ORIGINAL RESEARCH

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MD/PhD Training in Canada: Results from a national trainee and program director review

Abstract

Purpose: There has been limited examination of clinician scientist training in Canada, particularly regarding training integration and funding. This study assessed program structure, funding, tuition and mentorship structures available at Canadian MD/PhD programs.

Methods: Clinician Investigator Trainee Association of Canada administered an anonymous survey to current trainees and program directors that captured program structure, trainee funding, tuition and mentorship opportunities and needs across institutions.

Results: In June 2015, 101/228 (44%) trainees and 9/13 (69%) program directors completed the online survey. In all programs, students completed the PhD degree prior to clerkship training. Seven programs offered research training upon completion of pre-clerkship, four offered concurrent clinical and research training, and three offered alternative structures. Nine held seminars exposing students to clinical and research integration and two offered clinician scientist skills courses. Stipend funding and tuition varied, especially during clinical training years. Regarding mentorship, all programs held regular meetings, though eight programs do not have formal mentorship opportunities. Both trainees and program directors identified the need for further career planning and development support as a student priority.

Conclusion: MD/PhD programs varied by program structure, funding, tuition and mentorship opportunities. Mechanisms to share and spread program innovations should be instated. Students may benefit from concurrent research and clinical training as well as courses specific to clinician scientist skill development. Decreasing debt burden may attract and retain trainees in this demanding path. To ensure mentorship programs align with trainee priorities, program directors should directly collaborate with students in their development and evaluation.

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There has been limited evaluation of current models for clinician scientist training in Canada. The lack of proper review and reporting of MD/PhD programs and trainee outcomes presents a significant challenge in evaluating the success of these programs to nurture the next generation of clinician scientists. Particularly, only limited data are available describing program models for clinical and research training integration and funding. The Clinician Investigator Trainee Association of Canada/Association des cliniciens-chercheurs en formation du Canada (CITAC/ACCFC) is a Canadian not-for-profit organization founded and operated by clinician investigator trainees. In 2015, CITAC/ACCFC surveyed current trainees and program directors to assess the current state of MD/PhD training in Canada. We compared program structure, stipend funding, tuition, and mentorship opportunities and needs across institutions. Given the gradual developmental history of MD/PhD training across Canada, the historical national funding strategies, and the low number of programs, we hypothesized that similar structures, funding, tuition and mentorship opportunities would be available at all institutions. There are a multitude of clinical and academic career trajectories possible with joint MD/PhD training; thus, we also hypothesized trainees and program directors would identify career planning as a mentorship priority that may not yet be adequately addressed.

Methods

Participants and Data Collection

Program directors and students enrolled in a joint MD/PhD program in Canada as of June 2015 were eligible for participation. In June 2015, CITAC/ACCFC institutional representatives distributed an email including a description of the study and an invitation to participate to all students and program directors at their respective institutions. Over the next 12 weeks, additional emails were sent as reminders to participate. No incentives for participation were provided. CITAC/ACCFC privacy policy ratified by the membership permits collection of anonymized data. Voluntary participation in the anonymous web-based surveys implied consent.

Survey Instrument

The two retrospective cross-sectional surveys were constructed to assess the programs and funding structures available across Canada. These surveys also captured student mentorship opportunities and needs as perceived by trainees and program directors. To encourage participation, the survey was brief,

limited to 19 questions for trainees and 22 questions for program directors, and was provided in both French and English. The first section of both surveys elicited basic program information, including type of degree obtained, research discipline and program structure of clinical and research training. The second section asked participants to report the amount and duration of guaranteed funding available during clinical and research training years. The third section elicited trainees' and program directors' perception of currently available mentorship opportunities and the three most important mentorship needs for trainees using multiple-choice and descriptive responses.

Analysis

The data were collected and analyzed anonymously. Most items in the trainee survey (15/19 items) and program director survey (16/22 items) were closed-ended and amenable to quantitative analysis. Descriptive statistics were used to report proportions for categorical variables and median (interquartile range, IQR) for continuous measures. Spearman's rho test was used to estimate the association between annual tuition and funding during clinical years across institutions. Fisher's exact test was used to test differences in trainee and program director perspectives on priority mentorship needs for trainees. The structure and funding of clinical and research training in Canadian institutions was delineated using trainee and program director survey data in addition to public data available online at institutional websites. These results were reviewed for accuracy by program directors.

Program structures were rated for degree of integration of clinical and research training on three levels based on the following criteria. The most basic level of integration was the existence of MD/PhD seminars that provide exposure to clinical and research integration (Level C). Another form of integration is based on structures that facilitate concurrent clinical and research training (Level B). Flexible structures can take many forms; for example, students take graduate courses and/or have designated research time during the MD training phase. In the PhD training phase, training may include taking longitudinal clinical skills courses and/or clinical placements. The third form of integration is curricular programming (e.g., MD/PhD-specific courses) specifically designed to develop skills in the integration of clinical and research perspectives (Level A).

TABLE 1. Mentorship opportunities and available at Canadian MD/PhD programs

Mentorship Opportunities	Number of Programs with Students Enrolled, N=13
Program-wide Meetings	13 (100%)
Frequency of Program-wide Meetings	
1-3+6 weeks	4 (31%)
1-3 months	3 (23%)
4-6 months	5 (38%)
Annually	1 (8%)
Content of Program-wide Meetings	
Program Administration	9 (69%)
Social	7 (54%)
Scientific Presentations by Trainees	6 (46%)
Guest Lectures	6 (46%)
Career Planning	3 (23%)
Skill Development	1 (8%)
Formal Mentorship (outside of program-wide meetings)	
Mentor program with senior trainee or faculty	4 (31%)
Peer mentorship program	1 (8%)
Web repository of mentorship resources	1 (8%)
Student Handbook	1 (8%)
No formal mentorship opportunities	8 (62%)

Results and Discussion

Trainee enrollment and research discipline

There are 15 MD/PhD programs across Canada, but only 13 had students enrolled at the time of the survey. The surveys were completed by 101/228 (44%) trainees and 9/13 (69%) program directors from across Canada during the study period. Response rates by program ranged from 0% (0/37, Université Laval) to 100% (4/4, University of Alberta). Of the trainees that responded, 85/101 (84%) were enrolled in an MD/PhD program, while 16/101 (16%) were enrolled in a joint Masters program. At the time of study, participants were in year 3 (2-5) (median; IQR) of training. Program directors identified a median 46% (IQR 31-55%) female gender distribution across programs. The majority of students identified their dissertation

research discipline as biomedical or basic science (75/101; 74%), with relatively few in other disciplines (15/101 clinical, 4/101 health systems and services, 3/101 social determinants of population health and 2/101 engineering).

Program structure and integration

All programs are structured so that students would complete the PhD degree prior to starting the MD clerkship training (Figure 1). Most (11/14) programs begin with MD training, including seven programs that offered research training only upon completion of pre-clerkship. Alternatively, McMaster University begins with research training, followed by alternating segments of clinical and research training. Western University allows candidates to choose between two options: the “pre-clerkship-PhD-clerkship” format or the format where the bulk of research training is completed prior to starting MD training. At University of Calgary, students may choose to pursue graduate training prior to, concurrent with, or after the pre-clerkship phase.

The level of integration between clinical and research training also varied across institutions (Figure 1). Using the criteria for integration described (see Methods), 9/13 (69%) MD/PhD programs provided Level C, 4/13 (31%) programs provided Level B and 2/13 (15%) programs provided Level A integration in their program structure. Regarding Level A integration, Queen’s University offers a course instructed by clinician scientists that covers topics such as work-life balance, social media in research and navigating the transition from trainee to investigator. At McGill University, a course explores topics such as bridging the gap between discovery and delivery in global health and moving research findings into clinical practice.

The impact of curricular integration on the preparation of trainees for a career as a clinician scientist cannot be assessed by these data alone. Previous research has shown that many MD/PhD graduates integrate research and clinical practice into their careers [4]. The current diversity of program structures offers trainees many options that may better cater to their learning needs; however, our data indicate that few programs offer concurrent training structures or other forms of clinical and research integration as options for students. Training integration is supported by a growing body of evidence suggesting that integrating (or interleaving) skills training may improve learning [10,11]. A 2011 survey of MD/PhD trainees at the University of Toronto identified that the majority (58%) of students reported that integration of PhD and MD training needed improvement and only 6% considered the program already well integrated [12].

	Level of integration		
	C	B	A
Alberta	Pre-clerkship	Graduate study	Clerkship
British Columbia	Pre-clerkship	Graduate study	Clerkship
Calgary	Pre-clerkship	Graduate study	Clerkship
	Graduate study	Pre-clerkship	Clerkship
	Pre-clerkship	Graduate study	Clerkship
Laval			
Manitoba	Pre-clerkship	Graduate study	Clerkship
McGill	Pre-clerkship	Graduate study	Clerkship
McMaster	Pre-clerkship	Graduate study	Clerkship
Memorial	Pre-clerkship	Graduate study	Clerkship
Montreal	Pre-clerkship	Graduate study	Clerkship
Ottawa	Pre-clerkship	Graduate study	Clerkship
Queen's	Graduate study	Pre-clerkship	Clerkship
Saskatchewan	Pre-clerkship	Graduate study	Clerkship
Sherbrooke	Pre-clerkship	Graduate study	Clerkship
Toronto	Pre-clerkship	Graduate study	Pre-clerkship
Western	Graduate study	Pre-clerkship	Clerkship
	Pre-clerkship	Graduate study	Clerkship

FIGURE 1. Plot of typical program structures of MD/PhD programs from across Canada. As of July 2015, Memorial and Saskatchewan Universities did not have any trainees enrolled in the MD/PhD program. Trainees at Western University and University of Calgary can pursue one of two or three program structures suited to their needs. Level C integration was defined as MD/PhD seminars that provide exposure to clinical and research integration. Level B integration was defined as having a structure for concurrent clinical and research training. Level A integration was defined as curricular programming such as a MD/PhD-specific course aimed to provide skills training specific to integration of clinical and research perspectives. Université Laval program structure and integration data and Université de Montréal and Université de Sherbrooke integration data were not available.

Longitudinal data on training outcomes and trainee satisfaction will be important to assess how to best prepare trainees for the clinician scientist career.

Building on the current achievements of the MD/PhD programs, at least two areas can be improved. First, few MD/PhD programs have structures in place to support engagement of students in concurrent clinical and research work throughout their training. Potential strategies to address this issue include creating flexibility for graduate coursework or research work to occur alongside medical training, as well as formal opportunities to develop clinical skills during research training through small-group sessions. Depending on the field of research, students in the MD training phase could be given a choice of when to merge into full-time graduate training. For those who pursue clinically-oriented research, it may be beneficial for students to have undergone more clinical

training prior to focusing on their PhD work. In contrast, other students may wish to begin graduate studies prior to medical training. A by-product of greater integration may be shortened programs of study [12].

Currently, all MD/PhD program structures require trainees to complete their graduate degree requirements prior to starting clerkship. During clerkship, trainees focus almost exclusively on clinical training in preparation for residency with little to no elective time for research. Four to seven years away from research, including the time for residency training, would be detrimental to a fledgling clinician scientist [13]. Improvement may be possible by increasing flexibility to allow for research during clerkship and transition to residency training; for example, the longitudinally integrated clerkship model provides weekly protected time to stay engaged in research and scholarship. In fact, increasing the flexibility of

FIGURE 2. Funding and tuition for MD/PhD trainees during medical training years at institutions across Canada. Top panel shows financial support and average tuition rates across medical training years. Bottom panel shows the difference between financial support and tuition rates during medical training years. The majority of programs with enrolled students (11/13) provide financial support for at least a portion of the medical training years. Just over half of programs (7/13) provide funding that is greater than tuition rates during medical training years. Note the MD tuition shown for Québec institutions correspond to rates for Québec residents; rates for Canadian non-Québec residents are higher. The tuition for McMaster and Calgary reflect three-year MD programs.

program structures aligns with recommendations for competency-based and flexible approaches in medical education from the Association of Faculties of Medicine of Canada (AFMC) [16].

Secondly, in addition to concurrent training in the distinct domains of research and clinical practice, trainees may benefit from structures that explicitly facilitate knowledge sharing, skill development and community building for the clinician scientist career path; which may take the form of specific curricular programming, as in the majority of the federally-funded MD/PhD programs in the United States [e.g. 14,15]. In Canada, two institutions, McGill University and

FIGURE 3. Top mentorship needs of MD/PhD trainees reported by trainees and program directors Bar plot displaying the proportion of program director and trainee respondents who identified each potential mentorship need as one of the three priority trainee needs for current MD/PhD students in Canada.

Queen's University, offer such for-credit courses. Opportunities to shadow or apprentice clinician scientists, in both their research and clinic settings, may provide key insights pertaining to integration in practice [15]. Another opportunity to foster integrated perspectives early in training lies in the involvement of clinician scientists in facilitating case-based learning for MD/PhD students in pre-clerkship period. Such programming could help meet the AFMC recommendations for building on the scientific basis of medicine [16]. Overall, offering diverse training pathways within each institution may preserve student choice, while ensuring quality and accessibility across the nation.

Funding

Funding for trainee stipends, specifically during medical training, was variable in both amount and duration across institutions (Figure 2). Importantly, all funding data reported here were collected at a time when CIHR MD/PhD Studentships were available to students. Since then, this funding source was eliminated and, thus, data presented here will not reflect current trainee stipends. Of the 11 programs with available survey or public data, all provided funding during research years, and 10 (91%) guaranteed at least \$20 000 CAD per annum during research training. Conversely, only 5/11 (45%) of the institutions offered any guaranteed funding for all years of clinical training, though all institutions provide guaranteed stipends for at least one year of clinical training (median; IQR: \$21 000; \$17 250 – 24 500 CAD per annum). Tuition costs also varied by institution (median;

IQR: \$15 000; \$12 950 - 21 150 CAD per annum). The annual guaranteed stipend was not associated with tuition costs during clinical years ($\rho = -0.28$, $p=0.412$), suggesting no statistical relationship between funding and tuition.

The pathway to becoming a clinician scientist has a number of financial disincentives. These disincentives include lengthier training, which can lead to higher debt loads, delayed employment, and potentially lower salaries upon employment [17]; therefore, decreasing debt burden as much as possible during MD/PhD training is critical to attract and retain trainees [18]. Our results show large differences in tuition and funding for MD/PhD programs in Canada, particularly during periods primarily devoted to medical training. Annual tuition rates range from \$3 334 at the Université de Montréal (Québec residents) (\$23 338 for 7-year program including 4-year MD) to \$26 056 for McMaster (\$156 336 for 6-year program including 3-year MD). While all programs guarantee financial support during graduate training, only just over half of programs provide support during medical training that surpasses tuition rates. Even when financial support is able to cover tuition, it may not be sufficient to cover costs of living in the major Canadian cities in which all MD/PhD programs are located. Differences in financial support can have a large influence on students' satisfaction and decisions as they consider MD/PhD training [19]. Financial concerns may even overshadow other factors when choosing a program, such as how program structures align with one's learning style or the quality of research being done in one's field of interest.

Mentorship opportunities

Trainees and program directors reported a range of formal mentorship opportunities available at their institutions (Table 1). All programs with students currently enrolled (13/15) hold program-wide meetings. These meetings occur at least every 6 months for 12/13 (92%) of these programs. The purpose and content of these meetings vary but can include program administration, socializing and mentorship between peers, scientific presentations by trainees and guest lectures. The majority of programs (8/13, 62%) have no formal mentorship opportunities geared toward clinician investigator trainees; however, four programs report mentorship programs with senior trainees or faculty. Each MD/PhD trainee at Western University, for example, has a committee focused on mentorship along the clinician scientist training pathway and work-life balance. At the University of Toronto, incoming students are paired with senior MD/PhD students, and all students can participate in a formal longitudinal mentorship program where they are paired with a clinician scientist or

MD/PhD alumni in residency. Every two years, a mentorship symposium is held and yearly transition seminars are conducted by senior trainees to discuss transitions in training (MD to PhD, PhD to MD, MD/PhD to residency).

Mentorship needs

When asked to identify the top three trainee mentorship needs, trainees and program directors suggested both common and differing areas for improvement (Figure 3). Trainees reported career planning and development, transitions in training and synergizing research and clinical interests to be among their most important mentorship needs. Program directors identified choosing a research supervisor and maintaining a good relationship, career planning and development and work-life balance and family. Overall, the need for further career planning and development support was identified as a student priority by both trainees and program directors. This may reflect uncertainty regarding the possible and most fitting career pathways as a clinician scientist. Indeed, unlike other areas of specialty training in medicine, the training trajectory to become a clinician scientist is varied and unclear [20].

Improving transitions in training were the second greatest unaddressed mentorship priority identified by trainees. Transitions are a major source of uncertainty and anxiety for MD/PhD students, particularly when entering graduate research and then returning to clinical medicine [21]. While preliminary evidence suggests that MD/PhD students perform similarly to MD students during clerkship, MD/PhD students report a lack of confidence in their clinical skills when entering their clinical rotations after spending several years in research [21,22]. As a result, students may actively seek structure and guidance at this stage [21,22]. The perception that an experienced mentor has already successfully completed these transitions may build confidence and motivate trainees to learn from mentors' suggestions and strategies.

Program directors and students differed in their perceptions that choosing a research supervisor and maintaining a good relationship were top mentorship needs (83% of directors *vs.* 25% of students, $p<0.01$). Though the underlying reasons for this discrepancy are unclear, this observation suggests a disconnect between students' and program directors' perceptions of important factors in mentor-mentee relationships. Interestingly, none of the program directors prioritized navigating institutional processes, while 34% of students ranked it as one of their top three concerns. Institutional processes place a nontrivial burden on trainees. An important role that academic mentors

could play would be to advocate for their mentees and guide them through these institutional processes, especially in the face of structural barriers [23,24]. In addition to spontaneous informal mentorship [25] from program directors and research supervisors alike, formal mentorship structures with defined goals and guidelines may be imperative for young investigator's success [26,27]. Given the discrepancies between students' and program directors' perceptions of mentorship needs, students should be partners in the design of such structures. As a first step, program directors should directly collaborate with students in their co-creation and evaluation to ensure the programs are in-line with students' priorities. Mentorship is a crucial component in the cultivation of medical students and clinician scientist trainees alike [28], and our results support a collaborative design process when developing mentorship programs.

This study is not without limitations. We relied on reporting from trainees and program directors. Though we did cross-validate with data published on institutional websites where possible, self-report may be vulnerable to error. Moreover, a few of the institutions did not provide complete survey information, resulting in some areas where data were missing. These limitations underscore the importance of consistent data management to track trainee experience, challenges, achievements and career trajectories.

Conclusion

The data from this national survey delineates several successes and areas of improvement for Canadian MD/PhD training structure, funding and mentorship, and initiates an examination of possible structures to best support the development of MD/PhD trainees. Given the recent national funding cuts [9] and evidence of a failure to maintain an effective training pipeline [29], understanding how MD/PhD programs are structured and maintained will be crucial in identifying strategies for sustainability and success in training the next generation of leaders in academic medicine. Certainly preserving and fostering the 15 MD/PhD programs is imperative to strengthen health research capacity in Canada. Overall, continuous efforts will be needed to disseminate innovations and learnings between programs and to better gauge the challenges, outcomes, and trajectories of current and future trainees.

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