

Ontario's Research Hospitals: A Strategic Resource for Canada

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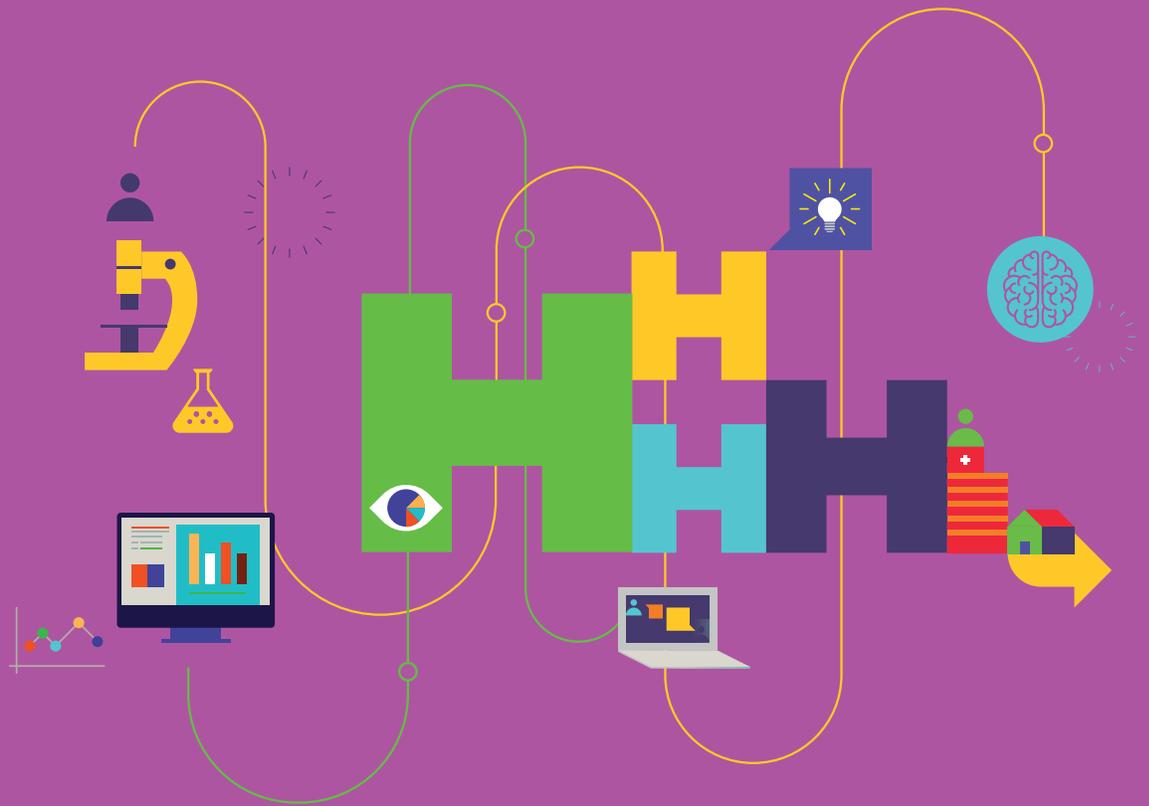
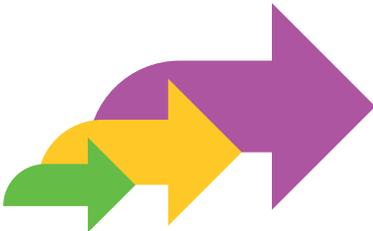


Table of Contents

Summary	1
Science Matters	3
Top Drivers of Research and Innovation in Canada	4
The Value and Impact of Hospital-based Research and Innovation	5
Funding Sources	12
International Trends in R&D Investment	14
Challenges and Opportunities	16
Future Vision	18
Call to Action	18
Conclusion	18
References	19



Summary

Ontario Hospitals are Top Drivers of Research and Innovation in Canada

In 2020-21, research hospitals attracted \$1.73 billion in investment, which supports almost 22,000 highly skilled researchers and support staff along with research space, equipment and technology.

The Research and Development Arm of Ontario's Health Care System

Over half of Canada's hospital-based research is conducted in Ontario and 19 of Canada's Top 40 research hospitals are in Ontario.

As with any major industry, Ontario's \$64.4 billion publicly funded health system—which comprises 40% of the provincial budget—requires a strong research and development (R&D) infrastructure to continually innovate, improve system performance and support the health of Ontarians.

The thousands of research initiatives underway span the entire research continuum from fundamental discovery, translational and clinical, to health service delivery and policy research.

Other components of the research ecosystem, including universities and commercial enterprises, critically rely on hospitals to be able to conduct clinical aspects of their research.

Hospitals are a major training ground for science in the province and attract top researchers from other jurisdictions.

Research is Directly Tied to Patient Care

In all areas of the province, patients both participate in and benefit from research. Hospital-based research occurs at the unique intersection of patients, clinicians, clinician-scientists and other researchers with linkages to universities, medical schools, specialized institutes and leading-edge biotech and pharmaceutical firms that develop and commercialize new treatments. Increasingly, research extends into community settings on urgent societal topics related to the social determinants of health.

Supporting Canada's Global Pandemic Leadership

Ontario's hospital-based scientists and clinicians have led or contributed to a host of breakthroughs involving critically important functions, such as isolating the SARS-CoV-2 virus, identifying variants through genetic research, conducting vaccine research and clinical trials, alleviating the human impact and much more. Throughout the pandemic, hospital-based research has been designated an essential service.

Driving Innovation and Commercialization

Research institutes, their business development and commercialization offices and partners work strategically to transform research outputs to marketable products and services for health and economic benefits. Recent commercial successes include:

- BlueRock Therapeutics – valued at USD \$1 billion
- Adela Therapeutics – attracted \$60 million in startup financing
- Rna Diagnostics – \$8 million in private sector investment for northern Ontario
- Turnstone Biologics and Virica – millions in private sector investment

Wide-Spread Economic Benefits

The pandemic has provided the most current, impactful example of how health research and innovation delivers economic benefits for societies, governments and individuals. Ontario's hospital-based research and innovation has mitigated the massive pandemic financial costs to date. There have been tremendous economic benefits from specific research breakthroughs as well as from countless step-wise advances.

Funding Environment

A mix of public and private sector sources, including federal and provincial governments, industry (pharma/biotech), philanthropy and health charities, provide direct funding support for hospital-based research.

- Of the \$1.73 billion in research funding in 2020-21, 34% (\$579 million) was generated directly by hospitals through philanthropy and other internal revenue generating activities.

Overall, R&D support in Canada has not kept pace with trends in other countries.

- In 2020, Canada's R&D expenditure as a percentage of gross domestic product (GDP) was only 1.7%, much lower than the Organisation for Economic Co-operation and Development (OECD) average of 2.5% (in 2019) and lower than Canada's highest level of 2.0% in 2001. Other countries are making substantial new R&D investments, including the United States (U.S.), United Kingdom (U.K.), and Korea.

Federal and provincial government R&D investment, along with effective policies are important to Canada's competitiveness in attracting further private sector investment and top researchers.

Challenges and Opportunities

As in many other sectors, the pandemic revealed and exacerbated a number of vulnerabilities while highlighting potential solutions. There is currently a need for:

- a more stable, modernized government funding approach
- more extensive integration of research and clinical care across the health care system
- enhanced capacity to attract and retain a diverse, highly skilled, science-based and research-intensive work force in a globally competitive environment.

Future Vision for Hospital-based Research

In considering how best to renew and advance the sector at this juncture, the OHA, together with its member hospitals, has identified a new vision for hospital-based research for the future:

A fully integrated health research and care delivery system across Ontario that drives sustainable and transformational science, clinical excellence, health equity and an agile, diverse workforce of scientists and innovators.

Call to Action

In view of the strategic importance of the hospital-based research sector to Ontario's and Canada's health and economic well-being, the OHA is calling on the provincial and federal governments to collaborate with us to help realize our future vision. The role of both levels of government will be essential to ensuring the stable, modernized funding approaches necessary to develop specific initiatives, bring the sector to the next level of excellence and remain competitive.



Science Matters

Research, discovery and innovation have long been at the root of human progress, shaping societies and the lives of individuals. Curiosity and the search for knowledge continually lead to new thinking, tools and ways of doing things that all effect change.¹ In our world today, the formal sphere of scientific research and innovation is often referred to as an ecosystem. The products of this complex ecosystem continually grow through the learning, feedback, competition and cooperation that takes place among its members.

There is no health care without science. Exponential growth in scientific advancement has led to profound capabilities in understanding and treating disease and improving health. It is easy to take for granted the common occurrence of “overnight breakthroughs,” which are more likely the result of long, painstaking work. Today, however, as the world continues to grapple with the COVID-19 pandemic and its impacts there is a renewed appreciation for science and what it needs to succeed.

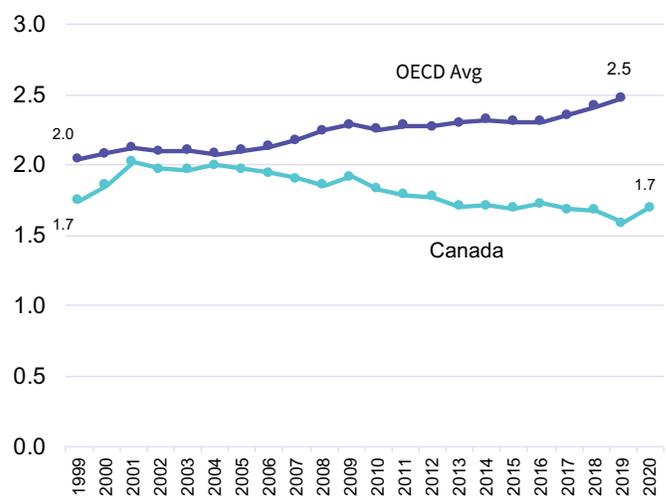
“Science and technology offer the only exit strategy from COVID-19...”

- OECD Committee for Scientific and Technological Policy²

The race to save lives and recover economies rests on science and there has been every expectation that it will deliver. Today, it is both surprising and not, that science has achieved another world-first: the development of not one, but several COVID-19 vaccines within months of isolating the SARS-CoV-2 virus. This development was made possible because of prior years of foundational research and investigation. This singular example highlights just how far advancements in scientific research have taken us and how critical health R&D is to human health and well-being as well as economic stability and prosperity. These linkages are in the spotlight more now than in recent memory.

Governments and other stakeholders in both the public and private sectors invest in health research and innovation because it pays off in ways that are both expected and unexpected. There is a shared understanding that not investing means taking a risk of losing out on valuable discoveries and falling behind others.

R&D as a Percentage of GDP



Today in Canada however, health research occurs in an environment in which support for scientific R&D has been waning over the last two decades. Canada’s combined public and private sector R&D for all science and technology was at its highest point in 2001 at 2.0% of GDP and stood at 1.7% in 2020. The average for OECD countries rose from 2% in 1999 to 2.5% in 2019.³ In 2021, Canada’s R&D investment totaled \$40 billion.⁴

Since the beginning of the pandemic, with a renewed appreciation for science, other countries are making substantial new R&D investments, including the United States (U.S.), United Kingdom (U.K.), and Korea. This is expected to increase competition among countries for top researchers.

Against this backdrop and in view of the turning point that the pandemic has brought about, now is a pivotal time to consider the role, impact and future of the important research that is conducted within Ontario’s hospitals, as key contributors in the research and innovation ecosystem.

Top Drivers of Research and Innovation in Canada

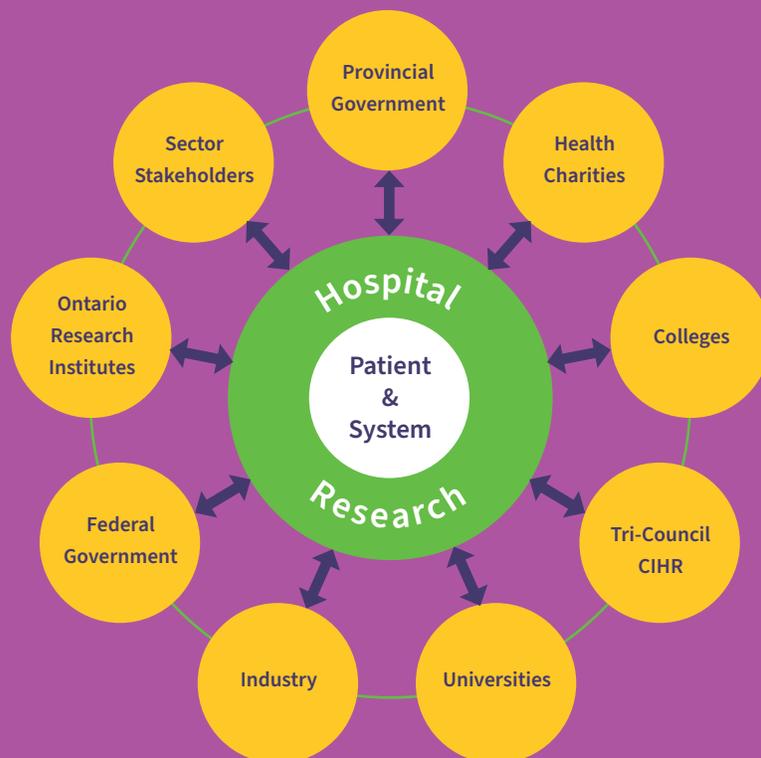
As a vital component of Canada’s research ecosystem, Ontario’s research hospitals are a **key strategic resource for the province and the country**. In 2020-21, research hospitals attracted \$1.73 billion in investment which supports almost 22,000 highly skilled researchers and support staff along with research space, equipment and technology.

Research hospitals are the largest contributors to health research and innovation in the province. Over half of Canada’s hospital-based research is conducted in Ontario and 19 of Canada’s Top 40 research hospitals are in Ontario.⁵ The sector has been built up over decades with world-class scientists and international and commercial connections. Research hospitals are tightly connected to universities and medical schools, are a major training ground for science in the province, and attract top researchers from other jurisdictions.

Research hospitals are unique in the ecosystem, fulfilling a role that no other research sector can carry out. Hospital-based research is the R&D arm of Ontario’s health care system and is directly tied to patient care with patients both participating in and benefitting from research. Other components of the ecosystem, including universities and commercial enterprises, critically rely on hospitals to be able to conduct clinical aspects of their research.

As the hub of innovation, research hospitals work to improve health and Ontario’s health system which contributes to the economy directly and through spin-off effects.

With all levels of government anxiously seeking a path to economic recovery from the consequences of the pandemic, it will be critical to enhance and leverage the existing role of hospital-based research and innovation, particularly in an environment of newly accelerated global competition for top research scientists.



The Value and Impact of Hospital-based Research and Innovation

The R&D Arm of Ontario's Health Care System

As the primary site for health research and innovation, Ontario's research hospitals represent the R&D arm of our publicly funded health system. The importance of maintaining an excellent research infrastructure cannot be overstated.

- Just as the business sector invests in R&D to be able to innovate and continuously improve performance, Ontario's health system, servicing 15 million people, requires the same focused efforts.
- The \$1.73 billion hospital research investment in 2020-21 represents an amount equal to 2.7% of the Ontario government's \$64.4 billion health sector expense* in 2020-21.⁶ Of the \$1.73 billion, \$101 million (6%) is funded by the provincial government and \$373 million (22%) is funded by the federal government.
- To mitigate the financial impact of the pandemic on the sector, the federal and provincial governments also provided emergency funds. These investments for 2020-21, which included \$105 million in federal Canada Research Continuity Emergency Funds and \$95 million in provincial bridge funding from the Ministry of Health, do not represent long-term revenue sources for the sector.
- In summary, the very large category of public expenditure which is the health sector, receives a relatively low level of research investment from public funding sources.

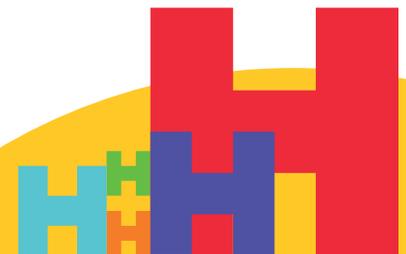
Research conducted in Ontario's hospitals is wide-ranging covering conditions and diseases from the most common to the most rare. The thousands of current initiatives span the entire continuum of research from fundamental discovery, translational and clinical to health service delivery and policy research.

Throughout the pandemic, hospital-based research has been designated an essential service. Without the rapid re-deployment of this critical research infrastructure,

* The \$64.4 billion health expenditure does not include \$19.1 billion in COVID-19 time limited funding in 2020-21.

Canada's and Ontario's pandemic response would not have been possible. Ontario's research hospitals continue to be an important part of a national and international pandemic effort coordinated across research institutes, universities, government, public health agencies and the private sector.

Research hospitals and their scientists and clinician-researchers have led or contributed to a host of breakthroughs in the pandemic response. This has involved critically important functions, such as isolating the virus and identifying variants through genetic research, conducting vaccine research and clinical trials for treatments, offering evidence and expertise to mitigate the individual and societal effects, and much more. Collectively, Canadian researchers published more than 3,000 COVID-19 related research papers between January and November 2020.⁷



The Hospital Research Landscape

... clinical trials • imaging studies • genetics • rehabilitation studies • heart disease • cancer • aging • dementia • stroke • mental health • arthritis • infectious disease • diabetes • kidney disease • asthma • pediatrics • musculoskeletal disorders • neurological disorders • palliative care • primary care • healthy aging • public health • health system improvement • self-help tools • online health care • health policy research ...

Supporting the COVID-19 Pandemic Response

The many health, social and economic impacts of the global pandemic continue to be felt across the country. These impacts, however, would have been far worse had it not been for the existing research infrastructure in Canada. With the support of provincial and federal governments, scientists have been able to apply their skills and expertise to address the most difficult challenges that have been posed by the pandemic.

➔ Targeting the Virus

Isolating the SARS-CoV-2 Virus

A team of researchers from Sunnybrook Research Institute, McMaster University and the University of Toronto isolated the SARS-CoV-2 virus in early March 2020. This effort by Drs. Robert Kozak, Samira Mubareka, Arinjay Banerjee and Dr. Karen Mossman was a critical first step in developing diagnostic tests, treatments and vaccines to combat the pandemic.⁸

Tracking COVID-19 through Gene Technology

Ontario hospital researchers are contributing at all levels of the Canadian COVID Genomics Network (CanCOGeN) which was formed under Genome Canada in April 2020. Through genome sequencing and analysis—using capabilities built up over a 20-year investment in Genome Canada and its provincial partners, including Ontario Genomics—the initiative has led to better understanding of the virus which is critical to ongoing tracking of the virus and an effective pandemic response.⁹

Targeted Research Funding for COVID-19

Ontario research hospitals were the recipients of 22 out of a total of 35 projects funded through the \$20 million provincially-funded Ontario COVID-19 Rapid Research Fund. The projects included clinical trials for new treatments, better testing, diagnostics, prevention and vaccine development as well as assessing aspects of the pandemic's impact on select population groups.¹⁰

➔ Stemming the Human Cost

Informing Policy Decisions

Leaders across a wide network that includes hospitals, their research institutes, universities, government and several agencies, continue to contribute to the science that informs government policy decisions for the well-being of communities and individuals. For example, hospital-based scientists across Ontario are among the expert members of the Ontario COVID-19 Science Advisory Table, its working groups and partner organizations.¹¹ Together, these experts have contributed to identifying and addressing countless challenges faced across the population, including physical and mental health impacts as well as economic impacts. By exchanging knowledge and creating new evidence, including through mathematical modelling which, for example, supports more effective and equitable vaccine distribution, it has been possible to target higher risk regions, vulnerable populations and essential workers. A tremendous knowledge base stemming from hospital-based researchers and their networks has been employed to inform policy decisions at the provincial and federal levels.



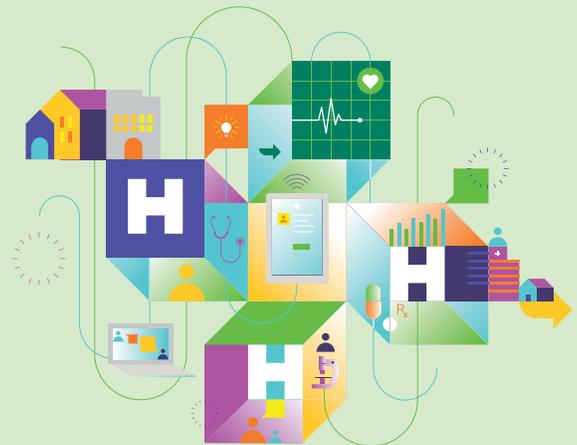
Contributing to Provincial Health Priorities

Research supports many key health priorities in Ontario.

Two major trends to which research is contributing include Ontario's changing demographics and the increased societal focus on mental health. In our aging population, many seniors live with one or more chronic conditions. Research into chronic disease that is conducted in many hospitals contributes to improved quality of life for patients and reduced health care costs. Research in the area of mental health spans a range of topics from the social determinants of health to highly specialized brain science. Brain research spans all age categories and is essential in revolutionizing not just mental health but related areas, such as brain injury treatments and in better understanding conditions such as autism.

- In support of brain health and healthy aging, Baycrest and MaRS co-founded Cogniciti, an innovative digital health firm. Scientists and clinicians at Baycrest and its Rotman Research Institute created a free online brain health assessment tool for use by individuals with memory concerns. The tool helps people determine whether concerns are likely normal or whether a physician assessment is warranted. Cogniciti also provides an online health tracker, a suite of learning programs and attracts new research subjects through a voluntary brain registry.¹²
- A program to assist Ontario's long-term care sector with regard to workforce challenges and care provided to long-term care residents is hosted by two of Ontario's research hospital sites—Brydère and Baycrest—as well as the Schlegel-UW Research Institute for Aging. The Centres for Learning Research and Innovation in Long-Term Care (CLRI), funded by the Ontario government, contributes to enhancing the quality of life for long-term care residents through assisting the province's long-term care homes in implementing applied research and innovative leading practices.¹³

- The wide-ranging research conducted at the Centre for Addiction and Mental Health (CAMH) includes the use of leading-edge technology, such as artificial intelligence, big data and brain imaging, to better understand how multiple factors, including genetics, play a role in mental illness and addiction across all age groups. This research will lead to new and more personalized treatments.¹⁴
- CAMH is becoming a global leader in brain injury research, collaborating with the Concussion Legacy Foundation Canada (CLFC) and the Canadian military to research how traumatic brain injuries progress. This research uses specialized brain imaging and overlaps with research into other neurodegenerative diseases, such as Alzheimer's.¹⁵
- Researchers at SickKids continue to make breakthroughs in understanding autism spectrum disorder (ASD) with genetic research as a major area of focus. Scientists recently developed a novel proprietary method for examining vast quantities of genetic data to discover genes and genetic patterns implicated in ASD. The new technique developed by the SickKids' team, published in the world's leading journal *Nature*, is likely applicable to identifying genetic patterns for other neurodevelopmental disorders or any other genetic condition. This breakthrough is expected to have an immediate impact in that it enables earlier diagnosis of ASD and opens the door for more personalized treatment for ASD and other genetic conditions.¹⁶



Research is Directly Tied to Patient Care

In no other setting are researchers as connected to patients or as involved in the delivery of care as in hospitals.

Hospital-based research occurs at the unique intersection of patients, clinicians, clinician-scientists and other researchers with linkages to universities, medical schools, specialized

institutes and leading-edge biotech firms that develop and commercialize new treatments. In many cases, clinician-scientists drive the research, coming up with new projects to improve patient care. Without the clinical connection, the science would not occur or would not be as effective.

➔ **Sepsis Treatment Breakthrough – High Patient and Economic Benefits through Commercial Partnerships**

Sepsis is a leading cause of death, a high-cost illness for health systems, is associated with severe COVID-19 infection and is a World Health Organization global health priority disease. Researchers from The Ottawa Hospital recently assessed the cost of sepsis to the Ontario health care system at \$1 billion annually. Teams of researchers across Canada in hospitals and universities are coordinating efforts to address this illness through targeted research funding.^{17 18}

At the hospital-based Lawson Health Research Institute in London, Ontario, Dr. Qingping Feng discovered a protein that is in development to become a new pharmaceutical to treat sepsis. Thirteen years after the discovery, the drug is now moving towards a trial that will involve treatment of patients with sepsis. Development of this discovery involved years-long collaboration among scientists, hospitals and the university and private sectors. This breakthrough and path towards commercialization has the potential for very significant health benefits for patients, economic benefits from commercialization and from major health system cost reductions through fewer hospitalizations, ICU stays and re-admissions.¹⁹ The commercialization process was facilitated through WORLDdiscoveries, a business development arm of London, Ontario research institutes with private-sector linkages.

➔ **Supporting Children and Families with Research and Knowledge Translation**

Bloorview Research Institute (BRI), located within Holland Bloorview Kids Rehabilitation Hospital has a strong focus on laboratory-based research that directly involves its client population of children and youth with disabilities and their families. Through several different labs, research that spans the range from the use of advanced technology for physical and neurorehabilitation to effective ways to promote healthy lifestyles, BRI research is tightly connected to care.²⁰ BRI's research is led by scientists and clinicians from wide-ranging disciplines including medicine, psychology, physiotherapy, bioethics, biomedical engineering and more.

BRI is also working to ensure that the knowledge gained from its research investment is accessible to those who will benefit most. Through a project called “Research Unlocked: Research Summaries for Families,” information on topics that are directly relevant and helpful to children, youth and their families is developed together with client involvement and made accessible to all.²¹

➔ **Hospitals are Essential for Clinical Trials**

More than 100 Ontario hospitals and other research sites are participating in approximately 3,500 open clinical trials that are coordinated through Clinical Trials Ontario (CTO). Many additional trials are conducted outside of the CTO process.²²

More than 115 COVID-19 related studies have been supported in multiple hospitals and investigative sites through CTO. Research hospitals often act as hubs for clinical trials conducted across Ontario's entire hospital system.²³



The benefits of hospital-based research are felt across the province. In smaller centres, research has the added benefit of supporting local community needs, attracting and retaining more health care providers to under-served areas, and enabling a wider range of specialized services and care to be provided closer to home.

➔ Hospital Research Supports Local Health Needs and Attracts Health Care Providers

The health needs of people living in northern Ontario is a priority for the Health Sciences North Research Institute in Sudbury with its focus on cancer, cardiovascular health, healthy aging, Indigenous health and more. As well, the establishment of the research mandate of Health Sciences North research hospital, together with the Northern Ontario School of Medicine, have worked to attract and retain physicians to more remote regions of Ontario.²⁴

The Thunder Bay Regional Health Research Institute works strategically to address regional health care needs as well, with research priorities that include cancer, cardiac disease, stroke, orthopaedics, Indigenous health, and lung disease. With a particular focus on developing biomarkers for positron emission tomography (PET) and magnetic resonance imaging (MRI), the Institute's work is aided by the use of a new cyclotron which produces radioisotopes for both patient care and research. Used in the area of cervical cancer screening and treatment, this research particularly benefits First Nations women who have higher barriers in accessing screening and care.^{25 26}

➔ Hospital Research Extends into and across Communities

Just as hospital services have long been extended well into the community with a range of programs to support health, research activities occur in the community setting as well. Research areas range from topics such as the social determinants of health to high-tech virtual care and everything in between.

- As part of the Li Ka Shing Knowledge Institute of St. Michael's Hospital, and with full affiliation with the University of Toronto, the MAP Centre for Urban Health Solutions brings together clinician scientists from a range of fields to better understand how social inequality impacts health.²⁷

- Research topics developed to meet urgent needs, with a focus on results, include: reducing disparities in access to health care and medication; Indigenous health; homelessness and housing; substance use, harm reduction and addiction; neighbourhoods and health; intimate partner violence; work and health; COVID-19 impacts and strategies, and many more topics. In researching complex community health issues to identify practical, scalable solutions, MAP is also collaborating across Canada with researchers, organizations, policy makers and people with lived experience to produce 10 evidence-based and tested solutions that can be implemented throughout other cities.²⁸ These initiatives span a range of key social equity topics in Ontario and Canada today.
- Clinician researchers at Hamilton Health Sciences are trialling and evaluating innovative digital technologies that extend care beyond the walls of the hospital. Evaluation results will inform future applications of these technologies:²⁹
 - Wearable medical devices that can monitor heart function and vital signs, in conjunction with video conferencing, allow patients to be discharged home much sooner and still receive high quality and consistent care.
 - Through the Tele-Resuscitation Project, even critical care can be supported virtually through live-stream technology. This project connects emergency physicians at McMaster Children's Hospital—the regional hub for children's health care—with emergency physicians at Niagara Health so that children with complicated, life-threatening conditions can be quickly stabilized using advanced techniques.
- Through a hub and spoke model, hospital research also works directly to support delivery of care in more remote and smaller centres. Kingston General Health Research Institute (KGHRI) is one of six academic centres involved in the Accelerated Remote Consultation Tele-POCUS in Cardiopulmonary Assessment (ARCTICA) project that is being implemented across Canada. ARCTICA brings advanced technology and remote support and training that enables physicians to use point-of-care ultrasound to assess the heart and lungs of patients with shortness of breath. This is being used in the fight against COVID-19 and the knowledge gained will have benefits that will continue for these remote communities.³⁰

Research Hospitals are a Major Training Ground for Science

Research hospitals fulfill an essential role in providing a wide range of education and training in conducting scientific research in a real-world, clinical or laboratory setting.

Research trainee positions exist in every research hospital in the province. In 2020-21 there were more than 5,200 postdoctoral fellows and graduate student research trainees in Ontario hospitals.

Hospitals offer formal programs for medical students and other clinical trainees who are integrating research with the pursuit of medical and other areas of clinical education. Research training opportunities also exist for summer students and undergraduates, supporting interests in careers in health care and the health sciences.

Trainees have a wide range of opportunities, including working directly with established researchers on specifically funded research initiatives. In addition to specific research topics, other training topics include commercialization, research study design, statistical analysis, and communications and grant writing.^{31 32 33}

Economic Benefits

Driving Innovation and Commercialization

In 2020-21, commercialized research in Ontario's hospitals resulted in 122 commercialized products and 239 intellectual property disclosures.³⁴ Research institutes and their business arms or commercialization partners work strategically to transform the fruits of research to marketable products and services for health and economic benefits.

➔ BlueRock Therapeutics – a \$1 Billion Success

BlueRock Therapeutics is a recent major success story. BlueRock is a firm that develops stem cell therapies in the field of regenerative medicine for neurology, cardiology and immunology with a focus on Parkinson's disease. This therapy has the potential to reverse degenerative disease and restore motor function to more than 7 million people with Parkinson's disease worldwide.

The firm was co-founded by University Health Network (UHN) researchers, Drs. Gordon Keller and Michael Laflamme with initial seed investment from Bayer AG and Versant Ventures. In 2019 the firm was wholly acquired by Bayer AG and valued at around USD \$1 billion.³⁵

The BlueRock story exemplifies the long chain of research impacts spanning decades. In the early 1960s, the discovery of stem cells was made by Drs. James Till and Ernest McCulloch at the Ontario Cancer Institute at Princess Margaret Hospital—part of today's UHN. Their work is renowned for transforming cancer therapies, laying the groundwork for regenerative medicine and in spurring the development of the biomedical industry in Canada and in the world.³⁶

➔ Adela Therapeutics – \$60 Million in Startup Financing

Adela is a newly launched biotech firm that recently attracted \$60 million in financing to commercialize a new “liquid biopsy” technology. The firm stems from research by two Princess Margaret Cancer Centre senior scientists, Drs. Daniel De Carvalho and Scott Bratman who developed a method whereby cancer and possibly other genetic diseases could be detected with a simple blood test, leading to earlier detection.³⁷

➔ Rna Diagnostics – \$8 Million in Private Sector Investment for Northern Ontario

Rna Diagnostics emerged from work conducted by Laurentian University and Health Sciences North Research Institute. This personalized medical technology developed by Dr. Amadeo Parissenti provides information for physicians to assess within weeks whether a patient's cancer treatment is effective. If treatment is not working, it can be switched early on, thereby saving precious time as well as reducing chemotherapy side-effects and costs of treatment for both patients and the health care system. An international clinical trial to validate the technology for use in breast cancer is underway in six countries across North America and Europe.^{38 39}

➔ Turnstone Biologics and Virica – Millions in Private Sector Investment

With the support of Ontario Research Fund (ORF) funding, researchers in Ottawa are creating a new industry centred on viral therapeutics for cancer and virus manufacturing. Startup companies include Turnstone Biologics and Virica Biotech. Both companies conduct their research, development and manufacturing in Ottawa. This research could improve cancer survival by revolutionizing cancer treatment as well as the manufacturing process for vaccines and other biological therapies.

Turnstone was founded based on research led by Dr. John Bell (The Ottawa Hospital and uOttawa), Dr. Brian Lichty (McMaster University) and Dr. David Stojdl (Children’s Hospital of Eastern Ontario and uOttawa). The Ontario Institute for Cancer Research (OICR) and BioCanRx have also played a key role in advancing the technology.^{40 41} In 2021, Turnstone raised \$80 million in investment funding on top of a previous \$50 million.⁴²

Virica was founded by Dr. Jean-Simon Diallo in 2018 after many years of research in his lab at the Ottawa Hospital Research Institute.^{43 44} In 2021, Virica opened its new Process Innovation Facility in Ottawa as part of the Ottawa Health Innovation Hub with a substantial injection of private sector financing.⁴⁵

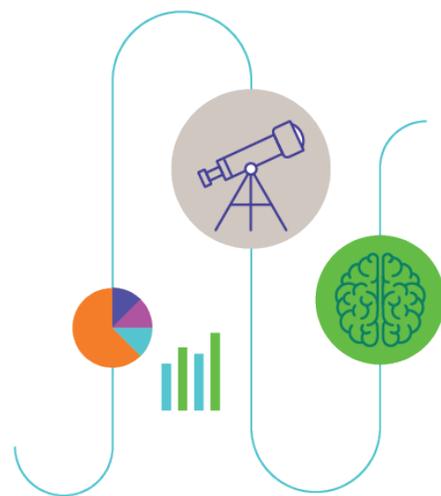
Wide-Spread Economic Benefits

The pandemic has provided the most current, impactful example of how health research and innovation deliver economic benefits for societies, governments and individuals. Healthier societies are better off overall and economically more productive. Tremendous economic benefits can result from specific research breakthroughs as seen above, as well as from a multitude of step-wise advances, especially when it comes to addressing our most common health issues.

Given that Ontario’s top four chronic diseases—cardiovascular disease, cancer, lower respiratory disease and diabetes—cause three quarters of all deaths and cost \$10.5 billion in annual public spending,⁴⁶ research aimed at reducing them will have tremendous economic as well as health payoffs.

One Canadian study estimated that over an 11-year period, every \$1 of investment in cardiovascular disease research funded by public or charitable organizations provides a return of approximately \$0.21 for the economy every year, in perpetuity. This is in addition to the health benefits that were estimated to be approximately 2.2 million quality-adjusted life-years over an 11-year period.⁴⁷

As well, in addition to the \$1.73 billion in direct economic activity from Ontario’s hospital-based research investment, there are secondary or “spin-off” economic benefits that have yet to be quantified. Earlier Canadian research and research from the U.S., U.K. and Australia have assessed the secondary impact to be as large as one to one and a half times the direct investment impact.^{48 49 50 51 52 53}



Funding Sources

Hospital-based research in Ontario is funded from a mix of sources including federal and provincial governments, industry (pharma/biotech), philanthropy, and health charities.

In 2020-21, hospitals attracted \$1.73 billion in research funding. Of this, 34% or \$579 million was generated directly by hospitals through philanthropy and other internal revenue generating activities.⁵⁴ This substantial self-generated funding reflects the fact that hospitals and their donors—who are most often patients and families—place a high value on research. Donors contribute because they see the valuable impact of research. While the large proportion of philanthropic funding is of tremendous benefit, the pandemic has demonstrated the vulnerability of this particular revenue source which has seen significant declines since the pandemic began.

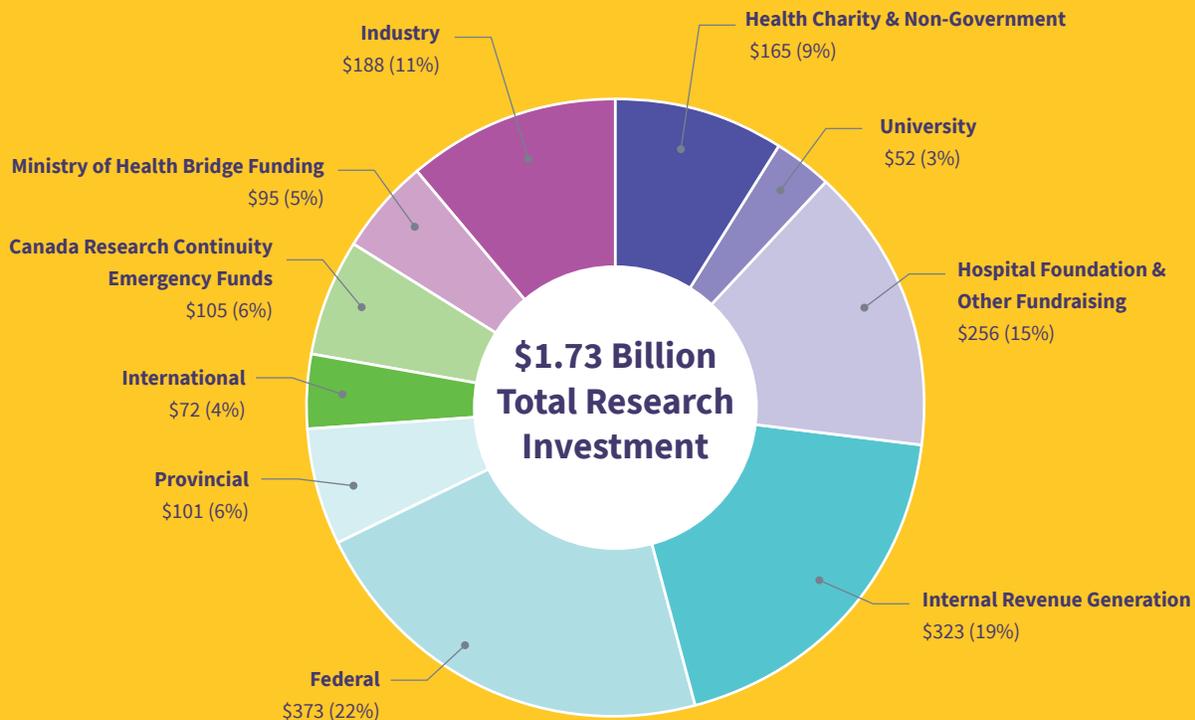
Federal Funding

Federal research funding in Canada flows through three major federal research granting councils:

- The Canadian Institutes of Health Research (CIHR)
- Natural Sciences and Engineering Research Council (NSERC)
- Social Sciences and Humanities Research Council (SSHRC)

As a fourth “pillar” of federal research funding, the Canada Foundation for Innovation (CFI) funds equipment and related research infrastructure to conduct leading-edge research. Federal funding for Ontario research hospitals totaled \$373 million in 2020-21, exclusive of \$105 million in funding made available through the federal Canada Research Continuity Emergency Fund in response to the COVID-19 pandemic.

Almost all federal funding for hospital research is from CIHR. Funding through CFI is matched by the province and the institute itself.



Ontario Funding Sources are Interconnected

In 2020-21, the Government of Ontario provided \$101 million in hospital research funding, exclusive of \$95 million in emergency bridge funding made available through the Ministry of Health in response to the COVID-19 pandemic. Provincial investment flowed through a number of specific programs including:

- Ontario Research Fund (ORF)
- Early Researcher Award (ERA)
- Health System Research Fund (HSRF)

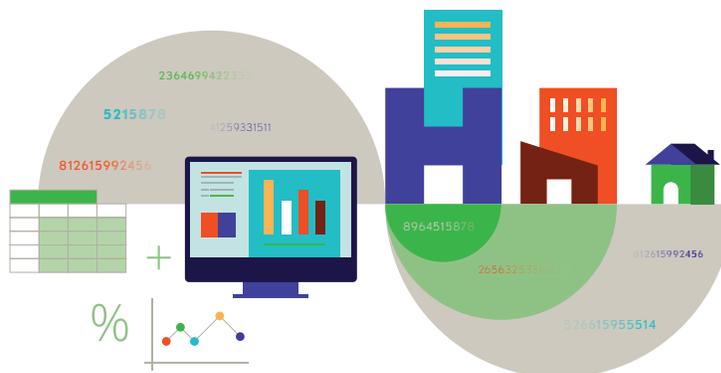
The ORF is hospitals' single most important provincial government funding source because it provides leveraged funding—additional funding attracted from the private sector and institutional contributions. Fluctuations in ORF funding therefore have a considerably magnified impact on available research funds.

A number of other large and impactful health research institutes operate in Ontario with funding from the province, the federal government and other sources. These organizations are separate from hospitals but they both rely on and support the hospital research infrastructure. As such, their funding levels have an impact on hospital research funding. These organizations are key connectors to biotech and the biohealth product business and in turn, hospitals facilitate direct links with patients and industry. The following institutes have relationships with hospitals for the purposes of carrying out their research which also includes funding support:

- Ontario Brain Institute (OBI)
- Ontario Genomics Institute (OGI)
- Ontario Institute for Cancer Research (OICR)
- Ontario Institute for Regenerative Medicine (OIRM)
- The Centre for Aging + Brain Health Innovation (CABHI)

Industry Funding

Industry invested \$188 million in hospitals in 2020-21 for clinical trials as well as basic research. Ontario is able to attract this level of investment from the private sector due to our leading scientists with innovative ideas, the publicly funded health system, and a diverse population. Ensuring that careers in research continue to be attractive is essential to driving even more industry investment to Ontario.



International Trends in R&D Investment

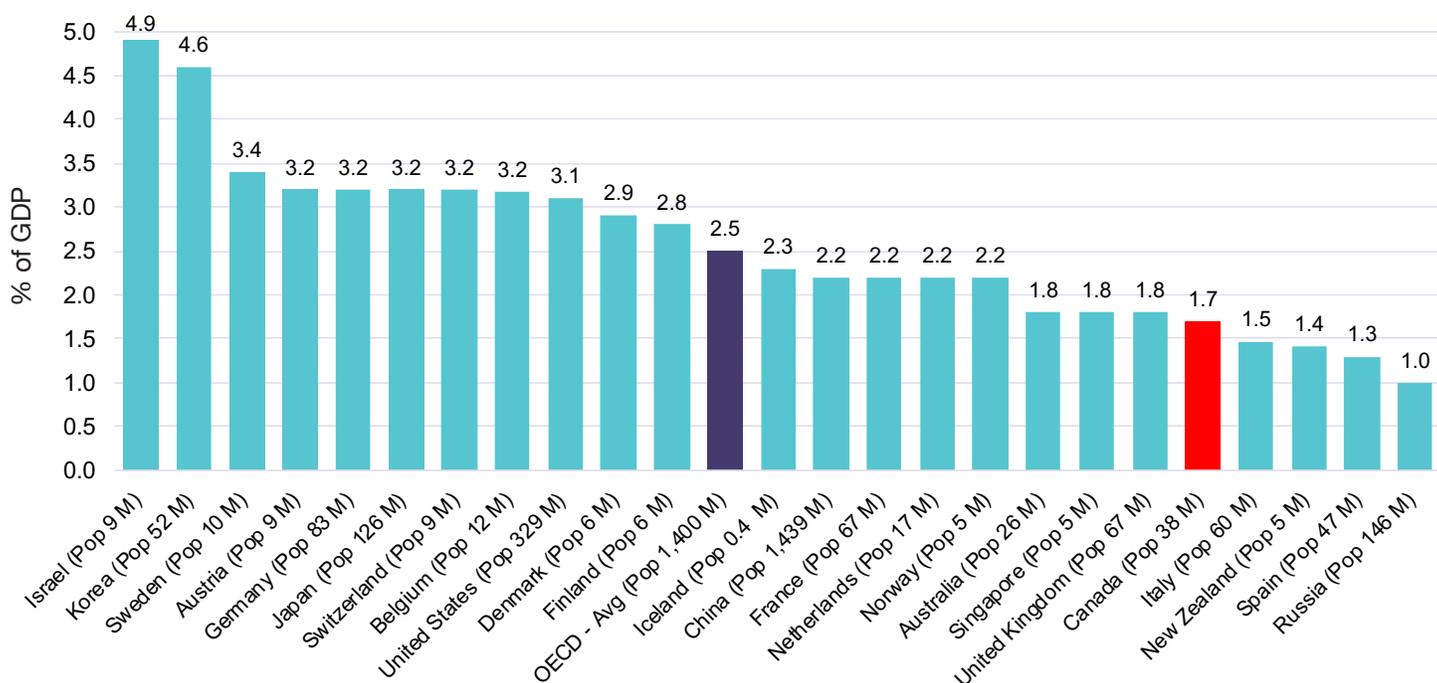
The importance of science is recognized across the world in a wide cross-section of participants and supporters. R&D of all types is funded and carried out by a range of sectors and organizations such as governments, universities, for-profit business, non-profit entities, dedicated research institutes and academic hospitals.

In the private sector, successful firms recognize the importance of strategic investment in R&D to being able to excel and compete. In the public sphere, all countries have an interest in harnessing R&D with advanced economies being most able to afford it. Despite the clear importance of R&D, there is significant variation across countries in how it is prioritized and within individual countries over time.

In Canada, the past two decades have seen a relative decline in investment in overall R&D. This decline has been flagged in several prominent reports with recommendations for changes to R&D funding and policy approaches.^{55 56 57 58}

These reports called for a cohesive, national funding strategy to support research and innovation and to spur greater research commercialization. While the federal government has responded with funding enhancements and as a result of the pandemic, substantially boosting Canada's R&D standing will require a sustained funding and policy effort over time. The role of provincial governments is also important in supporting research that leads to regional and local economic and health benefits.

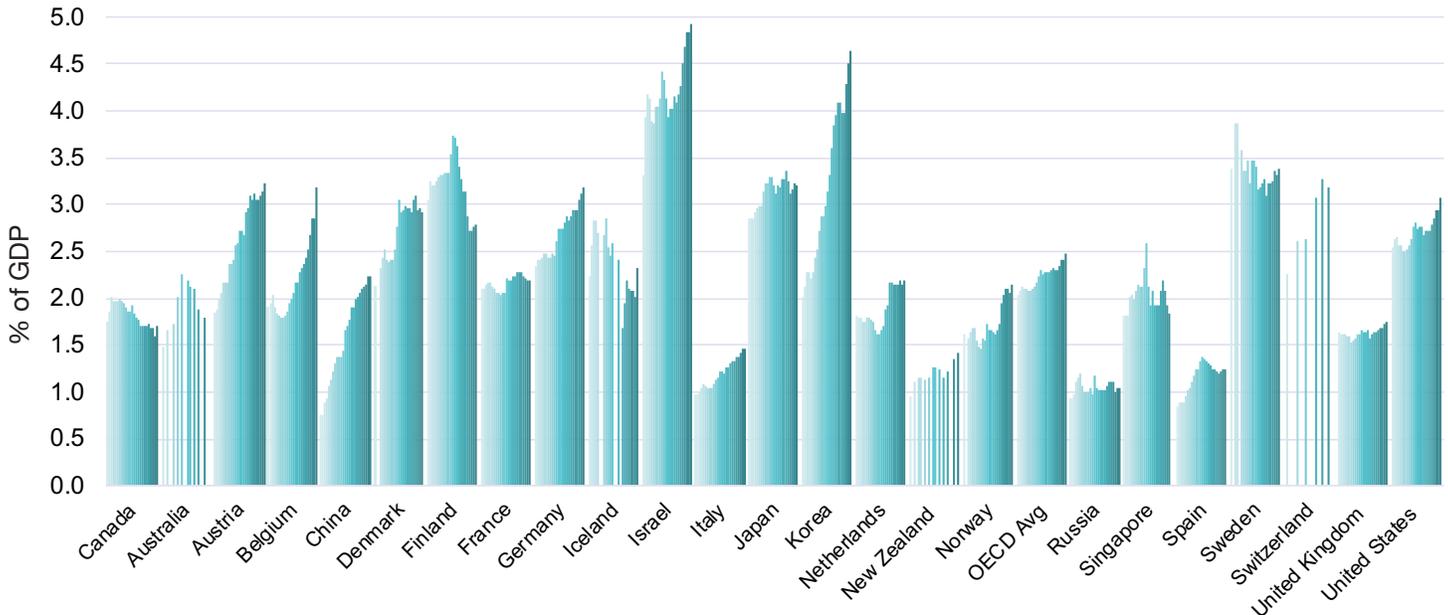
R&D as a Percentage of GDP (2019, Selected Countries)⁵⁹



Australia and Switzerland are 2017. Singapore is 2018. Canada and Austria are 2020.

Expenditure on R&D by all sectors in Canada (public and private), at 1.7% of GDP, is low compared to other countries. Currently, the OECD average is 2.5%. Gross domestic expenditure on R&D includes expenditure by government, private enterprise, higher education, private non-profit and foreign sources and in 2021 amounted to \$40 billion for Canada.⁶⁰

R&D as a Percentage of GDP (1999-2019, Selected Countries)



Australia and Switzerland up to 2017. Singapore is up to 2018. Canada and Austria are up to 2020.

The figure above shows trends for domestic R&D expenditure from 1999 to 2019 (latest year available for international data, with Canada and Austria data up to 2020). Canada has seen a decline over approximately two decades with the highest level being 2% of GDP in 2001, significantly exceeding the most recent 2020 level of 1.7%. Several countries saw a sharp decline following the 2007-08 world financial crisis. Canada's decline since 2007-08 is less pronounced than in some other countries as seen in the figure above but has been steady with the exception of a notable increase in 2020 over 2019.

International Developments Spurred by the Pandemic

A January 2021 OECD report highlighted that the pandemic has spurred a stronger commitment to R&D in several countries for the next few years with notable new investment being made by the U.S., U.K. and Korea.

“The announced U.S. federal R&D budget for 2021 shows a 6% increase over the fiscal year (FY) 2020 budget. Meanwhile, the United Kingdom remains committed to raising public R&D expenditure to GBP 22 billion by FY 2024-2025 and increasing its total R&D expenditure to 2.4% of gross domestic product by 2027. Korea also announced a new science and technology policy initiative “post

corona, science and technology policy direction for a new future” that identifies 30 promising technologies which will have high priority for government R&D funding. National strategies and funding commitments are likely to differ widely between countries, adding to future uncertainty for all the actors in research ecosystems, with important implications for the research workforce...”⁶¹

At the outset of the pandemic, the U.K.'s March 2020 budget announced an increase in public science investment to GBP 22 billion by 2024-25 (as noted in the quote above) from a previous level of GBP 9 billion per year.⁶² One year later, the March 2021 budget announced a new high-skilled migration policy to “...help the U.K. attract and retain the most highly skilled, globally mobile talent – particularly in academia, science, research and technology – from around the world. This will drive innovation, and support U.K. jobs and growth.”⁶³

More recently in the U.S. it was announced that over the next five years, almost a quarter of a trillion dollars are slated to be spent on scientific R&D as a competitive strategy in view of increasing levels of investment internationally.⁶⁴ While it is not clear whether this is part of the previously announced 6% budget increase noted above, it further reinforces that there is strong momentum in support of science investment.

Challenges and Opportunities

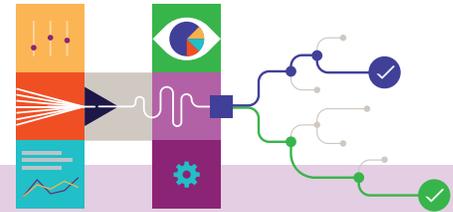
The pandemic's arrival posed severe challenges for hospital-based research and highlighted pre-existing vulnerabilities. Occurring simultaneously at the onset of the pandemic were: a scale-back of all non-essential research; a ramp-up of COVID-19 research; a sudden and significant loss of research revenue; and imminent wide-scale layoffs. The scale-back required suspension of industry-sponsored clinical trials. The loss of revenue and halt of research activity put at risk an estimated 10,000 to 15,000 jobs nationally and increased the risk of permanent loss of valuable early career researchers.

Funding

In response to the immediate risk, the OHA called on Prime Minister Justin Trudeau for emergency support for the sector nation-wide, which resulted in \$450 million for wage support and re-start of research for Canada.⁶⁵ By the end of 2020-21, Ontario's hospital-based research sector had received \$105 million in emergency funding through the federal Canada Research Continuity Emergency Fund and \$95 million in emergency bridge funding from the Ontario Ministry of Health. Additionally, the Government of Ontario invested over \$20 million for COVID-19 research through the Ontario COVID-19 Rapid Research Fund.⁶⁶

To date, charitable organizations, foundations, and other research funders have had a reduced ability to continue support. The full financial impact is still unknown and the potential to restore previous funding levels from health charities, philanthropy, and industry is not yet clear. As researchers shifted focus away from specifically funded government projects, it is also uncertain how these losses will be reconciled.

Unlike universities, research hospitals receive no base funding which universities source through tuition fees. Base funding provides stability to enable a better supported, more cohesive workforce as well as funding for research trainees and the necessary indirect operating expenses. Without base funding, hospital research relies more heavily on fluctuating, time-limited, project-based funding that poses challenges which do not occur in other research sectors.



Hospital-based Research Needs:

- a more stable, modernized government funding approach
- more extensive integration of research and clinical care across the health care system
- enhanced capacity to attract and retain a diverse, highly skilled, science-based and research-intensive work force in a globally competitive environment

The multiple funding sources, funding and research interdependencies across different research institutes, and the significant reliance on fundraising and other hospital-generated research funding gives rise to a less secure environment and highlights the need for a more stable, modernized funding approach in the future.

Research and Clinical Care Integration

Despite the rapid pivot towards COVID-19 research, the sector was not set up to support the pandemic without disrupting and compromising existing research. Other countries were in a similar position but to differing degrees with some able to rely on a more organized and technologically connected health system that allowed for a more effective pandemic response.

More extensive integration of research and clinical care across the health care system, in a model similar to that which exists in the U.K., would enable a more responsive system to mobilize around critical questions and urgent care needs as they arise. For example, the U.K.'s Clinical Research Network

provides an infrastructure that does not require each new research project to develop a dedicated infrastructure.^{67 68 69} In Ontario, such an infrastructure, if developed, might include rapid establishment of clinical trials, quickly conducting genomic sequencing and tracing COVID-19, for example.

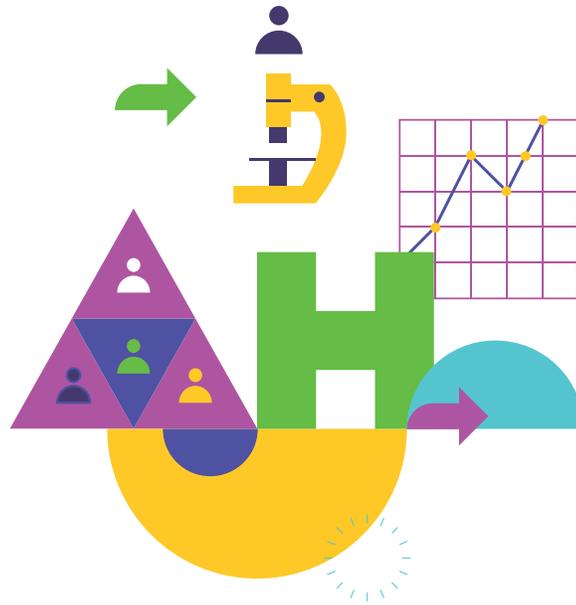
Increasing the coordination between research hospitals and the larger hospital system and further building on established connections would develop new research capabilities in other hospitals and other sectors across all corners of the province.

Support for the Research Community

People are the backbone of the research infrastructure. Ontario's excellent researchers and institutes act as a magnet in attracting other researchers and business investment, both of which are essential in continually refreshing and building up the strength of an institute.

The sector faces some complex labour issues, however, which are related to the funding issues described above. A common thread that has been identified across countries for some time is the precarity of employment of early career researchers.^{70 71 72 73} The OECD reports that early career researchers across the globe have had particular difficulties establishing themselves since the pandemic began as opportunities declined, at least in the short run.

As other jurisdictions substantially increase research funding to strengthen their capabilities post-pandemic, it is important that Canada be competitive in attracting and retaining young and mobile researchers who may otherwise relocate or leave the sector altogether.



Future Vision

In considering how best to renew and advance the sector at this juncture, the OHA, together with its member hospitals, has identified a new vision for hospital-based research for the future:

A fully integrated health research and care delivery system across Ontario that drives sustainable and transformational science, clinical excellence, health equity and an agile, diverse workforce of scientists and innovators.

The priorities and goals necessary in achieving this vision include:

Collaboration with Government

➔ Goal - The integration of research and innovation with the delivery of health care is recognized as essential to the provincial economy, equity, and the well-being of Ontarians

Sustainable and Innovative Funding

➔ Goal - Core funding for hospital-based research is essential to the health system

Dynamic Interconnected Networks

➔ Goal - Fully networked research, learning and clinical environments, drawing upon unique resources and population, for globally influential science and transformative health outcomes

Thriving Research Community

➔ Goal - A recruitment and retention strategy for scientists to create a community of diverse, interdisciplinary professionals to prepare for the health challenges of the future

Call to Action

In view of the strategic importance of the hospital-based research sector to Ontario's and Canada's health and economic well-being, the OHA is calling on the provincial and federal governments to collaborate with us to help realize our future vision. The role of both levels of government will be essential to ensuring the stable, modernized funding approaches necessary to develop specific initiatives, bring the sector to the next level of excellence and remain competitive.

Conclusion

The case for supporting research and innovation in any society is ageless and simple: the more we discover, the more we can do and the better off we can be. As part of the broader research and innovation ecosystem, Ontario's research hospitals have a unique and strategically important role that cannot be fulfilled by any other research sector, bringing tremendous value to individuals and to society in general.

If we do not work to continually cultivate and enhance our own excellent but potentially precarious health research ecosystem, Ontario's ability to discover and innovate will erode, leading to increased reliance on the scientific work of other jurisdictions for solutions and advancements for our own health system. As Canada strives to recover from the pandemic in a highly competitive global R&D environment, renewed support for research and innovation is more important than ever.

Through a new future vision for hospital-based research that involves collaboration with government, sustainable and innovative funding, and interconnected research, education and clinical networks, Canada will be on better footing for improving health and economic prosperity in the future. The OHA and its member hospitals look forward to working together with both the provincial and federal governments to leverage the valuable resource of hospital-based research.

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