Pilot Socioeconomic Impact Analysis of CFI and CIHR Funding: Medical Imaging R&D

Executive Summary

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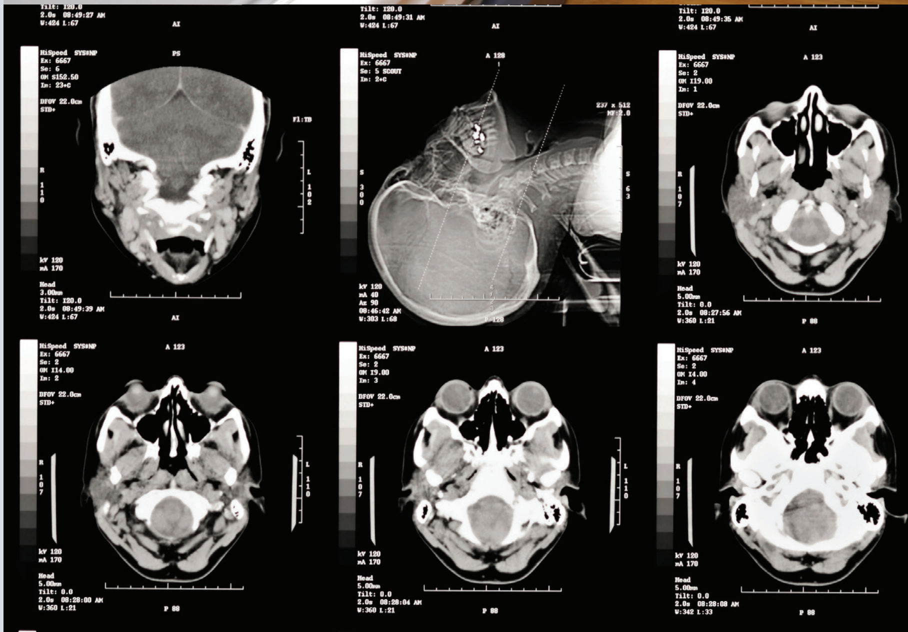

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Executive Summary

Medical imaging is one of Canada's research and development (R&D) strengths, and Canadian researchers have made important contributions to our understanding of human development and disease that go well beyond what would otherwise be expected of a nation of fewer than 40 million. Achieving and sustaining this level of excellence would not have been possible without the sophisticated physical research infrastructure supported by the Canada Foundation for Innovation (CFI) or Canadian Institutes of Health Research (CIHR) funding.

Given documented Canadian excellence in medical imaging and the application of medical imaging to the study of neurodegenerative and musculoskeletal diseases, to what extent has this excellence translated into socioeconomic benefits for all Canadians?

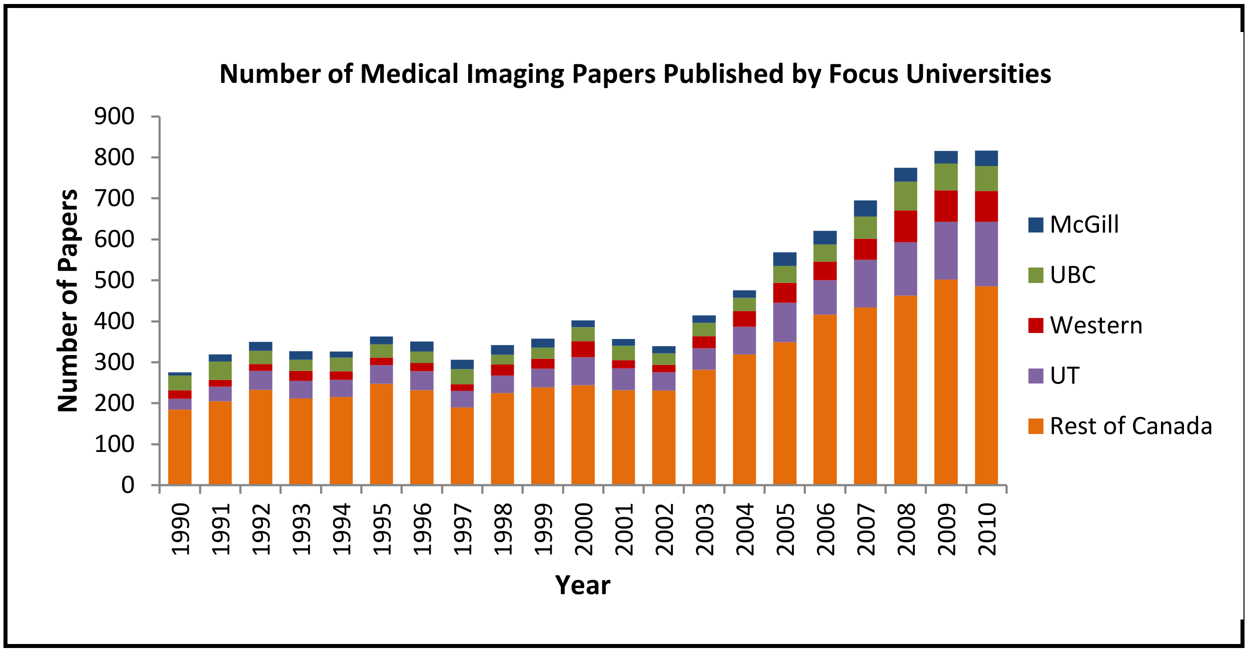
A policy commitment contained in the federal government's Science and Technology Strategy was to increase government's accountability to Canadians by "improving its ability to measure and report on the impact of S&T expenditures" (Industry Canada, 2007). Health and related life sciences and technologies is one of four priority areas that the government of Canada has committed to strengthening over time (Industry Canada, 2009).[1]

CFI and CIHR partnered in a pilot socioeconomic study using nonmarket valuation methods to begin to answer a critical question: *Given documented Canadian research excellence in medical imaging and the application of medical imaging to the study of neurodegenerative and musculoskeletal diseases, to*

[1] The other three are environmental science and technologies, natural resources and energy, and information and communication technologies.

what extent has this excellence translated into socioeconomic benefits for all Canadians?[2] **Figure ES-1** illustrates the growth in the number of papers published about the topic of medical imaging.

Figure ES-1. Growth in Scientific Publishing in Medical Imaging, 1990–2010
Scientific productivity, as measured by publications, experienced an inflection point in 2003, shortly after the creation of the Canada Foundation for Innovation in 1997 and the Canadian Institutes of Health Research in 2000. A single paper may be authored by researchers from multiple institutions and is counted for each specific institution or in the "Rest of Canada" category.



Source: Larivière and Lemelin, 2012.

ES.1 CANADA'S INVESTMENT IN MEDICAL IMAGING R&D AND RELATED HEALTH RESEARCH

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Between FY1998/99 and FY2011/12, CIHR, CFI, and their provincial and institutional partners invested $1,033 million in medical imaging R&D and related health research (2011$).[3] Of this sum, CFI projects amounted to $565 million, and CIHR grants and awards amounted to $468 million.

[2] The study was performed by an independent, non-profit research institute, RTI International, affiliated with Duke University, North Carolina State University, and The University of North Carolina. RTI International is a trade name of Research Triangle Institute.

[3] Excludes in-kind contributions.

Rather than evaluate the entire $1,033 million portfolio, the study focused on early medical imaging investments that were in place for long enough to have measurable outcomes. Four universities and their affiliated research hospitals and institutes participated: McGill University (McGill), The University of British Columbia (UBC), the University of Toronto (UT), and Western University (Western). Funding for these institutions was $387 million (2011$), of which $119 million was from CFI and its partners and $268 million was from CIHR.

The study's goal was to compare benefits from outcomes with the costs of that research in a systematic manner in order to estimate the public rate of return on investment.

ES.2 CT PERFUSION FOR DIAGNOSIS IN ACUTE STROKE

CT perfusion provides physicians with information about brain cells that are dead or about to die and assists physicians in their treatment decisions.

The case study for this analysis was computed tomography perfusion (CTP), an advanced imaging procedure that can be performed in just a few minutes using scanners readily available in hospitals' emergency departments. This imaging procedure uses computed tomography (CT) to measure blood flow in organs and tissues and is broadly used in acute stroke diagnosis.

It is estimated that there are more than 50,000 hospitalizations per year for strokes in Canada and approximately 300,000 people are living with the effects of a stroke. A report prepared for Public Health Agency of Canada quantified the national cost of stroke to be $3.6 billion for 2000 alone (PHAC, 2009).[4]

In a stroke situation, time is brain, and Dr. Ting-Yim Lee used CFI infrastructure and CIHR support to develop sophisticated yet easy to use tools for analyzing acute stroke.[5] GE Healthcare commercialized Dr. Lee's research, catalyzing a global sea change in how stroke victims' conditions are assessed.

CT perfusion allows the radiologist to assess blood flow in the stroke-affected part of the brain and identify brain cells that are

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[4] That estimate is composed of direct healthcare costs and the indirect costs of lost productivity and premature mortality.

[5] Dr. Lee has multiple affiliations and positions in London, Ontario: the Lawson Health Research Institute of the London Health Sciences Centre and St. Joseph's Health Care, the Robarts Research Institute, and Western University.

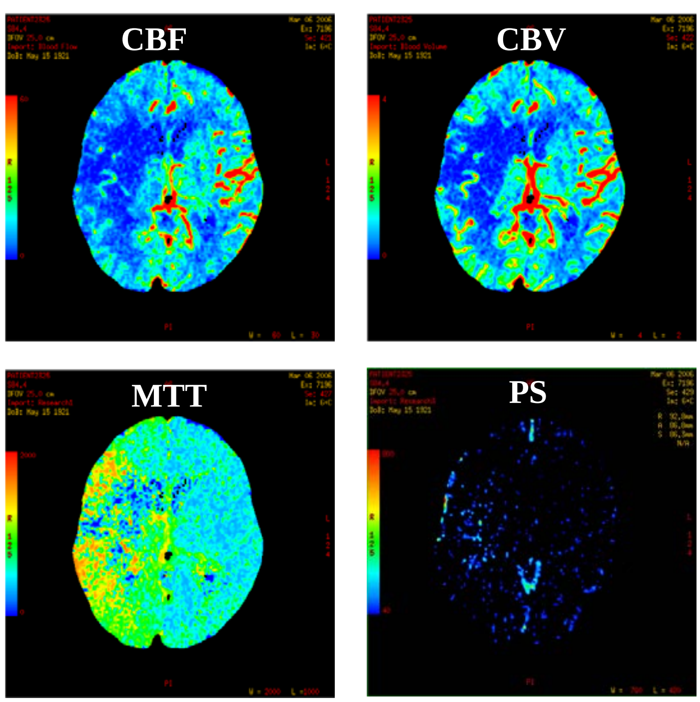
at risk but could be saved. In economic studies, human health benefits are quantified in terms of quality-adjusted life years (QALYs), or the additional quantity of life an intervention offers a patient, recognizing the fact that the person has suffered an adverse health event or has an illness. Although clinical trials are still underway, a recent analysis of CT perfusion using decision analytic models determined 0.12 additional QALYs for patients, on average, because of improved diagnosis and course-of-treatment decisions (Earnshaw et al., 2012). CFI and CIHR support the accelerated introduction of CT perfusion into clinical use by at least 5 years, according to leading neuroradiologists and stroke neurologists participating in this study. **Figure ES-2** presents four components of a CT perfusion study.

The value to Canadians attributable to public support of CT perfusion is between $87 and $130 million from 2000 through 2011.

The equivalent monetary value to Canadians attributable to public support of CT perfusion is $87 million and $130 million from 2000 through 2011. When the benefits are compared with all costs, the net benefits are between $42 million and $86 million.

Figure ES-2. Example CT Perfusion Study

This figure shows the four components of a CT perfusion study: cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT), and permeability-surface area (PS) maps. The maps are in traditional rainbow color scale, where blue is low and red is high. High CBF and CBV are good signs. Unfortunately, the blue areas show that the patient has poor CBF and CBV. High MTT (in red) is a bad sign because it means that blood is taking too long to transit the area.



Courtesy of Dr. Richard Aviv, Sunnybrook Health Sciences Centre, Toronto, Ontario.

The resulting benefit-to-cost ratio (BCR) is between 1.5:1 and 2.3:1, meaning that for every $1 invested, $1.50 to $2.30 in value to stroke victims accrued. Such high BCR estimates reflect the inherent value of sophisticated, yet simple to use, diagnostic tools that can inform clinical care and improved health outcomes (see ***Table ES-1***).

Table ES-1. Measures of Socioeconomic Return on CT Perfusion, 2000 through 2011

Measure	Value
Net economic benefits attributable to CFI/CIHR and partners ($ million)	$42M to $86M
Additional quality-adjusted life years for Canadian stroke suffers	2,845 to 4,270
Net present value of net benefits ($ million, base year = 2000)	$16M to $39
Benefit-to-cost ratio	1.5:1 to 2.3:1
Internal rate of return	28% to 46%

CT perfusion's value to Canadians is sufficiently large to account for 7% to 10% of the national CFI, CIHR, and partner investment in medical imaging R&D and related health research since 1998.

If one were to compare the benefits for CT perfusion with

- the total imaging investment in McGill, UBC, UT, and Western through FY2011/12, the benefits from CTP alone are sufficiently large to account for 19% to 28% of the $387 million invested in imaging research at these institutions, after adjusting for the time value of money.
- the total imaging investment in all Canadian universities through FY2011/12, the benefits from CTP are sufficiently large to account for 7% to 10% of the $1,033 million investment, after adjusting for the time value of money.

The ultimate beneficiaries are stroke victims whose doctors are better equipped to diagnose their condition rapidly and recommend a course of treatment more confidently. Clearly, medical imaging R&D is a socially optimal use of public funds.

The case of CT perfusion is an excellent example of the profound effect public support of a research program can have on health outcomes. However, there are other advances in development or entering commercialization for which benefits were not quantified. Imaging research can have a time horizon of 10 years or more before commercialization and clinical application. This is the case because of the need for extensive testing, validation, and trial in animal models and humans before use in a clinical setting.

CFI projects pooled federal, provincial, and partner funding to support cutting-edge research using instrumentation that was often unique in Canada. Having secured the research infrastructure positioned the researchers well to submit competitive and successful CIHR grant applications. Other downstream effects included

- international collaborations (e.g., attraction of U.S. National Institutes of Health [NIH] funding to Canada),
- highly qualified personnel (e.g., technicians, research associates, undergraduate and graduate students, postdoctoral fellows), and
- translation of knowledge outputs into new products and services and downstream improvements to clinical care.

Without CFI and CIHR, the overall level of medical imaging research performed nationally would be lower.

References

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