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# CANADIAN INNOVATION IN MEDICAL IMAGING IS TRANSFORMING HEALTH CARE

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THE GOVERNMENT OF CANADA HAS MADE SIGNIFICANT INVESTMENTS IN INITIATIVES THAT SUPPORT PUBLIC R&D. Understanding and measuring the impacts of this funding is necessary for evaluating the efficiency of public spending and assessing its contribution to achieving social and economic goals.

## CANADA IS A RESEARCH LEADER IN MEDICAL IMAGING

Medical imaging has transformed the way health care professionals diagnose and treat medical conditions. Technologies such as magnetic resonance imaging (MRI), computed tomography (CT) scans and positron emission tomography (PET) scans are among the several types of imaging that have become vital for determining optimal courses of care, confirming medical decisions and reducing unnecessary procedures.

Canada is a research leader in this field. A recent report by the Council of Canadian Academies identifies medical imaging as one of Canada's R&D strengths — a strength that has allowed

Canadian researchers to make important contributions to our understanding of human development and disease. These contributions go well beyond what would be expected of a nation of fewer than 40 million, and can be traced back to significant and sustained public research support in the field.

The Canada Foundation for Innovation (CFI) and the Canadian Institutes of Health Research (CIHR) collaborated on a socioeconomic impact assessment of medical imaging research.

## KEY MESSAGES

UNIQUE COLLABORATIVE STUDY demonstrates the social value of public research investment

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WORLD CLASS RESEARCH accelerates innovation in medical imaging

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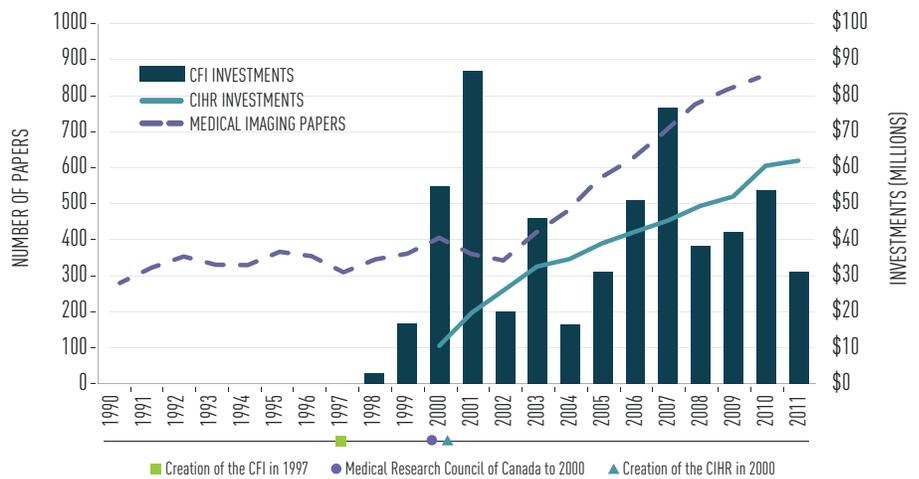
OPEN AND COMPETITIVE RESEARCH ENVIRONMENT enables leading researchers to advance concepts and commercialize ideas

# CANADA'S STRENGTH IN MEDICAL IMAGING STEMS FROM PUBLIC FUNDING

Figure 1 demonstrates Canada's growing strength in the field of medical imaging measured by the increase in both the volume and quality of scientific publications over the past two decades. In 2003, the number of medical imaging papers surged, beginning a seven-year upward trend. This increase in productivity was also associated with higher quality papers. (Average of Relative Citations = 2.35)

Achieving and sustaining this strength would not have been possible without the sophisticated research infrastructure supported by CFI funding or operating grants from CIHR. Between 1998 and 2011, the two organizations and their

FIGURE 1: MEDICAL IMAGING PAPERS AND INVESTMENTS BY THE CFI AND CIHR



partners invested \$1.03 billion in medical imaging R&D (2011\$): \$565 million from the CFI and \$468 million from CIHR. Given the time it takes to purchase and install state-of-

the-art infrastructure and conduct research, early investments made by the CFI and CIHR correspond with the observed dramatic increase in researcher productivity.

## IN A STROKE SITUATION, TIME IS OF THE ESSENCE

Dr. Ting-Yim Lee used CFI and CIHR funding to develop a sophisticated yet easy-to-use tool for measuring blood flow in various tissues including the brain, tumours, and the heart. The method has found applications in stroke for informing the selection of patients for thrombolytic treatment. In just a few minutes, emergency room physicians use readily available scanners to get information about blood flow in the brain to determine areas of damage and areas where cells are at risk of death. Western University granted a licence to GE Healthcare for the software implementing the method. GE Healthcare commercialized Lee's software, and now, more than 7,000 copies of the program are in use in North America, Asia, Europe and Australia.

## CT PERFUSION — ONE EXAMPLE OF CANADA'S RESEARCH LEADERSHIP IN MEDICAL IMAGING

To measure the socioeconomic impact of this funding, the CFI and CIHR partnered to conduct a unique study that traces the development and impact of one innovation — CT perfusion (CTP) — and compares the benefits with all associated public investments. Dr. Ting-Yim Lee of Western University and the Lawson Health Research

Institute, who developed the method, received infrastructure and research support from the CFI and CIHR, respectively, to measure how blood flows through the human body. This support helped Lee move his method from concept to prototype to a diagnostic tool that is currently being further assessed through clinical trials.

### THE ECONOMIC ANALYSIS OF CT PERFUSION REQUIRED ANSWERS TO THE FOLLOWING QUESTIONS

- HOW MANY CANADIANS SUFFER A MODERATE TO SEVERE ISCHEMIC STROKE PER YEAR?
- HOW LIKELY IS IT THAT THE EMERGENCY ROOM A STROKE VICTIM GOES TO IS EQUIPPED WITH CTP CAPABILITIES?
- HOW MUCH HAS CTP BEEN USED SINCE ITS INTRODUCTION IN 2000?
- WHAT IS THE BENEFIT TO THE PATIENT OF USING CTP, MEASURED IN QUALITY-ADJUSTED LIFE YEARS?
- WHAT IS THE MONETARY VALUE OF A QUALITY-ADJUSTED LIFE YEAR?
- WHAT IS THE COST OF CONDUCTING A CTP SCAN?
- HOW MUCH HAS THE PUBLIC INVESTED IN CTP RESEARCH?

**BENEFIT-TO-COST RATIO OF 2:1**

The study found a significant return on the investment made in CTP research — that value alone accounts for more than seven percent of medical imaging R&D investments by the CFI, CIHR and funding partners in all Canadian universities between 1998 and 2011. This is a conservative estimate because the benefits of CTP have been compared with all medical imaging R&D funding for the CFI infrastructure supporting CTP R&D and the CIHR health research relying on that infrastructure. Further, the benefits reflect only public sector economic returns and health outcomes in Canada; international adoption and private sector returns are not included in the analysis.

## CT PERFUSION IS MOVING ALONG THE INNOVATION CONTINUUM

The study confirms that CFI and CIHR investments are key elements in the innovation continuum. Successful translation of discoveries into applicable innovations can be lengthy and complicated. Movement along this “innovation continuum” requires participation at various stages by all sectors and actors within the science and technology ecosystem. It often takes a decade or more for clinical, including medical device, research to be

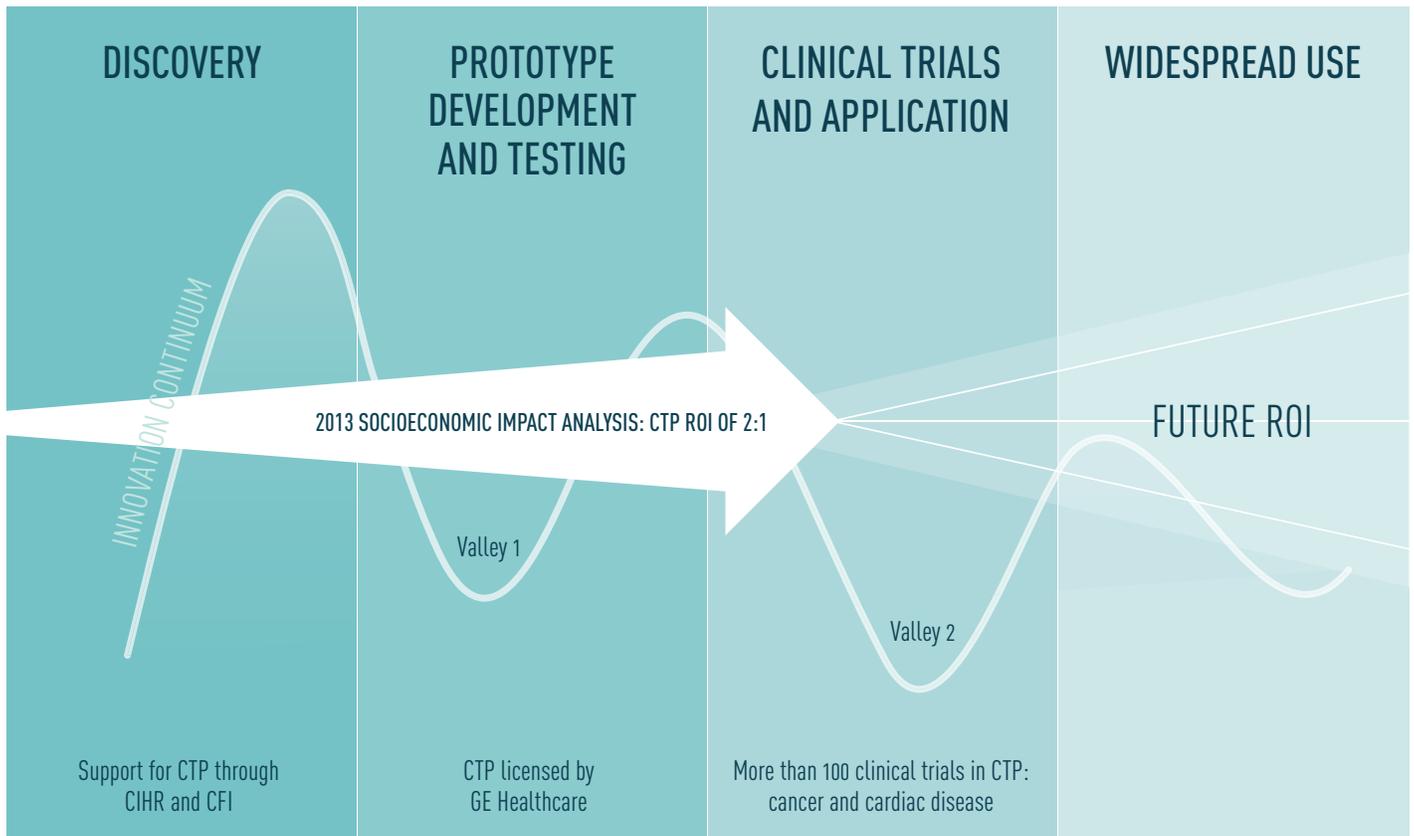
commercialized and applied in clinical practice due to the need for extensive testing, validation and trial in preclinical models, followed by further testing before widespread clinical use.

Figure 2 illustrates the innovation continuum and the progress of CTP along this path. Of note are the two so-called “valleys of death” — the points where innovations are most susceptible to failure. Valley 1 depicts the gap between theory and working prototype. Valley 2 reflects

the challenges in gaining acceptance and uptake of a proven clinical intervention. The science of knowledge translation continues to shed light on how to move through these valleys. CTP has successfully moved through valley 1 and is being used for stroke care while also undergoing rigorous assessment of its clinical safety and efficacy for other clinical applications. The results of these trials will impact future clinical uptake.

**FIGURE 2 : CTP ON THE INNOVATION CONTINUUM**

Figure adapted from the Canadian Institutes of Health Research Strategy for Patient-Oriented Research and Steven Reis, University of Pittsburgh and Harold Pincus, Columbia University



**ENTREPRENEURS AND PRIVATE SECTOR COMPANIES**  
**GOVERNMENT PROGRAMS**  
**SHARED INFRASTRUCTURE: LABS, EQUIPMENT, FACILITIES**

**INNOVATION ENABLERS**

# WHAT DOES THIS MEAN FOR POLICY MAKERS?

The case of CT perfusion (CTP) is one example of the profound effect public support of a research program can have on health outcomes. Public investment allowed research to develop at a pace that yielded a reliable and valid prototype that was of interest to industry and has been successfully commercialized and moved into clinical application. This has public policy implications:

## MAINTAIN A FOCUS ON EXCELLENCE

The CTP case is evidence of a system that works. Through an open and competitive peer review process, Dr. Ting-Yim Lee of Western University and the Lawson Health Research Institute secured funding from the CFI and CIHR to advance his research interests. His early work on blood movement attracted the attention of GE Healthcare who provided additional research support to Dr. Lee and his colleagues to further develop the CT functional imaging processes. Excellence, based on an open and competitive process, needs to be the cornerstone of public funding for both research infrastructure and research operating support. Recent studies suggest that industry is attracted to, and benefits most from, highly regarded academic researchers. Therefore, focusing on the attraction and retention of top academic talent motivated by the desire to advance research will provide the greatest benefit to Canadians over the long term.

## SUSTAIN AND BUILD ON AREAS OF RESEARCH STRENGTH

The State of the Nation 2012 report, entitled “Canada’s Science, Technology and Innovation System: Aspiring to Global Leadership,” calls for Canada to “not only invest more, but invest more strategically and coherently, building on our current strengths, and capitalizing on emerging opportunities” and reminds us that “Canada cannot afford to be complacent even in these areas of relative strength.” This study provides further evidence of Canada’s strength in medical imaging. As CFI- and CIHR-funded projects began to realize results, findings entered the literature, often in high-impact journals. Contributions to the literature, patent filings and other knowledge catalyzed international research opportunities including, in the case of CTP, participation in large-scale international clinical trials. To maintain this level of excellence, stable funding for state-of-the-art research infrastructure and operating funds for transformative science and technology development needs to be accessible to researchers through this open and competitive process.

## SUPPORT RESEARCH AND INNOVATION ALONG THE CONTINUUM

The Government of Canada has made it a priority to fund public research and commercialization to improve the nation’s competitive advantage through innovation. The case of CTP is an example of a technology that benefited directly from CFI and CIHR funding. While public funding permitted sufficient time for Dr. Lee to refine the methodology to ensure technical success for introduction into the clinical environment, CFI and CIHR support was also identified as a key accelerator of innovation. According to the leading neuroradiologists and stroke neurologists participating in this study, CFI and CIHR support accelerated the introduction of CTP into clinical use by at least five years. This was possible because Dr. Lee’s focus was on the ultimate beneficiary of the technology — the stroke patient. His early attention to knowledge translation and the role the private sector could play in moving his idea to market were key contributors to successfully traversing the early stages of the innovation continuum.