The Rising Challenge of Training Physician–Scientists: Recommendations From a Canadian National Consensus Conference

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Abstract

Physician–scientists are individuals who actively participate in patient care, have undergone additional research training, and devote the majority of their time to research. Physician–scientists are traditionally the primary catalysts in bridging the translational gap—that is, the failure to link fundamental new knowledge in the pathobiology of disease with advances in health care and health policy in a timely manner. However, there has been a shift away from training physician–scientists, and financial support for the physician–scientist is diminishing globally, causing the translational gap to grow. Given its socialized health care system and cultural and geographic diversity, Canada can serve as a unique case study in understanding how to address this phenomenon as a national priority. To this end, a Canadian national consensus conference was convened to develop recommendations for training programs and early-career supports for physician–scientists. Five recommendations were generated: (1) Establish an independent, national council whose mandate is to provide pan-Canadian oversight of physician–scientist training programs; (2) develop capacity for funding and mentorship support for physician-scientists; (3) develop coherent networks across a broad range of clinician–scientists, including physician–scientists, to reflect the unique cultural and geographic diversity of Canada and to reflect the interdisciplinarity of health research; (4) ensure that medical school curricula integrate, as a core curriculum feature, an understanding of the scientific basis of health care, including research methodologies; and (5) ensure that the funding of the physician–scientist trainee is viewed as portable and distinct from the operational funding provided to the training program itself.

There is a worldwide concern that the physician–scientist, defined as an individual trained in both clinical medicine and research, and for whom a major professional focus is health research, is an increasingly uncommon career path for medical graduates.[1,2] This decline follows a period of sustained focus and support for undergraduate and postgraduate training programs directed toward generating physician–scientists.[3] Additionally, this decline in physician–scientists, in both absolute numbers and as a percentage of the cadre of physicians trained, is a global phenomenon, giving rise to the consensus that the physician–scientist is an endangered species.[1,4–8] This problem is amplified by similar declines across the broader spectrum of health professionals who are also engaged in health research, collectively considered as clinician–scientists (e.g., nurse clinician–scientists), and who, in concert with physician–scientists, form the foundation of advancing health in the population.

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The Evolution of the Physician–Scientist

Traditionally, the continuum of clinical and translational science has been viewed as being composed of multiple pillars, spanning the most basic of research through to the development of health policy, health systems, and the delivery of health services. As described by Waldman and Terzic,[9] the entry into this continuum begins with a focus on the identification of targets, biomarkers, genes, pathways, and mechanisms, otherwise described as pillar 1 of health research in Canada (or pillar T0 in the United Kingdom). In Canada, pillar 2 health research incorporates clinical research and includes "first-in-human," phase I–II, and proof-of-concept studies, while pillar 3 encompasses health services research with an emphasis on population health and well-being. The final pillar (pillar 4) speaks to moving the knowledge created by such pipeline discovery into the community through health systems and health services research, population studies, and knowledge dissemination, and, at a more holistic and global level, into the development of social health policy. When viewed in this broader context, the concept of translational research covers a broad range of issues and needs. A lack of such research is the foundation of what is considered to be the "translational gap"—that is, the failure to move fundamental new knowledge in the pathobiology of disease into advances in health care and health policy in a timely manner.[10]

The problem is that there has been a shift away from the training of physician–scientists, who traditionally are the primary catalysts of translational research.[10–12] In the context of this Perspective, the term physician–scientist specifically refers to those physicians who have undertaken additional training to conduct health sciences research (discussed later), while recognizing

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that the full breadth of health sciences research incorporates a broad range of health professions (clinician–scientists) with whom physician–scientists integrate. It is estimated that 3% or less of clinical trainees enroll in pipeline programs designed to develop physician–scientists and which prepare them to undertake research-focused careers.[13–16] Yet such programs, typified by the MD/PhD training program, are successful. Among 24 MD/PhD programs within the United States, 81% of the graduates find employment in academia, research institutes, or industry.[17] Of those in academia, 82% were conducting research and 61% had identifiable research funding, with many of the investigators doing clinical as well as basic and translational research. Similar data have recently been published for Canadian-trained MD/PhDs.[18] The perception is that the MD/PhD program organizes the experimental and clinical thinking of the physician–scientist differently than clinical colleagues who have not undergone the rigors of scientific training. Moreover, in the United States, the MD/PhD is more likely to be successful in obtaining nationally funded research support than either the MD- or PhD-only graduate,[19] although there is evidence to suggest that the success of physician–scientists in R01 grant competitions is declining.[20] While similar data for Canada are lacking, physician–scientist training within family medicine in Canada has been shown to support academic productivity and to be an important path to developing physician–scientists who are experts in the translational pillars.[21–25]

The genesis of the decline in the training of physician–scientists is multifactorial. It has been driven, in part, by the changing expectations of new graduates who do not see (in their mentors) justification for maintaining competitive research programs and all the attendant risks, while simultaneously carrying out full clinical activities. While there is a general acceptance that the MD/PhD training program is the primary avenue by which physician–scientists are trained, it is not the only route. Notwithstanding this, there is an implicit understanding that the successful career path for a physician–scientist must, *a priori*, include not only MD training and a subsequent residency with or without clinical fellowship training, but also the completion of a PhD with a focused postdoctoral research program before one can begin his or her academic career.[26] Undertaking this lengthy process of attaining both an MD and a PhD is simply not an appealing lifestyle choice for the vast majority of young medical trainees.[11] Additionally, the issue of duration of training is integrally linked to the excessive financial burden borne by physician–scientist trainees.[11,27] The magnitude of this financial burden may also be associated with a reduced likelihood of undertaking postdoctoral training.[18] In the United States, this issue has been mitigated to some extent by the Medical Scientist Training Program, through the National Institute of General Medical Sciences, in which candidate students receive full federal funding.[28]

There is recognition that, broadly defined, the physician–scientist needs first and foremost to be trained sufficiently in the rigors of scientific inquiry. This training does not necessarily need to reflect a single training avenue or a discrete epoch of time within a medical curriculum; rather, the training needs to be a continuum. This approach has been exemplified by the development of integrated MSc or PhD programs, a concept that was crystallized in the United Kingdom by the creation of a pipeline for the training of physician–scientists, which begins at, or before, entry into medical school.[29] This concept built on the Academy of Medical Sciences report entitled *The Tenure-Track Clinician Scientist: A New Career Pathway to Promote Recruitment Into Academic Medicine*,[30] which argued for the creation of the Clinician Scientist Fellowship (CSF) program, designed to provide clinician–scientists with protected time for postdoctoral research while they are completing specialty training and to support them to become independent researchers. A critical evaluation of the outcomes of the CSF program clearly demonstrated that graduates had met or exceeded program expectations by a number of outcomes.[31] Most critically, CSF fellows had become pivotal to the formation of new interdisciplinary collaborations both within and outside of traditional academia and were driving change in the culture of clinical academic research.

The combined UK reports[29–31] also provide a cogent argument for the physician–scientist training continuum. The continuum begins with heightening medical students' awareness of career paths that support research early in their education, as well as developing department-specific mentors to provide advice on academic careers and study modules that offer opportunities to work with both researchers and educators. At its core, this program affirms the concept that the learning of clinical medicine should be integrated with a research perspective with the intent to develop an integrated clinical and research mind-set. From this, a professional identity as a physician–scientist will arise, which must then be nurtured and supported.

Similar approaches to enhancing the introduction of research early in a physician's career have been adopted elsewhere. For instance, the University of Queensland has created the Clinician Scientist Tract, in which a concurrent MBBS–MSc program exists for a select cohort of students, the majority of whom go on to get a PhD.[32] A similar program exists in Norway.[33]

The decline in physician–scientists, however, is not solely attributable to issues stemming either from training programs or residency training. There are issues of failure of support upon physician–scientists' uptake of their first academic position, a position that is increasingly attained much later in their career trajectory.[34] Average five-year retention rates of clinical academics within U.S. faculties of medicine range from as low as 63% to 77%, suggesting there is a significant issue with early retention.[35] And the issue is not necessarily financial. In comparing those departments with high retention rates versus those with lower rates, several key indicators of failure were evident: the failure of the environment to cultivate collegiality and excellence, the failure of the clinical academic to be appreciated by his or her patients, a lack of satisfaction with the ability to provide high-quality care, and a lack of satisfaction with how well his or her clinical location functions.[35] This is further compounded by the implicit belief that the physician–scientist must perform to the same standard of excellence in both patient care and scientific research as his or her peers, effectively doubling up on the expectations placed on these individuals.[36,37] These are not issues of institutional support per se but rather

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issues of the academic milieu in which a newly minted physician–scientist finds him- or herself.

The Canadian Context

Canada offers a unique case study for other countries confronting the physician–scientist challenge in that it has a fully funded socialized health care system with training programs driven by societal needs. At the core of this social accountability framework for the training of physicians is the need to ensure a physician workforce within Canada that will improve health outcomes across a culturally and geographically diverse population. This need is codified in the first recommendation of the Future of Medical Education in Canada Postgraduate (FMEC PG) document, which recommends "[ensuring] the right mix, distribution and number of physicians to meet societal needs."[38] Implicit in this recommendation is the need to ensure the right number of physician–scientists. With this context in mind, there is a need to clearly define the value proposition of training the physician–scientist. This issue of defining the value proposition has been addressed by the Canadian Academy of Health Sciences.[39] Prior to 1996, the value proposition of the Canadian physician–scientist consisted of broadly defined deliverables that centered on knowledge production and targeted research. A satisfactory outcome could include the development of informed policies and product development, tangible benefits to the health sector, and some evidence of broader economic-sector benefits. In little more than a decade, this value proposition has dramatically changed to center on a tightly defined return on investment, including advancing knowledge, building capacity, informing decision making, producing health benefits, and providing evidence of broader economic-sector benefits.[22,39]

This shift in value proposition is particularly important given the recognition by the Canadian Institutes of Health Research (CIHR) of a "revolution in Canada's health research landscape," where "The speed of discovery, convergence of disparate research fields and evolving needs of Canadians are creating a number of significant, mutually reinforcing trends that are changing the way health research and knowledge translation are being conducted."[40] This observation, and the attendant need to ensure that the physician–scientist workforce remains intact, has been echoed more recently by DeLuca and colleagues,[41] who noted the significant reduction in the number of physician–scientists being trained since the early 2000s and concluded that "it is time for a seismic shift in the way the next generation of clinician–scientists is educated." Among their recommendations for accomplishing this, they suggest that the *raison d'être* of clinician–scientist training needs to be the pursuit of scientifically innovative translational research.

Critically, just as the value proposition for the physician–scientist has become more tightly defined and the fundamental understandings of the underpinnings of disease have dramatically grown, the foundations needed to train and maintain individuals skilled in translational research have been crumbling.[23] Given this, we convened a Canadian national consensus conference to develop recommendations for training programs and early-career supports for physician–scientists. The resulting recommendations are discussed in detail below.

Developing the Canadian National Consensus Conference Recommendations

To develop national consensus recommendations for the training and support of physician–scientists, we used a consensus development panel.[42]

Approximately one year in advance of the consensus conference (held in February 2016), we assembled a consensus development panel of content experts from a broad range of constituents with direct impact or input into not only the training and career development of physician–scientists but also the delivery of health care to Canadians. This consensus development panel included individuals representing the Association of Faculties of Medicine of Canada (M.J.S.), FMEC PG (N.B.), Royal College of Physicians and Surgeons of Canada (K.A.H., T.H.), College of Family Physicians of Canada (W.V.N.), CIHR (D.L.G.), HealthCareCAN (T.S.), and Clinical Investigator Trainee Association of Canada (X.W., A.K.). The consensus development panel was supplemented by additional content experts in the formulation of national clinician–scientist training guidelines (N.D.R.) and in education scholarship (L.L.).

The consensus development panel then identified key topic areas of relevance to developing national guidelines, and both national and international content experts to lead discussions on specific topics (hereafter, working group leads). These discussions examined best practices and real-world applicability of national and international physician–scientist training, including addressing the nature of the desired end product. Recognizing that no jurisdiction had yet developed the "ideal" training program for physician–scientists, we invited content experts from across Canada and other countries, where significant inroads had already been made in developing sustainable clinician–scientist or physician–scientist training programs (i.e., the United Kingdom, Australia, and the United States), to present their experience. Our selections for potential Canadian attendees were based on topic interest and expertise, or nomination by their respective national organizations. International attendees were identified by the consensus development panel based on acknowledged expertise.

Those who chose to attend were then assembled into one of five working groups. We constituted these working groups to reflect attendees' expressed preconference preferences, which they formed by perusing literature provided by the working group leads in advance of the meeting. Working group topics included the following: (1) recruitment into medical school; (2) scholarship in the training program (including the nature of the educational pathways); (3) mentorship of early faculty appointees; (4) postgraduate training scholarship; and (5) the role of interdisciplinary research teams.

At the end of day 1 of the conference, each working group formulated key recommendations relevant to their individual topics. On day 2, each working group presented their key recommendations to all conference attendees. Following the presentations from the individual working groups, a roundtable panel was convened, the purpose of which was to reflect on the

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recommendations of the individual working groups. The roundtable group consisted of a senior physician–scientist, an MD/PhD trainee, two resident trainees (an MD/PhD and a non-MD/PhD), and a junior clinician–scientist, with members drawn from both specialist and family medicine physician scholars. The roundtable discussion was followed by a redeployment of the working groups to refine their individual recommendations.

In the final session, all attendees returned to develop key consensus points in a facilitated session (led by Murray Bryant, PhD). These consensus points formed the basis of the recommendations given below. Over the ensuing months, the consensus development panel worked to refine and formalize the recommendations. Prior to submission for consideration for publication, the draft manuscript was distributed to all conference attendees for comments or corrections.

The Canadian National Consensus Conference Recommendations

Consensus definition of physician–scientist

There exists a range of definitions of the physician–scientist as well as a broad range of nomenclatures, including clinician–scientists and clinician investigators. The consensus development panel elected to use the term physician–scientist to describe those "physicians who actively participate in patient care, who have undergone additional research training, devote the majority of their time to research, and play an important role in closing the gap between research and clinical practice." This definition was adopted fully recognizing that health research is conducted by a broad range of health professionals and that it is increasingly conducted in highly integrated teams whose approaches span all of the pillars of research. The consensus development panel also recognized—in preparing the physician–scientist to engage at any point along the range of research from basic sciences through clinical, health policy and health services, population health, and education research—that the nature of training will be highly variable. Thus, the development of a physician–scientist should also embrace a range of avenues of training, such as avenues leading to an MD/PhD, MD/MSc, or MD/MPH (as a few examples), as the core issue is in fact not the nomenclature but rather the appropriate level of training needed to fully engage in health research as it applies to each of the pillars of research. While the traditional model of undertaking subspecialty fellowship or family medicine training followed by a one- or two-year intensive training period focused on research may suffice to prepare physician–scientists for productive research collaborations, this is inadequate for those who aim to be competitive, independent scientists in their chosen field. Such individuals may require several years of additional training to be competitive for national and international peer review funding. This is not to say that all training must occur in the postresidency training years but, rather, that the training of a physician–scientist should be an integrated process that spans the formative years of medical school training and thereafter becomes an integral component of the careers of such individuals. Additionally, the consensus conference attendees identified, based on existing evidence,[43] the continuing mentorship and protection of physician–scientists throughout their early careers as key enablers.

Recommendations for the training and early-career support of physician–scientists

The full list of recommendations is given in List 1.

Recommendation 1. Establish an independent, national council whose mandate is to provide pan-Canadian oversight of physician–scientist training programs, with a focus on establishing stable, multiyear funding that acknowledges a diversity of training approaches with uniquely defined deliverables. This council should be tasked with establishing and maintaining approaches for tracking physician–scientist trainees and ensuring that the value proposition of the Canadian physician–scientist meeting societal needs is maintained.

Implicit in this recommendation is the belief that to the extent to which the provision of health care to all Canadians is a national standard, so too must be the certainty that foundational new knowledge, which will impact upon societal health, will be transformed into clinical practice and health policy by individuals whose raison d'être is to do so.

This recommendation intends that the training of the physician–scientist should be flexible and allow for multiple avenues of training. While the MD/PhD program is recognized as the most traditional route of training, the breadth of skills needed to fulfill the promise of translational medicine is sufficiently broad enough that any single training program will be insufficient. Therefore, a national physician–scientist training program should embrace not only the MD/PhD program but also a diversity of training programs such as masters in public health (MPH), masters in clinical sciences (MSc Clin Sci), and discrete postresidency and postgraduate research training programs not necessarily attached to a graduate degree. Excellent examples of such training programs already exist and must be nurtured. For instance, Canadian family medicine training programs incorporate physician–scientist training as a "focused practice" option during residency.[44,45] And the Royal College of

List 1

Recommendations for Training and Early-Career Supports for Physician–Scientists[a]

1. Establish an independent, national council whose mandate is to provide pan-Canadian oversight of physician–scientist training programs, with a focus on establishing stable, multiyear funding that acknowledges a diversity of training approaches with uniquely defined deliverables.
2. Develop capacity for funding and mentorship support for physician–scientists.
3. Develop coherent networks of clinician–scientists, including physician–scientists, to reflect the unique cultural and geographic health care issues of Canada and to reflect the interdisciplinarity of health research.
4. Ensure that medical school curricula integrate, as a core curriculum feature, an understanding of the scientific basis of health care, including research methodologies.
5. Ensure that the funding of the physician–scientist trainee is viewed as portable and distinct from the operational funding provided to the training program itself.

[a]Developed by the Canadian national consensus conference.

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Physicians and Surgeons of Canada's Clinician Investigator Program provides a curriculum and mentorship specifically targeted at clinical-research integration and skills for physician–scientists. These programs should be integrated across the entirety of physician training programs from entry into medical school to completion of residency training.

Investment in and expansion of physician–scientist training in Canada must be informed by experiences elsewhere. For instance, the United States, led through successive National Institutes of Health (NIH) directors, began a remarkable program of direct investment in translational research through the 1990s and mid-2000s. Included within this initiative was the creation and subsequent expansion of clinical research training programs, the funding of academic health centers with Clinical and Translational Science Awards, increased direct funding to support the clinical research training curriculum, and enhanced funding of newly minted physician–scientists.[7,28] This period witnessed not only a growth in the number of physician–scientists but also an increased proportion of funding directed toward health research.[8] However, beginning in approximately 2004, with the failure of the NIH budget to grow, and indeed its decline once inflation was factored in, the United States began to witness a marked decline in the number of physician–scientists being trained and engaged in early-career funding programs.[8]

The lesson here transcends national borders: The failure to invest in the physician–scientist training program directly correlates with a loss of the specific cohort of individuals tasked with catalyzing the bridging of the translational gap. Therefore, the recent phase-out of the CIHR-funded MD/PhD program and the consequent questions regarding the future of Canadian physician–scientists cannot be ignored.[46] This recommendation recognizes that funding needs not only to be restored but also to be enhanced and targeted to train the next generation of physician– and clinician–scientists. This includes federal funding to Canadian universities' MD/PhD programs, which, at its peak, cost less than 0.23% of the total national health research operating budget,[46] and stable funding for the Clinician Investigator Program. There is an equally urgent need for dedicated funding to support the early years of a physician–scientist's career following appointment to an academic position, including salary protection, debt relief, and operating funds. The introduction of the NIH's Lasker Clinical Research Scholars Program, while still in its early years, directly addresses this issue and can serve as a model on which to base similar initiatives.[47]

Recommendation 2. Develop capacity for funding and mentorship support for physician–scientists. The adequacy of protection of the initial years as an academic is a critical determinant of success.[43] While the percentage of time "protected" is highly variable, the concept that the primary focus of the physician–scientist is research lies at the core of the definition of a physician–scientist. Ensuring that the fledgling physician–scientist has predictable clinical rotations, dedicated scientific time, and limited ad hoc clinical work is key to his or her success.[36,48] Within the Canadian health care system, the funding of academic clinicians falls to provincial jurisdictions, while the granting of protected time falls to the individual medical schools; as such, this recommendation is a combined responsibility.

The issue of mentoring spans the entirety of the career track of the physician–scientist, and, therefore, mentoring must evolve throughout a trainee's career and be tailored not only to the nature of the training program or early-career track but also to the individual physician–scientist.[49,50] In the early years of physician–scientist training, individual trainees should be closely mentored by an established physician–scientist who follows the mentee through their training program.[36] Such a mentoring role should be considered integral to the culture necessary to ensure the success of physician–scientists and should be approached and recognized as an academic deliverable.

Recommendation 3. Develop coherent networks of clinician–scientists, including physician–scientists, to reflect the unique cultural and geographic health care issues of Canada and to reflect the interdisciplinarity of health research. Canada is a diverse country that encompasses a tremendous breadth of cultural, ethnic, and geographic diversity. Physician–scientist training programs should take advantage of this and develop coherent networks of physician–scientists, other clinician–scientists, and nonclinician–scientists (e.g., epidemiologists), with the aim of creating unique, individually tailored programs that reflect Canada's diversity.

Recommendation 4. Ensure that medical school curricula integrate, as a core curriculum feature, an understanding of the scientific basis of health care, including research methodologies. The competencies in this curriculum feature need to be based on highly integrated learning opportunities, with activities designed to progressively model the integration of clinical and research activities, which is a characteristic of the physician–scientist. These competencies should be seen as integral aspects of the training of a physician–scientist throughout both the undergraduate and postgraduate education program levels. Thus, specific core research competencies, which should be sufficiently robust not only to foster a fundamental understanding of translational research but also to nurture those individuals who are poised to develop into physician–scientists, should be identified for inclusion. The natural extension of this concept is that traditional residency or postgraduate training programs should be sufficiently resilient to allow for those individuals who are on track for a physician–scientist career path to effectively integrate research training rotations with clinical rotations, thereby leading to an enhanced set of skills prior to starting a fellowship training program.[20,30,51–53]

The current worldwide shift in both undergraduate and graduate curricula toward competency-based medical education (CBME) provides a unique and timely opportunity to incorporate this recommendation into any educational program that is evolving toward CBME. Indeed, such an integration should be viewed with some degree of urgency as the full spectrum of CBME is being conceptualized.

Recommendation 5. Ensure that the funding of the physician–scientist trainee is viewed as portable and distinct from the operational funding provided to the training program

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itself. The national council (see recommendation 1) should be charged with ensuring this portability. This recommendation is a significant departure from conventional funding models in Canada, the United States, and Europe. It recognizes that the optimum research training program for an individual physician–scientist trainee may not be geographically located at the same site as their medical training. This recommendation is linked closely to recommendation 1 in that the institution of an independent, national council whose mandate is to provide pan-Canadian oversight of physician–scientist training programs would lend itself well to ensuring the portability of trainees (and, therefore, their funding) both nationally and internationally.

Conclusion

At a time when the generation of new foundational scientific knowledge is increasing rapidly, our investments and dedication to cultivating physician–scientists equipped to generate and translate that knowledge into health care delivery and health policy is waning. This is incongruent with the societal contract that exists within countries such as Canada, which recognizes and values the translation of new knowledge into practice.

This Canadian national consensus conference, and its attendant recommendations, was based on the premise that our model of physician–scientist training must be congruent with our socialized health care system whose delivery spans a diversity of organizations and jurisdictions. The complexity of such a system is heightened as it evolves and constantly responds to new evidence and challenges. The physician–scientist is critical to the success of this evolution, and, therefore, the sustainability and success of these individuals is integral to the success of the Canadian health care system and our continued position as an international leader in the advancement of health care.

The five recommendations generated through the national consensus conference articulate key opportunities to ensure success as we train and support Canada's future physician–scientists. The recommendations are based on the consensus of the participants and were not subject to an analysis of their implications. Each recommendation has strengths and weaknesses which, if discussed, raise the level of awareness and sensitivity to the complexity and components of the system that the physician–scientist exists in and draws upon for success. The physician–scientist is a product of his or her training, thus the training focus of the recommendations. However, the physician–scientist is also a product of the funding, resources, practice setting, context, environment, and infrastructure in which he or she is embedded. In further discussing the training of clinician–scientists, it will be important to model how changes in the availability of research funding and the nature of clinical practice settings influence both training and career success. These recommendations come forward at a time when it is clear that translational health policy, health systems services, and community-based primary health care researchers are key drivers of the return on investment to improve the health of Canadians.

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