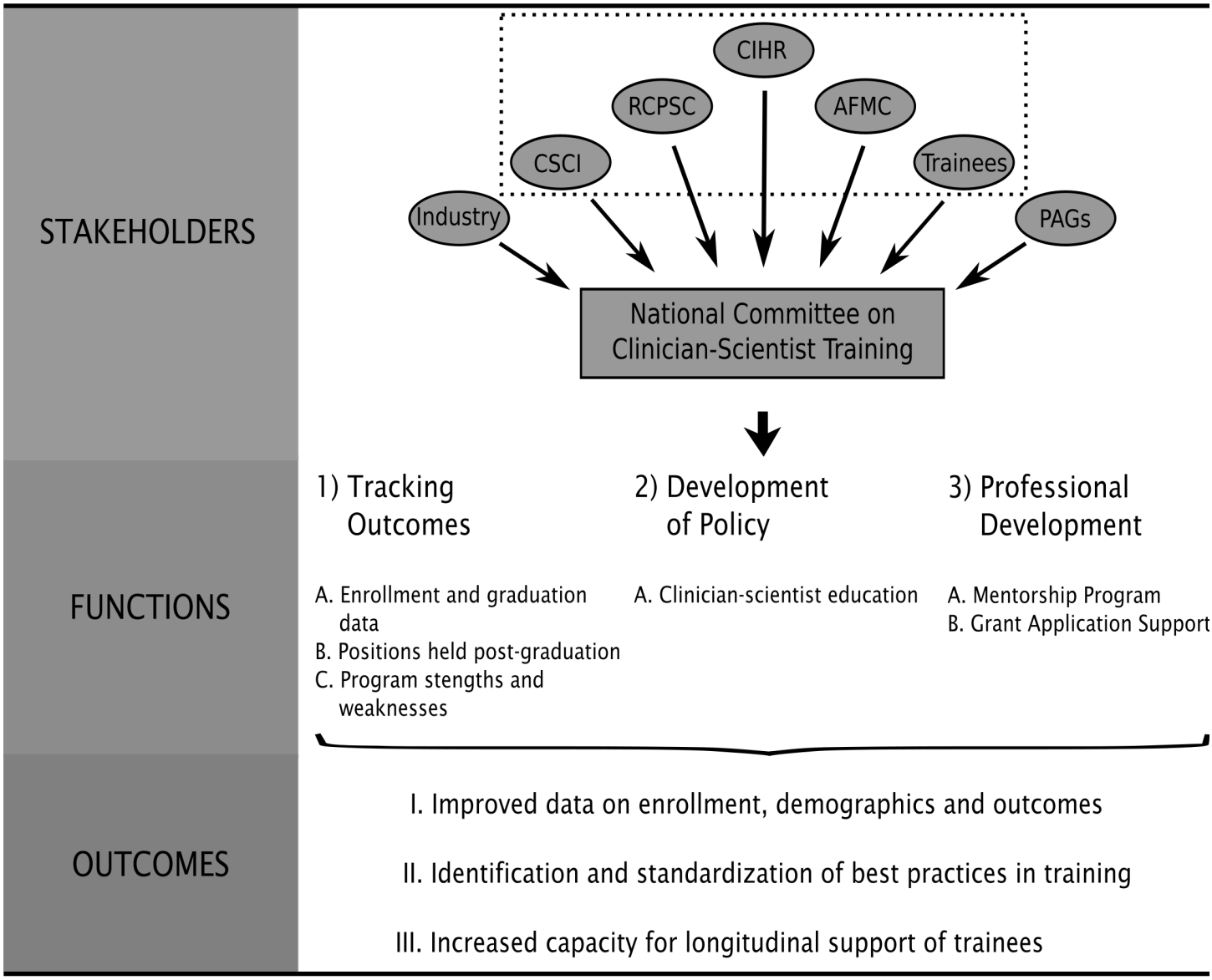

FIGURE 1. Proposed structure of a national body overseeing MD-PhD training in Canada. Overview of the stakeholders, functions and expected outcomes of a national body tasked with overseeing clinician-scientist training in Canada. Proposed core stakeholders, denoted by the dotted line are: CIHR (Canadian Institutes of Health Research), RCPSC (Royal College of Physicians and Surgeons of Canada), the Association of Faculties of Medicine of Canada (AFMC), CSCI (Canadian Society for Clinical Investigation), and Trainee organizations (CFMS (Canadian Federation of Medical Students) and CITAC (Clinician Investigator Trainee Association of Canada). Additional stakeholders essential for focused aspects of the committee's mandate are Patient Advocacy Groups (PAGs) and Industry Groups.

their CAPER database and could provide essential resources on education policy and outcomes tracking. The Royal College of Physicians and Surgeons of Canada (RCPSC) is another stakeholder that already, in some provinces, administers and funds the Clinician-Investigator Program and Surgeon-Scientists Training Program. Their familiarity with training at the post-graduate medical education stage would be key to education policy streamlining, scientific and clinical academic networking and resource allocation. Their prioritization of clinician-scientist training was re-iterated in their 2016 publication on the topic [2]. Other stakeholders, outlined in Figure 1, include trainee groups, like those represented by the authors, as well as patient advocacy groups (PAGs), practicing clinician-scientists (CSCI) and industry groups, including those in pharmaceutical and medical devices.

The main tasks of the national body should be focused enough to be manageable while encompassing areas where barriers to training arise. Policy development on effective clinician-scientist training should be a key pillar, whereby the body acquires data for evidence-based decision making, including tracking trainee and alumni career indicators. These data could include academic positions held, grants and funding obtained and scientific communication metrics (e.g., lay and academic publication numbers and h-index). Creation of a national body would facilitate sharing of this information across various stakeholders and ensure MD-PhD programs, for instance, are providing sufficient support for trainees across Canada in a way that plays to regional strengths and needs. In cooperation with this national body, stakeholder organizations and groups would have the capacity to record and publish trainee and graduate statistics, including outcome measures of program success, which would be established through consultation with existing MD-PhD and post-graduate medical education training programs. Evidence of program effectiveness could be collected and subsequently used to shape education and health policy at a national level.

Individual institutions and organizations are already working on collecting training outcomes [28], but without a national body, proper sharing of knowledge and uniform implementation of successful training strategies will be challenging. As an example, existing evidence suggests that effective mentorship is a crucial factor for clinician-scientist trainee success, but not all MD-PhD programs in Canada have mentorship opportunities [29,30]. A national body will be able to build on this evidence and ensure future investments in training creates opportunities for success for all trainees.

Development of policy, facilitation of knowledge sharing and the collection of evidence on training outcomes must be complemented by supporting clinician-scientist training through administration of grants and awards, as is currently done by the RCPSC at the faculty and fellow levels and by the NIH for USA clinician-scientist trainees. With RCPSC as a key stakeholder, CIHR's current administration of grants and other trainee scholarships, as well as their only recently removed MD-PhD funds, the infrastructure is within reach for a more coordinated and comprehensive approach to funding of clinician-scientist trainees. A national body would also provide a means to pool financial resources from other stakeholders, including PAGs, which often administer their own individual grants to clinical fellows and early-career faculty.

Maintaining longitudinal support for trainees begins with medical school and extends to early-career faculty. In the USA, the NIH has acted similar to our proposed body, tracking outcomes of MD-PhD program trainees. NIH statistics in 2007 and 2008 show that 81% of MD-PhD graduates were employed in academia, research institutes or industry. Of those in academia, 82% of graduates had active research programs in addition to their clinical practice, representing the hallmark of a clinician-scientist [12]. In a survey of alumni of McGill's MD-PhD program, 60% of trainees who have completed residency and fellowship training were working as clinician-scientists [28]. Essential to the success of these programs are sufficient funding and professional development opportunities to maximize trainee success while minimizing barriers to completing training. The NIH has identified that early-career financial support resulted in 60% of clinician-scientists with such support obtaining major research funding later on whereas only 10% did so without support [24]. Early-career funding would additionally help relieve the tension between a clinician-scientist's obligations to research and clinical duties.

Novel areas of training advancement can be explored with a national body. By representing shared interests to train expert clinicians and researchers, there is the potential to incorporate, in an appropriate way, industry groups to share resources and knowledge on commercialization of discoveries, as well to provide financial support. Coordination of pilot programs that help improve and shorten training, while removing barriers to success, can be explored through the committee. Additionally, while the majority of the discussion herein has focused on MD-PhD training, CIP trainee development would also be a mandate of the national body – although we acknowledge that further exploration of the unique needs and requirements of those trainees remains to be done.

Without a change in the prioritizing of clinician-scientist training in Canada, no coordinated effort towards mitigating training barriers for clinician-scientists will be implemented. A concerted group directed towards prioritizing and supporting clinician-scientist training programs can begin to address the barriers of increased debt burden, lengthy training, limited research funding opportunities, limited mentorship and tension between clinical and research responsibilities. Leadership from the core stakeholders must step up and meet, with the intended purpose of creating a National Committee on Clinician-Scientist Training. As described above, shared knowledge and resources exists, and the mandates of these stakeholders align to progress Canada's training programs.

Similar calls for a re-evaluation of the clinician-scientist training process are being made in the USA, with commentators pointing out an urgent need for reducing training time [31,32], improved efforts in clinician-scientist recruitment and career development [32]. These calls in USA recognize the need for improving the training of clinician-scientists, yet in Canada the attitude has been to remove support entirely [15]. USA, NIH in particular, remains focused on building capacity and supporting clinician-scientist trainees, and there is no reason it should not be the same in Canada. Similarly, in the UK, recent program changes are helping to support and fund clinician scientists to address existing gaps [33].

In today's evidence-driven landscape of medical practice, the need for clinicians actively engaged in biomedical research is greater than ever. The benefits of clinician-scientist training are clear, with a greater proportion of these trainees successfully obtaining research funding and pursuing research-heavy careers than the general population of medical graduates; however, significant barriers to clinician-scientist training existing, including long training times, a lack of longitudinal support and a dearth of dedicated funding sources. As a result, the clinician-scientist training process has remained problematic. The trainees of Canada are ready to engage and establish a national body to reaffirm clinician-scientists as a core tenet of academic medicine in Canada.

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Previous presentations

Early work by the authors on this topic has been presented as a position paper at the Canadian Federation of Medical Students (CFMS) 2016 Spring General Meeting in Montréal, Quebec.

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