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Dear Dr. Naylor,

On behalf of the Lawson Health Research Institute (Lawson) we are grateful for the opportunity to offer our perspectives and suggestions to inform the work of the Government of Canada's Review of Federal Support for Fundamental Science.

Lawson is a hospital-based health research institute jointly owned by London Health Sciences Centre and St. Joseph's Health Care London, and affiliated with Western University, London, Ontario. We are the 8<sup>th</sup> largest hospital-based institute in Canada with external research funding in 2015 of approximately \$90 million, over 200 basic and clinical scientists and an additional 300 associate scientists, and a training environment for around 300 graduate students and postdoctoral research fellows. Last year we attracted \$20.5 million in federal research funding including grants from each of the three research councils. We have also received over \$50 million in investment for new equipment over the life of the Canada Foundation of Innovation. Industry-partnered research is an important part of our productivity and totaled \$12.5 million in 2015.

The following thoughts in response to the specific questions posed by the Review Panel represent a consensus of the Lawson Research Executive, which includes representation from senior research group leaders, mid-career and early career investigators spanning the breadth of health research from CIHR pillars 1 to 4. Our perspectives are clearly weighted towards the environment of health research, but we believe the underlying weaknesses and needs underlying federal funding of fundamental research are common to all disciplines.

**Underlying issues that drive the specific Review questions:**

Relative to competitor nations, there has been a serious lack of financial investment into fundamental science through all three federal research councils relative to Canada's potential for global scientific performance and economic benefits. In the health field the national, annual expenditure on health research in Canada is just 2.9% of total health care expenditures, compared to 4.2% in Australia, 4.5% in the US and 6.2% in the UK (Sources: Research Australia, NIH, CDC, HRCS Online, UK Public Spending, Global Advantage Consulting, CIHI).

A particular victim of under-investment has been CIHR pillars 3 and 4 whereby fundamental research findings at a clinical or pre-clinical level cannot be effectively tested and translated within our health systems or applied to population health. Redirecting funding away from CIHR pillars 1 and 2 to expand our capacity in pillars 3 and 4 has rightly been rejected, since to weaken fundamental science further would be to damage the engine of discovery. The full mandate of CIHR can only be achieved through the differentially faster growth of pillar 3 and 4 research through incremental funding. It is noteworthy that the Collaborative Health Research Program (CHRP), which is a combined CIHR/NSERC program, not only has allowed for cross-disciplinary research but has also been able to accommodate elements of all CIHR pillars as well as industrial translation. This shows that pillars 3 and 4 relate well to the mandate of other research councils as well as pillars 1 and 2 of CIHR.

A virtually static investment in CIHR over the last 5-10 years, and a real decrease relative to inflationary costs, has had serious impacts on the nature of health research. When the number of papers published in the field of medical sciences in Canada is tracked relative to those originating from the USA there has been no meaningful increase in relative productivity (Table 1). A similar trend is apparent relative to other competitor countries also. However, Canada's ranked position amongst nations for the number of citations from these same papers since 2000 has steadily decreased from 2<sup>nd</sup> to 8<sup>th</sup>. This could indicate a reluctance to tackle high risk but high gain science in a harsh funding climate, to the detriment of Canada's scientific standing.

**Table 1**

Year	# Cdn Papers as a % of US	International citations ranking
2000	11.5%	2
2005	12.8%	3
2010	14.6%	6
2014	15.4%	7
2015	15.6%	8

Source: SJR International Science Rankings

### **Specific Committee Questions.**

- 1. Are there any overall program gaps in Canada's fundamental research funding ecosystem that need to be addressed?**

### **SHORT-TERM CHANGES REQUIRED:**

#### **Strategic alignment:**

CIHR, NSERC and SSHRC have each evolved funding mechanisms that are tailored to their particular research communities. This heritage and partnership with the research communities should be maintained and strengthened such that any future research council architecture should retain these three key elements. However, there has been no overall fundamental science strategic plan that crosses the three research councils and other federal

funding agencies, and is also partnered with provincial agencies and health charities. This lack of central vision harms not only the strategic direction of science and an ability to rapidly change in an evolving world, but the overall quality of training of our present cohort of scientists and those of tomorrow, and their access to state-of-the-art equipment. A better integration of the mandates of our research councils and other funding agencies would help to break down the silos of environmental, economic, energy, basic and health research. One helpful vehicle might be the creation of a 'Fundamental Research Advisory Council' to be chaired by the Government Chief Science Officer. The Council would include active researchers who are thought leaders in their fields and would provide visionary strategic advice and direction that crossed all research councils, and so plan for future multi-disciplinary opportunities for researchers to answer priority issues.

### **Scope:**

The financial model of federal research funding is rate-limiting because it does not recognize the full costs of research, i.e., direct study costs, associated indirect costs, investigator salaries, equipment upgrade and maintenance costs, and training costs. The more research an institution such as Lawson hosts the more it costs the institution to find matching funds to support it. There is a system-limiting capacity to expand output to the potential of the investigators. This is particularly true for research hospitals that do not have access to block funding from provincial ministries of higher education. We recommend that future federal funding of fundamental research include the principle of providing for the full costs of research, including a contribution towards investigator salaries. This is particularly important to hospital research institute-employed scientists who do not usually have access to career security through university tenure.

### **Training:**

The CIHR has all but abandoned meaningful support for advanced research training at graduate, postdoctoral or young investigator levels. In particular, funding for the training of clinician researchers through MD/PhD joint degrees has been abolished. The concept of Centres for Clinical Investigation enabling first-in-human research is becoming extinct in Canada. This major deficiency also impedes the ability of basic science researchers to move their discoveries into the translational science realm. We would recommend that core funding for support of a number of leading clinical research training centres be created that would complement our major Academic Health Science Networks, and would 'flesh out' the value of the Strategy for Patient-Orientated Research (SPOR). Preventing the extinction of Canada's capacity to train internationally-competitive clinician scientists is a priority need.

### **Partnerships:**

Despite successive federal governments highlighting the lack of private sector investment in research and development there is a lack of effective research partnership programs through the research councils where private sector companies can co-fund to advance fundamental science. Whilst recognizing that individual relationships are crucial for research-industry partnerships, the research councils could function as coordinating hubs to match researchers to

industry partners and their needs. This should be much more elaborate than the present MITACS program, although MITACS has been highly successful in linking trainees with industry. One possibility would be to link commercialization NCEs closely into the more integrated research councils.

## **LONG-TERM FUNDAMENTAL CHANGES IN POLICY:**

### **Integration:**

As mentioned above, the research councils increasingly function in silos such that there is limited opportunity for truly trans- or multi-disciplinary research. Examples of where this is required include the growing roles of computer science in health informatics, of engineering in medical device design and manufacture, and behavioral science and media studies as related to disease prevention and population health education. Whilst the maintenance of core funding streams within the three research councils is important, the barriers between them should be dismantled such that the best ideas that cross these artificial boundaries can be embraced and funded. This is best achieved through strategic oversight that covers all of the councils.

There are now over twenty federal agencies that have the funding of direct costs for health research as at least a part of their mandate. This has resulted in considerable overlap and redundancy between multiple federal programs for health, such as Brain Canada, Genome Canada, the Mental Health Commission, CIHR, Canada Health Infoway, Strategic Infrastructure Fund, Canada First Research Excellence Fund, Network Centres of Excellence, Canada Foundation for Innovation, etc. This has severely compromised the productivity of investigators through having to prepare multiple funding applications with differing formats, each with a low chance of success; and duplicates administration costs and volunteer grants review needs. We strongly recommend that all of the elements of agencies that fund direct health research be collapsed into a single organization for better strategic utilization of resources and administrative costs. Whilst the Canada Foundation for Innovation has been hugely successful, the provision of state-of-the-art equipment needs to be more closely linked to the award of operating funds to ensure full use.

### **Quality and Retention:**

Once again, leading Canadian scientists are starting to migrate to the USA. This needs to be reversed before it gains more momentum. There is a disturbing absence at present of any career development salary award structure through CIHR with the loss of mid-career and senior scientist awards. The Canada Research Chair (CRC) envelope has not been expanded in 15 years such that there is now a shortage of prestigious awards with research protected time to retain our best and emerging scientists. A particular issue is the career stability of the health researchers employed within our research hospitals, since they do not have the opportunity of university tenure and are largely employed on renewable short-term contracts. More than 50% of health research in Canada is performed within research hospitals rather than university campuses, and yet Canada Research Chairs are allocated through the universities. We value greatly the synergistic partnerships between universities and research hospitals, but access to federal resources should have equal opportunity. Retention of our best hospital-based scientists would be better protected through direct access to an expanded, federally-funded scientist salary award structure, including the CRCs.

The scientific training environment needs to start at a graduate student level. Whilst each university has accreditation of its departmental graduate training environments there are, at present, no national training standards for science graduate and postdoctoral fellows. If you are well trained through a high standard laboratory it is often a matter of luck. Funding mechanisms to recognize excellence within training centres for fundamental science, and to allow exchange trainee visits from elsewhere, for advanced training from national leaders in the field would improve the quality of training nationwide.

### **Implementation of Knowledge:**

In the health disciplines there is a crucial gap in the ability of health providers to take published research findings from their own centres, or elsewhere, and to evaluate these within the reality of a care environment. Only with such real life data can innovations be selected for adoption by health funders as the next standard of care. In the absence of a separate federal agency to fund the adoption of health innovations it is recommended that a 5<sup>th</sup> pillar be created within CIHR with additional funding. Pillar 5 would be open to applications from health provider organizations to test and report on the success, or otherwise, of testing health innovations. A precedent for the success of such a fund is the Adopting Research to Improve Care (ARTIC) program funded by the Government of Ontario.

## **2. Are there elements or programming features in other countries that could provide a useful example for the Government of Canada in addressing these gaps?**

There are several examples of practices from competitor countries that have proven success in fostering fundamental science in both basic and clinical science environments. In the USA the NIH has successfully introduced early researcher operating grants to ensure that new scientists have a productive start to their careers as independent researchers, as well as collaborative grants for co-discovery with industry partners. Importantly, the NIH has long-recognized the importance of core funding to allow institutions to act as national hubs for advanced clinical research training, thus ensuring a succession plan for translational health scientists.

In the United Kingdom the equivalent of CIHR pillars 3 and 4, and elements of pillar 2, were separated from the Medical Research Council and combined together with a mandate for innovation adoption within a National Institute of Health Research. This has strong health provider linkage as a part of the NHS and ensures that innovations can be ‘pulled’ from fundamental research into the next standards of health care.

In Germany the Max Planck Institutes are an excellent model for partnered and contract research facilitated, and partly supported, by federal government together with industry. They provide an excellent bridge for scientists trained at tax payers’ expense to be successfully integrated into industry through early career exposure.

### **Secondary Questions:**

## **1. Are granting councils optimally structured and aligned to meet the needs of the current research community in Canada?**

**Are the current programs the most effective means of delivering the objectives of these organizations?**

**And are they keeping pace internationally?**

**The review should take into account the several reviews and evaluations that were performed in recent years on the councils and on science and scholarly inquiry in Canada.**

No, no and no. We have a deeply fragmented system with multiple overlapping federal agencies, as described above, which wastes investigator time and duplicates administrative systems. We recommend a strategic oversight body to coordinate the strategic directions of the research councils or their streamlined successors in line with national priorities, and to ensure that artificial barriers do not exist to advancing multi-disciplinary research. Infrastructure-funding agencies such as CFI should be linked to the provision of operating grants such that new equipment is optimally utilized immediately.

Each research council should have investigator-initiated core funding programs, multi-disciplinary shared funding opportunities to suit the research questions, and the capacity for targeted research through RFAs to tackle topical issues in line with societal priorities and government strategies.

A cross-cutting division could be created across all three research councils dedicated to the application of fundamental science through commercialization, industry partnership, and linkage to health providers and other societal support programs. A cross-cutting platform could better mobilize inter-disciplinary resources to tackle ‘big science’ through shared core facilities and maintain international presence in strategic areas.

Canada has a shrinking presence in scientific publishing. The National Research Council publications should be our national showcase of science, but are generally of poor quality in terms of what they publish and are of very low impact. Re-launching those journals as a publishing arm of the research councils could re-energize them as foci for Canadian science, especially for expert review articles.

**2. Are students, trainees and emerging researchers, including those from diverse backgrounds, facing unique barriers within the current system and, if so, what can be done to address those barriers?**

The increasing tendency for senior health researchers to remain employed and scientifically active long past the nominal retirement age has created a serious bottleneck of resources in both the universities and research hospitals to the detriment of career advancement for more junior scientists. Succession planning is difficult compared to industry, for instance. The situation could be remedied by recognition of the full costs of research, including contributions to investigator salaries, as occurs with NIH funding, or the expansion of competitive research council scientist salary awards, including the CRCs. New salary awards could be weighted to preferentially grow capacity in areas of strategic priority such as aboriginal health or CIHR pillars 3 and 4.

As described above, there are no national training standards for each area of science so there is at present no consistency of training experience. National training centre accreditation for areas of fundamental basic and clinical sciences could be implemented where training centres would qualify for competitive training awards and would be site-visited at intervals to retain accreditation.

Trainees and young faculty cannot easily move between industry and not-for-profit academic institutions to foster collaborations and innovation pipelines for commercialization. The provision through federal government of part-assistance with salary support such that private and public sectors researcher exchanges could occur for defined periods, without loss of productivity to either sector, would help the integration of industry, particularly Canadian-based companies, into the support of fundamental science. This might be an expanded mandate of the MITACS program which has been very successful.

**3. Is there an appropriate balance between funding elements across the research system, i.e., between elements involving people and other direct research costs, operating costs, infrastructure and indirect costs? What are best practices for assessing and adjusting balances over time?**

No. As occurs in the UK, the federal government should adopt the principle of funding the full costs of research including direct and indirect costs, necessary equipment and upgrades to complete research goals, scientist salary and training support.

At present, regional and national core facilities established to foster ‘big science’ are in reality not readily accessible to all. In the health sciences open application processes and financial assistance to access facilities such as high capacity computing, advanced informatics analysis, specialist advanced technology, ‘omics’ analyses, national databases, etc., should be implemented.

The federal government is only one of a number of key sector funders of fundamental science in Canada. Others include the provincial and territorial governments, industry and business, non-governmental organizations/foundations (such as the health charities), and our universities and research hospitals. At present there is little strategic coordination between these partners. A national multi-sector, multi-partner agenda for the direction of fundamental science in Canada should be created to ensure optimal utilization of funding support. This could be monitored through bi-annual national research summit meetings.

**4. Are existing review processes rigorous, fair and effective in supporting excellence across all disciplines? Are they rigorous, fair and effective in supporting riskier research and proposals in novel or emerging research areas or multidisciplinary/multinational areas?**

No. CIHR in particular has implemented ‘reforms’ that have diminished fairness, effectiveness and transparency. It took a ministerial letter and researcher direct intervention to set this back on a course consistent with international standards of review. The retention of face-to-face peer review is an essential feature of review processes.

At a broader level, the implementation of more pilot grants within each of the research councils would enable the exploration of new, emerging areas where little pilot data is presently available. With regard to the core investigator-initiated project grant competitions the funding rates with existing financial investment by federal government are unacceptably low and waste the talents of expensively-trained researchers. A move to a NSERC-type granting model where a higher percentage of researchers get sufficient funding to keep research groups in existence, while at least 25% have access to larger grants capable of supporting definitive, internationally competitive studies, would help to sustain a critical mass of research groups nationally. The smaller grant stream could preferentially favour young investigators and new, high risk research ideas. At present there is absolutely no mechanism to sustain the expertise within a highly productive research unit given the unpredictable nature of scarce federal granting. It is very difficult to plan growth within an individual research group to attain international leadership because there is little chance that high risk but truly innovative science will be funded by our research councils at present.

**5. Are granting council programs and structures sufficiently flexible to reflect and accommodate the growing internationalization of research? Are granting council programs and structures accommodating the full range of research areas; multidisciplinary research; and new approaches ranging from traditional knowledge, including indigenous research, to more open, collaborative forms of research? If not, what steps could be taken?**

No. There is an urgent need to remove silos and barriers for multi-disciplinary research to occur. In the health research field the health charities provide an equivalent level of research operating support nationally as does the CIHR. There is a need to incorporate health charities research support into the federal framework to remove duplication of administration whilst maximizing availability of operating funds. An effective federal peer-review system could be used to allocate all operating and career awards for both federal government and NGO resources. The research councils should ensure that ‘ownership and branding’ of the added value in grants funded should be available to the health charities to ensure future philanthropic support. The health charities might be provided with a governance position on the board of CIHR in recognition of the partnerships.

**Funding of facilities/equipment:**

**1. Is the Canada Foundation for Innovation optimally structured to meet the needs of the current research community in Canada? What are the strengths and weaknesses of the current model in delivering the objectives of this organization, including its ability to work complementarily with the granting councils? What is the appropriate federal role in supporting infrastructure operating costs and how effective are current mechanisms in fulfilling that role?**

CFI is an excellent program that should be expanded further. However, there is a strong emphasis on the purchase of the latest technology. The maintenance costs of cutting-edge CFI-enabled technology after the initial five years of operation, and incremental upgrades to equipment, is creating substantial financial pressures on institutions. A continuation of support



for the operational costs of equipment purchased with CFI support throughout its life cycle should be an equal priority. CFI support for equipment should be linked to operating funds in order to optimize the equipment utilization. This might be best done by embedding CFI as a cross-cutting platform across all three research councils.

The concept of linking CFI quotas to university federal funding levels is outdated. Many research institutions, such as hospital research institutes where the majority of health research actually occurs in many provinces, are independently governed and are not part of the universities. All independent research institutions should be allowed to separately apply outside of a financial quota determined through their affiliated universities.

**2. What are best practices (internationally/domestically) for supporting big science (including, inter alia, international facilities and international collaboration)?**

Provincial and national core facilities are appropriate for big science technology and informatics, but access for all legitimate users is a major issue nationwide. An accreditation system for research institutions would allow open access to such cores for appropriately trained and productive scientists.

Technologies that are one-of-a kind in year 1 may be considered better as institutional core facilities 5 years later, and individual laboratory equipment 5 years later. The approach to core infrastructure needs to evolve with the science.

**3. Many requests for government support for research are not tied to the cycles of the four major research agencies, but they have economic or competitive relevance nationally or regionally, or major non-governmental financial support, or implications for Canada's international standing as an active participant in big science projects or major multi-institutional projects. How can we ensure that the Government has access to the best advice about funding these types of projects in the future?**

A shared strategic oversight of the three research councils and CFI would create more flexibility in rapidly establishing RFAs to tackle emerging needs. Additionally, a more robust system for research partnerships between the private sector and federal research agencies would facilitate industry/business having a greater financial stake in emerging solutions to urgent issues. Shared strategic oversight of the research councils would allow more tailored multi-disciplinary and multi-sector rapid response grants to be evaluated to tackle rapid response needs. The rapid response granting system would cross all three research councils with the support of CFI when required, and would operate in parallel with the structured, investigator-initiated science grants competitions.

**Funding of platform technologies:**

**1. What types of criteria and considerations should inform decisions regarding whether the Government should create a separate funding mechanism for emerging platform technologies and research areas of broad strategic interest and societal application? Are there any technologies that would appear to meet such criteria in the immediate term?**

**When there is a rationale for separate funding, how to ensure alignment of funding approaches?**

The primary criterion should be global direction of science, and Canada's capacity to meaningfully contribute to emerging areas. For example, our provincial and territorial health systems provide an excellent data source for computer-driven health informatics and data mining. A national health registry drawn from the individual provincial administrative health databases would be a powerful research tool from the perspectives of precision medicine through to population health.

**2. Today's emerging platform technology may rapidly become a standard tool used tomorrow by a wide variety of researchers. If such technologies are initially given stand-alone support via a dedicated program or agency, what factors should inform decisions on when it would be appropriate to "mainstream" such funding back into the granting councils?**

A primary factor will be cost. As technologies become widespread the standardized unit costs generally come down. Cost per study could be one metric to determine when national core technologies become regional, then institutional, then individual research group assets.

It makes no sense to have a separate agency for platform technologies when we have a heavily fragmented funding system already. Equipment and technology platforms should be consolidated within CFI, and CFI should be an integrated component of a larger research council overall strategy.

We thank the Review Panel for the opportunity to offer forth these suggestions. The work of the Panel is both crucial and urgent if we are to avoid 'lost generations' to fundamental science in Canada. The early signs of this are already apparent with the numbers and quality of graduates willing to enter additional training in science declining year by year. The listed Lawson scientists who serve on our Research Executive and who are all active researchers would be happy to expand thinking on any of the enclosed suggestions if this would benefit further the work of the Panel.

Yours sincerely,



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