Acknowledgements

This report was prepared by a team of staff at CCSRI including Dr Siân Bevan, Vice-President, Research; Lisa Carney, Research Analyst; Dr Carolyn Goard, Research Communications Specialist; Rudy Valentim, Senior Advisor, Research Monitoring and Evaluation; Robyn Widenmaier, PULSE Volunteer; and Dr Michael Wortzman, Assistant Director, Research Programs. The report benefited from valuable inputs, comments and feedback from Canadian Cancer Society staff and researchers. It was designed by Angus Brown, Manager, Materials Production and Design.

Additional members of the CCSRI team who are instrumental in ensuring CCSRI’s high standards of expert peer review, research monitoring, evaluation and strategic impact include Jessica Balmer, Carol Bishop, Cate Mennega, Lori Moser, Sheila Porter, Roberta Varga and Dr Christine Williams.

An electronic version of the report is available on the Canadian Cancer Society website.

For inquiries please contact CCSRI at research@cancer.ca
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Welcome Message

Since 1938 the Canadian Cancer Society has been working toward creating a world where no Canadian fears cancer. With the number of new cases of cancer expected to rise dramatically over the next 15 years, there is a clear call for us to do more collectively to defeat this disease.

With the support of Canadians across the country, the Society works to eradicate cancer and improve the lives of those living with this disease. Our donors allow us to support world-class cancer research, provide support programs and cancer information services and advocate for healthy public policies.

Our donors are making a difference.

Thanks to our donors’ support, we remain the largest national charitable funder of cancer research in the country. Supported by donations invested through the Canadian Cancer Society Research Institute (CCSRI), our researchers are poised to make lasting impacts on cancer care in Canada and beyond.

We’re making progress.

In this year’s CCSRI Research Impact Report, we celebrate the diverse impacts of our research and how it has influenced the scientific community, program delivery, government policy and clinical practice. Last year, our researchers’ accomplishments ranged from the expansion of legislation to ban flavoured tobacco, to challenging our view of how blood cells develop, to defining benchmarks for quality in end-of-life care. You can learn more about these and many other advances in the “research outcomes and impacts” section of this report. These discoveries will help us prevent cancer, raise survival rates and enhance the quality of life throughout the cancer journey.

There is still much more to do.

In 2015 we awarded 135 new research grants and awards, committing to provide $38.3 million to researchers over the next 5 years.

We are proud to ensure that donor dollars fund the best research across the country. We thank the scientists and community representatives who offer their service in our expert review process, which is widely recognized as a gold standard.

We also thank our generous donors for their continued support. Research funding partnerships with organizations like Brain Canada, the Canadian Institutes of Health Research, the Canadian Breast Cancer Foundation, the Lotte & John Hecht Memorial Foundation, the National Pancreatic Cancer Canada Foundation and Craig’s Cause Pancreatic Cancer Society, among others, make achieving our mission possible. Joining forces in the fight against cancer allows us to achieve the most impact, against the most cancers, in the most communities in Canada.

Reflecting on the considerable progress we have made this year, we eagerly anticipate the advances to come. We hope that you enjoy this report and that it will serve as a valuable resource to showcase the impact of the excellent research we are so proud to support.

Dr Siân Bevan
Vice-President, Research
Canadian Cancer Society

Dr Calvin Roskelley
Scientific Chair
Advisory Council on Research

We wish to acknowledge the contributions of our former Chief Mission Officer and Scientific Director, Dr Christine Williams. For over a decade she played a key role in laying the foundation for continued success of the former National Cancer Institute of Canada and the Society. Her leadership and commitment were critical to ensuring the Society’s position as a leader in cancer research and engagement with the research community.
Executive Summary

The mission of the Canadian Cancer Society is to eradicate cancer and enhance the quality of life of people living with and beyond cancer. CCSRI is the Society’s research arm, which supports the mission by funding research aimed at reducing cancer incidence, reducing cancer mortality and enhancing the quality of life for those living with and beyond cancer. The Society is the largest national charitable funder of cancer research in Canada. Since 1947, our donors have supported thousands of Canadian researchers with more than $1.3 billion in cancer research funding. Through research grants, awards and 3 major research centres, CCSRI supports work across the research spectrum.

This report provides an overview of CCSRI’s investments in 2015 and highlights the impact of the research funded. We provide an analysis of CCSRI’s investment portfolio, give a summary of selected research outcomes, tell 80 stories about the impact that our researchers are making across the country, and explain CCSRI’s expert review and evaluation processes.

Thanks to our donors, CCSRI made significant investments in cancer research in 2015

- $38.1M in cancer research across the country
- $28.3M in basic, biomedical and translational research
- $6.3M in prevention research
- $3.5M in quality of life research
- $24M in research relating to specific cancer types
- $14.1M applicable to multiple or all cancer types
- Supported 297 principal investigators, 557 co-applicants
- 306 grants and 51 career awards in 10 provinces across 39 research institutions
- 100 new grants & 35 new career awards

CCSRI researchers made significant progress in the fight against cancer in 2015

- 22 impacts on healthcare and program delivery
- 4 impacts on policy
- 1 patent licensed
- 1 industry investment
- 1,073 publications, 1,932 presentations, 1,987 collaborations

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1 This report covers the Society’s fiscal year February 1, 2015 to January 31, 2016.
2 Investigators may be assigned to more than one research project and may have more than one designation. Principal investigators who were also co-applicants were counted only once as principal investigators.
Research funded by our generous donors is making a difference. These stories highlight some of our highest impact research of the year. They demonstrate the breadth of our research across the cancer spectrum and its reach all across Canada. We thank our donors for making these important discoveries possible.

**An ultrasensitive blood test for cancer**

Dr Shana Kelley at the University of Toronto developed an extremely sensitive blood test that uses sensors on a chip to detect cancer mutations. This new, non-invasive test is fast and simple to perform. It is now being developed as an alternative to tissue biopsies to detect cancer, monitor how patients respond to therapy and personalize treatment decisions.


**A new standard for managing cancer pain**

Pain from advanced cancer that has spread to the bone can be treated with radiation therapy. However, the pain can temporarily get worse before getting better. Dr Edward Chow of the Sunnybrook Research Institute in Toronto and the Canadian Cancer Trials Group based at Queen’s University in Kingston led a clinical trial showing that the steroid dexamethasone could prevent pain flare-ups from radiation therapy. They concluded that this treatment should be part of standard care for bone metastases, which could change how advanced cancer is managed worldwide.

Reference: Lancet Oncology, November 2015

**Progress in leukemias**

Dr Guy Sauvageau at the Institute for Research in Immunology and Cancer, Université de Montréal, led a study of 2 forms of acute myeloid leukemia (AML) and identified for the first time a pattern of gene activity shared by these 2 subsets. This new information should advance how AML is diagnosed and how treatments can be tailored to improve survival.

Reference: Nature Genetics, September 2015

**E-cigarettes in Canada**

By studying over 14,500 Canadians, Dr David Hammond at the University of Waterloo found that e-cigarette use was highest among tobacco smokers and young people. About half of youth who had tried e-cigarettes had never smoked tobacco, underlining the urgency of fully understanding the health effects of e-cigarettes as they rise in popularity.

Reference: Preventive Medicine, December 2015

**Pancreatic tumours in a dish**

Dr Senthil Muthuswamy at the Princess Margaret Cancer Centre, University Health Network in Toronto, developed 3-D “mini-tumours” called organoids from human pancreatic cancer cells. These organoids closely mimicked how pancreatic tumours grow in people and are being used to test new drug treatments for pancreatic cancer, which has one of the lowest survival rates of any cancer.

Reference: Nature Medicine, November 2015
Genetic risk of aggressive stomach cancer

An aggressive form of stomach cancer is more common in Newfoundland families. By studying nearly 4,000 people from 75 families, Dr David Huntsman at the BC Cancer Agency in Vancouver determined that those with mutations in the CDH1 gene have a high chance of developing this stomach cancer – a 70% chance for men and a 56% chance for women. If people in this high-risk group are closely monitored, stomach cancers may be detected earlier and treated more effectively.

Reference: JAMA Oncology, April 2015

Tricking cancer stem cells to stop growing

Dr Daniel De Carvalho at the Princess Margaret Cancer Centre, University Health Network in Toronto, found something surprising and promising about an anticancer drug that targets colorectal cancer stem cells. The drug tricks the cancer stem cells into responding as if they had been infected with a virus, which limits the cancer cells' ability to multiply – an approach that may complement new immunotherapies.

Reference: Cell, August 2015

A new understanding of blood cells

By developing new ways to study single cells, Dr John Dick at the Princess Margaret Cancer Centre, University Health Network in Toronto, showed that specialized blood cells develop much more quickly from stem cells than previously thought, changing the “textbook” view of how blood cells are made. This paradigm shift could open up new opportunities for understanding blood cancers and how to treat them.

Reference: Science, January 2016

Canadian benchmarks for quality of end-of-life care in cancer

Dr Lisa Barbera of the Sunnybrook Research Institute and Canadian Centre for Applied Research in Cancer Control in Toronto found considerable variation in healthcare services provided to patients at the end of their lives across 4 provinces: British Columbia, Alberta, Ontario and Nova Scotia. She established benchmarks and quality indicators that will help regions evaluate their services and support resource allocation to improve healthcare delivery.


A new treatment strategy for prostate cancer

Dr Robert Day at the Université de Sherbrooke provided the first proof of concept that blocking a protein called PACE4 stops prostate cancer growth in mice. Anti-PACE4 therapy triggered prostate cancer cells to die and shrank tumours by 60%. A new collaboration is now advancing clinical testing and commercialization.

Reference: Oncotarget, February 2015
Research Investment in 2015

Dr Sheila Singh (right) and team members Dr Parvez Vora (centre) and Maleeha Qazi (left). McMaster University
Investment by funding program

Thanks to our donors, CCSRI supports the best cancer research in Canada through open grant competitions and strategic research centres. Our grants and awards support researchers across the country who are studying how to reduce the number of cancers diagnosed, improve survival rates and enhance the quality of life of people affected by cancer. Our support of research centres establishes collaborative networks spanning the cancer research spectrum.

Grants and awards

<table>
<thead>
<tr>
<th>Grants and awards</th>
<th>Funding Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention Research Grants</td>
<td>to accelerate risk reduction research – up to <strong>$600K</strong> over 4 years</td>
</tr>
<tr>
<td>Canadian Cancer Society-Partner Prevention Research Grants</td>
<td>to reduce cancer incidence by promoting collaboration – up to <strong>$800K</strong> over 4 years</td>
</tr>
<tr>
<td>Career Development Awards in Prevention</td>
<td>for post-doctoral and clinical fellows and junior faculty to provide salary and research support – up to <strong>$225K</strong> over 3 years</td>
</tr>
<tr>
<td>Innovation Grants</td>
<td>to support high-risk/high-reward creative solutions in cancer research and feed the scientific idea pipeline – up to <strong>$200K</strong> over 2-3 years</td>
</tr>
<tr>
<td>Innovation to Impact (i2I) Grants</td>
<td>to support the development of successful findings from Innovation Grants – up to <strong>$450K</strong> over 3 years</td>
</tr>
<tr>
<td>Impact Grants</td>
<td>to support well-developed cancer research programs to significantly advance the scientific understanding of cancer – up to <strong>$1.25M</strong> over 5 years</td>
</tr>
<tr>
<td>Quality of Life Research Grants</td>
<td>to support research aimed at reducing the burden of disease for patients, survivors and their families – up to <strong>$300K</strong> over 2-3 years</td>
</tr>
<tr>
<td>Knowledge to Action Grants</td>
<td>to close the gap between research evidence and practice, to improve outcomes across the cancer trajectory – up to <strong>$100K</strong> over 2 years</td>
</tr>
<tr>
<td>Travel Awards</td>
<td>for trainees attending conferences – up to <strong>$2K</strong></td>
</tr>
</tbody>
</table>

Research centres

| Canadian Centre for Applied Research in Cancer Control (ARCC)                     | is a pan-Canadian research network whose mission is to improve cancer control and the delivery of care through interdisciplinary leadership in health economics, services, policy and ethics research, education and knowledge translation. |
| Canadian Cancer Trials Group (CCTG) – formerly the NCIC Clinical Trials Group (NCIC CTG) | is a cooperative oncology group involving more than 80 member institutions across Canada. It carries out national and international multicentre trials in cancer prevention, therapy and supportive care. |
| Propel Centre for Population Health Impact                                       | is a pan-Canadian, collaborative enterprise that conducts research, evaluation and knowledge exchange to accelerate improvements in the health of populations to help prevent cancer and other chronic diseases, particularly in the areas of tobacco control and youth health. |

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3 Grant programs as of December 2015. For full program details, visit cancer.ca/research.
In 2015 our donors’ investments were spread across several unique funding programs. This year marks the completion of our transition to our new program offerings following the redesign of our research programs in 2011. Innovation Grants accounted for the largest proportion of CCSRI’s portfolio ($15.45 million) followed by research centres ($8.21 million) and Impact Grants ($7.54 million).
Investment by research area

Through CCSRI, our donors support research that spans the cancer trajectory from prevention, to diagnosis and treatment, to end-of-life care. In 2015 we invested $38.1 million in research:

- $28.3 million (74%) in basic, biomedical and translational research
- $6.3 million (17%) in prevention and risk reduction research
- $3.5 million (9%) in quality of life research
Investment by cancer type

CCSRI supports research across all cancer types. In 2015, 63% of CCSRI’s portfolio targeted specific types of cancer. The other 37% was invested in research that has implications for multiple or all cancer types.

### Research targeting specific cancers: $24M

- **Head and neck**: $0.6M
- **Lung**: $3.7M
- **Liver**: $0.4M
- **Colorectal**: $1.6M
- **Prostate**: $1.9M
- **Bone**: $0.6M
- **Leukemia, lymphoma, and multiple myeloma**: $4.5M

### Other cancer types: $0.5M

### Research applicable to multiple/all cancers: $14.1M

$ = $38.1M
The CCSRI research portfolio covers a diverse range of cancers, including those that impose a high burden on Canadians and those that are particularly challenging to treat. Below, our 2015 investment in specific cancer types is displayed by percentage and compared to the percentage of estimated new cancer cases and deaths in 2015.4

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Thanks to our donors, the Canadian Cancer Society is the largest national charitable funder of cancer research in Canada. Through CCSRI, we invest more than any other national charity in 16 specific cancer types including pancreas, lung and colorectal cancers.\(^5\)

\(^5\) Based on the most recent Canadian Cancer Research Alliance’s survey of government and voluntary sector investment in cancer research in 2013 published in November 2015.
Investment by region

The Society is proud to support excellent cancer research across Canada. Our researchers exemplify how research crosses geographical borders through their national and international collaborations and far-reaching impacts on fundamental knowledge, policy, practice and programs. In 2015 CCSRI supported 297 lead scientists at 39 of the top research institutions across Canada. Their work is making a difference both at home and abroad.
# Investment by institution

CCSRI supports researchers at Canada’s top universities, hospitals and research centres. In 2015 CCSRI supported 357 grants and career awards across 10 provinces and 39 research institutions.6

<table>
<thead>
<tr>
<th>Province</th>
<th>Research Institution</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>Alberta Health Services – CancerControl Alberta</td>
<td>$223K</td>
</tr>
<tr>
<td></td>
<td>University of Alberta</td>
<td>$408K</td>
</tr>
<tr>
<td></td>
<td>University of Calgary</td>
<td>$150K</td>
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<tr>
<td></td>
<td><strong>Alberta Total</strong></td>
<td><strong>$788K</strong></td>
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<tr>
<td>British Columbia</td>
<td>BC Cancer Agency</td>
<td>$3.6M</td>
</tr>
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<td></td>
<td>University of British Columbia</td>
<td>$2.4M</td>
</tr>
<tr>
<td></td>
<td>University of Victoria</td>
<td>$250K</td>
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<td></td>
<td><strong>British Columbia Total</strong></td>
<td><strong>$6.2M</strong></td>
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<tr>
<td>Manitoba</td>
<td>University of Manitoba</td>
<td>$489K</td>
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<tr>
<td></td>
<td><strong>Manitoba Total</strong></td>
<td><strong>$489K</strong></td>
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<tr>
<td>New Brunswick</td>
<td>University of Moncton</td>
<td>$49K</td>
</tr>
<tr>
<td></td>
<td><strong>New Brunswick Total</strong></td>
<td><strong>$49K</strong></td>
</tr>
<tr>
<td>Newfoundland and Labrador</td>
<td>Memorial University of Newfoundland</td>
<td>$136K</td>
</tr>
<tr>
<td></td>
<td><strong>Newfoundland and Labrador Total</strong></td>
<td><strong>$136K</strong></td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>Dalhousie University</td>
<td>$155K</td>
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<tr>
<td></td>
<td>IWK-Grace Health Centre</td>
<td>$24K</td>
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<td></td>
<td><strong>Nova Scotia Total</strong></td>
<td><strong>$179K</strong></td>
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<tr>
<td>Ontario</td>
<td>Cancer Care Ontario</td>
<td>$917K</td>
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<tr>
<td></td>
<td>Centre for Addiction and Mental Health</td>
<td>$350K</td>
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<tr>
<td></td>
<td>Children’s Hospital of Eastern Ontario</td>
<td>$124K</td>
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<tr>
<td></td>
<td>Lawson Research Institute (London)</td>
<td>$84K</td>
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<tr>
<td></td>
<td>McMaster University</td>
<td>$1M</td>
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<tr>
<td></td>
<td>Mount Sinai Hospital</td>
<td>$900K</td>
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<tr>
<td></td>
<td>Ontario Institute for Cancer Research</td>
<td>$1118K</td>
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<tr>
<td></td>
<td>Ottawa Hospital Research Institute</td>
<td>$822K</td>
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<tr>
<td></td>
<td>Queen’s University</td>
<td>$1.7M</td>
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<tr>
<td></td>
<td>St. Michael’s Hospital</td>
<td>$100K</td>
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<tr>
<td></td>
<td>Sunnybrook Research Institute</td>
<td>$866K</td>
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<tr>
<td></td>
<td>The Hospital for Sick Children</td>
<td>$1.6M</td>
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<tr>
<td></td>
<td>University Health Network (Princess Margaret Cancer Centre, Toronto General Hospital,</td>
<td>$4.3M</td>
</tr>
<tr>
<td></td>
<td>Toronto Western Hospital)</td>
<td></td>
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<tr>
<td></td>
<td>University of Guelph</td>
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<tr>
<td></td>
<td>University of Ottawa</td>
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<td></td>
<td>University of Toronto</td>
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<td></td>
<td>University of Windsor</td>
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<td></td>
<td>Western University</td>
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<td></td>
<td>Women’s College Hospital</td>
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<td></td>
<td>York University</td>
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<tr>
<td>Prince Edward Island</td>
<td>University of Prince Edward Island</td>
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<td></td>
<td><strong>Prince Edward Island Total</strong></td>
<td><strong>$138K</strong></td>
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<tr>
<td>Quebec</td>
<td>Institut national de la recherche scientifique</td>
<td>$74K</td>
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<tr>
<td></td>
<td>McGill University and its affiliate institutions</td>
<td>$3.2M</td>
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<tr>
<td></td>
<td>Université Laval and its affiliate institutions</td>
<td>$638K</td>
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<tr>
<td></td>
<td>Université de Montréal and its affiliate institutions</td>
<td>$2.9M</td>
</tr>
<tr>
<td></td>
<td>Université de Sherbrooke</td>
<td>$335K</td>
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<td></td>
<td><strong>Quebec Total</strong></td>
<td><strong>$7.3M</strong></td>
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<tr>
<td>Saskatchewan</td>
<td>University of Saskatchewan</td>
<td>$86K</td>
</tr>
<tr>
<td></td>
<td><strong>Saskatchewan Total</strong></td>
<td><strong>$86K</strong></td>
</tr>
</tbody>
</table>

6 Excludes non-geographic specific research community support.
Clinical trials

In 2015 our donors provided $5.38 million to support the Canadian Cancer Trials Group (CCTG), which is the only Canadian cancer trials group that conducts the entire range of clinical trials across all cancer types. These trials involve coordinated efforts across Canada and beyond to test new ways to prevent cancer, improve survival and enhance quality of life of those living with cancer worldwide.

In 2015 CCTG led or was involved in 105 active trials relating to more than 20 different cancer types (shown below).

16,429 Canadian patients and 12,789 patients outside of Canada have participated in these trials since they began.

Trials took place in 92 centres in communities all across Canada (shown below).

944 Canadians were newly enrolled in trials in 2015 (shown below).

Trials involved 24 institutions outside of Canada.

7 A trial can be active in multiple provinces. In addition, an active trial can be closed to patient accrual.
Strength through partnerships

The Canadian Cancer Society collaborates with health research organizations across Canada to set strategies that shape cancer research and have even more impact with every donor dollar.

Canadian Cancer Research Alliance

As a founding member of the Canadian Cancer Research Alliance (CCRA), we are part of an alliance that collectively funds 60-80% of the cancer research in Canada. In 2015 we released Target 2020: A Strategy for Collaborative Action, 2015–2020, to guide cancer research in Canada for the next five years. We are leading and participating in goals to:

• reduce cancer incidence
• support foundational discovery research
• transform clinical care with innovation
• improve patient experience
• improve health services and the adoption of research

We co-chaired the 3rd Canadian Cancer Research Conference – the largest scientific cancer meeting in the country – attracting almost 1,000 participants in 2015. With support from the Cancer Research Society, the Canadian Cancer Society co-hosted the Careers in Cancer Research Development program with the Canadian Institutes of Health Research – Institute of Cancer Research to support early career scientists.

Collaborative investment

Funding partnerships extend the impact of donors to the Canadian Cancer Society and promote coordinated action against cancer.

• A new partnership with Brain Canada and the Brain Tumour Foundation of Canada is supporting 4 new Impact Grants, representing a joint investment of $5M, to bring new approaches to brain cancer. The research community and donors responded quickly to this initiative, which extends into 2016.

Brain Canada is proud to partner with the Canadian Cancer Society to create a bridge between cancer and neuroscience research by supporting these outstanding brain cancer research projects.

Inez Jabalpurwala, President and CEO, Brain Canada Foundation

• A new partnership with the Princess Margaret Cancer Centre is supporting 1 new Impact Grant to understand the RAS protein – mutated in about 30% of cancers – representing a joint investment of $1.25M.
• Extending a partnership that has supported 15 grants since 2013, the Lotte & John Hecht Memorial Foundation invested in 4 new Innovation and Impact Grants with the Society in 2015, representing new investments of $1.2M.

The Society’s Innovation Grants are accelerating positive change in cancer treatment. With its determination to look outside the box, from oncolytic viruses and immunotherapy to the simplicity of aspirin as a potential prevention tool for ovarian cancer, the fundamentals for significant improvements in cancer care are being established.

Angela Webster, Executive Director, Lotte & John Hecht Memorial Foundation

• We extended a partnership with the Canadian Institutes of Health Research – Institute of Cancer Research to support 1 new Prevention Research Grant in 2015, representing a joint investment of $600K.

CIHR-ICR is dedicated to supporting research that reduces the burden of cancer on individuals and families - by partnering with CCSRI we are able to increase our impact by investing together. Collectively we are able to have a tremendous impact on the burden of cancer on Canadians.

Dr Stephen Robbins, Scientific Director,
Canadian Institutes of Health Research – Institute of Cancer Research

• We partnered with the National Pancreatic Cancer Foundation of Canada, Craig’s Cause Pancreatic Cancer Society and the QEII Foundation to support 1 new Innovation to Impact Grant testing an oncolytic virus to stop cancer spread, representing a joint investment of $450K.

• We continue to partner with the Canadian Breast Cancer Foundation to support 2 young scientists focused on breast cancer prevention, with Prostate Cancer Canada to support 1 Innovation Grant seeking a better biomarker for prostate cancer, and the New Brunswick Health Research Foundation, Craig’s Cause Pancreatic Cancer Society, and the QEII Foundation to support 1 Innovation Grant on the early detection of pancreatic cancer.
Our visionary donors

Named research grants, programs and funds
The Canadian Cancer Society Research Institute and its research programs are funded through donations to the Canadian Cancer Society. We would like to express our gratitude to all the visionary donors who contributed to our research impact in 2015.

Research grants and awards
Gifts from the following donors enabled the funding of an award or an entire research project. Their vision and generosity have been recognized with the naming of a grant or award. Thank you for making a difference in the lives of Canadians.
The Bernard and Francine Dorval Prize Award for Excellence
The Brain Tumour Foundation of Canada Impact Grant of the Canadian Cancer Society and Brain Canada in support of Dr Michael Taylor, brain cancer, 2015-2020
The Brooke’s Donkeys Innovation Grant of the Canadian Cancer Society in support of Dr Kevin Petrecca, brain cancer, 2014-2016
GIVETOLIVE Research Scientist Award in Prevention Research in support of Dr Ryan Rhodes, exercise and prevention, 2011-2016
The Glentel Innovation Grant of the Canadian Cancer Society in support of Dr Maja Krajnovic, childhood leukemia, 2013-2015
The Mrs Grace Limbert Innovation Grant of the Canadian Cancer Society in support of Dr David Spaner, leukemia and immunotherapy, 2013-2015
The Great Canadian Innovation Grant in support of Dr Angela Brooks-Wilson, cancer genetics, 2015-2017
The John Murphy Innovation Grant of the Canadian Cancer Society in support of Dr Jennifer Stinson, adolescent cancer care, 2015-2017
Lotte & John Hecht Memorial Foundation Innovation, Innovation to Impact, and Impact Grants of the Canadian Cancer Society in support of innovative cancer research, 2013-2018
Louisa Gale Scholars in support of several cancer researchers, 2013-2016
The Marilyn Hopper Innovation Grant of the Canadian Cancer Society in support of Dr Jayne Danska, leukemia, 2013-2015
The Marjorie Sheridan Innovation Grant of the Canadian Cancer Society in support of Dr Antonis Koromilas, colon cancer and oncolytic virus therapy, 2013-2015
Mary Burleigh Stewart Cancer Research Scholarship
The Minor Hockey Fights Cancer/Mannam Family Innovation Grant of the Canadian Cancer Society in support of Dr Greg Stanisz, cancer imaging, 2013-2016
The Nick Natale Innovation Grant of the Canadian Cancer Society in support of Dr Stephen Girardin, colorectal cancer, 2014-2016
The Pedal for Hope Impact Grant of the Canadian Cancer Society in support of Dr Lillian Sung, childhood cancer, 2014-2019
The Prairie Women on Snowmobiles Innovation Grant of the Canadian Cancer Society in support of Dr Rama Khokha, breast cancer, 2014-2016
A Quality of Life Grant of the Canadian Cancer Society in memory of Edna Goebel in support of Dr Roanne Thomas, breast cancer survivorship, 2013-2015
A Quality of Life Grant of the Canadian Cancer Society in memory of Frank Tyrrell in support of Dr Robert Klaassen, leukemia, treatment management, 2013-2015
A Quality of Life Grant of the Canadian Cancer Society in memory of James Tyrrell in support of Dr Kim Edelstein, young adult cancer survivorship, 2013-2017
The Rachelle Archambault Innovation Grant of the Canadian Cancer Society in support of Dr Ming-Sound Tsao, lung cancer, 2013-2015
Ride2Survive Brain Cancer Impact Grant of the Canadian Cancer Society and Brain Canada in support of Dr Poul Sorensen, brain cancer, 2015-2020
The W. Gary Rowe Innovation Grants of the Canadian Cancer Society in support of Dr Mani Larijani, leukemia and lymphoma, 2013-2016 and Dr Ken Hirasawa, novel cancer therapy, 2014-2017
The WICC Ontario (Ottawa Region) Innovation Grant of the Canadian Cancer Society in support of Dr Andrew Makrigiannis, breast cancer and immunotherapy, 2014-2016
Funds
Thank you to the following donors for their commitment to funding excellence in cancer research.

- Bill Barley Innovation Fund in support of non-Hodgkin lymphoma research
- Birdsell Family and Friends Brain Cancer Research Fund
- Cardone Family Cancer Fund in support of brain cancer research
- Circles of Friends Pancreatic Cancer Research Fund
- Cleans for Cleavage Breast Cancer Research Fund
- Comda Conquering Cancer Fund in support of cancer research
- Craig’s Cause Pancreatic Cancer Research Fund
- The Diller Project Catalyst Fund in support of brain cancer research
- Ed Kozystko and Frances Kozystko Fund for Cancer Research
- Face Off Against Cancer Fund in support of cancer genomics research
- Fonds Catalyst de la Caisse Desjardins de Nicolet pour la recherche sur les sarcomes in support of sarcoma cancer research
- Fonds Sylvain Poissant pour le cancer du peau in support of skin cancer research
- Fung and Duen Au-Yeung Foundation Fund in support of cancer prevention research
- Ginty Jocius Brain Cancer Research Fund
- Haladner Memorial Foundation Research Fund in Memory of Gertrude Green in support of ovarian, breast and prostate cancer research
- Helen Mary Storey Ovarian Cancer Research Fund
- The Hodgson Family Ovarian Cancer Research Fund
- Jack Dell’Accio Fund in honour of Vito Dell’Accio for research into hard-to-treat cancers, prevention awareness and survivorship
- Junk Rangers Fund for Cancer Research in support of liver cancer research
- The Kate Linder and Friends Fund for Women’s Cancer Research in support of breast and ovarian cancer research
- Love for Lizzie Fund in support of childhood cancer research
- The Lusomé Cancer Research Fund in support of breast cancer research
- The Marion Dorothy Pauderis Innovation Fund in support of Innovation Grants
- Michael Albert Garron Foundation Synovial Sarcoma Research Fund in support of musculoskeletal cancer research
- Norris Family Pediatric Brain Cancer Research Fund
- Peter Nikkel Fund in support of prostate cancer research
- The Prairie Women on Snowmobiles Breast Cancer Research Impact Fund
- Red Lipstick Warriors Catalyst Fund in support of colon cancer research
- Sarcoma Steps Fund in support of sarcoma research
- TELUS Catalyst Fund in support of brain cancer research
- Tets Haya Memorial Fund in support of colon cancer research
- Walk the Talk Lymphoma Research Catalyst Fund
- WICC Alberta Brain Cancer Research Fund
- WICC BC Fund in support of cancer prevention research

Brain Canada Gift-Matching Initiative
Thank you to Brain Canada, and to the following donors whose investments in this partnership enabled the full funding of 3 Impact Grants in brain cancer research. Together, we are advancing research with the greatest potential to unravel this complex disease.

- Brain Tumour Foundation of Canada
- Ride2Survive
- Winnipeg Police Services Half Marathon
Why Do You Support Canadian Cancer Society Research?

What donors say

“Pancreatic cancer has one of the lowest survival rates of any cancer. Our partnership with the QEII Foundation and the Canadian Cancer Society’s Nova Scotia Division has made a significant impact to pancreatic cancer funding across Canada. We hope these research projects will provide hope to those diagnosed with pancreatic cancer, in terms of screening, early diagnosis, treatment and care.”

Stefanie Condon-Oldreive, Founder, Craig’s Cause Pancreatic Cancer Society

“I support cancer research because I have lost too many family members and friends to cancer and this is my way of fighting back. I have seen first-hand how efficiently the research dollars are distributed. CCSRI is committed to minimizing dollars spent on overhead and maximizing the dollars going to support the work of cancer researchers.”

Dr Hanne Ostergaard, Edmonton, Alberta

“Partnering with the Canadian Cancer Society and Brain Canada means more dollars are going toward brain cancer research – one of the most devastating types of cancer, especially for young children. Coming together with our collective resources and mutual drive for innovation will make a significant impact. This is exactly what patients and families tell us we need to do. And our generous donors are right behind us all in this effort!”

Susan Marshall, CEO, Brain Tumour Foundation of Canada

“I donate to brain cancer research in the hope a more successful treatment can be developed than the treatment my late husband received – the chemo and radiation were not working, and there seemed to be no other options. I donated to the Canadian Cancer Society because I trust their expertise and judgment when it comes to cancer research.”

Lois Weick, Regina, Saskatchewan
What researchers say

“I have been immensely impressed by the quality of the Society’s expert review process. I am both grateful and honoured to have been funded by the Society, which has been a key determinant of my early and ongoing success.”

Dr Christine Friedenreich, Alberta Health Services – CancerControl Alberta

“The Canadian Cancer Society has been pivotal in supporting cancer research in my group. Interacting with Society staff, volunteers and scientists has been an enduring source of motivation and inspiration.”

Dr Claude Perreault, Institute for Research in Immunology and Cancer

“I have been very impressed by how fairly grants get reviewed by CCSRI. CCSRI is clearly looking for the best ideas to make a real impact, and I have become a donor to the Canadian Cancer Society after seeing the care that is taken.”

Grant panel reviewer
Research Outcomes and Impacts in 2015
Tracking research progress

This section of the report provides a summary of selected research outcomes and impacts drawn from 463 progress reports submitted in 2015. Outcomes and impacts are summarized and mapped according to the results chain framework.\(^8\)

Scientific and financial progress reports are submitted by principal investigators of all research grants and awards at multiple stages during the term of funding. CCSRI requires annual scientific and financial reports and post-grant reports (submitted 2 years after completion of a grant). Progress reports allow CCSRI to monitor grants and awards by collecting a variety of quantitative and qualitative information regarding research findings, outcomes and impacts.\(^9\)

CCSRI carefully tracks and monitors the progress, outcomes and impacts of every research program. CCSRI has adapted the results chain framework to demonstrate the many ways in which research activities impact the Society’s mission. It provides CCSRI with a systematic and consistent way of monitoring and evaluating research over time and along the research spectrum. The results chain hierarchy provides a simplified description of a program and is organized according to 7 levels of results. It shows the logical relationships between the resources that are invested, the activities that take place and the sequence of changes that result. The ultimate goals of CCSRI’s research programs are often ambitious and long term. As such, it is imperative to develop strong program descriptions providing details not only on the intended long-term outcomes but also the short-term and intermediate outcomes and the sequence in which they are likely to take place.

In adapting the framework, CCSRI classifies research performance measures according to the 7 levels of results.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Why do we fund research?</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>End results</td>
<td>Reduction of cancer incidence rates, cancer mortality rates, or enhancement in the quality of life of Canadians living with and beyond cancer</td>
</tr>
<tr>
<td>6</td>
<td>Practice and behaviour change</td>
<td>Research used by other researchers, healthcare practitioners and program experts, policy-makers and advocates, in training of new researchers, trainees launching careers in cancer research and commercialization</td>
</tr>
<tr>
<td>5</td>
<td>Knowledge, attitude and skill changes</td>
<td>Development of new knowledge or methods in cancer research, publications of research findings, presentations, consultations and briefings</td>
</tr>
<tr>
<td>4</td>
<td>Reactions</td>
<td>Media coverage, media requests, honours or awards, leadership roles and dissemination requests</td>
</tr>
<tr>
<td>3</td>
<td>Engagement</td>
<td>Collaborations and multidisciplinary research activities</td>
</tr>
<tr>
<td>2</td>
<td>Activities</td>
<td>Research and other related activities such as training and teaching</td>
</tr>
<tr>
<td>1</td>
<td>Inputs</td>
<td>Project budgets, leveraged funds, fellows, students and other personnel</td>
</tr>
</tbody>
</table>


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\(^8\) This framework was introduced and adapted for the Society by Steve Montague (PMN).

\(^9\) Progress reports collect short-term outcomes and impacts on an annual basis. Long-term impacts related to level 7 of the results chain framework are generally uncovered through in-depth evaluation studies and are beyond the scope of this report.
# Outcomes and impacts

**WHAT** difference is our research making?

<table>
<thead>
<tr>
<th>#</th>
<th>Impacts on healthcare and program delivery</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Research findings cited in clinical and service guidelines, in health professional education material, used in program development, etc.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#</th>
<th>Impacts on policy</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Research findings cited in public policy documents, advocacy publications, etc.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#</th>
<th>Impacts on work of other researchers</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>53</td>
<td>Research findings cited in relevant scientific literature, scientific methods used by other researchers, etc.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#</th>
<th>Impacts on training of new researchers</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Research findings cited in text books, reading lists, etc.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#</th>
<th>Impacts on commercialization</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1 patent licensed, 1 industry investment</td>
<td></td>
</tr>
</tbody>
</table>
**WHO** is influenced by the knowledge generated and how?

Researchers, healthcare practitioners, policy-makers, public and other stakeholders

<table>
<thead>
<tr>
<th>Publications</th>
<th>Press releases</th>
<th>Advisory committee memberships, leadership roles, etc.</th>
<th>Collaborations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,073</td>
<td>160</td>
<td></td>
<td>1,724</td>
</tr>
<tr>
<td>904 peer-reviewed publications</td>
<td></td>
<td></td>
<td>1,117 with researchers</td>
</tr>
<tr>
<td>169 non-peer-reviewed publications</td>
<td></td>
<td></td>
<td>188 with policy-makers</td>
</tr>
<tr>
<td>1,932</td>
<td></td>
<td></td>
<td>467 with healthcare practitioners</td>
</tr>
<tr>
<td>297</td>
<td></td>
<td></td>
<td>215 with other stakeholders</td>
</tr>
<tr>
<td>1,987</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>215</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>868</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HOW** is research supported?

<table>
<thead>
<tr>
<th>Investments</th>
<th>Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>357</td>
<td>1,913</td>
</tr>
<tr>
<td>306 grants</td>
<td>297 principal investigators</td>
</tr>
<tr>
<td>51 career development awards</td>
<td>557 co-applicants</td>
</tr>
<tr>
<td>1,913</td>
<td>198 fellows</td>
</tr>
<tr>
<td></td>
<td>437 students</td>
</tr>
<tr>
<td></td>
<td>424 other highly qualified personnel</td>
</tr>
</tbody>
</table>
Every year, about 900 children under the age of 15 are diagnosed with cancer in Canada. In 2015 Canadian Cancer Society donors invested $4.5 million in childhood cancer research. As the largest national charitable funder of childhood cancer research in Canada, we are proud to be leading the fight. Society-supported researchers are actively searching for new ways to detect, diagnose and treat childhood cancers, as well as reduce long-term side effects faced by many as a result of their treatments.
Thanks to our donors, we support more childhood cancer research than any other Canadian charity

$47 million in the last 15 years

71% 1980s

83% today

Our donors’ investment in research is saving and improving the lives of children

Cancer can be detected earlier

Researchers discovered vinblastine, a drug that is instrumental in treating certain types of childhood lymphoma and brain cancer.

Our research discovered that retinoblastoma, a cancer of the eye, arises in children when the RB1 gene is mutated. Doctors can now test for RB1 to diagnose and treat cancer earlier.

Better treatments are available

Our research discovered stem cells. This work was critical for the development of bone marrow transplants, a life-saving treatment for several cancers, including childhood leukemia.

More children are surviving cancer

Clinical trials are using these findings to design more personalized treatments to improve survival and reduce long-term side effects.

We still have more work to do

#1 cause of death by disease among Canadian children past infancy

2/3 of survivors will suffer long-term side effects from treatment

Help us support more world-class childhood cancer research. Donate at cancer.ca or call 1-888-939-3333.
Research Impact Stories

Dr. Camilla Zimmermann, University Health Network, Princess Margaret Cancer Centre
Research funded by Canadian Cancer Society donors is making a difference. These stories highlight some of the year’s high-impact research findings. They demonstrate the breadth of our research across the cancer spectrum and its reach all across Canada. We thank our donors for making these important discoveries possible.

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In the last 10 years:

- **$27M** invested
- **75** principal investigators supported
- **149** grants and career awards
- **36** institutions

Some of our research achievements include:

**1990s**
- **Dr Steven Narod** shows that women who inherit mutations in the BRCA1 gene are at increased risk for breast and ovarian cancers.

**2000s**
- **Dr Eduardo Franco** and international scientists pinpoint human papillomavirus (HPV) as the cause of cervical cancer, leading to the development of the HPV vaccine, first approved in 2006.

**2011**
- **Dr David Malkin** develops a new cancer surveillance protocol for people with a hereditary cancer syndrome called Li-Fraumeni syndrome to dramatically improve survival rates. The protocol was adopted at many cancer centres worldwide.

**2013**
- **Dr David Hammond** shows that displaying calorie counts on restaurant menus helps people make healthier food choices, which could help prevent cancer.

**2014**
- **Dr Angela Brooks-Wilson** begins work on her Great Canadian Innovation Grant to study why some “super-seniors” never get cancer.
A new breast cancer susceptibility gene

Dr Mohammad Akbari, Women’s College Hospital

Dr Mohammad Akbari led an international team who studied blood samples from over 15,000 women with familial breast cancer. Mutations in the RECQL gene were associated with increased breast cancer susceptibility, pinpointing RECQL as a new tumour suppressor. RECQL has been added to some genetic profiling tests to help assess a woman’s breast cancer risk.1

This research was supported through a partnership with the Canadian Breast Cancer Foundation.

Workplace risks for lung cancer

Dr Paul Demers, Cancer Care Ontario, Occupational Cancer Research Centre

Exposure to cancer-causing substances in the workplace may account for 20%–30% of all cancers in blue collar workers. Dr Paul Demers is part of an international team that demonstrated that bricklayers have an increased risk of lung cancer, which may be due to inhalation of quartz dust. Another study revealed that cooks, who may inhale cooking oil or combustion fumes, did not have an increased risk of lung cancer. Understanding occupational risks for cancer is important to protect workers.2,3

Informing healthy eating guidelines

Dr Caroline Diorio, Université Laval

High breast density is a known risk factor for breast cancer. Dr Caroline Diorio and her team published a study in 2014 that linked high consumption of sugar-sweetened drinks with higher breast density in premenopausal women. This research was integrated into healthy diet guidelines at the University of California, San Francisco Medical Center for Women’s Health.4

BRCA mutations in pancreatic cancer

Dr Steven Gallinger, Mount Sinai Hospital

Dr Steven Gallinger and his team are exploring the link between BRCA mutations – most commonly known for their role in breast cancers – and pancreatic cancer. By studying the DNA of over 300 people with pancreatic ductal adenocarcinoma, the most common form of pancreatic cancer, 4.6% were shown to have BRCA mutations. These mutations were more common in Ashkenazi Jewish people, identifying a high-risk group that could particularly benefit from gene testing. Identifying which patients have BRCA mutations could lead to more tailored treatments for this hard-to-treat cancer.5
Promoting physical activity in kids

Dr Jason Gilliland, Western University

Regular physical activity has been linked to a lower risk of cancer. However, the majority of Canadian children are not active enough. Dr Jason Gilliland is assessing the impact of the ACT-i-Pass program, developed with his partners, which offers Grade 5 students a free access pass to recreational services. Some schools have already integrated the program into their curriculum, and public health nurses are educating students about it. Community groups and local school boards are also promoting ACT-i-Pass to encourage active lifestyles in children.

This work was funded in partnership with the Canadian Institutes of Health Research.

Assessing the risk of aggressive stomach cancer

Dr David Huntsman, BC Cancer Agency

An aggressive form of stomach cancer is more common in Newfoundland families. By studying nearly 4,000 people from 75 families, Dr David Huntsman determined that those with mutations in the CDH1 gene have a high chance of developing this stomach cancer - a 70% chance for men and a 56% chance for women. If people in this high-risk group are closely monitored, stomach cancers may be detected earlier and treated more effectively.6

Genetic susceptibility to meat-derived carcinogens

Dr Will King, Queen’s University

Cooking meat at high temperatures can release chemicals called heterocyclic aromatic amines (HAAs) that have been linked to colorectal cancer. Dr Will King and his team found that high HAA exposure was linked to more colorectal precancers (detected by colonoscopy) in people with genetic features that made them better at metabolizing HAAs. A subgroup of people who are genetically susceptible to meat-derived carcinogens may particularly benefit from preventive dietary changes.7

Influencing ovarian cancer risk in BRCA mutation carriers

Dr Joanne Kotsopoulos, Women’s College Hospital

Inherited mutations in BRCA genes are associated with an increased risk of ovarian cancer. Dr Joanne Kotsopoulos was part of an international team that studied over 6,500 women with BRCA mutations and found that those with the fewest ovulation cycles over their lifetimes had the lowest risk of ovarian cancer. Breastfeeding for more than 12 months or using oral contraceptives also lowered risk, providing information about factors that can reduce cancer risk in these women.8
Early benefits of HPV vaccination

Dr Aisha Lofters, University of Toronto

Dr Aisha Lofters was part of a team that followed over 260,000 girls, about half of whom were eligible for Ontario’s publicly funded, school-based human papillomavirus (HPV) vaccination program in Grade 8. The vaccination program reduced the risk of abnormal cervical growths by more than 40% when the girls were in Grades 10 to 12 and suggested a similar reduction in the risk of warts. These results show early benefits of HPV vaccination programs aimed at preventing cancer.

Scanning tonsils for HPV-related cancer

Dr Miriam Rosin, BC Cancer Agency

The human papillomavirus (HPV) is associated with 25%–35% of cancers in the oral cavity and throat. However, it is difficult to see and detect early cancers without tissue biopsies. Dr Miriam Rosin and her team developed a non-invasive method to scan tonsil tissues, which could be used to study how tonsil cancer develops and improve diagnosis. Dr Rosin and her collaborator Dr Connie Eaves also showed that HPV genes could trigger abnormal tonsil cell growth. Dr Rosin’s research program provides evidence for the British Columbia Oral Cancer Prevention Program, which leads initiatives to encourage policy change and community awareness in oral cancer prevention.

Photo credit: Rosin Lab

Ivan Sun, member of Dr Miriam Rosin’s team, BC Cancer Agency

Photo credit: Rosin Lab
Advances in tobacco control

In the last 10 years:

$20M invested
18 principal investigators supported
32 grants and career awards
14 institutions

Some of our research achievements include:

2000s
Dr Jennifer O’Loughlin shows that smoking just 1 or 2 cigarettes may be all it takes for some teens to become addicted to nicotine.

2000s
Dr David Hammond and others demonstrate the effectiveness of graphic health warnings on cigarette packages, implemented in Canada in 2001.

2002
Dr Geoffrey Fong launches the International Tobacco Control Policy Evaluation Project, a large-scale, long-term international study of tobacco use.

2013
Dr Steve Manske finds that many youth tobacco users choose flavoured products, evidence that influences several provinces to ban them.

2014
Dr Michael Chaiton finds that exposure to tobacco smoke on patios makes it harder for smokers trying to quit to stay smoke-free, supporting a ban on smoking in public places in Ontario.
Exposing kids to second-hand smoke at school

Dr Sunday Azagba, University of Waterloo, Propel Centre for Population Health Impact

Second-hand smoke increases the risk of developing cancer. Dr Sunday Azagba and his collaborators at the Society-funded Propel Centre for Population Health Impact found that smoke-free school policies significantly reduced exposure. However, over half of the surveyed students had been exposed to second-hand smoke on school property in the past month. This highlights the need for further work on how smoke-free policies are implemented to maximize their success. 

New tobacco labels direct smokers to quit hotline

Dr N. Bruce Baskerville, University of Waterloo, Propel Centre for Population Health Impact

In 2012 Health Canada introduced new graphic health warning labels for cigarette packs that for the first time included a toll-free quitline number. Dr N. Bruce Baskerville and his collaborators at the Society-funded Propel Centre for Population Health Impact found that in the first 6 months after introduction of the new labels, the quitlines reached more callers, including those in vulnerable groups. Over 80% of callers had seen the quitline numbers on the labels. This research has been presented to the Ontario Ministry of Health and Long-Term Care Cessation Task Force.

Impact of graphic cigarette warning labels

Dr Kirsten Bell, University of British Columbia

Dr Kirsten Bell and her colleagues analyzed warning labels on tobacco packages from Canada, the United States, the United Kingdom and Australia. They found that smokers related to the images in different ways and that some took steps to physically hide the graphic labels. These findings provide insight into how warning labels can be tailored to be most effective.

This work was funded in partnership with the Canadian Institutes of Health Research.

Research on quitting smoking impacts healthcare training

Dr Michael Chaiton, University of Toronto

Dr Michael Chaiton’s research has focused on the influence of smoking on patios, retail availability of tobacco and the use of quit aids to understand what motivates smokers. His findings have been used to update an online tobacco training course that is used by over 1,000 healthcare professionals every year.
Impact on international tobacco policies

**Dr Geoffrey Fong**, University of Waterloo

Dr Geoffrey Fong is leading the International Tobacco Control Policy Evaluation Project, a world-first view of the impact of tobacco control efforts in Canada and 21 other countries. This project has assessed the impact of Canadian graphic warnings on cigarette labels to reduce smoking, which is now being used to inform cigarette packaging regulations by the Food and Drug Administration in the US.¹⁶

E-cigarette use in Canada

**Dr David Hammond**, University of Waterloo

By studying over 14,500 Canadians, Dr David Hammond and his team revealed that e-cigarette use was highest among tobacco smokers and young people. About half of youth who had tried e-cigarettes had never smoked tobacco, underlining the urgency of fully understanding the health effects of e-cigarettes as they rise in popularity.¹⁷

Translating research to influence flavoured tobacco policies across Canada

**Dr Steve Manske** and **Dr Leia Minaker**, University of Waterloo, Propel Centre for Population Health Impact

Along with their team at the Society-funded Propel Centre for Population Health Impact, Dr Steve Manske and Dr Leia Minaker published a key report in 2014 describing the use of flavoured tobacco products, particularly among youth. They have presented at provincial hearings and worked with the Canadian Cancer Society in efforts that resulted in 5 provinces (Nova Scotia, Alberta, Ontario, Quebec and New Brunswick) introducing legislation to restrict or ban flavoured tobacco and the federal government banning most flavoured mini-cigars.¹⁸

Hookah use in Canadian youth

**Dr Leia Minaker**, University of Waterloo, Propel Centre for Population Health Impact

Dr Leia Minaker and a group at the Society-funded Propel Centre for Population Health Impact found that 1 in 20 Canadian grade 9 to 12 students were using a hookah – a significant increase since 2010. Youth who smoked shisha tobacco often chose flavoured tobacco, and over a third believed that hookah smoking was less harmful than cigarettes. Given the negative health effects and rise in popularity, hookah use needs continued monitoring to inform public policies to protect youth.¹⁹
A quit smoking website for men

Dr John Oliffe, University of British Columbia

Many programs designed to help people quit smoking take a “one-size-fits-all” approach. Dr John Oliffe with Dr Joan Bottorff and their team studied men and found that they were specifically motivated to quit by health and fitness, financial and family factors, and responded to positive messaging and interactive tools. With this information, they developed the first quit smoking website targeted at men – QuitNowMen.ca – which was launched during National Non-Smoking Week.²⁰

Nicotine addiction in young people

Dr Jennifer O’Loughlin, Centre de recherche du CHUM – Pavillon Hôtel-Dieu (affiliated with Université de Montréal)

Through leadership of the Nicotine Dependence in Teens project, which has been studying youth smoking since 1999, Dr Jennifer O’Loughlin and her colleagues found that someone’s first smoking experience influenced addiction. Young adults who experienced feelings of relaxation, a rush or buzz, rapid heartbeat or dizziness when they first smoked were more likely to become more physically dependent. Understanding these factors can inform prevention efforts to reduce teen smoking.²¹

QuitNowMen.ca, developed by Dr John Oliffe and team, University of British Columbia
Advances in cancer biology

In the last 10 years:

- **$87M** invested
- **327** principal investigators supported
- **582** grants and career awards
- **42** institutions

Some of our research achievements include:

**1971**
Dr Peter Ottensmeyer becomes one of the first scientists to see individual atoms, leading to the development of a new electron microscope now used around the world to study cells and other structures.

**1976**
Dr Victor Ling finds that P-glycoprotein causes cancer cells to resist chemotherapy.

**1986**
Dr Anthony Pawson discovers an important protein “module” used to transmit signals within cells, pioneering a new research area leading to targeted cancer therapies.

**1990s**
Dr Gerry Johnston, Dr Richard Singer and Dr Brenda Andrews pioneer the use of yeast cells in cancer research, helping researchers understand why cells can multiply out of control.

**1992**
Dr Arnold Greenberg purifies a protein that leads to a greater understanding of how the body stimulates tumour cells to commit suicide.

**2000s**
Dr Michel Tremblay’s research on understanding a family of genes that can act as cancer initiators or cancer suppressors sparks worldwide interest in developing drugs to target these genes.

**2013**
Dr Shawn Li discovers a complex cellular pathway that could explain why chemotherapy is ineffective against some cancers, which could improve treatment strategies.
Using yeast to understand how cells repair DNA damage

Dr Grant Brown, University of Toronto

Maintaining proper DNA replication during cell division is important to prevent cancer-causing mutations from forming. Dr Grant Brown and his team studied how proteins act in response to DNA damage in yeast to predict what happens in humans. They found that a protein called Slx4 assembles near areas of stalled DNA replication and helps alert the cell that DNA has been damaged. Understanding how Slx4 works provides insight into how cancer develops, since defective Slx4 has been linked to cancer in humans.

Tracking breast cancer cells as tumours grow

Dr Connie Eaves, BC Cancer Agency

A single cancer can be a complex mix of different cells, which likely contributes to the tumour’s biology and response to treatment. Dr Connie Eaves and her team developed a technique to monitor patterns of how breast cancer cells grow in mice. The DNA of each cancer cell was tagged with a unique “barcode” so that researchers could track groups of cancer cells over time. They discovered that diverse cell populations quickly arose during breast tumour development in mice, challenging the belief that breast cancers develop slowly.

A new way to regulate a protein

Dr Julie Forman-Kay, The Hospital for Sick Children

Proteins can take on different shapes in cells depending on their function. Some proteins can shift between a flexible (or disordered) shape and one that is more stable. Dr Julie Forman-Kay and her team showed that chemical “tags” could modify the 4E-BP2 protein that helps control protein production. This modification changes the shape of the 4E-BP2 protein to turn it “off.” Since protein production can be altered in cancer, this opens up a new avenue for targeted cancer treatment.

Dual effects of the Stat1 protein

Dr Antonis Koromilas, Jewish General Hospital (affiliated with McGill University)

The Stat1 protein suppresses cancer by blocking tumour growth and triggering anticancer immune responses. However, it also increases resistance to chemotherapy. Dr Antonis Koromilas and his research team found that Stat1 controls the balance of key proteins to promote drug resistance. These findings provide information about how to design new treatments that preserve the anti-tumour activities of Stat1 but eliminate its promotion of drug resistance.

Dr Koromilas is the recipient of the Marjorie Sheridan Innovation Grant of the Canadian Cancer Society.
Revealing a 3-D protein structure

Dr Mani Larijani, Memorial University of Newfoundland

An enzyme called AID alters genes in immune cells, allowing them to create millions of slightly different proteins that can detect different infections and foreign materials. AID activity is sometimes misdirected, which can lead to blood cancers, so understanding how it is regulated is important. Dr Mani Larijani and his team used a combination of computer simulations and biochemistry to uncover the 3-D structure of AID on its own and also when it was mutating DNA. The team is using this knowledge to design drugs to block uncontrolled AID activity in cancer.27

Dr Larijani is the recipient of the W. Gary Rowe Innovation Grant of the Canadian Cancer Society.

Understanding a key step in cancer spread

Dr John Lewis, University of Alberta

Dr John Lewis and his team used a powerful imaging technique to track how cancer cells spread from inside to outside blood vessels - an important step in how cancer cells spread, or metastasize, in the body. Cancer cells created extensions through the vessel walls to help them pass through, and blocking these cell structures virtually stopped cancer spread in mice. This work identified a promising target to prevent cancer from reaching an advanced metastatic stage, which accounts for many cancer-related deaths.28

A molecular switch that gets cells moving

Dr Shawn Li, Western University

Uncontrolled cell movement is important to cancer spread (metastasis). Cells move by reorganizing structural proteins to change their shape and propel themselves forward. A protein called Rac1 stimulates the front edge of the cell to stretch forward, while the RhoA protein helps the back and sides of the cell to catch up. Dr Shawn Li and his team found that growth signals trigger a “switch” in the cell that redistributes 4 proteins that control Rac1 and RhoA. Further research will examine whether abnormalities in this switch contribute to metastasis, which could reveal a new target for cancer therapies.29

Dr Jiane Mriouah, member of Dr John Lewis’ team, University of Alberta
A link between glioblastoma in children and adults

Dr Mathieu Lupien, University Health Network, Princess Margaret Cancer Centre

Glioblastoma is an aggressive and hard-to-treat form of brain cancer. About a third of childhood glioblastomas have a mutation in a protein called the H3.3 histone. Dr Mathieu Lupien, collaborator Dr Peter Dirks (The Hospital for Sick Children) and their teams found that, while these mutations are rare in adult glioblastomas, the amount of H3.3 in adult stem cell–like glioblastoma cells is lower than normal. New therapies that target this protein may therefore offer an alternative for both children and adults.30

Changes in DNA organization in multiple myeloma

Dr Sabine Mai, University of Manitoba

Dr Sabine Mai and her team used advanced imaging techniques to show that DNA is organized differently in multiple myeloma (a type of blood cancer) cells versus the blood cells they came from. DNA organization is important as it influences how genes are expressed, which can promote cancer. This work provides information about how multiple myeloma develops and new treatment targets.31

Molecular events in cell death

Dr Heidi McBride, Montreal Neurological Institute (affiliated with McGill University)

Cell death is normally triggered by a complex series of molecular events, which cancer cells can resist. Dr Heidi McBride and her team defined a sequence of critical events that occur in the mitochondria (the cell’s energy hub) during cell death. This work highlighted the importance of a small protein called SUMO1 and brought together many aspects of how cells are triggered to die, providing clues about how the process goes awry in cancer.32
Two proteins doing the same thing

**Dr Sylvain Meloche**, Université de Montréal, Institute for Research in Immunology and Cancer

Two similar proteins called ERK1 and ERK2 play important roles in cell signalling that tell cells when to multiply, mature and survive. Their overactivation can cause cancer. There has been considerable debate about whether ERK1 and ERK2 have distinct functions. Dr Sylvain Meloche and his team studied both proteins in genetically engineered mice and found that ERK1 and ERK2 served redundant functions. This could influence how drugs that disrupt ERK signalling are used and designed to effectively treat cancer.33

How brain cancer cells invade

**Dr Christian Naus**, University of British Columbia

Dr Christian Naus and his team discovered that glioma brain tumour cells interact with healthy brain cells called astrocytes to form small communication channels between them. Tumour cells transfer molecules called microRNAs into astrocytes that promote malignancy. Blocking this pro-invasion signal can now be investigated as a new therapeutic approach for gliomas, the most common type of brain tumour in adults.34

Protein imbalance in prostate cancer

**Dr Gilbert Privé**, University of Toronto

Cells have processes to destroy excess or damaged proteins, and changes in them can lead to cancer. One protein involved in “tagging” proteins for destruction, SPOP, is mutated in some prostate cancers. Dr Gilbert Privé and his team found that SPOP mutations affect protein tagging in prostate cells and reduced its function. Cells with mutations accumulated a cancer-promoting protein called DEX. This could identify new approaches to correct protein imbalances in cancer.35

New method to predict protein interactions

**Dr Igor Stagljar**, University of Toronto

Interactions between proteins within cells control how they act. However, for about one-third of all human proteins their interactions with other proteins are unknown. Dr Igor Stagljar and his team used their innovative method of measuring protein interactions to collaborate with Dr Igor Jurisica (Princess Margaret Cancer Centre) to predict a map of all of the interactions between human proteins. This tool predicted over 250,000 interactions, including thousands of new ones. This work provides important tools to study proteins in cancer.36
Blocking a cancer-driving protein

Dr Marc Therrien, Université de Montréal

Mutations in BRAF – a protein that promotes cell growth and division – can cause it to become overactive and lead to cancer. Dr Marc Therrien and his team were the first to determine the 3-D structure of BRAF in its inactive “off” state, which provided important insight into how BRAF works and can be altered by mutations. Through an industry collaboration, the team is using this knowledge to develop novel BRAF inhibitors as potential anticancer drugs.37

Tracking cancer cells through innovative imaging

Dr Roger Zemp, University of Alberta

Dr Roger Zemp and his team developed an experimental system that detected tumours as small as 1 mm, with better resolution than magnetic resonance imaging (MRI). Photoacoustic imaging could detect a gene they turned on in cancer cells in living mice. This technique will be used to study how genes work and to track how tumours develop, spread and respond to treatment.38
Advances in stem cell research

In the last 10 years:

$26M invested

55 principal investigators supported

105 grants and career awards

20 institutions

Some of our research achievements include:

1960s
Dr James Till and Dr Ernest McCulloch discover stem cells in bone marrow, leading to the possibility of bone marrow transplants as a new cancer treatment.

1982
Dr Connie Eaves and Dr Allen Eaves show that stem cells can be coaxed to grow in a test tube while nearby leukemic cells are killed, allowing a new form of bone marrow transplant that uses a patient’s own stem cells instead of donor cells.

1994
Dr John Dick discovers that leukemia cells originate from cancer stem cells, an important finding to explain how leukemia develops and guide the development of new therapies.

2004
Dr Peter Dirks identifies and characterizes cancer stem cells that drive brain cancer.

2009
Dr Mick Bhatia describes key differences between normal human embryonic stem cells and abnormal cancer stem cells, which could lead to better cancer treatments.

2014
Additional research by Dr Mick Bhatia shows that human stem cells made from adult donor cells remember what cell types they came from, which has important implications for new stem cell therapies.
Redefining blood cell development

**Dr John Dick**, University Health Network, Princess Margaret Cancer Centre

By developing new ways to study single cells, Dr John Dick and his team showed that specialized blood cells develop much more quickly from stem cells than previously thought, changing the “textbook” view of how blood cells are made. This paradigm shift could open up new opportunities for understanding blood cancers and how to treat them.39

A driving force behind relapse in childhood brain cancer

**Dr Peter Dirks**, The Hospital for Sick Children

Dr Peter Dirks and his team studied how different cell types contributed to the growth of a form of medulloblastoma - the most common childhood brain cancer. They found that a rare group of cells marked by a protein called Sox2 acted like cancer stem cells, sustaining the growth of the tumour. These cells divided very slowly and were not killed by chemotherapy, offering an explanation for how some medulloblastomas come back after treatment. They also found a drug that could kill these cells, which could lead to long-lasting remission.40

Stem cells preserving aging breast tissue

**Dr Rama Khokha**, University Health Network, Princess Margaret Cancer Centre

Dr Rama Khokha and her group found a link between stem cells, aging and breast cancer. They discovered a set of genes that increases the number of stem cells in the breast tissue of old mice, preserving the tissue’s health. Understanding how stem cells maintain tissues is important for the prevention of cancer and other diseases associated with aging.41

This study was supported through the former Canadian Breast Cancer Research Alliance.

“Understanding how stem cells maintain our tissues is important for the prevention of all diseases associated with aging, including cancer.”

– Dr Rama Khokha

Targeting brain cancer stem cells with an existing drug

**Dr Sheila Singh**, McMaster University

Dr Sheila Singh and her team studied a protein called CD133 that is highly expressed on certain glioblastoma (GBM) cells. These cells in this aggressive brain cancer act like stem cells by initiating and sustaining tumour growth and resisting treatment. The researchers identified pyrvinium, a drug originally approved to treat pinworm infections, as a promising lead to selectively trigger death of CD133-marked GBM cells.42
Advances in cancer genomics

In 2015:

$2M invested

17 principal investigators supported

17 grants and career awards

7 institutions

Some of our research achievements include:

2011
Dr Michael Taylor discovers that medulloblastoma, a common form of childhood brain cancer, can be classified into 4 subtypes with distinct molecular profiles, changing how these tumours can be treated.

2012
Dr Samuel Aparicio and others reveal how the cancer genome evolves in triple-negative breast cancer, a particularly hard-to-treat form of the disease.

2014
Dr Robert Bristow and an international team identify a molecular “signature” that could predict prostate cancer recurrence, identifying patients who may need more aggressive treatment.

2014
Dr Sohrab Shah develops a new computer-based method to group genetic mutations in cancer cell populations to study how tumours evolve over time.
Perspectives on gene tests for breast cancer

Dr Yvonne Bombard, St Michael’s Hospital, Canadian Centre for Applied Research in Cancer Control

There is variation in how gene expression tests are being used to help guide treatment decisions for early breast cancer. Dr Yvonne Bombard of the Society-funded Canadian Centre for Applied Research in Cancer Control and her team found that while oncologists value these tests, they have concerns over their high cost and potential inappropriate use. Doctors found the tests easy to explain, but experienced gaps in patients’ understanding and expectations of them. This highlights a need for tools to support communications and clinical practice guidelines to standardize when the tests should be used.43

Molecular variations in prostate tumours

Dr Robert Bristow, University Health Network, Princess Margaret Cancer Centre

Not all prostate cancers behave the same, even when the tumours have similar clinical features. Dr Robert Bristow and a team from the Canadian Prostate Cancer Genome Network studied prostate tumours from several men, examining different regions to create “portraits” for each sample. They found many differences in the genetic abnormalities depending on the region in a single tumour. They also discovered a new role for the MYCL1 protein. This provides important information for tailoring prostate cancer treatment.44

“The ability to understand the unique genetics of each tumour within a man’s prostate gland means that we can now understand the big picture of the cancer.” – Dr Robert Bristow

Link between inflammation genes and cancer

Dr Rayjean Hung, Mount Sinai Hospital

Dr Rayjean Hung and an international team completed the first large-scale study of genetic variation in genes related to inflammation in people with 5 cancers: lung, ovarian, prostate, breast and colorectal. They identified a new genetic variant linked to lung, colorectal and breast cancers, providing more information about the genetic basis of how cancer develops. Her research has also been used to inform the design of a commercial test that assesses variation in gene sequences.45

Preferences on genetic test results

Dr Dean Regier, BC Cancer Agency, Canadian Centre for Applied Research in Cancer Control

As genetic testing becomes more common, an important issue emerges - when DNA is sequenced to test for one condition, other mutations can be found. Dr Dean Regier of the Society-funded Canadian Centre for Applied Research in Cancer Control and his team studied Canadians’ preferences on receiving genetic information. While two-thirds of participants valued knowing all mutations with a high association to disease, three-quarters wanted to choose what information they received. These findings support individualized decision-making for patients and have important implications for Canadian healthcare policies.46
A link between 2 leukemias

Dr Guy Sauvageau, Université de Montréal, Institute for Research in Immunology and Cancer

Dr Guy Sauvageau led a study of 2 forms of acute myeloid leukemia (AML) and identified for the first time a pattern of gene activity shared by these 2 subsets. This new information should improve how AML is diagnosed and how treatments can be tailored to improve survival.

Predicting how cancer gene mutations affect gene expression

Dr Sohrab Shah, BC Cancer Agency

Cancer develops as a result of gene mutations that accumulate and allow cells to grow out of control. Dr Sohrab Shah and his team developed a new mathematical model and computer software to analyze how gene mutations affect gene activity in thousands of tumours from 12 different cancer types. They identified over 100 new suspected cancer genes and several mutations whose effects were similar across many cancers. This work will help prioritize genes to study as new therapeutic targets in cancer.

“Our new method helps to determine which mutations in cancer cells are altering biological activity. This work provides a path forward to further our understanding of biological processes gone awry in cancer and to improve the potential of identifying the most important mutations for personalized, targeted therapy.” – Dr Sohrab Shah
Daniel Tesolin, member of Dr Christopher Phenix's team, Thunder Bay Regional Research Institute
Advances in detection, diagnosis and treatment

In the last 10 years:

$228M invested

667 grants and career awards

410 principal investigators supported

47 institutions

Some of our research achievements include:

1951
Dr Harold Johns develops the Cobalt-60 Unit or “Cobalt Bomb,” which begins the modern era of radiation therapy.

1958
Dr Robert Noble and Dr Charles Beer discover vinblastine, a chemotherapeutic still used to treat many cancers.

1965
Dr Phil Gold and Dr Samuel Freedman discover a protein that can be measured in a blood test to help detect cancer early and monitor treatment effects.

1980
Dr Anthony Miller and Dr Cornelia Baines launch the National Breast Screening Study, which influenced public policy in Canada and other countries.

2011
Dr Gang Zheng develops a new class of nanoparticles, called porphysomes, which target and destroy tumours by converting light from a laser into energy that kills cancer cells.

1955
Dr David Boyes and Dr H.K. Fidler develop a large-scale provincial screening program for early detection of cervical cancer in BC, which became a model for the entire country.

1965
Dr David Perrin tests a new compound that improves the quality of positron emission tomography (PET) imaging, making it faster and more accurate at detecting cancers.

2013
Dr Helen Chan and Dr Brenda Gallie use the drug cyclosporine to improve treatment of childhood eye cancer.
Improving radiation therapy for lung cancer

Dr Jean-Pierre Bissonnette, University Health Network, Princess Margaret Cancer Centre

Dr Jean-Pierre Bissonnette and his team have been using advanced medical imaging to track how lung tumours respond to radiation therapy. They identified small regions of tumours that are more active and resistant to treatment and may be able to withstand higher doses of targeted radiation. A new radiation protocol is being implemented at centres across Canada and the United States, which may have a significant impact on improving lung cancer survival.

Defining optimal treatments for stomach cancer

Dr Natalie Coburn, Sunnybrook Research Institute

People with gastric adenocarcinoma, the most common form of stomach cancer, have different rates of survival in different parts of the world, which may be due to different surgical, chemotherapy, radiation and supportive care approaches. Dr Natalie Coburn assembled a panel of gastric cancer experts from around the world who evaluated over 400 treatment scenarios. The panel rigorously defined what treatments were necessary and most appropriate in different situations. Dr Coburn’s research has informed the development of new clinical guidelines for gastric cancer surgery in Ontario, expected to be released in 2016.

Targeting PACE4 for prostate cancer treatment

Dr Robert Day, Université de Sherbrooke

Dr Robert Day and his team provided the first proof of concept that blocking a protein called PACE4 stops prostate cancer growth in mice. Anti-PACE4 therapy triggered prostate cancer cells to die and shrank tumours by 60%. A collaboration with the Centre for Drug Research and Development (CDRD) is now advancing clinical testing and commercialization.

“We’re very excited to see this new treatment approach taking steps toward the clinic. If successful, this collaboration could be a great example of how results from the lab can translate effectively to improved patient care.” – Dr Robert Day

Research from Dr Robert Day’s team, Université de Sherbrooke
Left: Detection of PACE4-expressing tumours in mice. White arrows point to tumours.
Right: Detection of PACE4 protein (stained brown) in prostate cancer cells
Tricking cancer stem cells to stop growing

**Dr Daniel De Carvalho**, University Health Network, Princess Margaret Cancer Centre

Dr Daniel De Carvalho and his team found something surprising and promising about an anticancer drug that targets colorectal cancer stem cells. The drug tricks the cancer stem cells into responding as if they had been infected with a virus, which limits the cancer cells’ ability to multiply—an approach that may complement new immunotherapies.51

A marker for a rare ovarian cancer

**Dr David Huntsman**, BC Cancer Agency

A rare form of ovarian cancer that usually affects women in their teens and young adulthood progresses aggressively even when caught early. More than 90% of these tumours have a mutation in the SMARCA4 gene. Dr David Huntsman and his team found that loss of SMARCA4 was exceptionally specific to this form of ovarian cancer, which means it could be useful for diagnosing these cancers and designing new therapies.52

A marker to predict response to targeted therapy in CML

**Dr Xiaoyan Jiang**, BC Cancer Agency

People with chronic myelogenous leukemia (CML) are often treated with imatinib (Gleevec). However, not all people respond, and drug resistance can emerge. Dr Xiaoyan Jiang and her colleagues discovered high levels of the ATG4B protein in a subset of CML cells from patients who were resistant to imatinib. Blocking the ATG4B gene triggered these cells to die and made them more sensitive to treatment, identifying ATG4B as a promising biomarker for imatinib resistance and a new therapeutic target in CML.53
Linking breast cancer biomarkers to tumour size
Dr David Juncker, McGill University

Dr David Juncker and his team identified 6 biomarkers in blood samples from mice with breast cancer that increased proportionally as the tumours grew. In some cases, biomarker levels predicted a tumour before it could be felt under the skin. Blood biomarker levels that change with disease could be a non-invasive way to diagnose cancers early and monitor how they respond to therapy.54

A new ultrasensitive blood test for cancer biomarkers
Dr Shana Kelley, University of Toronto

Dr Shana Kelley and her group have developed an extremely sensitive blood test that uses sensors on a chip to detect cancer mutations. This new, non-invasive test is fast and simple to perform. It is now being developed as an alternative to tissue biopsies to detect cancer, monitor how patients respond to therapy and personalize treatment decisions.55

“Our chip-based approach to detecting cell-free nucleic acids provides a straightforward and sensitive way to look for tumour-related sequences using non-invasive sampling and we are excited about its application to the further development of liquid biopsy-based patient monitoring.”
– Dr Shana Kelley
Sniffing out lung cancer with an electronic nose

**Dr Annette McWilliams**, BC Cancer Agency

Dr Annette McWilliams and her colleagues found that an electronic “nose” (e-nose) that detects a profile of chemicals in exhaled breath could differentiate between people with lung cancer from high-risk smokers without lung cancer. This supports the potential for the e-nose device to be used as a screening tool to identify lung cancers at an early stage.56

Pancreatic tumours in a dish

**Dr Senthil Muthuswamy**, University Health Network, Princess Margaret Cancer Centre

Dr Senthil Muthuswamy and his team have grown 3-D “mini-tumours” called organoids from human pancreatic cancer cells. These organoids closely mimicked how pancreatic tumours grow in people and are being used to test new drug treatments for pancreatic cancer, which has one of the lowest survival rates of any cancer.57

A new tool to see aggressive cancers

**Dr Christopher Phenix**, Thunder Bay Regional Research Institute

An enzyme called cathepsin B that is highly active in some tumours may be useful to mark aggressive cancer and predict how tumours will respond to treatment. Dr Christopher Phenix and his team created a new chemical probe that produces a fluorescent signal when cathepsin B is active. This probe could be adapted for diagnostic imaging to visualize aggressive tumours in the body.58

Visualizing pancreatic cancer

**Dr Raymond Reilly**, University of Toronto

Pancreatic cancer is difficult to treat effectively and is often diagnosed at an advanced stage. Dr Raymond Reilly and his team developed a way to clearly detect growing pancreatic tumours in mice. The molecule they developed attaches to pancreatic cancer cells and produces a radioactive signal that could be detected on a positron emission tomography (PET) scan. This new technology could be developed to detect pancreatic cancer in humans, help determine its stage and monitor how the cancer responds to therapy.59
Realistic human lung cancers in mice

Dr Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre

Several lung cancer drugs target the EGFR protein, but almost all people eventually develop resistance. Dr Ming-Sound Tsao and his team created new mouse models of 6 different human lung cancers with EGFR mutations by implanting tumour tissue into mice. The lung cancers in these mice mimic each tumour’s original appearance, molecular features and response to therapy. They will be used to learn more about how lung cancer develops and to find new treatments.60

Dr Tsao is the recipient of the Rachelle Archambault Innovation Grant of the Canadian Cancer Society.

“Mouse models derived from patient tumours may speed up the development of new cancer drugs and improve patient selection for emerging molecularly targeted treatments.” – Dr Ming-Sound Tsao

Developing a 2-in-1 treatment to avoid drug resistance

Dr John White, McGill University

Dr John White (left) and his collaborator Dr James Gleason (right) are studying how 2 anticancer agents can be combined to maximize their effects: vitamin D receptor (VDR) activators and inhibitors of HDACs, enzymes involved in gene regulation. The team previously developed hybrid molecules that could activate VDR and block HDACs at the same time, which had promising effects in oral cancer cells. They have now added chemical modifications to the hybrid molecules that greatly improved their HDAC blocking ability. This “2-in-1” treatment may be less prone to drug resistance than either agent alone.61

Research from Dr Ming-Sound Tsao’s team

Microscopic image of a type of lung cancer displaying a micropapillary growth pattern
## Advances in immunotherapy

### In the last 10 years:

- **$17M** invested
- **77** grants and awards
- **53** principal investigators supported
- **22** institutions

### Some of our research achievements include:

- **1984**
  - Dr Tak Mak clones the T-cell receptor gene, helping to shape the field of immunotherapy.

- **1995**
  - Dr Patrick Lee discovers that a type of virus can kill cancer cells, while sparing normal cells. Dr Peter Forsyth and others build on this to advance the field of oncolytic virus therapy.

- **2013**
  - Dr John Bell and Dr Jean-Simon Diallo design new cancer-fighting viruses to attack cancer cells.

- **2014**
  - Dr Rebecca Auer shows that a flu vaccine can be used in mice to reduce cancer spread after cancer surgery, an approach being tested in clinical trials.

- **2014**
  - Dr Claude Perreault reveals a new approach to identify molecules that attract T cells, which could help increase the number of people who could benefit from immunotherapies.
How cancer-killing viruses attack tumour blood vessels

**Dr John Bell**, Ottawa Hospital Research Institute

Oncolytic viruses (OVs) attack cancer cells while leaving healthy cells intact. Many tumours produce a protein called VEGF to stimulate the growth of new blood vessels into and around the tumour. Surprisingly, some OVs infect these abnormal blood vessels, but spare normal ones.

Dr John Bell and his team showed that the tumour’s overproduction of VEGF suppresses its blood vessels’ natural antiviral response, allowing OVs to infect and destroy the tumour’s blood vessels. VEGF levels may be able to predict which patients will respond better to OV therapy.62

Teaching immune cells to suppress cancer

**Dr Frank Jirik**, University of Calgary

Activating a protein called STING can shrink tumours in mice by disrupting blood vessels. Dr Frank Jirik and his team discovered that STING activators converted immune cells called macrophages from a tumour-promoting state to a tumour-suppressing state and their anticancer effects in mice depended on the number of macrophages. This could explain why tumours respond differently to STING activators and why the approach has not always been successful in clinical trials. These agents may be further developed as cancer immunotherapies.64

Dr Jirik is the recipient of the Women in Insurance Cancer Crusade Alberta Innovation Grant of the Canadian Cancer Society.

Combining approved drugs with viruses to treat cancer

**Dr Jean-Simon Diallo**, Ottawa Hospital Research Institute

Dr Jean-Simon Diallo and his team discovered a combination treatment that enhances the cancer-killing effects of oncolytic viruses (OVs) – viruses that selectively kill cancer cells in the body. Combining OVs with approved chemotherapies that disrupt microtubules (tube-like structures involved in cell division and other cell processes) worked better in mice than either treatment alone. These findings identify a new opportunity to use approved cancer drugs to enhance the effects of OVs.63

This work was generously supported by the Lotte & John Hecht Memorial Foundation.

Improving immunotherapy for leukemia

**Dr David Spaner**, Sunnybrook Research Institute

Activating a protein involved in the immune response called TLR7 can have anticancer effects. However, Dr David Spaner and his team found that shutting down the TLR7 response with an immune signal called IL-6 can counterintuitively slow chronic lymphocytic leukemia (CLL) progression. This has implications for IL-6 blockers as anticancer therapies. Dr Spaner’s research on immunotherapy for CLL has generated interest from the pharmaceutical industry, including funding for a Phase 1 clinical trial.55

Dr Spaner is the recipient of the Mrs Grace Limbert Innovation Grant of the Canadian Cancer Society.
Advances in clinical trials

In the last 10 years:

- $71M invested
- 28,164 enrolled patients
- 257 trials
- 112 Canadian centres
- 40+ countries involved

Some of our research achievements include:

- **1980**: Canadian Cancer Society establishes the NCIC Clinical Trials Group (now the Canadian Cancer Trials Group) at Queen’s University.
- **2001**: BR.10 trial reveals that 2 chemotherapies work best for lung cancer, changing clinical guidelines.
- **2003**: MA.17 trial shows that letrozole reduces breast cancer recurrence, changing care worldwide.
- **2011**: PR.7 trial demonstrates that people with prostate cancer benefit from a drug “holiday” to improve quality of life.
- **2011**: MAP.3 trial shows that exemestane prevents breast cancer in high-risk women.
Marine sponges reveal promising new prostate cancer drug

Dr Raymond Andersen, University of British Columbia

Advanced prostate cancer is treated with hormone therapies that block the androgen receptor (AR). Although most men initially respond, cancers often return in an incurable form. Over the last decade, Dr Raymond Andersen and his collaborator Dr Marianne Sadar (BC Cancer Agency) discovered a new class of chemicals in marine sponges that block AR in a new way. In 2009, they co-founded a company called ESSA to develop these chemicals into drugs for the clinic. This year, with approval from Health Canada and the US Food and Drug Administration, they launched their first clinical trial in men with advanced prostate cancer who no longer respond to hormone therapy.

A new standard for managing cancer pain

Dr Edward Chow, Sunnybrook Research Institute, Canadian Cancer Trials Group

Pain from advanced cancer that has spread to the bone can be treated with radiation therapy. However, the pain can temporarily get worse before getting better. Dr Edward Chow, Dr Alysa Fairchild and the Society-funded Canadian Cancer Trials Group led a clinical trial showing that the steroid dexamethasone could prevent pain flare-ups from radiation therapy. They concluded that this treatment should be part of standard care for bone metastases, which could change how advanced cancer is managed worldwide.

Testing a new drug for advanced lung cancer

Dr Peter Ellis, Juravinski Cancer Centre, Canadian Cancer Trials Group

The most common form of lung cancer, non-small cell lung cancer (NSCLC), can be treated with drugs that target a protein called EGFR. However, many people fail to respond or become resistant to the treatment. Dr Peter Ellis of the Society-funded Canadian Cancer Trials Group led an international Phase 3 clinical trial to determine whether the drug dacomitinib, which targets EGFR and other related proteins, could improve survival for people with NSCLC who had not responded to chemotherapy or drugs that target the EGFR protein alone. Dacomitinib did not increase survival, although it did prolong the time it took for the cancer to progress. While dacomitinib should not be recommended for advanced NSCLC, it is now being explored as an earlier therapy for lung cancers.

Two drugs are not always better than one

Dr Jolie Ringash, University Health Network, Princess Margaret Cancer Centre, Canadian Cancer Trials Group

The Society-funded Canadian Cancer Trials Group led a study with an Australian team to determine whether people with advanced colorectal cancer would benefit from a combination of 2 targeted therapies. Dr Jolie Ringash assessed the impact of the drug combination on the quality of life of patients. Compared to treatment with one drug, the combination treatment delayed cancer progression slightly but caused a more rapid decline in quality of life. Based on these results, the drug combination is not recommended.
Clinical trial uses a diabetes drug to treat breast cancer

Dr Vuk Stambolic, University Health Network, Princess Margaret Cancer Centre and
Dr Pamela Goodwin, Mount Sinai Hospital, Canadian Cancer Trials Group

Dr Vuk Stambolic and his team completed a clinical trial where women with early-stage breast cancer were given metformin – a drug used to treat diabetes – between diagnosis and their surgery to remove the tumour. Metformin lowered insulin levels in the blood and changed insulin-related cell signalling in the tumours, suggesting that women with tumours that respond to insulin could benefit from metformin. In collaboration with Dr Pamela Goodwin of the Society-funded Canadian Cancer Trials Group, a Phase 3 clinical trial is now testing over 3,500 women with early breast cancer with metformin or a placebo in addition to standard therapy. An early study of the first 492 women enrolled showed that metformin had promising benefits on body weight and metabolism.69,70

Using new lung cancer subtypes to predict response to chemotherapy

Dr Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre, Canadian Cancer Trials Group

Dr Ming-Sound Tsao and a multi-institutional team that included the Society-funded Canadian Cancer Trials Group performed the first clinical analysis of 5 newly identified subtypes of lung adenocarcinomas. They showed that certain subtypes predicted a higher risk of cancer recurrence. Patients with these subtypes particularly benefited from chemotherapy after surgery to improve survival. This work shows that subtype classification should be integrated into the routine diagnosis of lung cancers and future clinical trials.71
Establishing the benefit of radiation therapy for prostate cancer

**Dr Padraig Warde**, University Health Network, Princess Margaret Cancer Centre, Canadian Cancer Trials Group and

**Dr Michael Brundage**, Queen’s University, Canadian Cancer Trials Group

Dr Padraig Warde of the Society-funded Canadian Cancer Trials Group collaborated with international partners to launch a major clinical trial of over 1,000 men to determine whether men with prostate cancer that had spread to nearby tissues benefit from adding radiation therapy (RT) to a type of hormone therapy called androgen deprivation therapy (ADT). After the 15-year study, the trial firmly established that RT significantly improved survival. A companion study led by Dr Michael Brundage showed that the side effects of RT had an impact on quality of life, but the effect was modest and temporary. The benefits of adding RT to ADT outweighed the risks, resolving a key debate in clinical practice.\(^{72,73}\)

Additional radiation reduces breast cancer recurrence

**Dr Timothy Whelan**, Juravinski Cancer Centre, Canadian Cancer Trials Group

Dr Timothy Whelan of the Society-funded Canadian Cancer Trials Group led an international clinical trial showing that additional radiation was beneficial for women who had undergone breast-conserving cancer surgery. After 10 years of follow-up, women who received radiation to the chest wall and nearby lymph nodes, in addition to radiation of the breast itself, had a lower risk of breast cancer recurrence, but no increase in survival. Interim findings from this study were incorporated into Ontario and British Columbia clinical practice guidelines.\(^{74}\)
Advances in support for people living with and beyond cancer

In the last 10 years:

$32M invested
77 principal investigators supported
157 grants and career awards
33 institutions

Some of our research achievements include:

2005  
Dr Harvey Chochinov shows that a new form of psychotherapy focused on patient dignity can reduce suffering among people with cancer nearing the end of life.

2010  
Mary McBride shows that childhood cancer survivors have higher odds of hospitalization and longer hospital stays, findings that are being used to help improve childhood cancer survivor care.

2014  
Dr Camilla Zimmermann finds that offering palliative care earlier gives patients a better quality of life.
Canadian benchmarks for quality of end-of-life care in cancer

Dr Lisa Barbera, Sunnybrook Research Institute, Canadian Centre for Applied Research in Cancer Control

Dr Lisa Barbera of the Society-funded Canadian Centre for Applied Research in Cancer Control and her team found considerable variation in healthcare services provided to patients at the end of their lives across 4 provinces: British Columbia, Alberta, Ontario and Nova Scotia. She established benchmarks and quality indicators that will help regions evaluate their services and support resource allocation.75

Encouraging physical activity in breast cancer survivors

Dr Jennifer Brunet, University of Ottawa

While physical activity has important health benefits for breast cancer survivors, few achieve the recommended levels. Dr Jennifer Brunet and her team identified several motives to be physically active (e.g. social support and feelings of personal fulfillment) and barriers (e.g. distance to the location and cancer-specific physical limitations). Dr Brunet’s research has informed clinical practice guidelines in physical activity for cancer patients in Ontario and refined local physical activity programs.76

Improving pain and symptom management in cancer care

Dr Denise Bryant-Lukosius, McMaster University

Dr Denise Bryant-Lukosius and her team studied how regional cancer centres in Ontario promote the use of best practice guidelines to control cancer pain and symptoms. They identified new ways to improve them to ensure consistent, high-quality care, and the results are informing policies and practices at Cancer Care Ontario and the Ontario Cancer Symptom Management Collaborative. They have also influenced the strategic plan of the Juravinski Cancer Centre (JCC) in Hamilton, Ontario, and impacted its policies to improve pain and symptom management for cancer patients.

A simple question that may improve patient care

Dr Harvey Chochinov, University of Manitoba

Dr Harvey Chochinov, an international expert on patient dignity, calls upon healthcare providers to ask patients and families a simple question to improve care: “What do I need to know about you as a person to give you the best care possible?” Dr Chochinov and his research team found that for most healthcare providers, asking this question (termed the Patient Dignity Question, or PDQ) taught them something new about their patients and increased their empathy. Almost half said it influenced their care. Nearly all patients and family members felt this information was important for their doctor to know. The PDQ is currently being integrated into standard clinical care practice around the world.77
Rehabilitation for head and neck cancer survivors

Dr Sara McEwen, Sunnybrook Research Institute

Head and neck cancer (HNC) survivors can experience significant impairments in their day-to-day function after treatment. Dr Sara McEwen, collaborator Dr Jolie Ringash and their team are developing a rehabilitation consultation toolkit to help identify HNC survivors’ needs, set individualized goals and develop action plans. The researchers have held several focus groups and published the protocol for a pilot study, which will launch in 2016. They have also created an online repository of rehabilitation resources for HNC survivors and healthcare providers (www.hncrehab.ca).78

Online support for breast cancer survivors

Dr Joanne Stephen, University of Calgary (formerly BC Cancer Agency)

Many cancer survivors find comfort in talking with peers who have gone through a similar experience and educating themselves about their disease. Dr Joanne Stephen is leading a clinical trial to evaluate whether young breast cancer survivors respond better to education alone or in combination with online support groups led by peers or professional therapists. The study has already encouraged 8 Canadian psychosocial oncology programs to participate in “CancerChatCanada,” a national program of online cancer support groups. This research could improve support provided to breast cancer survivors. This study was supported through the former Canadian Breast Cancer Research Alliance.

Communication in cancer care

Dr Sally Thorne, University of British Columbia

Dr Sally Thorne and her team studied the changing communication needs and preferences of people living with cancer from the time of diagnosis, to treatment decision-making, to coping. Interviews identified aspects of communication that were helpful (e.g. healthcare providers’ respect for emotional needs while treating patients as intelligent and competent individuals) and unhelpful (e.g. overloading of information at diagnosis). Communication needs also changed as people progressed to advanced cancer. This information can inform best practices in cancer care communication.79

Early palliative care in the cancer clinic

Dr Camilla Zimmermann, University Health Network, Princess Margaret Cancer Centre

For people with advanced cancer, early palliative care can benefit their clinical outcome and quality of life. Dr Camilla Zimmermann and her team provided a model of how an outpatient palliative care clinic can be integrated into existing cancer care by describing how this has been implemented at the Princess Margaret Cancer Centre in Toronto. In addition to improving patients’ quality of life, symptom control and satisfaction with their care, this model also improved satisfaction with care in family members. This model could be adapted by other hospitals and cancer centres to impact the patient experience. In recognition of her leadership, Dr Zimmermann was invited to contribute to updating clinical practice guidelines on palliative care by the American Society of Clinical Oncology (ASCO).80
Research from Dr Peter Dirks’ team, The Hospital for Sick Children
Medulloblastoma stem cells (pink)

Research from Dr Mani Larijani’s team, Memorial University of Newfoundland
A potential drug to block the AID protein

Research from Dr David Juncker’s team, McGill University
Fluorescence image of a microarray with sets of 4 spots to detect different proteins

Research from Dr Sylvain Meloche’s team, Université de Montréal, Institute for Research in Immunology and Cancer
Mouse embryo stained to detect ERK proteins
References


76. Wurz A, St-Aubin A, Brunet J. Breast cancer survivors’ barriers and motives for participating in a group-based physical activity program offered in the community. Support Care Cancer. 2015;23(8):2407-2416.


Human Papillomavirus (HPV): Taking Action to Prevent Cancer

**Our goal:** prevent HPV-related cancers

HPV infects both females and males. Some types of HPV can cause cancer, including cancers of the mouth, throat, anus, cervix, vagina, vulva and penis.

Thanks to donors, we’ve invested $4M in research on HPV and cancer in the last 15 years.

**We’re making progress**

We now have vaccines to prevent the infections responsible for at least 70% of cervical cancers.

All provinces and territories have free HPV vaccination programs for girls.

**There’s still more to do**

HPV vaccination rates vary widely across Canada. 6 provinces have committed to comprehensive school-based HPV vaccination programs for boys.

**Take action**

Help us make sure that more boys and girls get vaccinated. Support HPV vaccination programs in your province or territory.

Help us support more world-class research on HPV and cancer prevention. Donate at cancer.ca or call 1-888-939-3333
Impact of our researchers

- Dr Eduardo Franco helps prove that HPV causes cervical cancer and advances HPV vaccines and cervical cancer screening.
- Dr Greg Matlashewski helps identify a genetic risk factor for HPV-related cancer.
- Dr Raghu Rajan demonstrates that an HPV test is cost effective for cervical cancer screening.
- Dr Irving Salit identifies HPV biomarkers linked to anal precancers in men.
- Dr Paul Brassard uses an HPV test to improve cervical cancer screening in remote areas.
- Dr James Omichinski finds a new way to block HPV replication, which could lead to antiviral treatments.

1990s to 2000s

- 2006: 1st HPV vaccine approved in Canada.
- 2007: Provinces begin to implement HPV vaccination programs for girls.
- 2009: 2nd HPV vaccine approved in Canada.
- 2010: All provinces and territories have implemented HPV vaccination programs for girls.
- 2012: Prince Edward Island expands HPV vaccination program to boys.
- 2013: Alberta expands HPV vaccination program to boys.
- 2014: 3rd HPV vaccine approved in Canada.
- 2015: British Columbia introduces HPV vaccination program for a subset of males at higher risk of infection.
- 2016: Nova Scotia, Manitoba and Quebec announce expansion of vaccination program to boys.

Ontario announces expansion of vaccination program to boys.

Canadian HPV vaccine milestones
A Focus on Brain Cancer

We need to move the needle on the survival rate for brain cancer. Twenty years ago, 23% of Canadians diagnosed with brain cancer survived at least 5 years after their diagnosis – today that number is still only 25%.

It is estimated that 3,000 Canadians were diagnosed with brain cancer in 2015, and 2,100 died from the disease.
Canadian Cancer Society support of brain cancer research

Thanks to our donors, the Canadian Cancer Society is the 2nd largest national charitable funder of brain cancer research. Our donors invested over $1.8 million in brain cancer research through our Research Institute in 2015. This supported 18 lead investigators across Canada exploring what causes brain cancer, how to defeat it and how to improve lives of childhood cancer survivors living with side effects from intense treatments.

Funded by our donors, the Canadian Cancer Trials Group (CCTG) is the only Canadian clinical trials group that studies all cancer types, with the ultimate goal of reducing the effects of cancer and improving survival. In 2015, 6 brain cancer clinical trials were active and involved 421 patients from cities across the country, including Victoria, Vancouver, Surrey, Calgary, Edmonton, Regina, Saskatoon, Winnipeg, London, Hamilton, Toronto, Montreal, Sherbrooke, Quebec City, Trois Rivieres, Saint John’s, Halifax and Saint John.

We’re making progress! Our researchers continue to bring new insight and approaches to tackling brain cancer. In 2015, the Canadian Cancer Society supported key research findings, including:

- Dr Peter Dirks from The Hospital for Sick Children discovered a type of brain cell that sustains tumour growth, resists chemotherapy and likely causes relapse after treatment in medulloblastoma, the most common brain cancer in children.

- Dr Sheila Singh from McMaster University discovered that a drug originally approved to treat pinworm infection has potential to treat glioblastoma, an aggressive brain cancer.

- Dr Sohrab Shah from the BC Cancer Agency identified over 100 new suspected cancer genes in several cancers, including brain cancer, to advance personalized treatments.

We need to do more! In 2015 the Canadian Cancer Society committed to 11 new research grants and awards testing innovative approaches for brain cancer, representing $6 million in new funding for the next 5 years. This significant commitment was due in part to an innovative partnership between the Society and Brain Canada. This collaboration provided an inspirational matching platform for donors through the Canada Brain Research Fund, a public-private partnership established by the Government of Canada. Canadians responded enthusiastically, donating more than $3 million, matched dollar for dollar by our partnership. The initiative supports 5 Impact Grants awarded in 2015 and 2016 that are exploring novel ways to detect brain cancer early and treat it more effectively in children and adults. We are pleased to acknowledge and thank the Brain Tumour Foundation of Canada, Ride2Survive, the Winnipeg Police Services Half Marathon and the many other Canadians who contributed so generously to this partnership.
Lung cancer kills twice as many Canadians as breast and prostate cancer, combined.

Lung cancer is the leading cause of death from cancer for both men and women in Canada, accounting for nearly 27% of all cancer deaths.

It is estimated that 26,600 Canadians were diagnosed with lung cancer in 2015, and 20,900 died from the disease. Tobacco use is the leading cause of lung cancer. Radon exposure is the leading cause of lung cancer among non-smokers, accounting for about 3,000 lung cancer deaths in Canada every year.

Thirty five years ago, less than 13% of Canadians diagnosed with lung cancer survived at least 5 years after their diagnosis. The outlook is only a little better today at 17%. More research is needed to detect and treat lung cancer earlier and prevent it in the first place.
Canadian Cancer Society support of lung cancer research

Thanks to our donors, the Canadian Cancer Society is the largest national charitable funder of lung cancer research. Our donors invested $3.7 million in lung cancer research through our Research Institute in 2015. This supported 35 lead investigators across Canada exploring the biology behind lung cancer and new ways to detect it, treat it and prevent it before it starts.

Funded by our donors, the Canadian Cancer Trials Group (CCTG) is the only Canadian clinical trials group that studies all cancer types, with the ultimate goal of reducing the effects of cancer and improving survival. In 2015, 9 lung cancer clinical trials were active and involved 1,095 patients in cities across the country, including Kelowna, Vancouver, Edmonton, Regina, Saskatoon, Winnipeg, Hamilton, London, Ottawa, Toronto, Thunder Bay, Montreal, Quebec City, Sherbrooke, Saint John and others.

We’re making progress! Our researchers continue to bring new insight and approaches to tackling lung cancer. In 2015 the Canadian Cancer Society supported key research findings, including:

• Dr Leia Minaker of the Society-supported Propel Centre for Population Health Impact at the University of Waterloo found that hookah use for smoking shisha tobacco has increased in youth, highlighting the need for better surveillance to inform policies on tobacco control.

• Dr Geoffrey Fong from the University of Waterloo has influenced global tobacco control efforts, including studying the impact of graphic warnings on cigarette labels in Canada, which is informing international standards.

• Dr Ming-Sound Tsao from the University Health Network, Princess Margaret Cancer Centre, and Canadian Cancer Trials Group, showed that people with certain subtypes of lung cancer respond better to chemotherapy, encouraging the use of subtype classification for personalized treatment.

• Dr John Oliffe from the University of British Columbia developed a quit smoking website for men, based on studying factors that specifically motivate men.

• Dr Jean-Pierre Bissonnette from the University Health Network, Princess Margaret Cancer Centre, developed a new radiation treatment protocol for lung cancer that is being implemented at centres across Canada and the United States.

• Dr David Hammond of the University of Waterloo found that e-cigarette use in Canada was highest among smokers and young people – about half of whom had never smoked before – underlining the urgency to fully understand their health effects as they quickly rise in popularity.

We need to do more! In 2015 the Canadian Cancer Society committed to 17 new research grants and awards testing new ways to fight lung cancer, representing $6.5 million in new funding (including $625,000 in partnership with the Princess Margaret Cancer Centre) for the next 5 years.
Pancreatic cancer has one of the lowest survival rates of any cancer.

It is estimated that 4,800 Canadians were diagnosed with pancreatic cancer in 2015, and 4,600 died from the disease.

Today, only 8% of Canadians diagnosed with pancreatic cancer will survive at least 5 years after their diagnosis. More research is needed to detect and treat pancreatic cancer earlier.
Canadian Cancer Society support of pancreatic cancer research

Thanks to our donors, the Canadian Cancer Society is the largest national charitable funder of pancreatic cancer research. Our donors invested almost $1.3 million in pancreatic cancer research through our Research Institute in 2015. This supported 15 lead investigators across Canada exploring the biology behind pancreatic cancer and new ways to detect and treat it.

Funded by our donors, the Canadian Cancer Trials Group (CCTG) is the only Canadian clinical trials group that studies all cancer types, with the ultimate goal of reducing the effects of cancer and improving survival. In 2015, 2 pancreatic cancer clinical trials were active and involved 94 patients from cities across the country, including Vancouver, Saskatoon, Regina, Calgary, Winnipeg, Ottawa, Toronto, Sault Sainte Marie, Kingston, Barrie, Sudbury, Hamilton, London, Sherbrooke, Montreal, Quebec, Halifax and Moncton.

We’re making progress! Our researchers continue to bring new insight and approaches to tackling pancreatic cancer. In 2015 the Canadian Cancer Society supported key research findings, including:

• **Dr Steven Gallinger** from *Mount Sinai Hospital* determined how common BRCA mutations are in pancreatic cancers and identified a high-risk group that could benefit from genetic testing.

• **Dr Raymond Reilly** from *the University of Toronto* developed an imaging technique to visualize growing pancreatic tumours in mice, improving how pancreatic cancer can be studied.

• **Dr Senthil Muthuswamy** from *the University Health Network, Princess Margaret Cancer Centre*, developed 3-D “mini-tumours” called organoids from human pancreatic cancer cells, which can be used to test new treatments.

We need to do more! In 2015 the Canadian Cancer Society committed to 7 new research grants and awards testing new ways to study pancreatic cancer, representing $3.3 million in new funding (including $775,000 in partnership with the National Pancreatic Cancer Canada Foundation, Craig’s Cause Pancreatic Cancer Society, QEII Foundation and Princess Margaret Cancer Centre) for the next 5 years. These include:

• **Dr Shoukat Dedhar** from the *BC Cancer Agency* is testing new drugs in animal models and patients with pancreatic cancer to overcome drug resistance.

• **Dr Rebecca Auer** from the *Ottawa Hospital Research Institute* is developing a vaccine to boost the immune system after pancreatic cancer surgery to prevent remaining cancer cells from spreading.

• **Dr David Perrin** from the *University of British Columbia* is developing a toxin derived from wild mushrooms to selectively target cancer cells, including pancreatic cancers.
A Focus on Colorectal Cancer

It is estimated that 25,100 Canadians were diagnosed with colorectal cancer in 2015, and 9,300 died from the disease.

Today, 64% of Canadians diagnosed with colorectal cancer will survive at least 5 years after their diagnosis. More research is needed to ensure all eligible Canadians are screened, find new colorectal cancer treatments and prevent the disease before it starts.
Canadian Cancer Society support of colorectal cancer research

Thanks to our donors, the Canadian Cancer Society is the largest national charitable funder of colorectal cancer research. Our donors invested almost $1.6 million in colorectal cancer research through our Research Institute in 2015. This supported 29 lead investigators across Canada exploring the causes of colorectal cancer, new ways to detect and treat it, and new ways to improve the quality of life of those living with cancer.

Funded by our donors, the Canadian Cancer Trials Group (CCTG) is the only Canadian clinical trials group that studies all cancer types, with the ultimate goal of reducing the effects of cancer and improving survival. In 2015, 6 colorectal cancer clinical trials were active and involved 890 patients from cities across the country, including Victoria, Vancouver, Regina, Ottawa, Toronto, Kingston, St Catharines, Barrie, Hamilton, Sherbrooke, Montreal, Laval, Halifax, Fredericton, Moncton and many others.

We’re making progress! Our researchers continue to bring new insight and approaches to tackling colorectal cancer. In 2015 the Canadian Cancer Society supported key research findings, including:

- **Dr Daniel De Carvalho** from the University Health Network, Princess Margaret Cancer Centre, showed that a drug could trick colorectal cancer cells into responding as if they had been infected with a virus, suppressing their ability to multiply.

- **Dr Will King** from Queen’s University showed that people with certain genetic features are more susceptible to meat-derived carcinogens and risk of colorectal cancer.

- **Dr Jolie Ringash** from the University Health Network, Princess Margaret Cancer Centre, and Society-funded Canadian Cancer Trials Group, found that while a combination of 2 drugs delayed progression of advanced colorectal cancer, patients’ quality of life deteriorated much faster.

We need to do more! In 2015 the Canadian Cancer Society committed to 12 new research grants and awards to study colorectal cancer, representing $4.1 million in new funding (including $625,000 in partnership with Princess Margaret Cancer Centre) for the next 5 years. These include:

- **Dr Alberto Martin** from the University of Toronto is investigating how gut bacteria contribute to the development of colorectal cancer.

- **Dr Ivan Topisirovic** from the Jewish General Hospital is mapping the energy metabolism of colorectal cancer cells to discover weak points that can be targeted by treatment.

- **Dr Mitsuhiko Ikura** from the University Health Network, Princess Margaret Cancer Centre, is studying how mutations in a protein called RAS drive tumours like colorectal cancer in order to identify new therapies.
It is estimated that 2,800 Canadians were diagnosed with ovarian cancer in 2015, and 1,750 died from the disease.

Today, only 45% of Canadian women diagnosed with ovarian cancer will survive at least 5 years after their diagnosis. More research is needed to detect ovarian cancer earlier and improve treatment.
Canadian Cancer Society support of ovarian cancer research

Thanks to our donors, the Canadian Cancer Society is the 2nd largest national charitable funder of ovarian cancer research. Our donors invested almost $1.3 million in ovarian cancer research through our Research Institute in 2015. This supported 19 lead investigators across Canada exploring the biology behind ovarian cancer and new ways to detect and treat it.

Funded by our donors, the Canadian Cancer Trials Group (CCTG) is the only Canadian clinical trials group that studies all cancer types, with the ultimate goal of reducing the effects of cancer and improving survival. In 2015, 3 ovarian cancer clinical trials were active and involved 266 patients from cities across the country, including Vancouver, Kelowna, Surrey, Calgary, Edmonton, Winnipeg, Ottawa, Toronto, Kingston, Barrie, Hamilton, London, Thunder Bay, Sherbrooke, Montreal, Quebec, St. John’s, St. John, and Halifax.

We’re making progress! Our researchers continue to bring new insight and approaches to tackling ovarian cancer. In 2015 the Canadian Cancer Society supported key research findings, including:

• Dr David Huntsman from the BC Cancer Agency identified a new diagnostic biomarker for a rare and aggressive form of ovarian cancer.

• Dr Joanne Kotsopoulos from Women’s College Hospital uncovered new risk factors for ovarian cancer in women with BRCA mutations.

• Dr Rayjean Hung from Mount Sinai Hospital revealed genetic variations involved in inflammation that increase the risk of developing several cancers, including ovarian cancer.

We need to do more! In 2015 the Canadian Cancer Society committed to 6 new research grants and awards testing new approaches for ovarian cancer, representing $2.1 million in new funding (including $750,000 in partnership with the Lotte & John Hecht Memorial Foundation) for the next 5 years. These include:

• Dr Daniel Durocher from Mount Sinai Hospital is studying how to counter drug resistance from a new drug for advanced ovarian cancer.

• Dr Brad Nelson from the BC Cancer Agency is testing the combination of oncolytic viruses and antibodies to selectively target and kill ovarian cancer cells.

• Dr Amit Oza from the University Health Network, Princess Margaret Cancer Centre is conducting a clinical trial to see if aspirin can be used to prevent ovarian cancer in high-risk women.
How CCSRI Selects the Best Research
Expert review process

4 steps to funding our gold-standard research

1. APPLY
   Hundreds of researchers from across Canada submit applications to the Canadian Cancer Society Research Institute.
   
   710 applications were received

2. REVIEW
   Review panels of the top experts from Canada and around the world volunteer their time to evaluate the research applications and their potential impact on people affected by cancer.
   
   221 researchers and 23 community representatives volunteered 9,182 hours to identify gold-standard projects

3. RECOMMEND
   Scores are assigned to each application and presented to the Advisory Council on Research (ACOR), the Society’s most senior scientific advisory group. ACOR recommends which projects should be funded.
   
   16 leading scientists, clinicians and other experts are members of ACOR

4. INVEST
   The Society supports the most innovative and promising cancer research in Canada, thanks to our donors.
   
   In 2015 we invested $38.1 million to support 297 lead scientists. Only 14% of applications were funded – we need your support to do more!

In 2015 we could have supported 104 additional priority-rated grants representing a potential funding commitment of $27M.

We need your support to invest in more world-class research.

Donate at cancer.ca or call 1 888 939-3333.
### Newly awarded grants and awards in 2015

In 2015 CCSRI awarded 135 new research grants and awards, representing new commitments of $38.3 million over the next five years.

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<thead>
<tr>
<th>Category</th>
<th>Commitment</th>
<th>Partnerships</th>
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<tr>
<td>5 Prevention Research Grants</td>
<td>$2.35 million commitment</td>
<td>1 in partnership with the Canadian Institutes of Health Research and its Institute of Cancer Research</td>
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<tr>
<td>4 Career Development Awards</td>
<td>$900 thousand commitment</td>
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<tr>
<td>63 Innovation Grants</td>
<td>$12.32 million commitment</td>
<td>3 in partnership with the Lotte &amp; John Hecht Memorial Foundation</td>
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<tr>
<td>9 Innovation to Impact Grants</td>
<td>$3.9 million commitment</td>
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<td>13 Impact Grants</td>
<td>$15.7 million commitment</td>
<td>4 in partnership with Brain Canada, 1 in partnership with Brain Tumour Foundation Canada, 1 in partnership with Princess Margaret Cancer Foundation and 1 in partnership with the Lotte &amp; John Hecht Memorial Foundation</td>
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<tr>
<td>4 Quality of Life Research</td>
<td>$1.1 million commitment</td>
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<tr>
<td>6 Knowledge to Action Grants</td>
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<tr>
<td>31 Travel Awards</td>
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Advisory Council on Research and program development committees

As the Society’s most senior scientific advisory group, the Advisory Council on Research (ACOR) provides strategic advice related to CCSRI’s research programs and ultimately ensures that we fund the best cancer research in Canada. ACOR is made up of national experts who have a superior understanding of cancer research and its relevance to cancer control. ACOR members also have strong ties to CCSRI, having served as expert peer reviewers or panel chairs in the past. Members help evaluate the review process, provide advice to senior leadership on research funding strategies, recommend support for particular grants and programs, and help monitor the overall direction and focus of the research institute. ACOR members volunteer hours of their time to help the Society achieve its mission.

Dr Robert Bristow, University Health Network, Princess Margaret Cancer Centre, Toronto

Pamela Fralick, Canadian Cancer Society, Toronto (Ex-officio)

Dr Carolyn Gotay, University of British Columbia, Vancouver (Vice-Chair)

Dr Eva Grunfeld, University of Toronto, Toronto

Dr David Huntsman, BC Cancer Agency, Vancouver

Martin Kabat, Canadian Cancer Society – Ontario Division, Toronto

Dr Jon Kerner, Canadian Partnership Against Cancer, Toronto

Dr Michael Moran, The Hospital for Sick Children, Toronto

Dr Hanne Ostergaard, University of Alberta, Edmonton

Dr Morag Park, McGill University, Montreal

Dr Louise Parker, Dalhousie University, Halifax (Term Complete)

Dr Jolie Ringash, University Health Network, Princess Margaret Cancer Centre, Toronto

Dr Stephen Robbins, University of Calgary, Calgary (Ex-officio)

Dr Gary Rodin, University Health Network, Princess Margaret Cancer Centre, Toronto

Dr Calvin Roskelley, University of British Columbia, Vancouver (Scientific Chair)

Dr Michel Tremblay, McGill University, Montreal (Term Complete)

Dr Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre, Toronto

Dr Christine Williams, Canadian Cancer Society, Toronto (Ex-officio)

CCSRI also relies on 3 program development committees corresponding to the broad areas in which CCSRI funds research: prevention and risk reduction; basic, biomedical and translational; and quality of life. These subcommittees provide support and advice to ACOR and CCSRI on research funding priorities and programs. The committees are chaired by ACOR members but are primarily composed of experts from the wider scientific community in Canada and internationally.

Prevention program development committee

Dr Rachel Ballard-Barbash, National Cancer Institute, Rockville

Dr Siàn Bevan, Canadian Cancer Society, Toronto (Ex-officio)

Dr Deborah Bowen, Boston University, Boston

Dr Angela Brooks-Wilson, BC Cancer Agency, Vancouver

Dr Paul Demers, Cancer Care Ontario, Toronto

Dr Eduardo Franco, McGill University, Montreal

Dr Christine Friedenreich, Alberta Health Services – Cancer Control Alberta, Calgary
Dr Carolyn Gotay, University of British Columbia, Vancouver (Chair)
Dr David Hammond, University of Waterloo, Waterloo
Barbara Kaminsky, Canadian Cancer Society – British Columbia/Yukon Division, Vancouver
Dr Jon Kerner, Canadian Partnership Against Cancer, Toronto
Dr Will King, Queen’s University, Kingston
Dr Robert Nuttall, Canadian Cancer Society, Toronto
Dr Louise Parker, Dalhousie University, Halifax
Rowena Pinto, Canadian Cancer Society – Ontario Division, Toronto
Dr Barbara Riley, University of Waterloo, Waterloo
Dr Jill Tinmouth, Sunnybrook Research Institute, Toronto

Basic, biomedical and translational program development committee
Dr Siân Bevan, Canadian Cancer Society, Toronto (Ex-officio)
Dr Robert Bristow, University Health Network, Princess Margaret Cancer Centre, Toronto
Dr David Huntsman, BC Cancer Agency, Vancouver
Dr Michael Moran, The Hospital for Sick Children, Toronto
Dr Hanne Ostergaard, University of Alberta, Edmonton
Dr Morag Park, McGill University, Montreal
Dr Stephen Robbins, University of Calgary, Calgary
Dr Calvin Roskelley, University of British Columbia, Vancouver (Chair)
Dr Michel Tremblay, McGill University, Montreal (Term Complete)
Dr Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre, Toronto

Quality of life program development committee
Dr Shabbir Alibhai, University Health Network, Toronto General Research Institute, Toronto
Dr Lynda Balneaves, University of Toronto, Toronto
Dr Siân Bevan, Canadian Cancer Society, Toronto (Ex-officio)
Gillian Bromfield, Canadian Cancer Society, Toronto (Term Complete)
Dr Michael Brundage, Queen’s University, Kingston
Mélanie Champagne, Canadian Cancer Society – Quebec Division, Montreal
Dr Harvey Chochinov, University of Manitoba, Winnipeg
Dr Lise Fillion, Université Laval, Quebec
Dr Eva Grunfeld, University of Toronto, Toronto
Dr Jeffrey Hoch, St. Michael’s Hospital, Toronto
Dan Holinda, Canadian Cancer Society – Alberta Division, Calgary
Gabriel Miller, Canadian Cancer Society, Ottawa
Dr Patricia Parker, University of Texas, Houston
Dr Jolie Ringash, University Health Network, Princess Margaret Cancer Centre, Toronto
Dr Gary Rodin, University Health Network, Princess Margaret Cancer Centre, Toronto
Dr Zeev Rosberger, McGill University, Montreal (Chair, Term Complete)
Dr Lillian Sung, Hospital for Sick Children, Toronto
Recognition of long service

Many experts have volunteered hundreds of hours to support CCSRI’s expert peer review process. The following individuals were recognized for their outstanding support of the Society’s research programs in 2015 upon reaching their 5th or 10th year of service.

5 years of service
Dr Deborah Anderson, University of Saskatchewan, Saskatoon
Dr Samuel Aparicio, BC Cancer Agency, Vancouver
Dr Shairaz Baksh, University of Alberta, Edmonton
Dr Kevin Bennewith, BC Cancer Agency, Vancouver
Dr David Brindley, University of Alberta, Edmonton
Sharon Chandler (Community Representative), Toronto
Dr Robin Cohen, Jewish General Hospital, Montreal
Dr Daniel Durocher, Mount Sinai Hospital, Toronto
Dr Gerardo Ferbeyre, Université de Montréal, Montreal
Dr Spencer Gibson, University of Manitoba, Winnipeg
Dr Michael Hendzel, University of Alberta, Edmonton
Dr Igor Karp, Western University, London
Dr Karen Kopciuk, Alberta Health Services, Calgary
Dr Marianne Koritzinsky, University Health Network, Princess Margaret Cancer Centre, Toronto
Dr Piotr Kozlowski, University of British Columbia, Vancouver
Dr Maja Krajnovic, Université de Montréal, Montreal
Dr Sam Kung, University of Manitoba, Winnipeg
Dr Shawn Li, Western University, London

Dr Donald Mabbott, The Hospital for Sick Children, Toronto
Dr Sylvie Mader, Université de Montréal, Montreal
Dr Sylvain Meloche, Université de Montréal, Montreal
Dr Torsten Nielsen, University of British Columbia, Vancouver
Dr Michael Patterson, Juravinski Cancer Centre, Hamilton
Dr Gilbert Privé, University Health Network, Princess Margaret Cancer Centre, Toronto
Dr Lillian Sung, The Hospital for Sick Children, Toronto
Robert Tuck (Community Representative), North Bay
Dr Josie Ursini-Siegel, McGill University, Montreal
Dr James Wright, Juravinski Cancer Centre, Hamilton
Dr Jeremy Wulff, University of Victoria, Victoria

10 years of service
Dr Robert Bristow, University Health Network, Princess Margaret Cancer Centre, Toronto
Dr Margaret Fitch, Sunnybrook Health Sciences Centre, Toronto
Dr David Hunstman, BC Cancer Agency, Vancouver
Dr Anne Leis, University of Saskatchewan, Saskatoon
Dr Stephen Robbins, University of Calgary, Calgary
Dr Calvin Roskelley, University of British Columbia, Vancouver
Dr André Veillette, Institut de Recherches Cliniques de Montréal, Montreal
Celebrating Research Excellence

Awards for Excellence in Cancer Research

Discussion panel with award recipients
Since 1993, the Canadian Cancer Society has recognized outstanding cancer science by awarding Canadian Cancer Society Awards for Excellence to deserving Canadian researchers. This year, we celebrated the achievements of the following award recipients for their contributions to our understanding of how cancers arise, how they work and how to defeat them.

**Robert L. Noble Prize**

The Robert L. Noble Prize is awarded to an investigator permanently residing in Canada whose contributions have led to significant accomplishments in a body of work in basic biomedical cancer research and who is normally still engaged in the conduct of cancer research.

It honours Dr Noble, an esteemed Canadian investigator whose research in the 1950s led to the discovery of vinblastine, a widely used anticancer drug.

**Shared by**

**Dr Rama Khokha** of the Princess Margaret Cancer Centre and the University of Toronto, for her outstanding contributions to our understanding of how cancers develop and to advancing research methods. Her discoveries of how the hormone progesterone impacts breast stem cells have transformed how researchers think about the links between sex hormone status, stem cell biology and breast cancer risk.

And

**Dr James T. Rutka** of The Hospital for Sick Children and the University of Toronto, for his exceptional achievements in translational cancer research and dedication to improving outcomes for children with brain cancer. His research on how pediatric brain cancers evolve has identified potential new drug targets and led to new ways of classifying medulloblastomas, changing the way clinicians make treatment decisions.
Bernard and Francine Dorval Prize
The Bernard and Francine Dorval Prize is awarded to a young investigator permanently residing in Canada who began his or her independent research career within the previous 10 years. The recipient must be the principal investigator of activities conducted in Canada that have made outstanding contributions to basic biomedical research that have the potential to lead to, or have already led to, an improved understanding of cancer treatments and/or cures.

It honours Bernard and Francine Dorval, 2 individuals who are dedicated, longstanding supporters of the Society’s research programs.

Awarded to
Dr Russell Jones of McGill University, for his leadership in the fields of immunology and cancer biology. His contributions to our understanding of cancer cell metabolism and the behaviour of cells in the immune system have made major impacts on the scientific community, including the first revelation that the AMPK gene can act as a tumour suppressor.

O. Harold Warwick Prize
The O. Harold Warwick Prize is awarded to an investigator permanently residing in Canada who has undertaken studies in Canada that have led to significant advances in cancer control and who is normally still engaged in the conduct of cancer research.

It honours Dr Warwick, a pioneering researcher in cancer control and treatment, who became the first executive director of both the former National Cancer Institute of Canada and the Canadian Cancer Society.

Awarded to
Dr Laurence Klotz of the Sunnybrook Health Sciences Centre and the University of Toronto, for his transformative contributions to evidence-based treatment standards for prostate cancer. His call for conservative management of men with a low risk of developing aggressive prostate cancer has led to reductions in overtreatment and improved quality of life for hundreds of thousands of men around the world.
William E. Rawls Prize

The William E. Rawls Prize is awarded to a young investigator permanently residing in Canada who began his or her independent research career within the previous 10 years. The recipient must be the principal investigator of activities conducted in Canada that have made outstanding contributions that have the potential to lead to, or have already led to, important advances in cancer control.

It honours Dr Rawls, who served on numerous committees and advisory groups of the former National Cancer Institute of Canada and was elected president in 1986. His research focused on viruses, particularly those involved in chronic diseases and cervical cancer.

Awarded to

Dr Michael Taylor of The Hospital for Sick Children and the University of Toronto, for his significant contributions to the study of the molecular genetics and epigenetics of the childhood brain cancers medulloblastoma and ependymoma. By defining how these cancers can be grouped into several distinct subtypes, his research is improving how children with brain cancer are treated and enhancing their quality of life.
Dr. Jennifer Brunet (back row, 2nd from left) with team members and physical activity study participants, University of Ottawa