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OPINION ARTICLE

Shaping the Future of Research: A perspective from early career researchers in Vancouver, Canada [version 1; peer review: 1 approved with reservations, 1 not approved]

Peter G.K. Clark¹, James M. McCoy², Jenny H.L. Chik^{3,4}, Azadeh HajiHosseini⁵, Manuel Lasalle¹, Brianne A. Kent ⁶, Stefanie L. Vogt ²

¹Simon Fraser University, Burnaby, BC, Canada

²Michael Smith Laboratories, University of British Columbia, Vancouver, BC, Canada

³University of British Columbia, Vancouver, BC, Canada

⁴Department of Pathology and Laboratory Medicine, University of British Columbia, Vancouver, BC, Canada

⁵Decision Neuroscience Laboratory, Department of Psychology, University of Toronto Scarborough, Toronto, ON, Canada

⁶Djavad Mowafaghian Centre for Brain Health, University of British Columbia, Vancouver, BC, Canada

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Abstract

Future of Research is an organization dedicated to championing, engaging, and empowering early career researchers (ECRs). The organization was founded in 2014 and has since inspired other groups to advocate for a more equitable and sustainable research enterprise. Here we report the findings of the Future of Research Vancouver Symposium. The goals of the Vancouver symposium were to ascertain the perspective of ECRs in Canada and to outline pathways to a sustainable future for Canadian research. The symposium had two sessions. The first session was a series of talks that were intended to prepare attendees with an informed understanding of several perspectives in the science enterprise, with a particular focus on the Canadian system. The second session was a series of interactive workshops to identify the greatest challenges facing ECRs in Canada and to propose solutions. The results of the workshops illuminated three main themes for the challenges facing Canadian ECRs: funding, mentorship, and the divide between academia and other sectors. These themes are similar to those discussed at the Future of Research symposiums in the United States, emphasizing that these issues are not isolated to Canada; however, Canadian policies are trailing behind the progress being made in other countries.

Keywords

training, funding, mentoring, junior scientists, career development, science policy, research enterprise

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1. **Michael Hendricks** , McGill University, Montreal, Canada
2. **Holly O. Witteman** , Laval University/Université Laval, Québec City, Canada

Any reports and responses or comments on the article can be found at the end of the article.

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Corresponding author: Stefanie L. Vogt (svogt@msl.ubc.ca)

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Executive summary

The Future of Research Vancouver Symposium (FoRV2017) was held on February 20th, 2017, following increasing concern by members of the local academic community that the voices of junior researchers were not being considered in discussions around the future of funding and training structures in Canadian research.

In laboratories and offices across Canada today, the majority of research is undertaken by early career researchers (ECRs), namely graduate students and postdoctoral fellows (PDFs). ECRs design and execute experiments, collect and analyze data, write papers, and are often solely responsible for supervising more junior team members. This multifaceted contribution suggests that ECRs play a core role in Canada's science, technology and health sectors.

However, the Canadian research landscape now presents significant challenges to ECRs:

- The number of PhDs awarded annually by Canadian universities are growing, as are the length of PDFs' tenures. However, the number of junior faculty positions available at Canadian universities has shrunk.
- Canadian ECRs are often advised to seek alternative career paths, but report high levels of dissatisfaction with the career development and professional training available to them.
- A lack of "staff scientist" or stable mid-career options make academic employment undesirable to many trainees, and result in lab management problems including institutional knowledge loss, and a dearth of supervision and support.
- Wages for Canadian ECRs are not internationally competitive, which is exacerbated in BC by Vancouver's high cost of living, and many ECRs do not receive basic employment benefits available to other working residents.
- ECRs report high levels of symptoms of poor mental health.

Recent announcements regarding increases in the Canadian research councils' budgets offer promise for positive change, but few details have been offered on actual plans to improve opportunities for ECRs.

To effect change, junior researchers must identify the multifaceted challenges they face, and confront the role that academia, government, and industry can play in addressing them. As such, the opening session of FoRV2017 consisted of talks and panel discussions from local members of the scientific community, including industry and academic leaders, who have been vocal regarding ECR issues and the sustainability of Canadian science. This panel was followed by workshops aimed at discussing the issues that had been raised, and prompting potential solutions from attendees. Workshops focussed on 4 core topics: (1) how trainees could be better prepared for careers in science, (2) how sustainable and secure career pathways could be created for

ECRs, (3) how funding of research in Canada could be structured to balance basic research, knowledge translation, and training of ECRs, and (4) how scientists and institutions could be better incentivised for behaviours that support the future of Canadian science.

Based on the responses from attendees, and further literature review and discussion among organisers, we endorse the following recommendations:

1. Improve **ECR-targeted funding**, including grants which provide operating costs for ECRs and support the transition from a PDF to junior faculty position, and recognising ECRs contributions to grants awarded to their supervising professors.
2. Develop guidelines for **mentorship and training**, such as professional development programs, and tools to help supervising professors provide high-quality mentorship, including incentivising them to allow ECRs to seek training outside the supervisor-ECR relationship.
3. Bridge gaps between academia and **alternative career paths**, such as through partnered research with private industry, and internships with non-academic groups.

If the future of Canadian research lies in its junior researchers, then strategies must be laid out for how universities, government, and the knowledge-intensive industries can be better at nurturing our ECRs. Recent grassroots campaigns, such as #SupportTheReport to encourage the Canadian government to take up the recommendations of the Fundamental Science Review, have shown that effective change is possible. Canadian ECRs must be ready to stake their claims in their future, and we hope that meetings such as FoRV2017 are only the beginning.

Introduction

In Canada, a large proportion of science, engineering, and social research is carried out by early career researchers (ECRs), a term that encompasses graduate students, postdoctoral fellows (PDFs), and principal investigators (PIs) who have held their independent position for less than five years. ECRs represent not only the core workforce of most academic institutions, but the next generation of scientific leaders. However, there has been growing concern that current funding and training structures almost entirely ignore the best interests of ECRs.

Between 2002 and 2011, the number of PhDs awarded annually by Canadian universities increased by 68% to over 6000¹. However, this has not been met with an accompanying increase in the number of faculty positions. Between 2010 and 2017, the number of assistant professorships in Canada, representing potential faculty positions that these PhD graduates could hope to one day occupy, declined by 15.9%². Overall, about 16% of PhD holders in the Canadian labour force are employed in tenure-track positions¹. Therefore, the graduate training environment should reflect the reality that most students will need to find employment outside of academia. As a way to increase employment options for scientists, mid-career positions including staff scientists and group leaders have been proposed³. Staff scientists could offer

many additional benefits to labs, including providing on-hand supervision for trainees, and acting as reservoirs of institutional knowledge. However, the current grant-by-grant nature of most research funding makes such permanent positions difficult to implement for all but the largest groups.

Canadian PhDs do find high levels of employment outside of academia¹, but many graduates are concerned about a lack of career training and exposure to alternative career paths for graduate students and PDFs, collectively termed “trainees”. For example, among PhD students in Canada, only 51% are satisfied with the available advice and workshops concerning academic careers, and only 40% are satisfied with the resources for non-academic careers¹. Around 70% of Canadian PDFs report being satisfied with the resources and supervision available to them from PIs, but only ~40% are satisfied with opportunities for career development and professional training⁴. Postdoctoral fellowships are ostensibly trainee positions, thus it is particularly concerning that PDFs are so dissatisfied with the training opportunities available to them. Some of the areas where Canadian PhD holders feel their professional development has been lacking include training in communication with non-specialist audiences, business and financial management, and the ability to work in a team¹. Given that skills like team management are core to running a lab as a professor, this is a significant weakness for Canadian science.

Canadian PDFs also report high levels of dissatisfaction with their salaries⁴. In 2016, around half of Canadian PDFs were earning less than \$45,000 CAD per year; if such a PDF were a sole earner with dependents, this salary may place them below the Canadian Low Income Cut-Off⁴. In the same period, salary of UK PDFs increased to ~CAD\$60,000⁴, while recent US Department of Labor rulings have led to a dramatic increase in the salary of some US PDFs to ~CAD \$59,500. Moreover, other countries offer PDF salary increments based on experience, while Canadian PDFs will often see no salary increase even after a 5-year appointment, which is the maximum appointment length for a PDF at the University of British Columbia, Vancouver. The relatively low salaries may make Canada a less desirable destination for those seeking postdoctoral positions; indeed, the proportion of non-Canadian citizens holding postdoctoral positions in Canada declined from 56% in 2009 to 42% in 2016⁴. British Columbia and Vancouver are particularly unattractive for prospective ECRs, as costs of living here are among the highest anywhere in North America⁵. Geographical cost of living adjustments to ECR salaries and fellowships have been suggested by other groups around the world to make working in cities like Vancouver possible³, but have been largely ignored by government and academic groups.

Another cause for dissatisfaction among Canadian PDFs concerns employment benefits. Although the majority of Canadian PDFs have access to basic provincial health care, only around half have access to extended health benefits that cover the cost of prescription medication and dental and vision care⁴. Furthermore, while all Canadian PDFs pay federal and provincial income tax, whether supported by fellowships or by their supervisor's grant funding, only those classified as “employees”

are eligible for government benefits available to other Canadian employees, such as the Canada Pension Plan or Employment Insurance (EI). Since federally funded parental leave is available only to those employees who contribute to EI, 38% of Canadian PDFs report being ineligible for paid parental leave and a further 38% are unsure of their eligibility⁴. It should be noted that some fellowship-funded PDFs do receive paid parental leave but the amount and duration is not regulated, and thus varies depending on the specific source of funding. The lack of paid parental leave and unaffordability of child care is particularly problematic because the average age of Canadian PDFs has now increased to 34 years⁴, meaning that the most productive years for a scientist now increasingly overlap with peak child-rearing years. These issues may also contribute to attrition of female researchers. While women make up 48% of PDFs across all fields⁴, they represent only 40% of Canadian faculty members²; however, this does represent an improvement from 36.6% five years ago.

For many years, Canadian ECRs who looked to apply for grants as new PIs have faced science funding budgets that did not keep pace with inflation⁶. Between 2008 and 2015, the number of grants awarded by the Canadian Institutes of Health Research (CIHR) to early career PIs declined by 38%⁷. Starting in 2014, CIHR diverted up to 45% of its funding for investigator-initiated research to the new Foundation Grant scheme, designed to provide longer term support for leaders in health research⁸. Foundation Grant funding has been heavily biased toward senior researchers; in the first Foundation competition, only 5% of funds were awarded to ECRs⁷. In 2017, the Foundation Grant eligibility rules were revised and ECRs became ineligible for funding via this mechanism⁹. While an equalization mechanism exists within the CIHR Project Grant scheme to ensure that the proportion of grants awarded to ECRs matches the proportion of applicants who are ECRs¹⁰, these grants are smaller in value: the average size of Foundation Grants is \$2.6 million CAD, while Project Grants are worth CAD\$720 thousand on average. More still needs to be done to ensure that Canadian ECRs have access to the funding that they will use to build their research programs.

Along with the dissatisfaction with current funding and training structures, there is growing awareness that ECRs worldwide experience high levels of depression and anxiety¹¹. A recent study showed that graduate students across the globe experience symptoms of depression at six times the rate of the general population, sparking concerns of a mental health crisis¹². More worryingly, ~75% of Canadian PDFs report symptoms of mental illness⁴. These factors can only be exacerbated by concerns over job security, and feelings of low status and underappreciation in the university hierarchy. These mental health concerns further underscore the need for extended health benefits (including counselling/therapy) among Canadian PDFs.

Despite these important concerns, there is hope for the future. The Fundamental Science Review, commissioned in 2016 to evaluate the effectiveness of Canada's investment in research, recommended a CAD\$1.3 billion increase in base funding of the three federal research granting agencies, the CIHR, the Natural Sciences and Engineering Research Council (NSERC), and the

Social Sciences and Humanities Research Council (SSHRC), just to bring Canada on par with peer nations⁶. Increased investment in ECRs was recommended, but few details were provided. The Fundamental Science Review helped galvanise scientists to campaign federal Members of Parliament for better research funding. While the recent 2018 Federal Budget did not meet all expectations, it did increase fundamental research funding by \$925 million over 5 years, with \$275 million set for international, inter-disciplinary, and high-impact research¹³. Furthermore, it proposes \$210 million over 5 years for Canada Research Chair (CRC) appointments specifically for ECRs. However, while this provides salary support it does not provide operating funds, a major issue as nearly half of the CIHR-funded tier-2 Canada Research Chairs held no CIHR operating grants in 2015⁷. Thus, while significant challenges still face Canadian ECRs, there is good reason to believe that strong advocacy by grassroots movements can reverse the decline in public funding of Canadian science.

While the specifics of funding bodies and university structure may differ, similar concerns are growing in many developed nations with long-standing publicly funded research programs. In 2014, in Boston, MA, a group of postdoctoral researchers founded Future of Research, an organization dedicated to championing, engaging, and empowering ECRs. Driven by what they perceived as a severe lack of investment in the next generation of scientists, they convened a symposium to learn what ECRs in the US were most concerned about. The ultimate goal of the Future of Research was to develop a series of recommendations for universities and governments, which could act as a roadmap to move toward a more equitable and sustainable research enterprise.

The outcomes of the Future of Research Boston Symposium were later published³. Broadly speaking, their recommendations were: (1) to promote discussions between ECRs and stakeholders on how the scientific enterprise could be reformed, (2) to increase transparency on career outcomes, and expectations of the balance between training and research in PDF appointments, and (3) to increase investment in ECRs, with more grants to PDFs to provide financial independence from PIs, and accountability for the quality of training received during a postdoctoral appointment. Since the symposium, Future of Research has played an essential role in advocating for increased pay for US PDFs, in response to changes in overtime payment thresholds set by the Department of Labor¹⁴.

Future of Research inspired other groups of PDFs and graduate students to form their own local organisations. Here we report the findings of the Future of Research Vancouver Symposium, which was organised by PDFs in Vancouver, BC, to discuss how to create a sustainable future for Canadian research.

Workshop overview

Future of Research Vancouver 2017 (FoRV2017) was organised by PDFs from the University of British Columbia (UBC) and Simon Fraser University (SFU). The event was hosted at the Vancouver Campus of SFU, on the afternoon of February 20th 2017, with 136 participants in attendance. The event was

financed through sponsorship from community partners, including universities (SFU, UBC), associations (UBC Postdoctoral Association), biotechnology companies (STEMCELL Technologies, Zymeworks Inc., AbCellera Biologics Inc., Mesentech Inc.), funding agencies (Michael Smith Foundation for Health Research, Genome British Columbia), research infrastructure programs (WestGrid), and research centres (Centre for Blood Research).

The first session of the workshop was focused on preparing attendees with an informed understanding of the current state of the scientific enterprise, with a focus on the Canadian system. A diverse range of speakers was sought to cover perspectives from many sectors of the research ecosystem to best frame the issues at hand. The session began with an introduction by Dr. James McCoy, a PDF at UBC and a member of the organising committee, to define some of the key challenges currently faced by ECRs. This was followed by keynote addresses by Dr. Santa Ono, President and Vice-Chancellor of UBC, and Dr. Terry Thomas, Senior Vice President (Research and Development) of STEMCELL Technologies, to convey perspectives on Canadian research from two of its largest sectors, namely academia and industry. This was followed by a panel discussion, composed of: Dr. Terry Thomas; Dr. Liisa Galea, a Professor at UBC and strong proponent of women in science; Dr. Lara Boyd, an Associate Professor at UBC and the representative of her institution to CIHR; and Dr. Eric Hsu, the lead for Data Science at Estuary Innovation group and a representative for alternative career paths for scientists.

The second session of the workshop was centred on discussions of the issues facing ECRs in Canada and possible solutions. The attendees self-selected one of four individual Breakout Sessions, each with a particular theme similar to those used at the FoR Boston event³. The themes for the four sessions were:

- *Session 1. How can trainees be better prepared for careers in science in 2017?*
- *Session 2. How should the supply of postdocs and graduate students be matched to demand to create sustainable, secure career pathways for young researchers?*
- *Session 3. How can the funding of science research in Canada be structured to balance and promote basic research, knowledge translation, and training of the next generation of scientists?*
- *Session 4. How can the current system of incentives be fixed so that scientists and institutions are rewarded for the behaviours that are believed to support good science?*

Breakout Sessions followed a similar procedure to that used at FoR Boston^{3,15}. Briefly, each Breakout Session began with a short introduction to the topic of discussion and relevant background information by moderators. The participants were then given time to brainstorm “problems” related to the topic and record their ideas on sticky notes. Subsequently, there was a group discussion about the problems and participants attempted to group the sticky notes to identify broader trends. A similar procedure was then followed to identify possible solutions. The problems and solutions

recorded on the sticky notes in the Breakout Sessions represent the primary data for this article. Before leaving the Sessions, participants were asked to complete an Exit Survey, which included questions regarding demographic data, opinions about the outcomes of the Breakout Session, and feedback towards future events. The workshop concluded with a reception that allowed participants to continue the discussions in an informal setting and network with the event sponsors.

Results

Demographic information from the Exit Survey (Table 1)

The Exit Survey results provided insight into the range of participants involved in the discussions. Diversity was desired to ensure the discussions incorporated inputs, views and opinions from a variety of sources, to ensure representation of the wider community of ECRs. The Exit Survey supplied to participants and the responses are available online ([Supplementary File 1](#)). From the 65 responses, the average age of attendees was 33 years old, with only Session 3 showing a notable digression from this average. The gender ratio was in favour of female participants (31:20), although there were a notable number of non-responders to this question. Attendees represented a variety of positions; however, the majority of attendees were either graduate students (31) or PDFs (22).

Breakout Session outputs

Problems and solutions identified in Breakout Sessions. The problems and solutions proposed by participants in each Breakout Session were recorded as described in Workshop Overview (for raw outputs see [Supplementary File 2](#)). As many of the data points showed overlap or were related, the data were summarized into sets of key problems and solutions, which are presented in [Table 2–Table 5](#). Note that the solutions supplied were not tied to specific problems that had been raised, and the grouping of this information into general themes has been performed *ex post*.

Rating of outputs identified in Breakout Sessions. After the discussion of possible problems and solutions described above, each Breakout Session concluded with an Exit Survey in which participants were asked to choose the most significant problem and most impactful solution identified in their Session. These answers are summarized in [Table 6–Table 9](#); all

responses (raw data) can be found in the Supporting Information ([Supplementary File 1](#)).

General Exit Survey data

Attendees were asked to evaluate the process and outcomes of FoRV2017 and their specific Breakout Session in the Exit Survey. The data from the Exit Survey were analysed to give the average responses reported below ([Table 10](#)). Questions requested a ranking between 1 and 5, with 5 representing complete agreement ([Supplementary File 1](#)). The lowest importance (3.3/5) was ascribed to the questions regarding whether a consensus was reached and whether it was important to reach consensus, showing that the majority of attendees believed that a general agreement on the discussed problems and solutions was neither necessary nor attained in order to achieve positive change for ECRs. In contrast, the importance for diversity - in the meeting, the speakers, the attendees and the discussions - was highly scored (4.1/5). Finally, attendees rated FoRV2017 highly, by giving a 4.2/5 score on whether they would recommend the event to friends and colleagues.

Discussion

There have been major changes to science funding in Canada and scientific research globally in the past decade, yet ECRs, particularly graduate students and PDFs, have had few opportunities to voice their opinions on these matters. FoRV2017 aimed to fill this gap. Although the Breakout Sessions focused on different topics, the identified problems and solutions showed significant overlap. Three major challenges facing ECRs in Canada that were brought up repeatedly relate to funding, mentorship, and the existing divide between academia and other sectors (particularly industry). We discuss each of these issues and potential solutions in more detail below.

Insufficient funding for ECRs in Canada

Shortage of funding throughout the Canadian science ecosystem. According to FoRV2017 participants, the underfunding of science is one of the largest issues facing Canadian research ([Table 3](#), [Table 4](#), and [Table 5](#)). This problem was also exposed by the Fundamental Science Review⁶ and felt across all facets of research, with calls for increased funding for both short-term and longer-term projects, fundamental research, and interdisciplinary research ([Table 4](#)).

Table 1. Demographic information from the Exit Survey.

Breakout Session	Number of responders	Age	Gender			Position									
			M	F	NR	PDF	GS	US	I	F	RS	P	U		
1	30	30.4	8	17	5	14	15							1	
2	12	31.3	4	7	1	1	8		1		2				
3	16	41.0	6	4	6	5	4	4		1	1	1			
4	7	32.2	2	3	2	2	4		1						
Total	65	32.7	20	31	14	22	31	4	2	1	3	1	1		

M = Male; F = Female; NR = No Response; PDF = Postdoctoral Fellow; GS = Graduate Student; US = University Staff; I = Industry; F = Funding body; RS = Research Scientist; P = Public; U = Unemployed.

Table 2. Problems and solutions identified in Breakout Session 1: *How can trainees be better prepared for careers in science in 2017?*

Theme	Problems	Solutions
Professional Development	<ul style="list-style-type: none"> Not trained for all roles of a PI Professional Development (PD) topics too centralised Training sessions not mandatory 	<ul style="list-style-type: none"> More tailored range of PD workshops Make PD training mandatory Dedicated funding for PD Career-based skills training
Alternative Careers	<ul style="list-style-type: none"> Lack of knowledge on how to transfer and market skills Lack of knowledge of opportunities, careers and options Unprepared for non-academic careers Lack of specific career advice, knowledge, and training 	<ul style="list-style-type: none"> Clear expectations for jobs by employers Invite speakers and panels with non-academic careers Funding for industry/community engagement Database to link with non-academic professionals
Confidence	<ul style="list-style-type: none"> Belief that scientific process is not translatable Lack of encouragement Imposter syndrome 	<ul style="list-style-type: none"> Support groups Help dealing with rejection Encouragement from mentors
Networking	<ul style="list-style-type: none"> Unaware how to network Need more networking opportunities 	<ul style="list-style-type: none"> More funding for travel and events Personal challenge to network more Network outside your immediate area More collaborations
Mentor Deficiencies	<ul style="list-style-type: none"> PIs not prepared to mentor for careers outside academia Poor mentorship Instances of poor etiquette and unprofessional behaviour 	<ul style="list-style-type: none"> Training for mentors Funding for mentorship duties Have additional external mentors
Lack of Specific Experience	<ul style="list-style-type: none"> Lack of opportunities to experience the private sector No/few industrial placements 	<ul style="list-style-type: none"> Co-ops for graduate students Short term internships and visits Exchanges without risk of repercussions from supervisors
Assorted	<ul style="list-style-type: none"> Lack of diversity Too focused on research, not enough focus on training and development Financial challenges 	<ul style="list-style-type: none"> Communicate with and engage the public on what scientists do Advocacy, engage policy-makers Credit for non-research activities, including grant authorship opportunities to be co-investigators More funding opportunities More community engagement

Table 3. Problems and solutions identified in Breakout Session 2: *How should the supply of postdocs and graduate students be matched to demand to create sustainable, secure career pathways for young researchers?*

Theme	Problems	Solutions
Alternative careers	<ul style="list-style-type: none"> Lack of knowledge of opportunities for PhDs Lack of opportunities to apply experience from a PhD Industry has a bad reputation Lack of understanding on translation of PhD skill set 	<ul style="list-style-type: none"> More communication between academia and industry Increased industry role in training and funding Industry-specific training Increased emphasis on and opportunities for networking
Training	<ul style="list-style-type: none"> Lack of industry experience Lack of extracurricular training 	<ul style="list-style-type: none"> Internships for building specific skills and networking Incorporate other PD and skills training into programs
Funding	<ul style="list-style-type: none"> Lack of investment in science from government (0.3% GDP) Insufficient research funds 	<ul style="list-style-type: none"> Competitive salary for PDFs Fund the institute, not the PI, to create more internal competition
Assorted		<ul style="list-style-type: none"> Mandated staff composition of labs and groups (by funding agencies)

Table 4. Problems and solutions identified in Breakout Session 3: How can the funding of science research in Canada be structured to balance and promote basic research, knowledge translation, and training the next generation of scientists?

Theme	Problems	Solutions
Funding Application Process	<ul style="list-style-type: none"> Long timeline Adjudication criteria focus on metrics not quality Quality of the peer-review system Time investment vs chance of success 	<ul style="list-style-type: none"> Engage reviewers from outside academia for relevant expertise on knowledge translation/knowledge mobilisation Evaluate the science more, and the scientist less Less emphasis on metrics Changes to the metrics used Evaluate other criteria such as merit and relevance Improved training of reviewers
Funding Resources	<ul style="list-style-type: none"> Limited financial resources Money allocated insufficient Only government and industry financing science Insufficient funding in Canada to support a knowledge economy 	<ul style="list-style-type: none"> Crowd-sourcing Engage and lobby government for more money for science
Funding Strategy	<ul style="list-style-type: none"> Minimal funding for basic research "Hot topics" get all the funding Insufficient short-term funding for pilot work Insufficient long-term funding Interdisciplinary and collaborative projects difficult to fund Sustainability of funding Evaluation favours established researchers to the detriment of ECRs and junior achievers Funding "excellence" not "impact" Don't know how to fund innovation 	<ul style="list-style-type: none"> Targeted funding for ECRs and to support transition from trainee to faculty/PI Mandated inclusion of ECRs in grant application teams for early career success and training in grant writing Short term pilot project grants with no expectation of returns Collaborative grants to promote interdisciplinary research and engagement of industry Increased funding for translational and applied research Funding devoted to basic research Wider distribution of funding Increased diversity of what is being funded Training for KT in grant proposals More funding opportunities
Public Engagement	<ul style="list-style-type: none"> Lack of public engagement Convince public that research has value even without immediate application 	<ul style="list-style-type: none"> Taxation benefits for donation to scientific research Getting the science to the public Convey to the public that all science matters, not just "hot topics"

The science funding increase announced in the Federal Budget 2018¹⁶ may make inroads to correct some of these issues. Although there was no change in federal science funding in Budget 2017¹⁷, Budget 2018 responded to many of the recommendations of the Fundamental Science Review⁶, including: increases in base funding for granting councils and the Canadian Foundation for Innovation; targeted funds for ECRs through new CRC allocations; targeted funds for international, interdisciplinary, fast-breaking and high-risk research; and support to develop better equity and diversity outcomes¹⁶. However, it is unlikely that these changes will fully resolve the concerns of FoRV2017 participants regarding research funding in Canada. For example, the increase in unfettered funding for investigator-initiated research in Budget 2018 amounts to a real dollar increase of 14% over five years¹³; however, the available federal funding per researcher decreased by 35% between 2007 to 2015⁶. Therefore, further funding increases will be required to restore the resources available to each researcher to the level available a decade ago.

FoRV2017 participants recommended direct engagement and lobbying of the government as a key action needed to encourage

funding increases (Table 2 and Table 4). Evidence that this approach can be successful comes from the recent #Support-TheReport campaign, which involved direct petitioning of parliamentarians by scientists and the public to support calls for increased science funding¹⁸. In addition, FoRV2017 participants suggested that alternative sources of funding should be further explored (Table 4). For example, industry could play a larger role in funding research (discussed in more detail below). In addition, public donors could also play a larger role; for example, universities could help researchers pursue crowd-funding mechanisms (Table 4). Given the diversity of existing funding sources, FoRV2017 participants recommended that tools should be established to help scientists identify and locate these sources (Table 4).

Insufficient ECR-targeted funding. In addition to the overall shortage of research funding in Canada, numerous FoRV2017 participants voiced concern that ECRs have additional difficulties in accessing these funds (Table 4, Table 5, and Table 8). Participants believed that an overemphasis on track record (as opposed to the proposed research) in grant applications makes it difficult for new PIs to compete for funding against

Table 5. Problems and solutions identified in Breakout Session 4: How can the current system of incentives be fixed so that scientists and institutions are rewarded for the behaviours that are believed to support good science?

Theme	Problems	Solutions
Motivations	<ul style="list-style-type: none"> Research output valued over training Culture of working extreme hours earns respect Driven by fame, power, reputation, grants and tenure Not motivated by joy of discovery 	<ul style="list-style-type: none"> Curtail tenure length Offer spectrum of academic positions Reputation and impact based on different factors
Evaluation Systems	<ul style="list-style-type: none"> Emphasis on impact factor, publications, and patents leads to smaller or alternative achievements not being valued ECRs have fewer opportunities Non-“sexy” research devalued Stakeholder engagement and KT are not rewarded, leading to devaluation and de-incentivisation 	<ul style="list-style-type: none"> Decrease emphasis on impact factor, publication record and citations Reward stakeholder engagement, community impact, KT, collaboration record, training, achievements Value quality over quantity Use stakeholder groups and public to inform evaluation criteria
Funding	<ul style="list-style-type: none"> Too much emphasis on money in science Need more grants for collaboration and KT Grants for established researchers lead to less funding for ECRs Emphasis on short-term results undercuts longer and more significant project goals and impacts 	<ul style="list-style-type: none"> Prolonged duration of funding More funding for ECRs More accountability from funding recipients, including towards KT Increase opportunities for collaborative, not competitive, research
Integrity and Transparency	<ul style="list-style-type: none"> Pressure for sycophancy to assist career Quantity of publications rewarded over quality Lack of reproducibility Undesirable to publish “negative results” Access to many publications limited Publication bias Peer reviewers asking authors to cite their papers 	<ul style="list-style-type: none"> Double blind review system Move to complete open access publication Sharing of all data, including negative results, in publications and personally Establish channels to correct, challenge or validate publication results Academic rewards for open science policies
Communication		<ul style="list-style-type: none"> Increase the profile of science among the public Opportunity to influence policy and meet with policy makers

Table 6. Rating of outputs identified in Breakout Session 1: How can trainees be better prepared for careers in science in 2017?

Question	Key responses (# of instances from n = 30 completed surveys)
<i>In your opinion, what was the most significant problem discussed in this session?</i>	<ul style="list-style-type: none"> Mentorship (14) Professional development and training (10) Money - salary or funding (5) Exposure to career paths (5)
<i>In your opinion, which solution discussed in this session would have the greatest impact if it were implemented?</i>	<ul style="list-style-type: none"> Professional development and training (12) Mentorship (8) Money - salary or funding (8) Exposure to career paths (3)

established researchers (Table 4 and Table 5). Participants put forward many proposals of how granting agencies could level the playing field for ECRs, such as evaluating proposals independent of CVs or conducting double-blind reviews to reduce bias in favour of established researchers (Table 4). In order to help ECRs build their track records, it was also suggested that trainees

should be recognised for their contributions to grant applications, such as by allowing them to be listed as co-investigators (Table 2). However, the intervention that numerous participants rated as the most potentially impactful is the establishment of dedicated funding for ECRs (Table 8). All three of the federal granting agencies have recognised and responded to this issue

Table 7. Rating of outputs identified in Breakout Session 2: How should the supply of postdocs and graduate students be matched to demand to create sustainable, secure career pathways for young researchers?

Question	Key responses (# of instances from n = 12 completed surveys)
<i>In your opinion, what was the most significant problem discussed in this session?</i>	<ul style="list-style-type: none"> • Bridging academia and industry (6) • Funding opportunities (3) • Training (3) • Exposure to alternative careers (2)
<i>In your opinion, which solution discussed in this session would have the greatest impact if it were implemented?</i>	<ul style="list-style-type: none"> • Bridging academia and industry (6) • Improved training (5) • Industry involvement in training (4) • Increased funding (3)

Table 8. Rating of outputs identified in Breakout Session 3: How can the funding of science research in Canada be structured to balance and promote basic research, knowledge translation, and training the next generation of scientists?

Question	Key responses (# of instances from n = 16 completed surveys)
<i>In your opinion, what was the most significant problem discussed in this session?</i>	<ul style="list-style-type: none"> • Funding adjudication process (7) • Access to funding for ECR (4) • Diversity of funding structure (3) • Distribution of funding (2)
<i>In your opinion, which solution discussed in this session would have the greatest impact if it were implemented?</i>	<ul style="list-style-type: none"> • Diversity of funding structure (4) • Targeted ECR funds (4) • Changes to funding adjudication (3) • Collaborative funding (2)

Table 9. Rating of outputs identified in Breakout Session 4: How can the current system of incentives be fixed so that scientists and institutions are rewarded for the behaviours that are believed to support good science?

Question	Key responses (# of instances from n = 7 completed surveys)
<i>In your opinion, what was the most significant problem discussed in this session?</i>	<ul style="list-style-type: none"> • How achievement is measured (3)
<i>In your opinion, which solution discussed in this session would have the greatest impact if it were implemented?</i>	<ul style="list-style-type: none"> • Collaborative research metrics (2) • Alternative metrics (2)

Table 10. Average scores from Exit Survey. Scores are out of a total of 5.

Question	Addressed stated objective?	Arrive at meaningful solutions?	Reach a consensus?	Important for consensus?	Important for diversity?	Recommend For?
Average	3.9	3.5	3.3	3.3	4.1	4.2

*Scores were on a scale of 1–5, with 5 being in the affirmative. For the question on reaching a consensus, 5 represented diverse views and 1 represented a consensus.

with controls established on ECR success rates or dedicated funds in at least one of their programs (including the CIHR Project Grant¹⁹, the NSERC Discovery Grant²⁰, and the SSHRC Insight Development Grant²¹); whether this will be sufficient will be evidenced in time.

It is uncertain whether the funding plan laid out in Budget 2018 will substantially improve the situation for ECRs. First, graduate scholarships and postdoctoral fellowships, which the FoR Boston recommendations favour as a means to give more independence to ECRs³, received no funding increases in Budget 2018¹³. On the other hand, Budget 2018 includes \$210 million CAD over five years to fund new CRCs, which could support the salaries of up to 250 early career PIs¹³. However, since CRC funds cannot be used toward operating expenses, ECRs hired with this salary support may continue to have difficulty acquiring sufficient funding for their research.

A need for improved mentorship and training of ECRs

Another major area of concern among FoRV2017 participants was the poor quality of mentorship that ECRs receive. Indeed, around half of the participants in Breakout Session 1 listed mentorship as their most significant concern (Table 6). There were several areas in which mentorship for ECRs was considered to be lacking. First, participants were concerned that there is little incentive for supervisors to invest time and effort in mentoring their graduate students and PDFs, since evaluation of PIs tends to be heavily weighted toward research output (i.e., publications and grants) rather than mentoring outcomes for their trainees (Table 5). Second, some participants believed that there is a lack of training available to PIs regarding how to train and mentor their trainees; the effect of this lack of experience among PIs can range from ineffective mentorship to unprofessional behaviour and misconduct (Table 2). Finally, participants expressed concern that trainees who intend to work outside academia are receiving especially poor mentorship, since many PIs place little value in or have little experience in work outside of academia (Table 2).

Participants of FoRV2017 put forward several proposed solutions for the mentorship problem in academia. Participants suggested that PI training in mentorship skills could be directly offered by universities, or that funds could be provided to PIs who wished to pursue mentorship training on their own (Table 2). In addition, professional development programs, run by the institution, could be made mandatory for graduate students or postdocs (Table 2); this policy would remove the ability of supervisors to dissuade their trainees from participating in external training and mentorship programs. Participants also suggested that trainees take mentorship into their own hands to a greater extent, and seek out mentors external to their supervisor and formal supervisory committee (Table 2).

Concerns around mentorship and training of ECRs have also been raised by numerous organisations in recent years. In BC, the UBC Graduate Student Society published a white paper on supervisory excellence, addressing what many graduate students perceived as a dire lack of mentorship in Masters and

PhD programs²². Several recommendations in this paper, including mentorship programs for supervising professors and setting measurable minimum standards for supervision by universities, closely match suggestions made by FoRV2017 participants. This paper has been met positively by UBC administration and the Faculty of Graduate Studies, prompting such measures as making seats available for students on the Faculty of Graduate Studies Committee, but actual change has yet to be demonstrated.

The FoR Boston group has recommended that supervisors, departments, and institutions be held accountable for providing a good training experience for postdocs by requiring direct feedback from postdocs to granting agencies³. They also suggested that anonymized, aggregated feedback on the training environment in individual departments could be made publicly available, to assist prospective graduate students and postdocs³. The participants of FoR Chicago similarly recommended that institutions and granting agencies conduct performance evaluations of mentorship practices by individual PIs²³. Much like the participants of FoRV2017, the attendees of the Chicago symposium also expressed a wish for improved training in mentorship skills for PIs²³. Clearly, a need for improved mentorship in academia is a common theme in universities throughout North America.

Bridging of academia and other sectors

The historical separation between academia and other sectors contributes to the issues faced by ECRs today. In recent years, the need to bridge this divide with industry²⁴, decision-makers²⁵ and the public²⁶ has become evident. The need to increase crosstalk, collaboration and engagement specifically with industry was highlighted by many FoRV2017 attendees across different Breakout Sessions (Table 2, Table 3, and Table 4). Such interaction would likely be mutually beneficial to both trainees and the industries in which they intend to seek employment.

Alternative career paths. Bridges between academia and other sectors will assist in exposing trainees to alternative career paths. In every field of study, Canadian PhD holders are more likely to be employed in a non-academic sector than as a full-time university professor¹; however, many FoRV2017 participants reported a lack of knowledge about what alternative career opportunities were available (Table 2 and Table 3). To address this issue, some participants expressed a desire to gain experience working in non-academic positions, such as through internships incorporated into the PhD program (Table 2 and Table 3). Of note, graduate students and postdocs in Canada can already complete internships in industry through the Accelerate program run by the non-profit organisation Mitacs²⁷. It is unclear whether some attendees might have been unaware of this program or whether demand for this type of internship exceeds capacity in the Accelerate program. Participants also suggested several ways that academic institutions could provide greater exposure to industry to their trainees, such as recruitment fairs and career panels (Table 2).

In addition to being unaware of alternative careers paths, attendees also reported feeling unprepared for these careers (Table 2).

Participants suggested several ways in which academic institutions could improve training for non-academic careers, including career-tailored professional development programs (Table 2) and directly involving industry in designing and implementing career training programs for graduate students and postdocs (Table 3). Participants also recommended that professional development programs place a greater emphasis on recognizing and marketing the transferrable skills that trainees gain during their academic training (Table 2). Concerns about poor training for careers outside of academia have also been raised in FoR symposia in the US. The FoR Chicago group, for example, recommended that professional development opportunities for graduate students and postdocs be expanded, through either curricular or extracurricular programs, and that “professional PhD” programs, featuring training in other areas such as business or law, be offered instead of or in addition to traditional PhD programs²³.

Engagement of other sectors

FoRV2017 attendees also felt that wider stakeholder engagement in science should be pursued. Building public support for science will be crucial to convincing policy-makers to enact many of the changes recommended in FoRV2017. In particular, funding increases suggested by FoRV2017 participants will require the direct engagement and lobbying of government; however, participants recognized that public support will also be required to influence policy makers (Table 5). In addition to direct appeals to the public, it is also important that ECRs present a united front to stakeholders such as granting agencies to effectively advocate for changes that will benefit ECRs³. Recent campaigns for increased research funding in Canada have led to the creation or increased the activity of ECR advocacy groups such as the Association of Canadian Early Career Health Researchers (ACECHR) and the Science & Policy Exchange; continued activity of these and other groups in the future will be required for full implementation of the recommendations made by FoRV2017 participants.

Conclusion

ECRs in Canada face many of the same challenges experienced by ECRs in the US. FoRV2017 participants highlighted insufficient funding, mentorship, and connection with industry as the most critical factors contributing to the hurdles faced by

Canadian ECRs. To make the research enterprise in Canada more equitable and sustainable, FoRV2017 participants recommend more funding directed to supporting ECRs (particularly research operating costs and career transition support), increased incentives and training for high quality mentorship, and strengthened partnerships with private industry in academic training and research initiatives. Following the Fundamental Science Review and the announcement of the 2018 federal budget, it is clear that progress is being made to support Canadian research; however, more is needed to support ECRs to retain and attract top talent towards building a more sustainable scientific enterprise in Canada.

Data availability

All data underlying the results are available as part of the article and no additional source data are required.

Competing interests

No competing interests were disclosed.

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The author(s) declared that no grants were involved in supporting this work.

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Supplementary material

Supplementary File 1: Exit Survey – text of the Exit Survey administered to participants, with quantitative scoring data, summarized qualitative answers, and raw qualitative answers.

[Click here to access the data.](#)

Supplementary File 2: Output from Breakout Sessions.

[Click here to access the data.](#)

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Holly O. Witteman

Department of Family and Emergency Medicine, Office of Education and Professional Development, Faculty of Medicine, Laval University/Université Laval, Québec City, QC, Canada

This paper describes the outcomes of a workshop conducted with n=136 participants, mostly postdoctoral fellows and graduate students, in Vancouver, Canada to discuss issues facing trainees. This event was modeled on a previous meeting held in Boston. The authors present a summary of participants' views regarding challenges faced by trainees and some potential solutions to address these. This manuscript offers a well-written account of issues facing trainees in Canada, and has potential policy implications. However, I have quite a number of concerns about this manuscript, which I detail below. I hope these are helpful to the authors to improve their manuscript and achieve the impact that they hope to have in Canadian science and research policy.

Reason for Not Approved

Note: I moved this point up to the top of my review after reflecting on the likely reaction of the authors and what they might first want to know from this review.

Research with human participants (a.k.a. "human subjects research") requires oversight by an research ethics board to be publishable in a reputable peer-reviewed journal. Was the survey approved by the relevant research ethics board (in this case, SFU, since that's where the data collection occurred)? Did all survey respondents provide informed consent to have their responses analysed and published? If the answer to either of these questions is no, this is problematic. This lack of information about ethical approval gave me great pause when reviewing this manuscript. Current practice in many other journals for a manuscript describing data from human participants without a statement about ethical approval is to send it back before it even gets to the editor. This is the reason I selected Not Approved. I would prefer not to have to select this, especially as this is a trainee-led manuscript, but this is a required element for human subjects research to merit publication in a peer-reviewed journal. I can't approve this manuscript without this. I'm sorry.

Overall

1. Having been extensively involved in policy discussions about Canadian health research funding and funding policy, I began this review by reading the manuscript twice—once with my existing base of knowledge, and a second time, attempting to put myself in the place of someone who is less familiar with the past few years of changes and events in Canadian health research policy. My experience as a reader was significantly worse the second time. To enable this manuscript to contribute to the global literature on science/research policy, it would be preferable if the authors were to more carefully explain terminology and particularities of the Canadian research funding landscape. For example, a reader from outside Canada may not be familiar with #SupportTheReport or the Fundamental Science Review. Merely providing a citation puts the onus on the reader to understand things that the authors should make clear and understandable.

2. There is often confusion about the definition of an early career researcher (ECR), particularly among policymakers. As it stands, this manuscript adds to the confusion. In the opening sentence, the authors refer to ECRs as a group that includes graduate students, postdoctoral fellows, and faculty within their first five years of appointment. This muddles the issues facing these groups. The issues faced by scientists who are still completing their training are considerably different from the issues faced by new faculty. Even within trainees, there are key differences between problems faced by graduate students versus postdoctoral fellows in Canada (for example, as the authors note: access to extended health benefits, employment insurance.) The workshop was organized by postdoctoral fellows and seems to have focused almost entirely on issues facing postdoctoral fellows and graduate students. The parent organization was postdoc-organized. ECR participants at the workshop seem to have been largely, or perhaps entirely (this is not clear due to missing data in Table 1), postdoctoral fellows or graduate students. Thus, aside from some introductory paragraphs about new faculty, which read as distinctly out of place within the rest of the manuscript, there is no apparent representation of new faculty's views about any of these issues. To improve the coherence and clarity of the manuscript, I recommend that the authors (a) clearly define ECRs as graduate students and trainees, (b) put the definition in both the abstract and in the main text, and (c) remove all sections focusing on new faculty.

3. What fields are covered in this manuscript and/or by the participants? The authors appear to be largely in biomedicine, with perhaps some representation in natural sciences? Many of the references and terminology hint to the majority of people involved in this work being in biomedicine, or, as termed at the Canadian Institutes of Health Research, "pillar 1" or "theme 1". The parent organization, Future of Research, also focuses on biomedicine. The other pillars of health research (2: clinical research, 3: health services research, 4: social, cultural, environmental, and population health research) do not seem to have been represented. This is suggested, for example, by the focus on industry as the logical non-academic path for employment, which is not the case in these other areas. In addition, were researchers from other fields (e.g., engineering, social sciences, humanities) represented? The disciplinary backgrounds of the people involved should be explicitly stated and it should be clarified for the reader whether the findings and views presented in the paper reflect the entirety of the Canadian research landscape or are focused on one or more particular segments.

4. Is this a policy brief with an appended report, a research paper, or an opinion/commentary paper (the category noted on the manuscript)? It presents aspects of all three of these. It is not possible for one manuscript to be all of these things. I would encourage the authors to pick one

and do it well rather than trying to make this manuscript try to be all three simultaneously. The guidance offered by the F1000 website states quite clearly that, "Opinion articles must focus on previously published literature and not include new research and data."

Abstract

5. The authors state, "however, Canadian policies are trailing behind the progress being made in other countries." As far as I can tell, this is never again discussed nor referred to, and no citations are provided to support this statement.

Executive Summary

6. The first major recommendation by the authors is to, "1. Improve ECR-targeted funding, including grants which provide operating costs for ECRs and support the transition from a PDF to junior faculty position, and recognising ECRs contributions to grants awarded to their supervising professors." I have three concerns about this. First, experiences in other countries suggest that transitional grants may simply prolong one's period of career uncertainty. In other words, rather than years of uncertainty ending at the point at which a scientist who wished to remain in academic science either secures a position or doesn't, such transitional grants move the "up or out" point to several years into one's faculty position. Second, are the authors concerned that such an option would impact negatively on start-up funds committed by institutions? Faculty start-up funds are already lower in Canada than, for example, in the US. Such a strategy risks further reducing institutions' commitment to new faculty by expecting them to use their transitional grants in the place of providing start-up funds. Third and finally, can the authors please clarify what they mean by "recognising ECRs contributions to grants awarded to their supervising professors"? I think they are referring to the situation in which a trainee can either be listed on a grant as a co-investigator or be paid off the grant, but not both. However, this is not clear and should be stated explicitly.

Introduction

7. The opening sentence refers to, "science, engineering, and social research," in Canada. This is an unusual collection of terms. Where is health research in this list? What happened to the humanities? More importantly, this broad opening leads me as a reader to expect that this paper will address all research areas, when in fact, as noted above in comment 3, this does not appear to be the case. It would help readers orient themselves if the authors were to avoid inviting this confusion in the opening line of the manuscript.

8. The authors state in their first paragraph, "However, there has been growing concern that current funding and training structures almost entirely ignore the best interests of ECRs." I am not aware of any longitudinal analyses of such concerns. Can the authors please provide a citation to support the assertion that such concerns are growing? It would also be helpful to clarify what they define as "the best interests of ECRs."

9. In my view, the Introduction would be stronger overall with the first paragraph completely removed. The second paragraph opens in a more compelling way and more swiftly leads the reader to an understanding of the problems addressed in the manuscript. If the authors were to do this, the concerns I raise above in comments 7 and 8 would no longer exist.

Workshop Overview

10. Given that the rest of the manuscript focuses on results from the second workshop session, it may be useful to have a summary of the first session beyond the list of people who presented. What did they present? Such a summary may or may not be possible at this date, depending on whether or not the session was recorded, but if it is possible, it would be a good addition to the paper.

11. To preface this next set of comments, I will note that my own training and current research combine social science methods with other fields. Also, I will note that this is the third manuscript I have reviewed this year from biomedical/natural scientists or clinicians demonstrating a lack of awareness of best practices in social sciences, including workshop and survey methods. It is too late now, but I hope that in future, the authors will involve colleagues in social sciences to help improve their workshop/focus group methods, survey methods, and analyses of data from these. Considering the data they already have and the things they already did and can't undo, this manuscript might be improved in the following ways:

- a. More detail is needed about the event. Who was invited to the event? How were invitations distributed? Were the organizers hoping to attract specific groups of people? How was this phrased in promotion materials?
- b. More detail is also needed about the survey process. The authors state, "Before leaving the Sessions, participants were asked to complete an Exit Survey, which included questions regarding demographic data, opinions about the outcomes of the Breakout Session, and feedback towards future events." Does that mean that participants were asked to complete the survey on paper right there, or was this a reminder issued to participants to please complete the online survey that would be sent to them later? Was the survey pre-tested in any way? Was it paper or online? The supplementary materials suggest it was a paper survey but it should be explicitly stated.
- c. Can the authors please better explain how they grouped ideas? They state, "Note that the solutions supplied were not tied to specific problems that had been raised, and the grouping of this information into general themes has been performed *ex post*." How was this done? By whom? Did the person/people doing this grouping have training and experience in qualitative research? Were two independent analysts involved (if so: what was their kappa) or did one person make these decisions? What qualitative methods were used?

Results

12. Like the Methods, the Results section is missing key data we would expect from this type of work. The authors should consult the Equator Network (equator-network.org) and consider the available reporting guidelines. Although I don't believe there exists a reporting guideline for a policy workshop such as this, the authors might consult and consider which elements of STROBE (cohort study) and COREQ (focus group) apply to their work. If their survey was conducted online, I would suggest they also consult CHERRIES.

13. What was the survey response rate (number of completes/136)? It looks like the response rate was, at most, about 50%. That's lower than we might typically expect for an event-linked evaluation survey. How did this happen? Did people leave without completing the survey? Did they not respond to requests to complete it online?

14. Several comments about Table 1:

- a. In the questionnaire provided in the supplementary file, the categories of positions are: Postdoc, Graduate/PhD student, Faculty, Other (please specify). These same categories (and subcategories as appropriate) should be used in this table. If no participants belonged to a given category (e.g., Faculty) then this should be shown in Table 1 with zeroes.
- b. Particularly with $n < 100$, it is inappropriate to report mean age to one decimal point. Even if $n \geq 100$, it isn't useful precision. There isn't a meaningful difference between 32 years old and 32.2 years old. Please report mean age as integers.
- c. Again re: reporting of age, for these kinds of descriptive statistics, one would typically report a measure of central tendency (usually either sample mean or median, depending on distribution) as well as a measure of dispersion (sample standard deviation if mean is used, interquartile range if median is used, sometimes full range.) If the authors are unsure which is most appropriate for their data, they may wish to consult with the statistical consulting service at their institution. These services often provide free or inexpensive consulting to students and trainees.

15. Several comments about Tables 2-5:

- a. Tables provide grouped listings of perceived problems and suggested solutions. I would suggest naming them this way rather than problems and solutions, to be clearer.
- b. Many of these points are opaque. For example, what do the following points mean? "Getting the science to the public" (What science? Which public? How would one define having gotten science to the public?) "Short term pilot project grants with no expectation of returns" (Surely this is not suggesting funding with no anticipated returns whatsoever?) "Quality of the peer-review system" (This is so vague it's meaningless. Can this be better explained?) "Professional Development (PD) topics too centralized" (What does this mean?) "Lack of extracurricular training" (What is this?) "Pressure for sycophancy to assist career" (What does this mean?) This is not an exhaustive list. There are many other points whose meanings are unclear.
- c. Some of the points display a lack of awareness about the research landscape. For example, one such comment is, "Engage reviewers from outside academia for relevant expertise on knowledge translation/knowledge mobilization." While, in my view, it's good to have knowledge users and knowledge brokers from outside academia reviewing relevant grants, the authors might consider consulting the Knowledge Translation panel from the last cycle of CIHR Project grants (KTR in the list available here: cihr.ca/e/50845.html), the reports from KT Canada, or the list of people responsible for KT at each province's SPOR SUPPORT unit and perhaps reflect on whether they are aware of academic expertise in this area. Other such examples include, "Mandated staff composition of labs and groups (by funding agencies)." This is outside the purview of funding agencies.
- d. Some of the points contradict each other. For example, directly one after the other are the suggested solutions, "Increased funding for translational and applied research," and, "Funding devoted to basic research."
- e. Some of the points appear to be poorly classified. For example, "Convince public that research has value even without immediate application," is listed under Problems while, "Convey to the public that all science matters, not just 'hot topics'," is listed under Solutions.
- f. A number of the points repeat themselves across tables and some categories lack meaning (e.g., "Assorted.") See comment 18 below for a potential suggestion of how to address this.
- g. While it's lovely to have the raw data supplied (thank you), the data themselves are even more difficult to interpret than the points in the tables.

16. The workshop included trainees in Vancouver from the University of British Columbia and

Simon Fraser University. If I am understanding correctly, there were no participants from other academic institutions. Is that correct? This is completely understandable given the nature of the event and the geography of Canada. However, it means that some of the ideas come across as under-informed. For example, Canadian institutions already offer mentorship training to PIs. Université Laval offers such training and, while it is not mandatory, it is strongly recommended. (To illustrate: I have taken it, as has every professor in my unit.)

17. Related to the above, some aspects of the report read as national; for example, statistics about Canadian funding, while others read as local; for example, references to, "Vancouver's high cost of living." The authors might wish to reflect on whether they wish to add more national context (e.g., "high cost of living in cities like Vancouver and Toronto") or focus even more on issues that are specific to trainees at institutions in Vancouver.

18. Similar to the above, and related to point 15c above, one of the suggestions was, "Training for KT in grant proposals." Such training exists; for example, trainees may wish to explore the training programs available through the Li Ka Shing Knowledge Institute at St. Michael's Hospital, Toronto (knowledgegetranslation.net), KT Canada, or other organizations. Given they are in BC, they should contact their provincial Strategy for Patient-Oriented Research (SPOR) Support for People and Patient-Oriented Research and Trials (SUPPORT) unit (bcsupportunit.ca). BC's KT component is led by Dr. Linda Li at UBC. They may also wish to consult the list of resources here cihr.ca/e/49443.html. This is but one example of many in which the authors present perceived problems and suggested solutions with no acknowledgement that such solutions already exist and, indeed, have existed for quite some time. (To illustrate: I attended a KT Canada Summer Institute as a PhD student in 2008.) Others include things like reviewer training, which is already underway at CIHR, or networking opportunities, which raises the question of whether the participants have made use of the existing networking opportunities available to them? It took me less than 60 seconds to search for 'biomedicine networking event Vancouver' and find three recent such events. Of course, it is not reasonable to expect trainees (nor anyone) to know every opportunity that's out there for them, but this manuscript would be improved by better mapping the perceived problems and suggested solutions onto current opportunities to identify true gaps. Right now, unfortunately, the results come across as a very long, semi-organized laundry list of perceived problems and suggestion solutions that range from very insightful to woefully under-informed. This is a shame, as the authors and their colleagues clearly put a great deal of time into understanding the context of research funding, organizing the workshop, and preparing this report. To help this manuscript better capitalize on that effort and the expertise that the authors and workshop participants bring re: their experiences as trainees, the authors might consider identifying a few key issues and solutions and contextualizing them in the broader literature. For example, the structure of postdoctoral training programs may be present as a key theme. This could be put in the context of previous literature such as: PMIDs [27543634](#), [25673353](#), [25771193](#), etc. This would also help reduce the large number of repetitive tables. The authors might consider consulting the chart in the paper published by Future of Research as an example of how taking the time to synthesize can help to better present data from a workshop such as this. Participants' ratings in Tables 6-9 might help identify the perceived problems and suggested solutions that are most important and worth highlighting. Grouping and identifying key issues and solutions is particularly defensible given the authors' own statement in the Discussion that, across breakout sessions, "solutions showed significant overlap."

19. There is quite an emphasis on mentorship in the results and discussion. I wonder if the

trainees who participated in the workshop have realistic expectations regarding what mentorship is and should be. Even the best-trained, most well-meaning PI may have trouble mentoring trainees seeking positions in industry, simply out of lack of experience in industry and a weak or nonexistent industry network. If the authors choose to continue discussing mentorship as one of their key issues, the manuscript might be improved by drawing more on the relevant literature. I recommend the authors consult work by Dr. Sharon Straus, who has done a great deal of work studying mentorship in academic medicine. Her book written with Dr. David Sackett is comprehensive, and the authors may wish to consult papers such as this systematic review of practices of good mentors and good mentees (Sanbunjack et al¹). Of note, the authors of the systematic review found that good mentees should be in the 'driver's seat', and should be respectful, organized, and committed. The point about mentees being in the driver's seat is particularly salient here, because if trainees wish to be better equipped to obtain a job in industry, that is a goal they should be driving towards. Reading some of the comments about mentorship, it is not evident that this is well-understood by workshop participants. It is reasonable to expect one's supervisor to support one's career progression. All supervisors should do this. However, in the same way that you wouldn't reasonably expect your hockey coach to help you prepare to play water polo, aiming for a career in industry will require a broader mentorship team than just your PI.

Discussion

20. The authors seemed to choose certain issues to highlight in the Discussion, for reasons that are not entirely clear. If they choose to follow my suggestion in comment 18 above, their selection of which issues to highlight will be driven by the data from exit surveys. Alternatively, if they choose to keep the current format, they should give the reader more of an indication about why they are focusing on these specific issues.

Minor comments

21. The authors open a paragraph in the Introduction, "Despite these important concerns, there is hope for the future." Although this is categorized as an opinion article, this level of editorializing is probably unnecessary. However, I leave it to the authors to determine what kind of article they wish to write.

22. In paragraph 8 of the Introduction, the authors state, "Furthermore, it proposes \$210 million over 5 years for Canada Research Chair (CRC) appointments specifically for ECRs." This did not align with my interpretation of the budget, so I went back and re-read page 89 of the full budget document. As I recalled, the budget signaled a desire for these CRCs to be allocated to more junior researchers, however, this is not the same as the authors' definitions of ECRs. The Government of Canada may choose to use overly broad and vague terms like "early career researcher" to refer to the recipients of Tier 2 Canada Research Chairs, meaning people with faculty appointments and who are up to 10 years past the receipt of their PhD plus extensions for leaves. However, the authors should strive to be clearer. Furthermore, the Government of Canada "expects" the granting councils to target new funding to early career researchers, which means this will likely occur, but this is a little more nuanced than the authors' statement that these funds are "specifically for" ECRs.

23. At the beginning of the Results, the authors note, "From the 65 responses, the average age of

attendees was 33 years old, with only Session 3 showing a notable digression from this average." Unless the authors believe that the higher mean age is meaningful for some reason and may explain differences between this session and others, I'm not sure this adds all that much to the paper. Also, it looks to me that this is likely because of the preponderance of non-trainee participants in this session (e.g., all the university staff at the workshop attended this session, constituting a full quarter of the people in the session.)

24. Were the authors among the n=136 participants? Were authors' views included in the data presented? If the answer to either of these is yes, this should be explicitly stated.

25. In the Discussion, the authors state that, "Recent campaigns for increased research funding in Canada have led to the creation or increased the activity of ECR advocacy groups such as the Association of Canadian Early Career Health Researchers (ACECHR) ..." ACECHR was not formed to campaign for increased research funding, though the organization has certainly worked on this as one of its more recent activities. The organization was formed in reaction to changes to the grant program structure and grant review mechanisms at the Canadian Institutes of Health Research (CIHR) in 2014. Modeling by Dr. Hendricks suggested that new investigators in their first five years as faculty were poised to lose approximately \$30M in grant funding in the new system, and indeed, the first new cycles suggested that without the stopgap measures put in place at the CIHR in response to ACECHR advocacy, that size of gap would have occurred. As the person who wrote the first draft of many of ACECHR's documents and now knows all the train numbers and schedules between Quebec City and Ottawa by heart, I can assure you that ACECHR's participation in advocating for sustainable federal research funding was neither the reason for ACECHR's creation nor was it an increase in ACECHR's activity. Joining in with a number of other organizations, with practically the whole Canadian research community on side, was far less work than the activities ACECHR did alone. Please correct this.

References

1. Sambunjak D, Straus SE, Marusic A: A systematic review of qualitative research on the meaning and characteristics of mentoring in academic medicine. *J Gen Intern Med*. 2010; **25** (1): 72-8 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the topic of the opinion article discussed accurately in the context of the current literature?

Partly

Are all factual statements correct and adequately supported by citations?

No

Are arguments sufficiently supported by evidence from the published literature?

Partly

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My areas of expertise relevant to this manuscript are: Canadian research/funding policy, survey and workshop methods. (My primary research is interdisciplinary and is best described as the intersections of health informatics, health education/communication/decision making, user-centered design and human-computer interaction.)

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 08 August 2018

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Michael Hendricks

Department of Biology, McGill University, Montreal, QC, Canada

This paper presents a snapshot of career and funding-related concerns for early-career researchers in Canada, focused on a particular event held to discuss these issues. It is important that the motivations for and outcomes of this event be broadly communicated. However, as it stands the piece is unfocused and potentially confusing for its intended audience. In fact, it is not clear who the intended audience is, or what it hopes to accomplish. I think these are issues that can be addressed with reorganization of the content and bringing more focus to the points and arguments made.

1. In Canada, there seems to be considerable confusion depending on the government agency, funder, or day of the week whether the term early-career researcher (ECR) refers to graduate students and postdocs (trainees), early-career faculty/Pis, or both. “Trainees” is itself a problematic term—designating the people who actually conduct the majority of federally-funded academic research “trainees” (particularly postdocs, who are by any measure professional scientists) is part of the justification for many of the labor conditions at issue in the piece.

While trainees and junior Pis share many of the same concerns about overall support for academic research, they also have distinct policy interests and career stage-specific needs and incentives. From the point of view of the authors, perhaps the biggest concern of lumping them together is that, in many cases, the interests and incentives of early-career Pis align much more with the interests of established Pis and institutions—particularly with respect to management/labor relations with graduate students and postdocs.

Because this article is focused on graduate students and postdocs, and because it is presumably in part addressed to a policy audience who may be less-familiar with these distinctions and the details of academic career progression, I think a clearer distinction needs to be made. It would be

most effective to focus on the concerns of trainees and transitions out of trainee status (outside and within academia), and just leave early-career PIs out of it.

2. The authors need to do a much better job at defining terms and concepts and the current “lay of the land.” Specifically, it should not assume familiarity with the Naylor Report and surrounding advocacy efforts. How are trainees supported now—what is the relative proportion of support from fellowships, grants to their PI, institutional funds? What are the advantages of fellowship funding over support from a grant? How even is institutional support across Canada or across programs within universities? How would more fellowships benefit trainees?

Policy makers often do not know that the great majority of trainees are supported on grants. This makes the section on insufficient ECR funding particularly confusing, as it seems to argue against itself by pointing out that all three granting councils have policies to support junior PIs in place. As far as I know, there is no longer a broad sense that junior PIs are in crisis with respect to funding opportunities compared to more established PIs within the main granting programs of the councils—or that this was ever the perception at NSERC or SSHRC. The authors should be careful not to generalize from specific issues that arose in the context of the CIHR reforms to the Canadian research enterprise as a whole, or at least make it clear when they are talking specifically about health-related research. In any case, the relationship of ECI PI grants to funding to support trainees is not clear. Again, this is a major weakness of lumping ECI PIs and trainees together.

3. Related to the above, if the goal is to influence policy, it needs to take a more opinionated tone, particularly in the Discussion. There are long lists of problems and solutions that read like a brainstorming session with very little synthesis or prioritization. How many of these problems are in effect the same problem (insufficient overall funding available through councils, not enough academic positions, inadequate mentoring or career resources)? What are the most urgent problems? What do you believe are the most practical and effective solutions? Which problems can be approached *without* additional money in the system, or cannot be addressed through funding policy (perhaps some of the issues around academic culture and mentorship)? Which can only be handled by institutions, which by funders, which by government? What three (or one or five) things should a grants council president or MP or university VPR come away from this piece understanding about what trainees need and want?

4. The piece (and event) are strongly focused on biomedical science. This focus should be made clear up front. The issues faced by students and postdocs (funding, job markets, mentorship) are similar in some ways but also vary substantially across fields, even within CIHR, and are radically different for those who fall under the NSERC or SSHRC umbrellas.

5. There are missed opportunities to frame the advocacy in terms of the purpose of research funding and the broader interests of the Canadian public, as represented by federal funding agencies. For example, an argument for shifting trainee support away from operating grants and toward more emphasis on fellowships could be made based on the goals of these programs. CIHR operating grants are awarded to conduct specific research on behalf of Canadians, there is no training mandate. In contrast, the purpose of CIHR fellowships is to create “scientific, professional, or organizational leaders within and beyond the health research enterprise.” This seems much more in line with training as envisioned in this paper. It is compatible with the diversification of training (e.g. to include other kinds of experience and professional training) while operating

grants as they are currently constructed are not. This could be seen as an argument for more fellowships, or to lobby funders to specifically evaluate on mentorship and training in operating grants.

6. Another example of this would be to make the case for why it is of benefit to Canada to have so many PhDs in the non-academic workforce—these arguments are articulated in the FSR and elsewhere. Right now, the piece can be read as emphasizing the needs of trainees, and it makes it much easier to be on your side if it is made equally clear how and why Canada needs you, your training, and your degrees. Should we be producing fewer PhDs? It would be one easy conclusion to draw from many of the arguments presented here, but it is a weak case for investing in better training.

The Canadian ECR community showed leading up to Budget 2018 that they can be forceful and effective advocates for good science policy. It was a major disappointment, then, that their specific concerns and trainee-related FSR recommendations were for the most part ignored. Continuing to advocate is essential, and I applaud all the effort that has gone into this. I think this piece will be a valuable snapshot of current conditions for trainees and should serve as a reference for institutions and policy-makers. However, to be most effective as a reference it needs more clarity and organization.

Is the topic of the opinion article discussed accurately in the context of the current literature?

Yes

Are all factual statements correct and adequately supported by citations?

Yes

Are arguments sufficiently supported by evidence from the published literature?

Partly

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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