Acknowledgements

This report was prepared by a team of staff at CCSRI including Dr Siân Bevan, Director, Research; Lisa Carney, Research Analyst; Dr Mavis Jones, Research Communications Specialist; Rudy Valentim, Senior Advisor, Research Monitoring and Evaluation, 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 Shelley Anderson, Jessica Balmer, Carol Bishop, Taryn Linder, Cate Menmema, Lori Moser, Sheila Porter, Roberta Varga, and Dr Christine Williams.

An electronic version of the report is available on the CCSRI website: cancer.ca/research

For inquiries please contact CCSRI at research@cancer.ca

focus /ˈfокəs/ n. & v. • n. 1 a state of clear definition. 2 the centre of interest, activity, or greatest energy (focus of attention). 3 the primary or principal site of an infection, malignant growth, or other disease. • v. 1 bring into focus, etc. 2 concentrate or be concentrated on. 3 converge or make converge to a focus.
# Table of Contents

**Message from the Vice-President, Research and Policy, and the Scientific Chair of the Advisory Council on Research (ACOR)**  
02

**Executive Summary**  
03

**How CCSRI Selects the Best Research**  
04
- Expert review process  
05
- Advisory Council on Research and program development committees  
06
- Recognition of long service  
09
- Funding programs  
10
- Program descriptions  
12

**Why Do You Support Canadian Cancer Society Research?**  
14

**Research Investment in 2014**  
16
- By research area  
17
- By cancer type  
18
- By cancer type relative to incidence and mortality rates  
19
- By region  
20
- By institution  
21
- By funding program  
22
- Clinical trials  
23
- Strength through partnerships  
24
- Our visionary donors  
26

**A Focus On Brain Cancer**  
28

**Research Outcomes and Impacts in 2014**  
30
- Monitoring and evaluation framework  
31
- Outcomes and impacts  
32
- Research impact stories  
34

**A Focus On Lung Cancer**  
80

**Celebrating Research Excellence**  
82

**A Focus On Pancreatic Cancer**  
86

**Society-funded Research in the Media: 2014 Highlights**  
88
Message from the Vice-President, Research and Policy, and the Scientific Chair of the Advisory Council on Research (ACOR)

The Canadian Cancer Society has a clear mission to eradicate cancer, and until we do, reduce its impact on Canadians through enhanced quality of life. With the support of Canadians, we work to support this mission by providing prevention and support programs, making cancer information available, supporting advocacy efforts and funding research aimed at reducing cancer incidence, reducing cancer mortality and enhancing the quality of life for those living with and beyond cancer. The research portfolio of the Canadian Cancer Society Research Institute (CCSRI) is tailored to work with the research communities pursuing these goals.

Thanks to the generosity of the Society’s donors, we are the largest national charitable funder of cancer research and the 4th largest funder in Canada. In this 2014 CCSRI Research Impact Report, you will read how evidence from research supported by the Society has changed clinical practice and government policies. Researchers funded by the Society have produced over 700 publications, many in prestigious journals like Nature, Science and The Lancet. Most importantly, new discoveries are improving our ability to prevent, detect and treat cancers and uncovering new ways to improve the quality of life for people affected by cancer.

In 2014 the Society invested in 187 new research grants and awards, representing new commitments of $42.3 million over the next 5 years. This year marked the 3rd year for CCSRI’s new research programs supporting scientific innovation and impact across the research spectrum: prevention, biomedical and clinical work, quality of life, and knowledge to action studies. These new programs have successfully engaged the research community, as evidenced by increasing numbers of applications each year. We are also excited to have launched the Prevention Network (preventionnetwork.ca) to support Canada’s prevention community to share and apply knowledge across the research, practice and policy communities and accelerate our collective impact on cancer.

This year the Society was proud to partner with several organizations to make collaborative investments in cancer research, including the Canadian Breast Cancer Foundation, the Canadian Institutes of Health Research, the New Brunswick Health Research Foundation, Craig’s Cause Pancreatic Cancer Society, QEII Foundation, Prostate Cancer Canada, Brain Canada, and the Lotte & John Hecht Memorial Foundation. We are also grateful to the many donors who have generously supported the Society’s research programs, and in particular, those who have endowed major gifts to research that have been recognized with the naming of CCSRI grants (see page 26). This work would simply not be possible without the ongoing support we receive from Canadians.

CCSRI grants and awards are considered a mark of excellence in the research community, and our expert review process (see page 05) remains a gold standard for rigour and efficiency. Our scientists and community volunteers provide exceptional service to this process. In 2014 we recognized 26 individuals who have committed their time to CCSRI for 5 years and 9 individuals who have volunteered for 10 years – all to ensure that we fund the best cancer research in the country (see page 09).

It is because of your support that we have been able to fund world-class research for over 65 years. It is no coincidence that, over that time period, we have seen the survival rate for all cancers rise from 28% to 63%. We hope you enjoy CCSRI’s 2014 Research Impact Report and find it a valuable resource highlighting the impact of excellent research that the Society is proud to support.

Dr Christine Williams
Vice President, Research and Policy
Canadian Cancer Society

Dr Calvin Roskelley
Scientific Chair
Advisory Council on Research
The Canadian Cancer Society has a clear mission to eradicate cancer and until we do, reduce its impact on Canadians through enhanced quality of life. With the support of Canadians, we work to support that mission by providing prevention and support programs, making cancer information available, supporting advocacy efforts and funding research aimed at reducing cancer incidence, reducing cancer mortality and enhancing the quality of life for those living with and beyond cancer. The research portfolio of the Canadian Cancer Society Research Institute (CCSRI) is tailored to work with the research communities pursuing these goals.

Thanks to the generosity of the Society’s donors, we are the largest national charitable funder of cancer research and the 4th largest funder in Canada. In this 2014 CCSRI Research Impact Report, you will read how evidence from research supported by the Society has changed clinical practice and healthcare and policy outcomes, provide an analysis of CCSRI’s investment portfolio, give a summary of selected research outcomes, and tell 83 stories about the impact of the research funded. We explain CCSRI’s expert peer review and evaluation processes, provide an analysis of CCSRI’s investment portfolio, give a summary of selected research outcomes, and tell 83 stories about the impact of the research funded. We explain CCSRI’s expert peer review and evaluation processes, provide an analysis of CCSRI’s investment portfolio, give a summary of selected research outcomes, and tell 83 stories about the impact of the research funded. We explain CCSRI’s expert peer review and evaluation processes, provide an analysis of CCSRI’s investment portfolio, give a summary of selected research outcomes, and tell 83 stories about the impact of the research funded.

This year the Society was proud to partner with several organizations to initiate partnerships and co-investments in research and cancer control initiatives, including the Canadian Institutes of Health Research, the Canadian Institutes of Health Research, the Canadian Institutes of Health Research, the Canadian Institutes of Health Research, and The Lancet. Most importantly, new discoveries are improving our understanding of cancer, providing prevention and support programs, making cancer information available, supporting advocacy efforts and funding research aimed at reducing cancer incidence, reducing cancer mortality and enhancing the quality of life for those living with and beyond cancer. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

This report provides an overview of CCSRI’s investments in 2014 and highlights the impact of the research funded. We explain CCSRI’s expert peer review and evaluation processes, provide an analysis of CCSRI’s investment portfolio, give a summary of selected research outcomes, and tell 83 stories about the impact of the research funded. CCSRI’s research is recognized across the country.

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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

The Canadian Cancer Society has a clear mission 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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.

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. Since 1947, the Society has supported thousands of Canadian researchers by providing more than $1.5 billion in cancer research funding. Through research grants, awards and three major research centres, CCSRI funds work across the research spectrum.
How CCSRI Selects the Best Research

Dr Bharati Bapat, Mount Sinai Hospital, Dr Andrew Craig, Queen’s University and others at a CCSRI expert review panel meeting
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.

   - 698 applications were received

2. **REVIEW** Review panels of top experts from Canada and around the world volunteer their time to evaluate the research applications and their potential impact on patients and populations affected by cancer.

   - 224 researchers and 27 community representatives volunteered
   - 9,665 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.

   - 17 leading scientists, clinicians and other experts are members of ACOR

4. **INVEST** The Society funds the most innovative and promising cancer research in Canada, thanks to our donors.

   - In 2014 we could have supported 155 additional priority-rated grants representing a potential funding commitment of $34.3M.
   - We need your support to invest in more world-class research.

   - In 2014, we invested $37 million in research, in support of 312 lead scientists. Only 20% of applications were funded – we need your support to do more!
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.

Robert Bristow, University Health Network, Princess Margaret Cancer Centre, Toronto
Pamela Fralick, Canadian Cancer Society, Toronto (Ex-officio)
Carolyn Gotay, University of British Columbia, Vancouver (Vice-Chair)
Eva Grunfeld, University of Toronto, Toronto
David Huntsman, British Columbia Cancer Agency, Vancouver
Martin Kabat, Canadian Cancer Society – Ontario Division, Toronto
Jon Kerner, Canadian Partnership Against Cancer, Toronto
Michael Moran, Hospital for Sick Children, Toronto
Hanne Ostergaard, University of Alberta, Edmonton
Morag Park, McGill University, Montreal
Louise Parker, Dalhousie University, Halifax
Jolie Ringash, University Health Network, Princess Margaret Cancer Centre, Toronto
Stephen Robbins, University of Calgary, Calgary (Ex-officio)
Gary Rodin, University Health Network, Princess Margaret Cancer Centre, Toronto
Zeev Rosberger, McGill University, Montreal (Term Complete)
Calvin Roskelley, University of British Columbia, Vancouver (Scientific Chair)
Michel Tremblay, McGill University, Montreal
Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre, Toronto
Christine Williams, Canadian Cancer Society, Toronto (Ex-officio)
Brian Wilson, University Health Network, Princess Margaret Cancer Centre, Toronto (Past Chair)
CCSRI also relies on three 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

Rachel Ballard-Barbash, National Cancer Institute, Rockville
Siân Bevan, Canadian Cancer Society, Toronto (Ex-officio)
Deborah Bowen, Boston University, Boston
Angela Brooks-Wilson, British Columbia Cancer Agency, Vancouver
Paul Demers, Cancer Care Ontario, Toronto
Eduardo Franco, McGill University, Montreal
Christine Friedenreich, University of Calgary and Alberta Health Services, Calgary
Carolyn Gotay, University of British Columbia, Vancouver (Chair)
David Hammond, University of Waterloo, Waterloo
Barbara Kaminsky, Canadian Cancer Society – British Columbia/Yukon Division, Vancouver
Jon Kerner, Canadian Partnership Against Cancer, Toronto
Will King, Queen’s University, Kingston
Robert Nuttall, Canadian Cancer Society, Toronto
Louise Parker, Dalhousie University, Halifax
Rowena Pinto, Canadian Cancer Society – Ontario Division, Toronto
Barbara Riley, University of Waterloo, Waterloo
Jill Tinmouth, Sunnybrook Research Institute, Toronto
Basic, biomedical and translational program development committee

Siân Bevan, Canadian Cancer Society, Toronto (Ex-officio)
Robert Bristow, University Health Network, Princess Margaret Cancer Centre, Toronto
David Huntsman, British Columbia Cancer Agency, Vancouver
Michael Moran, Hospital for Sick Children, Toronto
Hanne Ostergaard, University of Alberta, Edmonton
Morag Park, McGill University, Montreal
Stephen Robbins, University of Calgary, Calgary
Calvin Roskelley, University of British Columbia, Vancouver (Chair)
Michel Tremblay, McGill University, Montreal
Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre, Toronto
Brian Wilson, University Health Network, Princess Margaret Cancer Centre, Toronto

Quality of life program development committee

Shabbir Alibhai, Univeristy Health Network, Toronto General Research Institute, Toronto
Lynda Balneaves, University of Toronto, Toronto
Siân Bevan, Canadian Cancer Society, Toronto (Ex-officio)
Michael Brundage, Queen’s University, Kingston
Lise Fillion, Université Laval, Quebec
Jeffrey Hoch, St. Michael’s Hospital, Toronto
Dan Holinda, Canadian Cancer Society – Alberta Division, Calgary
Line Lafontaisie, Canadian Cancer Society – Quebec Division, Montreal
Patricia Parker, University of Texas, Houston
Jolie Ringash, Univeristy Health Network, Princess Margaret Cancer Centre, Toronto
Gary Rodin, Univeristy Health Network, Princess Margaret Cancer Centre, Toronto
Zeev Rosberger, McGill University, Montreal (Chair, Term Complete)
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 2014 upon reaching their 5th or 10th year of service.

5 years of service

Marcel Bally, British Columbia Cancer Agency, Vancouver
Samuel Benchimol, York University, Toronto
Joan Bottorff, University of British Columbia (Okanagan), Kelowna
Andrew Craig, Queen’s University, Kingston
Gillian Cunningham (Community Representative), North Saanich
Lise Fillion, Université Laval, Quebec
Paula Foster, Western University, London
Steven Gallinger, University Health Network, Toronto General Research Institute, Toronto
Diane Hawrylenko (Community Representative), Kitchener
Trang Hoang, Université de Montréal, Montreal
Meredith Irwin, Hospital for Sick Children, Toronto
Norman Iscove, University Health Network, Princess Margaret Cancer Centre, Toronto
Kevin Kane, University of Alberta, Edmonton
Will King, Queen’s University, Kingston
Susan Lees-Miller, University of Calgary, Calgary
Carmen Loiselle, McGill University, Montreal

Calum MacAulay, British Columbia Cancer Agency, Vancouver
Brian Marshall (Community Representative), Ottawa
Stefan Reinsberg, University of British Columbia, Vancouver
Daniela Rotin, Hospital for Sick Children, Toronto
Sohrab Shah, British Columbia Cancer Agency, Vancouver
Trevor Shepherd, Western University, London
Marko Simunovic, McMaster University, Hamilton
Daniel Sinnett, Université de Montréal, Montreal
Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre, Toronto
Brad Wouters, University Health Network, Princess Margaret Cancer Centre, Toronto

10 years of service

Michael Brundage, Queen’s University, Kingston
Aaron Fenster, Robarts Research Institute, Kingston
Margaret Fitch, Sunnybrook Research Institute, Toronto
Eduardo Franco, McGill University, Montreal
David Huntsman, British Columbia Cancer Agency, Vancouver
Rama Khokha, University Health Network, Princess Margaret Cancer Centre, Toronto
Anne Leis, University of Saskatchewan, Saskatoon
Hanne Ostergaard, University of Alberta, Edmonton
Claude Perreault, Université de Montréal, Montreal
## Funding programs

### Grants and awards

<table>
<thead>
<tr>
<th>Program Type</th>
<th>Description</th>
<th>Funding Details</th>
<th>Awards per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention Research Grants</td>
<td>To accelerate risk reduction research</td>
<td>up to $600K</td>
<td>5-6 new grants per year</td>
</tr>
<tr>
<td>CCS-Partner Prevention Research Grants</td>
<td>To promote collaboration and reduce cancer incidence</td>
<td>up to $800K</td>
<td>2-3 new grants every 2 years</td>
</tr>
<tr>
<td>Capacity Development Awards in Prevention</td>
<td>To provide salary and research support</td>
<td>up to $225K</td>
<td>4-8 new awards per year</td>
</tr>
<tr>
<td>Population Health Intervention Research Grants</td>
<td>To support research on rapidly unfolding events</td>
<td>up to $200K</td>
<td>1-2 new grants per year</td>
</tr>
<tr>
<td>Innovation Grants</td>
<td>To support high-risk/high-reward creative solutions in cancer research</td>
<td>up to $200K</td>
<td>40-50 new grants per year</td>
</tr>
<tr>
<td>Innovation to Impact (i2I) Grants</td>
<td>To support development of successful findings from a funded Innovation Grant</td>
<td>up to $450K</td>
<td>10-12 new grants per year</td>
</tr>
<tr>
<td>Impact Grants</td>
<td>To support well-developed cancer research programs</td>
<td>up to $1.25M</td>
<td>up to 10 new grants per year</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</td>
<td>up to $300K</td>
<td>4-6 new grants per year</td>
</tr>
<tr>
<td>Knowledge to Action Grants</td>
<td>To close the gap between research evidence and practice</td>
<td>up to $100K</td>
<td>up to 4 new grants per year</td>
</tr>
<tr>
<td>Travel Awards</td>
<td>For trainees attending conferences</td>
<td>up to $2K</td>
<td>30 new awards per year</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.

- **NCIC Clinical Trials Group (NCIC CTG)** is a cooperative oncology group involving more than 90 member institutions across Canada that 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, particularly in the area of tobacco control and youth health.
Dr John Bell (centre) with his team, Ottawa Hospital Research Institute
Program descriptions

Grants and awards

Prevention Research Grants to support and accelerate research and the application of new knowledge. Projects must demonstrate a specific and defined potential for impact on cancer incidence, for example prevention/risk reduction research, programs, and practice, including knowledge translation, best practices and health-related decision making at the individual, organizational or health system levels.

- 10 new grants in 2014, representing a $4.63 million funding commitment over the next 5 years
- 7 in partnership with the Canadian Institutes of Health Research and its Institute of Cancer Research

CCS-Partner Prevention Research Grants to support research in key prevention and risk reduction areas by working together with the Canadian Cancer Society to inform and influence public policy and programs offered by the Society. Programs must contain a training component to build research capacity in this area.

- 1 new grant in 2014 representing a $782 thousand funding commitment over the next 5 years

Capacity Development Awards in Prevention to provide salary and research support during the early years of a developing career for cancer prevention researchers.

- 6 new awards in 2014 representing a $1.35 million funding commitment over the next 4 years
- 2 in partnership with the Canadian Breast Cancer Foundation

Population Health Intervention Research Grants in partnership with the Canadian Institutes of Health Research – Institute of Population Health to support population health intervention research on rapidly unfolding programs, policies and resource distribution.

- 1 new grant in 2014 representing a $199 thousand funding commitment over the next 2 years

Impact Grants to support the progression of research programs through large-scale and long-term funding. They will accelerate and focus the knowledge gained from scientific findings, in the short or long term, into outcomes that will significantly advance the understanding of cancer and improve scientific knowledge, which will result in optimized patient care, improved cancer treatment or reduced cancer burden.

- 10 new grants in 2014 representing an $11.94 million funding commitment over the next 5 years

Innovation Grants to support innovative, creative problem solving in cancer research. They will accelerate the introduction of innovation into the entire cancer research system and contribute to the scientific idea pipeline.

- 97 new grants in 2014 representing an $18.55 million funding commitment over the next 3 years
- 6 in partnership with the Lotte & John Hecht Memorial Foundation, 1 in partnership with Prostate Cancer Canada, and 1 in partnership with Craig’s Cause Pancreatic Cancer Society and the New Brunswick Health Research Foundation
Innovation to Impact Grants to extend the funding pipeline by building on significant findings from successful Innovation Grants. This is an opportunity for investigators to advance their program of research to the point where they can apply for Impact Grants or other large-scale funding mechanisms.

- 4 new grants in 2014 representing a $1.79 million funding commitment over the next 4 years
- 1 in partnership with the Lotte & John Hecht Memorial Foundation

Quality of Life Research Grants to support research that has the potential to make a significant impact on the burden of disease in patients, survivors and caregivers. These grants explore psychosocial, survivorship, supportive care and end-of-life issues, to address research gaps, needs and opportunities, or models for follow-up care.

- 8 new grants in 2014 representing a $2.17 million funding commitment over the next 3 years

Knowledge to Action Grants to support research that will close the gap between what is known from research and what is done with that knowledge. These grants provide funding for projects that build on existing cancer research findings and aim to improve outcomes and experiences through knowledge translation for people and populations at risk, patients, their families and communities across the cancer trajectory.

- 4 new grants in 2014 representing a $398 thousand funding commitment over the next 3 years

Travel Awards are offered to PhD or MD/PhD students, and post-doctoral/clinical fellows to defray the travel costs associated with making a scientific presentation as a first author or presenter at a conference, symposium or other appropriate professional meeting.

- 46 new awards in 2014 representing a $89 thousand investment

Research Centres

CCSRI provides funding and support to three centre-based research initiatives:

Canadian Centre for Applied Research in Cancer Control (ARCC) is a pan-Canadian research network, supported in collaboration with the British Columbia Cancer Agency and Cancer Care Ontario, 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.

NCIC Clinical Trials Group (NCIC CTG) is a cooperative oncology group involving more than 90 member institutions across Canada that carries out national and international multicentre trials in cancer prevention, therapy, and supportive care. Based at Queen’s University.

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, particularly in the area of tobacco control and youth health. Based at the University of Waterloo.
Why Do You Support Canadian Cancer Society Research?

What donors say

“Volunteering in the region and on research panels gave me a great appreciation for the dedication and professionalism of the whole organization. I admire the researchers and vigorously applaud the work they do and the great benefits that accrue. For all these reasons, I choose to donate to cancer research funded by the Society and created the Bill Barley Innovation Fund.

Bill Barley, Ancaster, Ontario

“Supporting cancer research has never been more important than it is now. Treatments and care for cancer patients are improving, but there is still so much to do. Progress requires the focused talent of excellent scientists and funding is so difficult to get just now. The Canadian Cancer Society has been funding critical research for 67 years and has been a major contributor to the progress that has been made. That is why I continue to support the Society.

Dr Judy Birdsell, Calgary, Alberta

“Having the privilege of being a police officer means I have a chance to give back to my community. Pedal for Hope rallies fellow police officers throughout south east Ontario to make a difference in the lives of children living with cancer by supporting pediatric cancer research funded by the Society.

John Townsend, Peterborough, Ontario
What researchers say

"The research community and other funders have always viewed CCSRI’s peer review process as one of the best, or the best, in the country."

Dr Morag Park, McGill University

"The Innovation Grants program allows researchers throughout Canada to put ideas down on paper that they would love for their colleagues and the people on the grant review panel to take a look at and say ‘wow, that’s outside the box!’ It’s a really fantastic program and it’s one that I’m honoured to be part of."

Dr Craig Thomas, National Institutes of Health

"Through the CCSRI, we have had the opportunity to connect with fundraisers and donors and hear about their motivation, generosity and passion for supporting research. Without the support of the Canadian Cancer Society and fundraisers like the Peterborough Pedal for Hope, we would not be able to continue our research in helping to improve quality of life for pediatric cancer patients."

Dr Lillian Sung, Hospital for Sick Children
Research Investment in 2014

Members of Dr John Dick’s team.
University Health Network, Princess Margaret Cancer Centre
Investment by research area

CCSRI invested $37 million in research in 2014. Basic, biomedical and translational research accounted for the largest share of CCSRI’s research portfolio at $27.7 million (75%), which was broken down into the areas of diagnosis and treatment, fundamental cancer biology, early detection and screening. $5.5 million (15%) was focused on prevention and risk reduction research including tobacco, obesity, healthy eating and physical activity, fundamental cancer etiology, and occupational and environmental carcinogens. $3.8 million (10%) was focused on quality of life research in survivorship, end-of-life care, supportive care and the fundamental cancer journey.³

³ Research projects may cross research areas and relate to more than one category.
Investment by cancer type

Sixty per cent, or $22.2 million, of CCSRI’s research portfolio in 2014 related to over 20 specific cancer types, while $14.8 million (40%) had implications for multiple or all cancer types. Funding for specific cancer types is displayed below (similar cancer types are grouped).

Research targeting specific cancers: $22.2M

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Funding ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head and neck</td>
<td>0.5M</td>
</tr>
<tr>
<td>Lung</td>
<td>2.2M</td>
</tr>
<tr>
<td>Liver</td>
<td>0.4M</td>
</tr>
<tr>
<td>Colorectal</td>
<td>1.5M</td>
</tr>
<tr>
<td>Prostate</td>
<td>1.9M</td>
</tr>
<tr>
<td>Bone</td>
<td>0.5M</td>
</tr>
<tr>
<td>Leukemia, lymphoma and multiple myeloma</td>
<td>4.1M</td>
</tr>
<tr>
<td>Brain</td>
<td>1.6M</td>
</tr>
<tr>
<td>Breast</td>
<td>4.3M</td>
</tr>
<tr>
<td>Digestive tract</td>
<td></td>
</tr>
<tr>
<td>(oral, stomach, esophagus)</td>
<td></td>
</tr>
<tr>
<td>(excluding colorectal)</td>
<td>0.4M</td>
</tr>
<tr>
<td>Skin</td>
<td>0.6M</td>
</tr>
<tr>
<td>Pancreas</td>
<td>1.2M</td>
</tr>
<tr>
<td>Urinary tract (kidney bladder)</td>
<td>1.0M</td>
</tr>
<tr>
<td>Gynecological cancers</td>
<td></td>
</tr>
<tr>
<td>(uterus/endometrium, cervix, ovary)</td>
<td>1.2M</td>
</tr>
<tr>
<td>Other cancer types</td>
<td>0.8M</td>
</tr>
</tbody>
</table>

In 2014, CCSRI invested $3.1 million in pediatric cancer research.
Investment by cancer type relative to incidence and mortality rates

CCSRI’s 2014 funding for specific cancer types is displayed by percentage and compared to the percentage of new cancer cases and deaths in 2014.⁴

---

Investment by region

In 2014, CCSRI funded 312 lead scientists at 43 of the top universities, hospitals and research centres across Canada.
Investment by institution

In 2014, CCSRI supported 408 individual investments across 10 provinces and 43 research institutions⁵.

<table>
<thead>
<tr>
<th>Province</th>
<th>Research Institution</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>Alberta Health Services (Alberta Cancer Board)</td>
<td>115K</td>
</tr>
<tr>
<td></td>
<td>University of Alberta</td>
<td>335K</td>
</tr>
<tr>
<td></td>
<td>University of Calgary</td>
<td>254K</td>
</tr>
<tr>
<td></td>
<td>Alberta Total</td>
<td>704K</td>
</tr>
<tr>
<td>British Columbia</td>
<td>BC Cancer Agency</td>
<td>2.96M</td>
</tr>
<tr>
<td></td>
<td>University of British Columbia</td>
<td>2.23M</td>
</tr>
<tr>
<td></td>
<td>University of Victoria</td>
<td>397K</td>
</tr>
<tr>
<td></td>
<td>Vancouver Hospital &amp; Health Sciences Centre</td>
<td>100K</td>
</tr>
<tr>
<td></td>
<td>British Columbia Total</td>
<td>5.66M</td>
</tr>
<tr>
<td>Manitoba</td>
<td>Manitoba Institute of Cell Biology</td>
<td>73K</td>
</tr>
<tr>
<td></td>
<td>University of Manitoba</td>
<td>324K</td>
</tr>
<tr>
<td></td>
<td>Manitoba Total</td>
<td>397K</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>University of Moncton</td>
<td>38K</td>
</tr>
<tr>
<td></td>
<td>New Brunswick Total</td>
<td>38K</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>Memorial University of Newfoundland</td>
<td>157K</td>
</tr>
<tr>
<td></td>
<td>Newfoundland Total</td>
<td>157K</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>Dalhousie University</td>
<td>46K</td>
</tr>
<tr>
<td></td>
<td>Nova Scotia Total</td>
<td>46K</td>
</tr>
<tr>
<td>Ontario</td>
<td>Cancer Care Ontario</td>
<td>723K</td>
</tr>
<tr>
<td></td>
<td>Children's Hospital of Eastern Ontario</td>
<td>140K</td>
</tr>
<tr>
<td></td>
<td>Juravinski Cancer Centre (Hamilton-CIO)</td>
<td>250K</td>
</tr>
<tr>
<td></td>
<td>Lakehead University</td>
<td>2K</td>
</tr>
<tr>
<td></td>
<td>Lawson Research Institute</td>
<td>75K</td>
</tr>
<tr>
<td></td>
<td>McMaster University</td>
<td>824K</td>
</tr>
<tr>
<td></td>
<td>Mount Sinai Hospital</td>
<td>1.20M</td>
</tr>
<tr>
<td></td>
<td>University Health Network (Princess Margaret Cancer Centre, The Toronto Hospital General Division)</td>
<td>3.62M</td>
</tr>
<tr>
<td></td>
<td>Ontario Institute for Cancer Research</td>
<td>199K</td>
</tr>
<tr>
<td></td>
<td>Ottawa Hospital Research Institute</td>
<td>591K</td>
</tr>
<tr>
<td></td>
<td>Queen's University</td>
<td>5.63M</td>
</tr>
<tr>
<td></td>
<td>Ryerson University</td>
<td>69K</td>
</tr>
<tr>
<td></td>
<td>St. Michael's Hospital</td>
<td>100K</td>
</tr>
<tr>
<td></td>
<td>Sunnybrook Research Institute</td>
<td>993K</td>
</tr>
<tr>
<td></td>
<td>The Hospital for Sick Children</td>
<td>1.59M</td>
</tr>
<tr>
<td></td>
<td>Thunder Bay Regional Research Institute</td>
<td>90K</td>
</tr>
<tr>
<td></td>
<td>University of Guelph</td>
<td>139K</td>
</tr>
<tr>
<td></td>
<td>University of Ottawa</td>
<td>534K</td>
</tr>
<tr>
<td></td>
<td>University of Toronto</td>
<td>2.62M</td>
</tr>
<tr>
<td></td>
<td>University of Waterloo</td>
<td>1.95M</td>
</tr>
<tr>
<td></td>
<td>University of Windsor</td>
<td>98K</td>
</tr>
<tr>
<td></td>
<td>Western University</td>
<td>641K</td>
</tr>
<tr>
<td></td>
<td>Women's College Research Institute</td>
<td>169K</td>
</tr>
<tr>
<td></td>
<td>York University</td>
<td>190K</td>
</tr>
<tr>
<td></td>
<td>Ontario Total</td>
<td>22.50M</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Province</th>
<th>Research Institution</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prince Edward Island</td>
<td>University of Prince Edward Island</td>
<td>50K</td>
</tr>
<tr>
<td>Quebec</td>
<td>Universite de Montreal and its affiliate institutions</td>
<td>2.60M</td>
</tr>
<tr>
<td></td>
<td>Universite Laval and its affiliate institutions</td>
<td>1.14M</td>
</tr>
<tr>
<td></td>
<td>McGill University and its affiliate institutions</td>
<td>2.76M</td>
</tr>
<tr>
<td></td>
<td>Montreal General Hospital</td>
<td>2K</td>
</tr>
<tr>
<td></td>
<td>Universite de Sherbrooke</td>
<td>310K</td>
</tr>
<tr>
<td></td>
<td>Quebec Total</td>
<td>7.63M</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>University of Saskatchewan</td>
<td>179K</td>
</tr>
</tbody>
</table>

---

⁵ Excludes non-geographic specific research community support

Dr Alberto Martin (second from the right) with his team, University of Toronto
Investment by funding program

In 2014, CCSRI investments were spread across several unique funding programs. Innovation Grants accounted for the largest proportion of CCSRI’s portfolio ($14.45 million) followed by Research Centres ($8.10 million) and Impact Grants ($5.03 million). Commitments from the former Research Grants competitions were in their final year while investments in CCSRI’s current programs continued to grow.

- **Innovation Grants**: $14.45M
- **Knowledge to Action Grants**: $433K
- **Quality of Life Grants**: $1.25M
- **Research Centres**: $8.10M
- **Former Research Grants Competition**: $4.20M
- **Innovation to Impact Grants**: $299K
- **Research Community Support**: $197K
- **Career Development Awards**: $1.08M
- **Research Community Support**: $37M
- **Impact Grants**: $5.03M
- **Prevention Grants**: $1.91M
- **Prevention Grants**: $1.91M
- **Prevention Grants**: $1.91M

---

Research Community Support includes Canadian Breast Cancer Research Collaborative, workshops, honours and awards, prevention network, and Canadian Cancer Research Alliance partnership.

Career Development Awards include Prevention Initiative Junior Scientist Awards, Research Scientist Awards, Capacity Development Awards in Prevention, Travel Awards, and Junior Investigator Grant Panel Travel Awards.

Prevention Grants include Prevention Initiative Interventions, Prevention Research Grants, CCS-Partner Prevention Research Grants, Prevention Translation Supplement Awards and Population Health Intervention Research Grants - CIHR.

Former Research Grants Competition includes Research Grants and Program Project Grants.
Clinical trials

In 2014, CCSRI invested $5.38 million in the NCIC Clinical Trials Group (NCIC CTG), which is the only Canadian cancer trials group that conducts the entire range of clinical trials across all cancer types. In the past year, NCIC CTG led or was involved in 111 active trials relating to more than 27 different cancer types. These trials took place across 84 cancer centres reaching communities all across Canada. 17,073 patients were involved in these trials over their lifetime and 1,440 patients were enrolled in 2014 (shown below).

NCIC CTG led trials involved many patients from centres outside of Canada. Active trials in 2014 have involved 14,309 over their lifetime.

---

6 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 is proud to work with other organizations to support excellent cancer research.

**New Brunswick Health Research Foundation:** The Craig’s Cause Pancreatic Cancer Society, the QEII Foundation and the Canadian Cancer Society established a dedicated fund in 2014 to support pancreatic cancer research. In partnership with the New Brunswick Health Research Foundation, our first investment was made to support cancer scientists from New Brunswick develop a blood test to detect pancreatic cancer at an early stage.

**Canadian Breast Cancer Foundation:** Committed to engaging more Canadian scientists in research focused on preventing cancer and other chronic diseases, we partnered with the Canadian Breast Cancer Foundation to support 2 young investigators studying genetics to prevent breast cancer in thousands of women.

"By investing in the most promising and innovative research, we believe we can significantly reduce the prevalence of breast cancer so that fewer women experience a breast cancer diagnosis."

_Sandra Palmaro, Co-CEO, Canadian Breast Cancer Foundation_

**Lotte & John Hecht Memorial Foundation:** We proudly partnered with the Lotte & John Hecht Memorial Foundation in 2014 to support 7 new innovative research grants tackling cancer using creative approaches.

"The Foundation’s mandate to investigate alternative and innovative approaches is well aligned with the Society’s current strategy. A wonderful example is Dr Bell’s cutting edge work on immunotherapy with oncolytic viruses."

_Angela Webster, Executive Director, Lotte & John Hecht Memorial Foundation_

**Prostate Cancer Canada:** With Prostate Cancer Canada we invested in an innovative research grant in 2014 searching for a new biomarker for prostate cancer.

**Brain Canada:** And in 2014 the Canadian Cancer Society partnered with Brain Canada to establish a joint funding platform in support of new research that will quickly adopt innovations and accelerate the application of new knowledge to address problems in brain cancer. This partnership leverages funds from Brain Canada through the Canada Brain Research Fund, a public-private partnership established by the Government of Canada, which will enable the Society to fund more Impact Grants in brain cancer research.
“We recognize that the fight against cancers, such as pancreatic, must be fought by joining forces with partners such as the Canadian Cancer Society and the Craig’s Cause Pancreatic Cancer Society.”

Dr Bruno Battistini, CEO
New Brunswick Health Research Foundation
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 are pleased to list the named grants, awards and funds that contributed to our research impact in 2014.

Research grants/awards
Bernard and Francine Dorval Prize Award for Excellence
Bill and Kathleen Troost Innovation Grant of the Canadian Cancer Society
Brain Tumour Foundation of Canada Impact Grant of the Canadian Cancer Society and Brain Canada
Brooke’s Donkeys Innovation Grant of the Canadian Cancer Society
GIVETOLIVE Research Scientist Award in Prevention Research
Glentel Innovation Grant of the Canadian Cancer Society
Great-West Life, London Life and Canada Life Junior Investigator Award in Prevention Research
John Matthew Innovation Grant of the Canadian Cancer Society
Lois Savoie Innovation Grant of the Canadian Cancer Society
Lotte & John Hecht Memorial Foundation Innovation Grants of the Canadian Cancer Society
Lotte & John Hecht Memorial Foundation Innovation to Impact Grant of the Canadian Cancer Society
Louisa Gale Scholars
Marilyn Hopper Innovation Grant of the Canadian Cancer Society
Marjorie Sheridan Innovation Grant of the Canadian Cancer Society
Minor Hockey Fights Cancer/Mannarn Family Innovation Grant of the Canadian Cancer Society
Mrs Grace Limbert Innovation Grant of the Canadian Cancer Society
Nick Natale Innovation Grants of the Canadian Cancer Society
Pedal for Hope Innovation Grant of the Canadian Cancer Society
Pedal for Hope Impact Grant of the Canadian Cancer Society
Prairie Women on Snowmobiles Innovation Grant of the Canadian Cancer Society
A Quality of Life Grant of the Canadian Cancer Society in memory of Edna Goebel
A Quality of Life Grant of the Canadian Cancer Society in memory of Frank Tyrrell
A Quality of Life Grant of the Canadian Cancer Society in memory of James Tyrrell
Rachelle Archambault Innovation Grant of the Canadian Cancer Society
Ramona Rull Karson Innovation Grant of the Canadian Cancer Society
W. Gary Rowe Innovation Grants of the Canadian Cancer Society
WICC Ontario (Ottawa Region) Innovation Grant of the Canadian Cancer Society
Winnipeg Police Services Half Marathon Impact Grant of the Canadian Cancer Society and Brain Canada
Women in Insurance Cancer Crusade Alberta Innovation Grant of the Canadian Cancer Society
Funds
Bill Barley Innovation Fund
Birdsell Family and Friends Brain Cancer Research Fund
Cardone Family Cancer Fund
Circles of Friends Pancreatic Cancer Research Fund
Cleans for Cleavage Breast Cancer Research Fund
Craig’s Cause Pancreatic Cancer Research Fund
Ed Koystko and Frances Koystko Fund for Cancer Research
Fung & Duen Au-Yeung Foundation Fund
Ginty Jocius Brain Cancer Research Fund
Helen Mary Storey Ovarian Cancer Research Fund
Hodgson Family Ovarian Cancer Research Fund
Kate Linder and Friends Fund for Women’s Cancer Research
Love for Lizzie Fund
Lusomé Cancer Research Fund
Marion Dorothy Pauderis Innovation Fund
Michael Albert Garron Foundation Synovial Sarcoma Research Fund
Norris Family Pediatric Brain Cancer Research Fund
Prairie Women on Snowmobiles Breast Cancer Research Impact Fund
Sarcoma Steps Fund
Susan and Steven Horvath Cancer Prevention Research Catalyst Fund
TELUS Catalyst Fund
Tets Haya Memorial Fund
Walk the Talk Lymphoma Research Catalyst Fund
WICC Alberta Brain Cancer Research Fund

Many Society-funded researchers are also tireless fundraisers. Dr Lisa Porter and her research team moonlight as “Porter’s Lab Rats” in Windsor, Ontario’s Relay For Life.
A Focus On ...
Brain Cancer
We need to move the needle on the survival rate for brain cancer. Thirty 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 2,900 Canadians were diagnosed with brain cancer in 2014, and 1,950 died from the disease. More research is needed to detect and treat brain cancer earlier.

**Canadian Cancer Society Research Institute (CCSRI) support of brain cancer research**

Thanks to our donors, the Canadian Cancer Society invested over $1.6 million in brain cancer research through our Research Institute in 2014. This supported 24 lead investigators across Canada exploring the biology behind the causes of brain cancer and new ways to detect it, treat it and improve the quality of life for survivors – particularly children – who often live compromised lives coping with the side effects from treatments.

The Society-funded NCIC Clinical Trials Group is the only Canadian cancer trials group that conducts the entire range of clinical trials across all cancer types. In 2014, 7 brain cancer clinical trials were active that have involved 433 patients from cities across the country including Victoria, Vancouver, Surrey, Calgary, Edmonton, Regina, Winnipeg, London, Hamilton, Toronto, Montreal, Sherbrooke, Quebec City, Trois Rivieres, Halifax and Saint John.

**We’re making progress!** Society-funded researchers continue to bring new insight and approaches to tackling brain cancer. In 2014, the Canadian Cancer Society supported key research findings, including:

- **Dr Lisa Porter** from the *University of Windsor* showed that a protein called Spy1 balances the growth of brain stem cells and their ability to become different cell types. This fundamental knowledge could reveal new options for brain cancer therapies.

- **Dr Simon Graham** from *Sunnybrook Hospital* developed a tablet-based technology to improve brain cancer surgery. Using functional MRI, it allows surgeons to better plan and operate on brain tumours while sparing normal tissue and has already been used for a small number of patients.

- **Dr Donald Mabbott** from the *Hospital for Sick Children* found differences in the parts of the brain responsible for learning and memory in children who had been treated for brain cancer. This underscores the need to understand the long-term side effects of treatment, find more targeted therapies to reduce them, and develop appropriate supports for cancer survivors.

- **Dr Peter Forsyth**, who recently moved from the *University of Calgary* to the Moffitt Cancer Centre, has found a way to improve oncolytic viruses, which selectively kill cancer cells. His work in Calgary continues through an international collaboration and is revealing how to suppress the immune system to let oncolytic viruses reach tumours more effectively.

**Stay tuned!** In 2014 the Canadian Cancer Society invested in 9 new research grants testing new approaches for brain cancer, representing $2.7M in new funding for the next 5 years.

In 2014, the Canadian Cancer Society and Brain Canada joined forces to support all CCSRI Impact Grants awarded over the next two years focused on brain cancer research. These awards, the largest and most prestigious offered by CCSRI, have great potential to change the outlook of cancer. We look forward to announcing the first of these awards in 2015!
Research Outcomes and Impacts in 2014

Dr Aisha Lofters, University of Toronto
Monitoring and evaluation framework

This section of the report provides a summary of selected research outcomes and impacts drawn from 268 progress reports submitted in 2014. Outcomes and impacts are summarized and mapped according to the results chain framework.\(^7\)

Scientific and financial progress reports are submitted by principal investigators of all research grants and awards at multiple stages during the term of the funding. CCSRI requires annual scientific and financial reports and post-grant reports (submitted two 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.\(^8\)

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 seven 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 seven levels of results.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>End results 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 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 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 Media coverage, media requests, honours or awards, leadership roles, and dissemination requests</td>
</tr>
<tr>
<td>3</td>
<td>Engagement Collaborations and multidisciplinary research activities</td>
</tr>
<tr>
<td>2</td>
<td>Activities Research and other related activities such as training and teaching</td>
</tr>
<tr>
<td>1</td>
<td>Inputs Project budgets, leveraged funds, fellows, students, and other personnel</td>
</tr>
</tbody>
</table>


---

\(^7\) This framework was introduced and adapted for the Society by Steve Montague (PMN).

\(^8\) 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>11</th>
<th>Impacts on healthcare and program delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Research findings cited in clinical and service guidelines, in health professional education material, used in program development, etc.</td>
</tr>
</tbody>
</table>

| 4  | Impacts on policy | |
|----|------------------|
|    | Research findings cited in public policy documents, advocacy publications, etc. |

<table>
<thead>
<tr>
<th>37</th>
<th>Impacts on work of other researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Research findings cited in relevant scientific literature, scientific methods used by other researchers, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8</th>
<th>Impacts on training of new researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Research findings cited in text books, reading lists, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Impacts on commercialization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• 2 patents issued/licensed</td>
</tr>
<tr>
<td></td>
<td>• 1 industry investment</td>
</tr>
</tbody>
</table>

The partnership between the Society and Propel shows its strength once again – this time with flavoured tobacco controls. Propel conducts the largest Canadian survey of student tobacco use. We produced the evidence on use of flavoured tobacco and the Society tobacco control advocates inserted that evidence at the right time and with the right people. The result: new regulations banning flavoured tobacco products that protect thousands of Canadian youth from their deadly effects.

**Dr Leia Minaker and Dr Steve Manske**, Propel Centre for Population Health Impact
**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>
</tr>
</thead>
<tbody>
<tr>
<td>703</td>
<td>84</td>
</tr>
<tr>
<td>• 521 peer reviewed</td>
<td></td>
</tr>
<tr>
<td>• 182 non peer reviewed</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Presentations</th>
<th>Advisory committee memberships, leadership roles, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,186</td>
<td>1,167</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consultations/briefings</th>
<th>Collaborations</th>
</tr>
</thead>
<tbody>
<tr>
<td>228</td>
<td>• 860 with researchers</td>
</tr>
<tr>
<td></td>
<td>• 153 with policy-makers</td>
</tr>
<tr>
<td></td>
<td>• 314 with healthcare practitioners</td>
</tr>
<tr>
<td></td>
<td>• 186 with other stakeholders</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Honours and awards</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Media mentions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>570</td>
<td></td>
</tr>
</tbody>
</table>

**HOW** is research supported?

<table>
<thead>
<tr>
<th>Investments</th>
<th>Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>408</td>
<td>1,654</td>
</tr>
<tr>
<td>• 343 grants</td>
<td>• 312 principal investigators</td>
</tr>
<tr>
<td>• 65 career development awards</td>
<td>• 550 co-applicants</td>
</tr>
</tbody>
</table>

|                          | • 174 fellows                                       |
|                          | • 340 students                                      |
|                          | • 278 other highly qualified personnel               |
Research impact stories

Research funded by the Canadian Cancer Society will ultimately change cancer forever. The following represents some of the high-impact research findings of 2014 and highlights the breadth of research supported by the Society’s donors.

**Resolving a controversy around the treatment of sarcoma**
Dr Thierry Alcindor, McGill University, NCIC Clinical Trials Group

**Computer modelling to predict changes in tumour cells**
Dr Samuel Aparicio, British Columbia Cancer Agency

**Using a flu vaccine to improve cancer surgery outcomes**
Dr Rebecca Auer, Ottawa Hospital Research Institute

**Evaluating the effectiveness of programs to promote colorectal screening**
Dr Nancy Baxter, St. Michael’s Hospital

**Reprogramming stem cells**
Dr Mick Bhatia, McMaster University

**Improving kids’ access to cancer-preventing nutrition**
Dr Sherri Bisset, Université Laval

**Raising awareness of cancer risk through tailored videos**
Dr Joan Bottorff, University of British Columbia (Okanagan)

**A genetic signature to personalize prostate cancer treatments**
Dr Robert Bristow, University Health Network, Princess Margaret Cancer Centre

**Exercise improves outcomes throughout the cancer journey**
Dr Jennifer Brunet, University of Ottawa

**Fighting insomnia in cancer patients**
Dr Tavis Campbell, University of Calgary

**The genetic effects of stress in cancer survivors**
Dr Linda Carlson, University of Calgary

**Research on restaurant patio smoking contributes to new policy**
Dr Michael Chaiton, University of Toronto

**Patient dignity research has international impact**
Dr Harvey Max Chochinov, University of Manitoba
Revealing the mechanics of RNA editing
Dr Colin Collins, Vancouver Hospital & Health Sciences Centre

New knowledge about how cancer cells repair DNA
Dr Damien D’Amours, Université de Montréal

Uncovering genetic interactions leading to a common lung cancer
Dr David Dankort, McGill University

New diagnostic tools for prostate cancer
Dr Robert Day, Université de Sherbrooke

Accelerating a promising oncolytic virus treatment
Dr Jean-Simon Diallo, Ottawa Hospital Research Institute

A gene mutation that could be the trigger for leukemia
Dr John Dick, University Health Network, Princess Margaret Cancer Centre

A cellular process that influences how stem cells respond to damage
Dr John Dick, University Health Network, Princess Margaret Cancer Centre

Understanding self-renewal in cancer-initiating cells
Dr John Dick, University Health Network, Princess Margaret Cancer Centre

The link between sweet foods and drinks and breast cancer risk
Dr Caroline Diorio, Université Laval

A defective repair process helps melanoma take hold
Dr Elliott Drobetsky, Université de Montréal

A molecular balancing act protects against lung cancer
Dr Sean Egan, Hospital for Sick Children

Adding an anti-cancer drug gives oncolytic viruses a fighting chance
Dr Peter Forsyth, Moffitt Cancer Centre (formerly University of Calgary)

Using yeast to test how drugs interact with genes
Dr Guri Giaever, University of British Columbia

Workplace wellness programs to prevent cancer
Dr Carolyn Gotay, University of British Columbia

Increasing precision of brain cancer surgery with tablet technology
Dr Simon Graham, Sunnybrook Research Institute
Identifying new drug targets for breast cancer
Dr Peter Greer, Queen’s University

Calorie counts on menus influence eating habits and new legislation
Dr David Hammond, University of Waterloo, Propel Centre for Population Health Impact

Predicting which prostate cancers will metastasize
Dr Cheryl Helgason, British Columbia Cancer Agency

Discovering genetic mutations that make cancers more responsive to drugs
Dr Philip Hieter, University of British Columbia

Improving breast cancer screening in a high-risk group of childhood cancer survivors
Dr David Hodgson, University of Toronto

Population-wide studies of the genetics of lung cancer
Dr Rayjean Hung, Mount Sinai Hospital

A gene that helps predict response to colorectal cancer treatment
Dr Derek Jonker, Queen’s University, NCIC Clinical Trials Group

Revealing the mechanics of the immune system’s response to cancer
Dr Kevin Kane, University of Alberta

A new model to accelerate research on cancer genes
Dr Rama Khokha, University Health Network, Princess Margaret Cancer Centre

Boosting the power of an oncolytic virus
Dr Robert Korneluk, Children’s Hospital of Eastern Ontario

An oral supplement that may help prevent breast cancer
Dr Joanne Kotsopoulos, Women’s College Hospital

Understanding the impact of disability on access to cancer screening
Dr Aisha Lofters, University of Toronto

Investigating the long-term effects of cancer treatment on brain function in children
Dr Donald Mabbott, Hospital for Sick Children

Uncovering new information about cell division
Dr Paul Maddox, University of North Carolina at Chapel Hill
(formerly Institute for Research in Immunology and Cancer)
<table>
<thead>
<tr>
<th>Research Impact</th>
<th>Authors and Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluating the effectiveness of HPV vaccination</td>
<td>Dr Salaheddin Mahmud, University of Manitoba</td>
</tr>
<tr>
<td>Youth tobacco use studies lead to provincial bans on flavoured tobacco</td>
<td>Dr Steve Manske, University of Waterloo, Propel Centre for Population Health Impact</td>
</tr>
<tr>
<td>Interactions between diet and intestinal microbes that lead to cancer</td>
<td>Dr Alberto Martin, University of Toronto</td>
</tr>
<tr>
<td>New understanding about the onset of a form of kidney cancer</td>
<td>Dr Stephen Meyn, Hospital for Sick Children</td>
</tr>
<tr>
<td>Supporting schools to implement healthy eating and activity programs</td>
<td>Dr Donna Murnaghan, University of Prince Edward Island</td>
</tr>
<tr>
<td>Surgical prevention of cancer in women with BRCA gene mutations</td>
<td>Dr Steven Narod, Women’s College Hospital</td>
</tr>
<tr>
<td>A world leader in sarcoma research</td>
<td>Dr Torsten Nielsen, University of British Columbia</td>
</tr>
<tr>
<td>The link between traffic-related air pollution and prostate cancer</td>
<td>Dr Marie-Elise Parent, INRS – Institut Armand-Frappier</td>
</tr>
<tr>
<td>The relationship between obesity and arsenic body burden</td>
<td>Dr Louise Parker, Dalhousie University</td>
</tr>
<tr>
<td>Identifying cellular networks that determine the fate of stem cells</td>
<td>Dr Anthony Pawson, Mount Sinai Hospital and Dr Shawn Li, Western University</td>
</tr>
<tr>
<td>Clarifying decisions about PSA testing for prostate cancer</td>
<td>Dr Stuart Peacock, British Columbia Cancer Agency, Canadian Centre for Applied Research in Cancer Control</td>
</tr>
<tr>
<td>Cost-effectiveness of lung cancer screening</td>
<td>Dr Stuart Peacock, British Columbia Cancer Agency, Canadian Centre for Applied Research in Cancer Control</td>
</tr>
<tr>
<td>Public engagement in healthcare decisions</td>
<td>Dr Stuart Peacock, British Columbia Cancer Agency, Canadian Centre for Applied Research in Cancer Control</td>
</tr>
</tbody>
</table>
Myc genes in the onset of cancer
Dr Linda Penn, University Health Network, Princess Margaret Cancer Centre

Making immunotherapies work for more people
Dr Claude Perreault, Université de Montréal

Revealing an important protein for the growth of brain cancer
Dr Lisa Porter, University of Windsor

Motivating families to engage in cancer-preventing exercise through video game bikes
Dr Ryan Rhodes, University of Victoria

Testing the quality of life impact of a breast cancer prevention strategy
Dr Harriet Richardson, Queen's University, NCIC Clinical Trials Group

Identifying biomarkers that predict the course of prostate cancer
Dr Arun Seth, Sunnybrook Research Institute

A new method to help researchers predict how mutations will lead to cancer
Dr Sohrab Shah, British Columbia Cancer Agency

Trial identifies a better treatment option for aggressive lymphoma
Dr Lois Shepherd, Queen's University, NCIC Clinical Trials Group

A strategy to prevent bone loss in postmenopausal women undergoing breast cancer treatment
Dr Lois Shepherd, Queen's University, NCIC Clinical Trials Group

New knowledge about how breast cancer metastasizes
Dr Peter Siegel, McGill University

Revealing how cancer cells adapt to stress
Dr Poul Sorensen, British Columbia Cancer Agency

A prognostic test for prostate cancer
Dr Jeremy Squire, University of São Paulo (formerly Queen’s University)

A new way to identify mutant proteins associated with cancer
Dr Igor Stagljar, University of Toronto

Studying an online support group for breast cancer survivors
Dr Joanne Stephen, British Columbia Cancer Agency
Standardizing the treatment of dangerous side effects for children undergoing chemotherapy  
Dr Lillian Sung, Hospital for Sick Children  

Revealing the genome of a childhood brain tumour  
Dr Michael Taylor, Hospital for Sick Children  

Developing a new tool to understand drug interactions in cells  
Dr Marc Therrien, Université de Montréal  

Helping standardize colonoscopies to improve colorectal cancer detection  
Dr Jill Tinmouth, Sunnybrook Research Institute  

Mapping the causes of lung cancer  
Dr Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre  

Two new options for fighting pancreatic cancer  
Dr Ming-Sound Tsao, University Health Network, Princess Margaret Cancer Centre  

A new model to study the most common form of ovarian cancer  
Dr Barbara Vanderhyden, Ottawa Hospital Research Institute  

A potential new drug to tackle lymphomas  
Dr Tania Watts, University of Toronto  

New tool to improve the care of pancreatic cancer patients  
Dr Alice Wei, University Health Network, Princess Margaret Cancer Centre  

Improving radiation regimens to provide better pain control for bone metastases  
Dr Rebecca Wong, Queen’s University, NCIC Clinical Trials Group  

Improving treatment for the most challenging form of breast cancer  
Dr Eldad Zacksenhaus, University Health Network, Toronto General Research Institute  

Exploring breath analysis as a diagnostic tool for cancers  
Dr Haishan Zeng, British Columbia Cancer Agency  

A test to help predict which patients will benefit from bone marrow transplants  
Dr Li Zhang, University Health Network, Toronto General Research Institute  

Improving quality of life for cancer patients through early palliative care  
Dr Camilla Zimmermann, University Health Network, Princess Margaret Cancer Centre
Resolving a controversy around the treatment of sarcoma

Dr Thierry Alcindor, McGill University, NCIC Clinical Trials Group

Although some sarcomas (a cancer affecting soft tissues and bones) are treatable, for many advanced sarcomas the only option is palliative treatment. The current standard treatment relies on the chemotherapy drugs doxorubicin and ifosfamide, but there is controversy over whether the combination is more effective than doxorubicin alone. In a trial spanning 10 countries, Dr Thierry Alcindor of the Society-funded NCIC Clinical Trials Group tested whether the addition of ifosfamide to doxorubicin improved the survival rates of patients with advanced or metastatic sarcoma. Published in Lancet Oncology, this research showed that the combined drug treatment resulted in more toxic side effects for patients with no significant improvement in overall survival compared to doxorubicin alone. These findings suggest that the combination of doxorubicin and ifosfamide should not be considered the routine therapy for advanced sarcoma. However, since the combined treatment led to increased tumour shrinkage, it may be the treatment of choice for specific cases. This trial contributes compelling evidence to help resolve the controversy around standard treatment for sarcoma, and highlights the need for therapies that improve survival in patients with advanced cancer.¹

Computer modelling to predict changes in tumour cells

Dr Samuel Aparicio, British Columbia Cancer Agency

Understanding how cells behave within a tumour is complicated by cellular changes that occur as a tumour progresses. Published in the prestigious journal Nature, Dr Samuel Aparicio and Dr Sohrab Shah combined the identification of gene mutations in individual breast cancer cells with computer modelling, to predict how different cell populations within the same tumour evolve and grow over time. As certain cell populations are more resistant to treatment with drugs, understanding and predicting how they evolve in complex cancers may provide new targeted therapy options.²

¹ Dr Samuel Aparicio and Dr Sohrab Shah, British Columbia Cancer Agency
² Photo credit: BC Cancer Foundation
Using a flu vaccine to improve cancer surgery outcomes

**Dr Rebecca Auer**, Ottawa Hospital Research Institute

Natural killer (NK) cells are essential to the immune system's defenses against cancer as they can directly kill cancer cells. Extraordinary circumstances, such as surgery to remove a tumour, can suppress these cells, which can promote the spread of any remaining cancer cells. Building on earlier work where they found one vaccine that could prevent surgery-induced suppression of NK cells, Dr Rebecca Auer and her team have been seeking to identify the best candidate among many vaccines for this treatment. By administering different vaccines in a mouse model, they found that an inactivated flu vaccine significantly improved the ability of NK cells to kill cancer cells and reduced metastases after surgery. The vaccine has been tested in a small number of healthy volunteers and pre-surgical cancer patients, where it significantly increased NK cell activity in both groups. This important research, featured in The Economist and Scientific American, provides the impetus for a full-scale clinical trial to determine whether this vaccine should be widely used to improve outcomes for surgical cancer patients. Dr Auer holds the WICC Ontario (Ottawa Region) Innovation Grant of the Canadian Cancer Society.

Evaluating the effectiveness of programs to promote colorectal screening

**Dr Nancy Baxter**, St. Michael’s Hospital

Cancer screening programs are designed to catch cancer, or the beginning stages of it, early in order to offer treatment when it’s most effective. Randomized controlled trials in the 1990s, showing that the fecal occult blood test (FOBT) was an effective method to screen for colorectal cancer, led to Ontario public health initiatives to promote its use. Dr Nancy Baxter and her team evaluated the impact of these initiatives on FOBT screening participation and found that significant increases correlated with public health initiatives to promote the test. Their findings suggest that public health initiatives can be a valuable way to promote positive health behaviours.
Reprogramming stem cells

Dr Mick Bhatia, McMaster University

Stem cell transplantation has enormous application to many diseases, including cancer. The ability to convert adult cells to stem cells that can generate various cell types is a rising area of research. Published in the prestigious journal Nature Communications, Dr Mick Bhatia and his team showed that adult cells reprogrammed to stem cells had different potentials depending on the original adult cell type. They found that these stem cells remembered what cell type they came from at a genetic level, and preferentially wanted to revert back to that cell type. Discovering that stem cells are not created equal will have important implications in using tailored stem cell sources for specific therapies.¹

Improving kids’ access to cancer-preventing nutrition

Dr Sherri Bisset, Université Laval

There is strong evidence linking the risk of cancer with poor diet and long stretches of inactivity. It is important to act on this knowledge by helping people change these risk-increasing behaviours. Dr Sherri Bisset and her team have been studying school-based approaches to encourage healthy lifestyles in children. In particular, her team is developing tools to measure the schoolyard’s physical and social environment, to build our understanding of how schoolyards promote students to engage in active play. Their research on food security initiatives has identified limitations in existing programs designed to improve access to a nutritious diet for all people, regardless of income, place of residence or other factors. These findings have influenced anti-poverty advocates in Montreal, and have appeared in several publications connected with Table de concertation sur la faim et le développement social du Montréal Métropolitain, whose mission is to raise awareness about poverty and food security.
Raising awareness of cancer risk through tailored videos

Dr Joan Bottorff, University of British Columbia (Okanagan)

Efforts to reduce tobacco-related cancers often require creative and tailored approaches, especially for young people who may not fully appreciate the difficulty in giving up a smoking habit once they’ve started. Dr Joan Bottorff and her team have been developing a multi-pronged approach with tailored messaging for several audiences, including a series of videos that were first uploaded to YouTube in October 2013. Two of these videos are targeted at girls to help them understand their breast cancer risk and have received over 3,000 views. A video for boys about their cancer risk has received over 840 views, and one detailing the link between smoking and breast cancer posted in January 2014 has over 640 views. By using the popular medium of online video to deliver audience-appropriate health messaging, this project is showing a strong ability to reach different audiences with powerful prevention messages.

A Kelowna bus bench ad showing prevention messaging tailored to girls as part of Dr Joan Bottorff’s research

Photo credit: Bottorff research team

A genetic signature to personalize prostate cancer treatments

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

There is a critical need to distinguish which men diagnosed with prostate cancer are at high risk of cancer recurrence after treatment, so that they can be offered targeted and intensified therapy options to improve their survival. Dr Robert Bristow and an international team of collaborators (called CPC-GENE) identified a “signature” that could help clinicians group prostate cancer patients according to their prognosis. They found that a combination of genetic markers for DNA instability and hypoxia (oxygen deprivation) predicted which patients would have cancers that recurred, providing a way to identify patients needing more aggressive treatments. This may lead to better options for personalized therapy in high-risk prostate cancer patients, while avoiding over-treatment for patients with less aggressive cancers.

Exercise improves outcomes throughout the cancer journey

Dr Jennifer Brunet, University of Ottawa

Physical activity has benefits for cancer prevention, treatment and patient recovery and can improve quality of life for people living with cancer. Dr Jennifer Brunet is studying how to better engage cancer patients in exercise. In 2014 she received the prestigious Polanyi prize, awarded to top Ontario researchers, to recognize her contributions to understanding the role of physical activity in improving cancer prevention, treatment success and outcomes for survivors.
Fighting insomnia in cancer patients

**Dr Tavis Campbell,** University of Calgary

People with cancer can experience significant psychological effects that interfere with their recovery and quality of life. One of these is insomnia, which affects around a quarter of people during and after treatment. Cognitive behavioural therapy (CBT) is the recommended non-drug therapy for insomnia; however, another method – mindfulness-based stress reduction (MBSR) – has been suggested to have specific benefits for cancer patients who are experiencing disturbed sleep related to anxiety. Dr Tavis Campbell and his team conducted a trial to compare these 2 therapies, and in work published in the Journal of Clinical Oncology, they found that patients using MBSR showed similar improvements in some sleep parameters, such as total sleep time and reduction of stress, compared to CBT. However, CBT was found to work more quickly and have durable effects. These findings confirm that CBT is still the best non-drug choice for the treatment of insomnia in these patients.8

The genetic effects of stress in cancer survivors

**Dr Linda Carlson,** University of Calgary

Stress reduction methods reduce distress and cortisol levels in cancer survivors. Emerging research has suggested that high levels of stress may have negative effects at the genetic level, such as the shortening of telomeres, the end portions of chromosomes that provide stability and help protect against disease. While telomere length has been associated with breast cancer prognosis, a link between telomere length and stress is not well defined. Dr Linda Carlson and her team undertook the first study to test whether stress reduction techniques had a positive effect on the telomeres of breast cancer survivors. Women using stress reduction therapies were able to maintain telomere length over a 3-month period, whereas women using no therapies showed a decrease. These findings, which received considerable media attention, suggest that stress reduction therapies may impact important biological events in the body.7

In a second paper, the researchers reported on a large randomized trial comparing two strategies to support distressed breast cancer survivors: mindfulness-based cancer recovery (MBCR) and supportive-expressive group therapy (SET). While both therapies had a positive effect, MBCR was better at reducing stress and improving quality of life for breast cancer survivors.8 Both studies were supported through the former Canadian Breast Cancer Research Alliance.
Research on restaurant patio smoking contributes to new policy

**Dr Michael Chaiton**, University of Toronto

Some jurisdictions have banned smoking in public places, based on the harms of second-hand smoke. The public health measure to ban smoking on restaurant and bar patios has the potential to greatly reduce the risk of lung cancers and other diseases for non-smoking patrons and staff.

Dr Michael Chaiton and the Ontario Tobacco Research Unit took the novel approach of looking at the effects of patio smoke on smokers who were trying to quit. As part of the Ontario Tobacco Survey they asked 3,460 smokers whether they had been exposed to tobacco smoke on patios, and correlated this with successful quit attempts. Their findings, published in Tobacco Control, showed that smokers trying to quit were less likely to succeed and stay smoke-free after being exposed to tobacco smoke on a patio. This research was presented to the provincial Cessation Task Force and contributed to the evidence supporting a ban on smoking in public spaces in late 2014. In a second publication, Dr Chaiton analyzed the location of stores selling tobacco in Ontario. People living in neighbourhoods with lower socioeconomic status were more likely to have easy access to tobacco products, and most tobacco retailers were within walking distance from a school. Dr Chaiton’s research has important implications for policies which could limit access to tobacco for vulnerable youth.

Patient dignity research has international impact

**Dr Harvey Max Chochinov**, University of Manitoba

Each person on a cancer journey has different experiences, concerns and stresses that have an impact on their quality of life and treatment outcomes. Because of this, a cancer patient needs to have confidence in their healthcare provider’s ability to understand who they are as an individual. Dr Harvey Max Chochinov and his team developed and tested the Patient Dignity Inventory (PDI), a tool that helps clinicians achieve a deeper connection with their patients by understanding their personal concerns and priorities. This work has been internationally influential and the PDI has been translated into nearly a dozen languages for use in Spain, Portugal, Mexico, Scotland, and Germany. Dr Chochinov’s research is changing the care of cancer patients around the world.
Revealing the mechanics of RNA editing

Dr Colin Collins, Vancouver Hospital & Health Sciences Centre

Scientists have learned a great deal about the genetic changes that lead to cancer, but there are still missing pieces of the puzzle. One example is how RNA editing contributes to cancer. Normally DNA is copied into RNA as a step in the process of how proteins are made. If this RNA gets edited, the genetic instructions can change and lead to cancer. Using samples from prostate tumours, Dr Colin Collins and his team created a computer-driven strategy to study RNA editing that has allowed them to develop a detailed summary of RNA editing events, determine how common they are and if they lead to protein changes. Their findings provide more evidence for the connection between deregulated RNA editing and cancer, and importantly, provide a new tool to help scientists study and understand how this mechanism works.11

New knowledge about how cancer cells repair DNA

Dr Damien D’Amours, Université de Montréal

A trademark of cancer cells is their ability to replicate quickly. Cancer cells must therefore be able to quickly repair DNA that gets damaged during normal cellular processes. There are 2 main ways cells repair damaged DNA: non-homologous end-joining and homologous recombination. The cell cycle that controls how cells replicate also determines which way DNA gets repaired, although the underlying mechanism is unknown. Dr Damien D’Amours and his team reported in the journal Cell Cycle that a major DNA damage sensor, called the MRX complex, and the choice of which DNA repair pathway was used, were regulated by the Cdk1 cell cycle controller. This complex set of molecular interactions is important for understanding how cancer cells grow, and will reveal new treatment approaches for cancer.12
Uncovering genetic interactions leading to a common lung cancer

Dr David Dankort, McGill University

Lung cancer kills more Canadians than any other cancer. Adenocarcinoma is the most common lung cancer among never smokers (also common in smokers), and mutations in the KRAS gene are found in about 1 in 5 of these cancers. Cancers that fall within this subset are unresponsive to many drugs that work against other lung cancers, and are linked to poorer survival rates. Dr David Dankort and his team have been studying the relationship between mutations in KRAS and another cancer-related gene called Braf. In mice designed to express both a Braf mutation and 1 of 4 KRAS mutations, significantly fewer and smaller tumours were observed compared to controls. This suggests that in certain situations KRAS can act as a cancer-suppressing molecule and provides important information for the development of new lung cancer treatments. Dr Dankort’s CCSRI Grant is generously supported by the Melanoma Research Alliance.

New diagnostic tools for prostate cancer

Dr Robert Day, Université de Sherbrooke

Prostate cancer is the most commonly diagnosed cancer in men, and there is a need to identify new treatment strategies for the many men affected. Dr Robert Day and his team have been looking for new therapeutic targets for prostate cancer as well as new ways to predict disease progression. They have established 2 approved patents for new therapeutic compounds, and 2 other patents have been filed for diagnostic tools, all of which are aimed at improving care for prostate cancer patients.

Accelerating a promising oncolytic virus treatment

Dr Jean-Simon Diallo, Ottawa Hospital Research Institute

Oncolytic viruses (OVs) present a promising new therapeutic approach for cancer. These viruses are engineered to target cancer cells while sparing healthy ones. Dr Jean-Simon Diallo and Dr John Bell have been modifying OVs to overcome the natural antiviral defense systems in tumours to improve their ability to kill cancer cells. They have filed for a patent and entered into an agreement with a pharmaceutical company to use their virus modifying technology. Dr Diallo’s CCSRI Innovation Grant is generously supported by the Lotte & John Hecht Memorial Foundation.
A gene mutation that could be the trigger for leukemia

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

Cancer cells are difficult to control because of their remarkable capacity for growth, movement, and resiliency. In a study published in the prestigious journal *Nature*, Dr John Dick and his team investigated the importance of over 100 genes commonly mutated in the early stages of the blood cancer leukemia. They narrowed down the list to a mutation in a single gene DNMT3A, which is acquired in the very early stages of cancer. Cells with mutations in this gene were resistant to chemotherapy drugs and grew better than normal stem cells. These findings identify a possible initiating point for leukemia which could help doctors diagnose and treat patients earlier.  

A cellular process that influences how stem cells respond to damage

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

Haematopoietic stem cells (HSCs) can mature into any cell in the blood system. When HSCs are mutated by various stresses they can become cancerous, so the body must quickly respond when HSCs get damaged. In the journal *Nature*, Dr John Dick and his team reported that a cellular process, the unfolded protein response (UPR), was critical to how damaged HSCs react. When HSCs could not repair damaged proteins their default response was cell death. These findings reveal how the body eliminates damaged stem cells to maintain the overall health of the stem cell pool.

Understanding self-renewal in cancer-initiating cells

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

Exciting advances are being made in the field of cancer-initiating cells, or CICs. CICs can survive cancer treatments and repopulate tumours by a process called self-renewal, so it is crucial to develop therapies that target these cells. In *Nature Medicine*, Dr John Dick and his team reported that the self-renewal process of CICs in colorectal cancer relied on a molecule called BMI-1. Blocking BMI-1 in mice was able to stop tumour growth. These findings could lead to new treatments to prevent colorectal cancer recurrence.

The link between sweet foods and drinks and breast cancer risk

**Dr Caroline Diorio**, Université Laval

There is considerable evidence linking diet with the risk of developing cancer. A link between the consumption of sweet foods and breast cancer risk has been observed, but the mechanics of this link have been unclear. Dr Caroline Diorio and her team investigated whether increased sugar intake had an effect on breast density, an established risk factor for breast cancer. They showed that increased breast density was associated with high consumption of sugar-sweetened drinks in premenopausal women and with high consumption of sweet foods in postmenopausal women. While there is a need to better understand these findings, they point to an important connection between cancer risk and dietary sugar – a modifiable risk factor and a potentially important target for prevention initiatives.
A defective repair process helps melanoma take hold

Dr Elliott Drobetsky, Université de Montréal

Melanoma is an aggressive type of skin cancer caused primarily by excessive UV exposure. Dr Elliott Drobetsky and his team are studying a process called nucleotide excision repair, or NER, that removes UV radiation damage to DNA, thereby protecting against sunlight-associated skin cancer. They determined for the first time that NER was defective in human melanoma cells during a specific phase of their lifecycle and described the processes that led to this problem. These findings reveal important information about how melanoma develops, and could lead to new strategies for prevention and treatment.²¹

A molecular balancing act protects against lung cancer

Dr Sean Egan, Hospital for Sick Children

Lung cancer kills more Canadians than any other cancer and is expected to account for more than a quarter of all cancer deaths in the country this year. A molecular process known as Notch receptor signalling has an important role in the development of lungs, guiding cells to mature so that they can perform essential functions. Notch not only dictates what kinds of cells they will become but also plays a role when cells transform into cancer. Dr Sean Egan and his team investigated how some genes, such as Lfng and Jagged1, interact with Notch and other molecules to encourage developing cells to make right or wrong choices. They discovered that the interaction between the Jagged1 protein and Notch were important for achieving the correct balance of airway cell types needed in a normal adult lung. Taken together with earlier findings, their research suggests that the Notch system – when working correctly - helps prevent lung diseases by keeping cell types in balance.²²
Adding an anti-cancer drug gives oncolytic viruses a fighting chance

Dr Peter Forsyth, Moffitt Cancer Centre (formerly University of Calgary)

Oncolytic viruses (OVs) are cancer treatments designed to target and kill cancer cells directly. Their therapeutic potential is limited by the body’s immune system which can launch an attack against these viruses, thus clearing them before they can work completely. In a continuing collaboration with University of Calgary researcher Dr Wee Yong, Dr Peter Forsyth has found a way to improve oncolytic viruses that selectively kill cancer cells. They found that the cancer drug cyclophosphamide was able to improve the effectiveness of OVs in mice with brain tumours by suppressing the immune response, which allowed the viruses to reach tumours more effectively.23

Using yeast to test how drugs interact with genes

Dr Guri Giaever, University of British Columbia

Understanding how cancer cells respond to drugs will reveal new information on how drugs work and why some cancers are drug resistant. Dr Guri Giaever and her team have been using a powerful new method called chemogenomics to study how drugs affect different genes in a living organism, using yeast as their model system. Reported in the prestigious journal Science, they identified 317 experimental drugs that block the function of 121 genes, and found that these interactions can be organized into 45 signatures or types of chemical interactions. This research opens up exciting possibilities for drug development to block the cancer-causing functions of genes.24

Workplace wellness programs to prevent cancer

Dr Carolyn Gotay, University of British Columbia

Better habits around exercise and healthy eating can reduce the risk of developing cancer. However, making the necessary lifestyle changes can be especially difficult for people with work routines and environments that don’t support these activities. Dr Carolyn Gotay and her team conducted a trial of wellness programs in British Columbia workplaces. The provincial government decided to invest in one of these programs, WellnessFits, so it could continue in the workplaces where it was tested. The project has now received additional funding from the Canadian Partnership Against Cancer’s CLASP program (Coalitions Linking Action and Science for Prevention) to extend WellnessFits to rural or remote populations such as male-dominated workplaces in northern British Columbia and First Nations communities in the Yukon and Northwest Territories.

A study led by Dr Carolyn Gotay, University of British Columbia, is evaluating the impact of a sleep program on breast cancer for women shift workers like BC paramedic Renee MacCarron

Photo credit: Anne McCulloch
**Increasing precision of brain cancer surgery with tablet technology**

**Dr Simon Graham, Sunnybrook Research Institute**

One of the challenges with brain cancer is the precise surgery required to effectively remove a tumour. Neurosurgeons rely on magnetic resonance imaging (MRI) to determine the extent of a tumour’s spread and help them plan their approach, however traditional MRI cannot provide full information on the function of the areas of the brain that have been invaded by cancer. Dr Simon Graham and his team have developed a new tablet-based technology involving functional MRI, which allows surgeons to better plan and operate on brain tumours while sparing normal tissue. While this project is still in early stages, the approach has already had a clinical impact as it has been used by surgeons to assist with tumour removal for 18 patients.

![Image of Dr Simon Graham](https://example.com/graham.png)

**Identifying new drug targets for breast cancer**

**Dr Peter Greer, Queen’s University**

Enzymes called protein tyrosine kinases (PTKs) regulate a variety of functions in cells, including growth. When mutated, they may work abnormally and lead to uncontrolled growth of cells and cancer. Dr Peter Greer and his team have been studying mutations in PTKs called Fes and Fer, which are known to be involved in breast tumour growth. Using genetic models, they have discovered that both enzymes are strong candidates for targeted therapies, and have partnered with researchers at the University of Pittsburgh, Harvard University and 2 companies to develop novel inhibitor drugs. These partnerships will accelerate the development of targeted therapies for breast and other cancers where Fes and Fer are implicated.

![Image of Dr Peter Greer and Jeff Mewburn](https://example.com/greer.png)

**Photo credits:**

- Dr Simon Graham’s research is testing tablet-based MRI technology to assist surgeons in planning brain tumour removal. Photo credit: Graham lab
- Dr Peter Greer (front) and Jeff Mewburn, research associate, Queen’s University
Calorie counts on menus influence eating habits and new legislation

Dr David Hammond, University of Waterloo, Propel Centre for Population Health Impact

Obesity carries with it many consequences for health, including an increased risk of cancer, which has led to a growing number of public health strategies designed to curb this society-wide problem. One tactic that has been suggested is calorie labelling on restaurant menus, however the evidence showing how well this labelling works has been mixed. A world leader in research on the effectiveness of health warning labels, Dr David Hammond and his team conducted a trial where 635 adults were randomly assigned to 1 of 4 groups to test the influence of menu labelling on their ordering choices. 3 options had calorie counts and other nutritional information, and 1 option had none of this information. People whose menus displayed calorie content information consumed significantly fewer calories in their meal, however including additional nutritional information did not seem to have any added benefit. As a result of his work, Dr Hammond was invited to serve on key policy development bodies – including the federal/provincial/territorial Task Group on the Provision of Nutrition Information in Restaurant and Foodservice Outlets – to advise on nutritional labelling practices. His work has also been used by the British Columbia and Ontario governments in nutritional information initiatives, including new proposed legislation in Ontario that will require calories to be displayed on menus of all chain restaurants – the first regulation of its kind in Canada.25

Predicting which prostate cancers will metastasize

Dr Cheryl Helgason, British Columbia Cancer Agency

Most deaths from prostate cancer occur when the disease metastasizes, or spreads to other parts of the body. Dr Cheryl Helgason and her team have been looking for clues to help determine a patient’s risk of their cancer spreading. She is studying a class of genetic material called long non-coding RNAs (IncRNAs). IncRNAs don’t make proteins but have other functions that are only beginning to be understood. They identified a IncRNA called PCAT18 whose levels distinguished between localized and metastatic prostate cancer. They also found that PCAT18 regulated how prostate cancer cells grow and spread, suggesting that it could be used as a biomarker to predict metastasis as well as a potential drug target. Considering the impact of metastasis on prostate cancer survival, this finding has important implications for the outcomes of patients with this diagnosis.26

Discovering genetic mutations that make cancers more responsive to drugs

Dr Philip Hieter, University of British Columbia

Identification of genetic mutations can lead to more targeted cancer treatments. In the journal Genetics, Dr Philip Hieter and his team discovered that the inhibition of any one of 14 genes by a drug, together with a gene mutation found in cancer, led to increased sensitivity to chemotherapy. They are building on these findings with a Society-funded Innovation to Impact Grant to identify the full range of genetic mutations that confer sensitivity to chemotherapy.27
Improving breast cancer screening in a high-risk group of childhood cancer survivors

Dr David Hodgson, University of Toronto

Women who received chest radiotherapy treatment for Hodgkin lymphoma in childhood have an increased risk of breast cancer, and as a result, guidelines recommend that they begin screening for breast cancer earlier than women in the general population. However, there is limited evidence of how effective early screening is in this population. Dr David Hodgson and his team conducted the first study to test the effectiveness of screening of this group using mammography in combination with magnetic resonance imaging (MRI), which is the preferred method of screening for high-risk patients. In the journal Cancer, they reported that MRI plus mammography identified more cancers at an earlier stage than mammography alone. This research suggests a screening strategy to help detect breast cancer earlier in this high-risk population.28

Population-wide studies of the genetics of lung cancer

Dr Rayjean Hung, Mount Sinai Hospital

With the amount of information about human DNA now available, it is possible to do very large scale studies to identify changes across the genome associated with various diseases. Even rare genetic variations (which have traditionally been challenging to study due to the limited number of cases) can be uncovered. Published in Nature Genetics, Dr Rayjean Hung and her team combined data from 4 genome-wide association studies to identify previously unknown inherited genetic risk factors for lung cancer. In populations of European ancestry they found rare variants of the BRCA2 and CHEK2 genes that were associated with squamous cell lung cancer. They also found genetic associations for lung adenocarcinoma with a gene variant that had previously only been reported in Asian populations. In collaboration with researchers working on other adult cancers such as prostate, breast, colon and ovarian cancers, Dr Hung’s research team is currently leading efforts to identify genes that may have effects on multiple cancer types. These findings contribute new knowledge about the genetic basis of cancer, and have implications for the screening of high-risk individuals who carry these inherited mutations.29
A gene that helps predict response to colorectal cancer treatment

**Dr Derek Jonker**, Queen’s University, NCIC Clinical Trials Group

Cetuximab is an approved treatment for colorectal cancer, but its effectiveness is limited to those patients who do not have a mutation in the KRAS gene. As well, a significant proportion of this patient subset becomes resistant to the drug. Dr Derek Jonker of the Society-funded NCIC Clinical Trials Group studied colorectal cancer patient samples to narrow down the group of patients most likely to respond to cetuximab. By testing biomarkers that are known to have prognostic significance in other cancers it was found that while the proteins PIK3CA, PTEN and BRAF were not useful in this case, increased expression of the gene epiregulin was associated with a positive response to cetuximab. These findings support a personalized therapy approach for the treatment of colorectal cancer.¹⁰

Revealing the mechanics of the immune system’s response to cancer

**Dr Kevin Kane**, University of Alberta

The goal of immunotherapy, a promising new area for cancer treatment, is to harness the immune system to fight cancer. Dr Kevin Kane and his team have developed a method to identify the different proteins that T cells of the immune system are attracted to, in order to determine which ones can be used to target the killing of cancer cells. He has patented a cell-based microarray technology that helps classify the body’s immune response against cancer. Dr Kane holds the Women in Insurance Cancer Crusade Alberta Innovation Grant of the Canadian Cancer Society.³¹

A new model to accelerate research on cancer genes

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

Methods that identify genes driving cancer in model organisms can be difficult to apply to human cells. Reported in the prestigious journal Nature Genetics, Dr Rama Khokha and her team created an effective method of introducing mutations in the human genome to test for cancer-causing genes. Mice injected with these mutated human cells developed clinically relevant tumours, which led to the identification of several candidates for cancer-causing mutations. These findings highlight the capacity of this technique to reveal key cancer-driving genes.³²
Boosting the power of an oncolytic virus

Dr Robert Korneluk, Children’s Hospital of Eastern Ontario

One of the ways cancer cells avoid death (apoptosis) is to enlist the help of protective molecules called inhibitors of apoptosis proteins (IAPs). Drugs called Smac mimetic compounds (SMCs) are known to fight the protective work done by IAPs, making cancer cells easier to kill. Dr Robert Korneluk and his team tested whether SMCs could be enhanced by combining them with oncolytic viruses or other immune changers that increase the amount of pro-death molecules inside cells. In the high-impact journal Nature Biotechnology, they demonstrated that this combined attack worked better than either approach alone, killing cancer cells in mice resistant to existing treatments. They aim to start a clinical trial soon to test this approach in humans. Dr Korneluk’s CCSRI Innovation Grant is generously supported by the Lotte & John Hecht Memorial Foundation.

An oral supplement that may help prevent breast cancer

Dr Joanne Kotsopoulos, Women’s College Hospital

Women with mutations in the BRCA1 gene are at an increased risk of developing breast and ovarian cancers. It is believed that these high-risk individuals produce less BRCA1 protein, which provides an opportunity to reduce the risk of cancer by raising BRCA1 levels in cells. Dr Joanne Kotsopoulos and her team showed that an oral supplement called 3,3’-diindolylmethane (DIM) increased BRCA1 expression in women with a BRCA1 mutation. While this was a small study, it suggests a promising avenue for breast cancer prevention in high-risk women.
Understanding the impact of disability on access to cancer screening

Dr Aisha Lofters, University of Toronto

Cancer screening programs are an effective way to detect cancers early but only for those people who participate in them. Even where screening programs are organized and subsidized – as they are in Canadian provinces – many people still face obstacles to access them. Dr Aisha Lofters and her team have been researching the factors that contribute to low participation in breast cancer screening. Linking Canadian Community Health Survey data with mammography screening data, they were able to identify the screening patterns of over 10,000 women, about 4,600 of whom reported a disability. They found that women with severe disabilities were less likely to be screened than women with moderate or no disabilities. These findings identify women with severe disabilities as a group that could particularly benefit from supportive programs to help them access cancer screening programs.35

Investigating the long-term effects of cancer treatment on brain function in children

Dr Donald Mabbott, Hospital for Sick Children

Medulloblastoma is the most common malignant brain tumour affecting children. Typical treatment for this cancer involves surgery, chemotherapy and radiation. While survival rates are high, many patients endure long-lasting quality of life impairments, including intellectual and cognitive disabilities. Dr Donald Mabbott and his team have been studying the effects of treatment on brain structure and function in children with medulloblastoma, using imaging and memory testing. They found that, compared to healthy controls, these children had smaller regions of the brain associated with learning and memory, which also correlated with impairments in these abilities. This study contributes to a better understanding of the long-term damage to the brain caused by cancer treatment and highlights the need for more targeted therapies to minimize side effects for children with brain cancer.36
Uncovering new information about cell division

Dr Paul Maddox, University of North Carolina at Chapel Hill (formerly Institute for Research in Immunology and Cancer)

Cancer is triggered when something goes wrong in the basic machinery of cells. This can happen when cells divide, a vulnerable time when errors can be made in copying genetic information. Exploring the process of cell division will improve our understanding of cancer biology. Dr Paul Maddox and his team have been studying this process with a focus on the centromere, the piece that holds 2 strands of chromosomes together (i.e. the connection points in the familiar image of a DNA double helix). Published in Current Biology, they provided important information on the composition of centromeres. One particular component, the CENP-A nucleosome, was found to be assembled as an 8-protein complex that acts as a marker to ensure that parent and daughter cells have the same epigenetic information. These findings illuminate previously unknown aspects of the cell division process and suggest further paths of investigation to understand the events that ultimately lead to cancer.37

Evaluating the effectiveness of HPV vaccination

Dr Salaheddin Mahmud, University of Manitoba

The implementation of human papillomavirus (HPV) vaccination programs across Canada and other countries was the result of a coordinated effort between researchers who established the irrefutable connection between HPV and cervical (and other) cancers and the public health planners who mobilized to make the vaccine available. All Canadian provinces have publically funded, school-based vaccination programs available for girls aged 9–13, and Prince Edward Island and Alberta also have programs for boys. When the vaccine became available, many young women older than 13 elected to be vaccinated as a protective measure. Dr Salaheddin Mahmud and his team compared data on over 3,500 Manitoba women 15 or older who had received the vaccine with over 9,500 unvaccinated women (matching them by age). They found that while the vaccine was somewhat protective for women who received it between ages 15 and 17, there was a significant percentage of women who received it at age 18 or older who were not protected from HPV. This supports public health programs to administer the vaccine at an earlier age. Dr Mahmud is the recipient of the Great-West Life, London Life and Canada Life Junior Investigator Award in Prevention Research.38
Youth tobacco use studies lead to provincial bans on flavoured tobacco

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

Smoking is a major contributor to cancer, and addictions to cigarettes and other tobacco products are extremely difficult to break. Dr Steve Manske and Dr Leia Minaker of the Society-funded Propel Centre for Population Health Impact studied smoking behaviours among youth. Young people are at a pivotal point in their lives where they could either begin a lifelong addiction or stop a bad habit before it becomes worse. They found that over half of Canadian youth tobacco users choose flavoured tobacco such as flavoured mini cigars with names like “Grapes Gone Wild” and “Black ‘n Blueberry”. By partnering with the Society’s tobacco control advocates and others, this evidence was able to influence government policy. Provincial bills to ban flavoured tobacco products are now law in Alberta and have been proposed for Manitoba, Nova Scotia, Ontario and federally. Additional provinces are expected to follow suit. The researchers also reported that 32% of the youth in the study had smoked menthol cigarettes in the previous month, and these smokers were both more likely to smoke more cigarettes and continue smoking. This powerful finding has contributed to a change in the proposed Ontario legislation; while all bills had originally omitted menthol flavouring from the proposed ban, Ontario took the bold step of including menthol on its list.39 40

Interactions between diet and intestinal microbes that lead to cancer

**Dr Alberto Martin**, University of Toronto

Genetics, diet and gut microbiota – microbes that live in our intestines – all contribute to the development of colorectal cancer (CRC), but how these factors interact to promote cancer is not well understood. Dr Alberto Martin and his team investigated these interactions in a mouse model of CRC. In the prestigious journal Cell, they reported that gut microbiota resulting from a diet high in carbohydrates interacted with cancer-causing genes to stimulate cancer development. These findings have important implications for reducing cancer risk by altering diet and the composition of gut microbiota. Dr Martin’s CCSRI Innovation Grant is generously supported by the Lotte & John Hecht Memorial Foundation.41
New understanding about the onset of a form of kidney cancer

Dr Stephen Meyn, Hospital for Sick Children

Repairing mistakes in DNA is important for maintaining genomic stability, and defects in the DNA repair process can contribute to cancer. Dr Stephen Meyn’s team investigated the mechanism leading to genomic instability in the von Hippel-Lindau (VHL) gene, which is implicated in a type of kidney cancer known as clear-cell renal cell carcinoma. They discovered that the interaction between VHL and a protein called SOCS1 is blocked when VHL is mutated. As SOCS1 plays an important role in the DNA damage response, this interrupted communication contributes to the genomic instability found in kidney cancer. This is the first evidence that VHL helps protect against cancer by participating directly in the cell’s defences against DNA damage.42

Supporting schools to implement healthy eating and activity programs

Dr Donna Murnaghan, University of Prince Edward Island

Health promotion programs designed to encourage physical activity and good nutrition are key pieces of a cancer prevention strategy. Dr Donna Murnaghan of Thompson Rivers University, who holds an adjunct professorship at University of Prince Edward Island, and her team have been working to help schools, governments and communities implement evidence-based programming to support healthy lifestyle changes. Results from this research are being used to inform Prince Edward Island’s Wellness Strategy in schools for grades 5–12, and the researchers are also educating schools and policy-makers about how to use the information from this project. This work demonstrates how, with appropriate supports, evidence can be used to encourage behavioural changes.

Students participate in a local forum as part of Dr Donna Murnaghan’s Knowledge to Action Grant to support the implementation of healthy lifestyle programs for school age children

Photo credit: Murnaghan team
Surgical prevention of cancer in women with BRCA gene mutations

Dr Steven Narod, Women’s College Hospital

Women who carry a BRCA1 or BRCA2 genetic mutation carry a high risk of developing cancer of the breast, ovaries, fallopian tubes or peritoneum. Surgical prevention of cancer in these high-risk individuals can be achieved by removing the potential site of cancer initiation (where possible). In research supported by the former Canadian Breast Cancer Research Alliance, Dr Steven Narod and his team followed more than 5,700 women with BRCA1 or BRCA2 mutations for over 5 years. They found that surgical removal of the ovaries or ovaries plus fallopian tubes reduced the risk of ovarian, fallopian tube or peritoneal cancer by 80%. These findings show that offering preventive surgery to women with BRCA1 and BRCA2 mutations can have a profound effect on their risk of developing cancer. However, the impact on other aspects of their health and quality of life must also be carefully considered.43

A world leader in sarcoma research

Dr Torsten Nielsen, University of British Columbia

Sarcoma is a type of cancer that affects soft tissues, connective tissues and bones. Dr Torsten Nielsen and his team have been dedicated to finding new treatments for sarcomas, with Society funding supporting his work to advance new drugs to clinical trials. As a result of these efforts, Dr Nielsen has been appointed co-chair of the Society-funded NCIC Clinical Trials Group (CTG) sarcoma disease site committee. This not only places him in a national leadership role for sarcoma research but also – due to the NCIC Clinical Trial Group’s vast partnerships – supports his international influence on the development of new sarcoma therapies.

The link between traffic-related air pollution and prostate cancer

Dr Marie-Élise Parent, INRS – Institut Armand-Frappier

Prostate cancer is the most commonly diagnosed cancer in men, and little is known about how to prevent it. Dr Marie-Élise Parent and her team have been collecting data on environmental risk factors for prostate cancer over the last 10 years, accumulating one of the most extensive studies on this topic worldwide. They published an important finding that traffic-related air pollution correlated with an increased risk of prostate cancer for men living in Montreal. They are continuing to analyze and publish findings from the data they have collected, which could lead to the development of preventive strategies for prostate cancer.44
The relationship between obesity and arsenic body burden

Dr Louise Parker, Dalhousie University

Environmental exposures contribute to cancer risk, and some individuals are more susceptible to their harmful effects than others. Dr Louise Parker and her team have been studying the effects of diet on the “body burden” of arsenic from drinking water and food, the 2 major sources of arsenic exposure. They analyzed the amount of arsenic in the toenails of almost 1,000 people in Nova Scotia and found that those with eating habits that were connected with obesity (e.g. high in fast foods, artificial sweeteners and saturated fats, and low in fruits and nuts/seeds) had lower levels of arsenic in their toenails. These findings call for further research into whether obesity contributes to a reduced arsenic body burden, especially given that obesity increases the risk of several diseases, including many cancers. This study made the news in 2014 as researchers broke the Guinness World Record for the largest collection of toenails.45

Identifying cellular networks that determine the fate of stem cells

Dr Anthony Pawson, Mount Sinai Hospital and Dr Shawn Li, Western University

Understanding stem cell biology is important for many areas of health research. In cancer, the ability of stem cells to self-renew and differentiate are of particular interest, as these properties allow cancer stem cells to proliferate and survive treatment. Dr Anthony Pawson and Dr Shawn Li studied mechanisms which control the fate of stem cells. Published in the prestigious journal Cell, they identified that the tightly controlled actions of two proteins, Sos1 and Grb2, regulate stem cell differentiation. These important findings contribute to a greater understanding of how stem cells function in the body.46
Clarifying decisions about PSA testing for prostate cancer

Dr Stuart Peacock, British Columbia Cancer Agency, Canadian Centre for Applied Research in Cancer Control

The prostate-specific antigen (PSA) test is a popular yet controversial method of testing for prostate cancer. Only 1 out of about every 4 men with a high PSA level will develop cancer, and of these cancers, only about a third would go on to cause illness or death. This means that some men with high PSA levels may unnecessarily undergo preventive treatments and surgeries, which could have severe consequences on their quality of life. Dr Stuart Peacock, Co-director of the Society-funded Canadian Centre for Applied Research in Cancer Control, analyzed the cost-effectiveness of PSA screening in British Columbia, taking into account a range of population factors and potential outcomes. He found that doing a PSA test every 2 years, beginning at age 40, is cost-effective from a health services perspective, but the reduction in quality of life for men being tested outweighed the very small benefit to some individuals. This research supports the position that PSA screening should not be universally recommended. Rather, the decision to undergo testing should be discussed between individual men and their physicians, weighing their family history, personal health status, overall risk and quality of life factors.

Cost-effectiveness of lung cancer screening

Dr Stuart Peacock, British Columbia Cancer Agency, Canadian Centre for Applied Research in Cancer Control

Lung cancer kills more Canadians than any other cancer. Trials using computed tomography (3D scans) to find lung cancer in high-risk individuals (based on history of smoking) have been run in the United States and Canada to determine if a screening program could reduce mortality from lung cancers. Dr Stuart Peacock, Co-director of the Society-funded Canadian Centre for Applied Research in Cancer Control, analyzed the cost-effectiveness of screening within the Pan-Canadian Early Detection of Lung Cancer Study. The analysis showed that the combined average costs of screening high-risk individuals and treating cancerous nodules discovered through early detection were lower than the average cost of treating advanced lung cancer. These findings provide critical information on the costs and benefits of lung cancer screening to inform policy-makers on the value of screening programs. Computed tomography may be a valuable screening method for individuals at high risk of developing lung cancer while also maximizing healthcare resources.
Public engagement in healthcare decisions

**Dr Stuart Peacock**, British Columbia Cancer Agency, Canadian Centre for Applied Research in Cancer Control

Public input into healthcare decision-making is a growing priority in Canada. Dr Stuart Peacock, Co-director of the Society-funded Canadian Centre for Applied Research in Cancer Control, conducted a Canada-wide survey of decision-makers in cancer control to determine how public input was used. The survey revealed that despite views on the importance of public input in healthcare decisions, this evidence was used much less compared to clinical effectiveness or cost information. The survey also identified specific factors that reduced the chances of public input being used as evidence. These findings identify barriers to overcome and areas of focus in order to better integrate public input into healthcare decisions.49

Myc genes in the onset of cancer

**Dr Linda Penn**, University Health Network, Princess Margaret Cancer Centre

Advances in the understanding of what happens at the molecular level in cells have made a remarkable difference in how cancers are diagnosed and treated. Mutations that over-activate a gene called Myc and its family of proteins play an enormous role in cancer, as these Myc proteins function as master regulators to control how cells grow, move, change and die. Dr Linda Penn and her team investigated the Myc family using lung cancer samples and found 2 new mutations that over-activate Myc by a new strategy that changed the way it controlled other genes to drive cancer development. These findings, published in the journal Cancer Research, not only set the stage to identify new targets for anti-lung cancer drugs, but also reveal important information about how Myc potently contributes to the development of cancer.50
Making immunotherapies work for more people

Dr Claude Perreault, Université de Montréal

Cancer immunotherapy harnesses the immune system’s powerful ability to fight and control cancer. For example, researchers are trying to use T cells, the body’s natural killing machines, to kill cancer cells. T cells identify and attack other cells very specifically, so a greater understanding of molecules that they are attracted to is needed. Mass spectrometry is currently the only method to directly identify these molecules, however it can’t identify molecules that haven’t been well characterized. In a paper published in Nature Communications, Dr Claude Perreault and his team revealed a new approach that combined mass spectrometry with genomic sequencing to identify new molecules that attract T cells. Their findings could help increase the number of people diagnosed with cancer who could benefit from immunotherapies.

Revealing an important protein for the growth of brain cancer

Dr Lisa Porter, University of Windsor

Stem cells within brain tumours can drive cancer development and growth. However, they are difficult to identify and resistant to treatment, making them a top priority for new treatment approaches. Through her research supported by the former Canadian Breast Cancer Research Alliance, Dr Lisa Porter and her team discovered a cellular mechanism in breast cancer that is also important for brain cancer. In the prestigious journal Cancer Cell, they reported that a protein called Spy1 had a key role in balancing brain stem cell growth and the ability of cells to become different types of brain cells. This new knowledge about how brain cancer develops from a stem cell population provides new opportunities to develop brain cancer therapies.
Motivating families to engage in cancer-preventing exercise through video game bikes

Dr Ryan Rhodes, University of Victoria

Given that physical activity helps reduce the risk of developing cancer (and other chronic diseases), increasing participation in physical activity is an important public health goal. However, it can be challenging to motivate people to find the time and energy to exercise. Dr Ryan Rhodes has been taking advantage of the popularity of video games to make exercise more enjoyable. He and his team are testing interactive video games linked to a bicycle and are testing them with families in Halifax, Kingston and Victoria. In comparison to a stationary exercise bike in front of a television, children who biked while playing the interactive video game were better at adhering to an exercise routine. Dr Rhodes has developed a model to address the gap between good intention and behaviour when it comes to physical activity which is influencing healthy policy development at the Public Health Agency of Canada, as well as in Europe and Australia. Dr Rhodes is the recipient of the GIVETOLIVE Research Scientist Award in Prevention Research.

Testing the quality of life impact of a breast cancer prevention strategy

Dr Harriet Richardson, Queen’s University, NCIC Clinical Trials Group

Clinical trials are critical to proving the safety, efficacy and effectiveness of new drugs in humans. Following a clinical trial showing that exemestane – a drug that regulates estrogen levels in the body – was effective at preventing 65% of new cases of breast cancer in high-risk women, Dr Harriet Richardson of the Society-funded NCIC Clinical Trials Group conducted research to determine if there were any negative effects on quality of life associated with taking this preventive therapy. No important differences were observed in menopausal symptoms between women taking exemestane versus those who were not, providing important information for women considering this preventive treatment.51
Identifying biomarkers that predict the course of prostate cancer

Dr Arun Seth, Sunnybrook Research Institute

The more we understand about the genes involved in different cancers, the better equipped we are to detect cancer early and successfully treat it. Differences in how genes are being expressed can be used as biomarkers for cancer to predict disease progression and treatment resistance, so that samples from a patient may be tested to determine the best treatment approach. Dr Arun Seth and his team have analyzed samples from 100 prostate cancer patients who have undergone prostate removal. Published in Cancer Research, they identified a group of 24 biomarker genes to predict whether the cancer would come back. The identified biomarker genes affect how cells process nutrients, how tumours grow blood vessels and how signals are sent to tell cells how to behave. This knowledge could have a great impact on the clinical management of prostate cancer. 54

A new method to help researchers predict how mutations will lead to cancer

Dr Sohrab Shah, British Columbia Cancer Agency

When a person is given a cancer diagnosis it’s important to understand as much as possible about how the tumour is likely to behave, such as whether and where it might spread, and how it will react to different drugs. Different cell populations with different mutations have recently been identified within the same tumour, making determining a prognosis and treatment course challenging. These different cell populations also change over time, as the disease progresses and in response to therapy. In the journal Nature Methods, Dr Sohrab Shah and Dr Samuel Aparicio reported on their new approach called PyClone which uses statistical methods to group genetic mutations into different clusters of cell populations and track them over time. They tested this using ovarian cancer samples and found their method to be more accurate than conventional methods to predict how different cell populations evolve. This tool could be used in the future to more accurately assess disease progression and inform treatment strategies for many cancers. 55

Dr Arun Seth’s research uses a mouse model to assist in the identification of biomarkers for disease progression and treatment resistance

Image credit: Seth lab
**Trial identifies a better treatment option for aggressive lymphoma**

**Dr Lois Shepherd**, Queen’s University, NCIC Clinical Trials Group

Aggressive cancers must be met with aggressive treatments to extend or save the lives of patients. Chemotherapy drugs that attack cancer cells are also toxic to normal cells, causing side effects and affecting quality of life, making the development of less toxic treatments a priority. Dr Lois Shepherd of the Society-funded NCIC Clinical Trials Group compared 2 drug protocols for the treatment of aggressive lymphoma, which currently can only be cured by high-dose chemotherapy combined with autologous stem cell transplantation (ASCT). A combination of gemcitabine, dexamethasone and cisplatin (GDP) plus ASCT produced a response similar to the standard treatment of dexamethasone, cytarabine and cisplatin (DHAP) plus ASCT. However, patients receiving the GDP combination could participate on an outpatient basis, suffered fewer treatment-related hospitalizations due to toxicity and reported superior quality of life. These trial results could lead to an improved treatment experience for patients with aggressive lymphoma.56

**A strategy to prevent bone loss in postmenopausal women undergoing breast cancer treatment**

**Dr Lois Shepherd**, Queen’s University, NCIC Clinical Trials Group

Aromatase inhibitors are the standard hormonal therapy for postmenopausal women with breast cancer. However, these drugs can result in increased bone loss and risk of fractures. Work led by Dr Lois Shepherd of the Society-funded NCIC Clinical Trials Group compared whether bone mineral density, and thus bone health, was different among breast cancer patients treated with 1 of 2 different aromatase inhibitors. Published in Lancet Oncology, this research showed that bone mineral density did not differ between treatment groups, and that bisphosphonates could be used to prevent bone loss in patients who were treated with either aromatase inhibitor.57

**New knowledge about how breast cancer metastasizes**

**Dr Peter Siegel**, McGill University

While many breast cancers are now highly treatable, in cases where treatment has failed or the cancer has spread, the prognosis can be very poor. Dr Peter Siegel and his team have been examining the processes that lead to breast cancer metastasis. In 1 publication they reported the events needed for 2 molecular pathways – related to TGFbeta and ErbB2 – to facilitate the migration and survival of breast cancer cells. In a 2nd publication they showed that breast cancer cells use a protein called LPP to help them migrate and invade healthy tissue. These important insights suggest new targets for treatment strategies to prevent metastases from breast cancer.58 59
Revealing how cancer cells adapt to stress

Dr Poul Sorensen, British Columbia Cancer Agency

One of the ways cancers survive and thrive is their ability to adapt to harsh environments. Cancer cells can adjust their metabolism to survive periods of starvation where they have limited access to nutrients. In the journal Cell, Dr Poul Sorensen and his team published their finding that a molecule called eEF2K - activated by another molecule called AMPK - helps cancer cells adapt to nutrient deprivation. Their research points to a new target for combatting tumours that have adapted to stresses, including those that have developed drug resistance, as eEF2K may selectively protect these tumours.60

A new way to identify mutant proteins associated with cancer

Dr Igor Stagljar, University of Toronto

Protein interactions between cells help coordinate key signalling events that tell cells how to behave. Proteins bearing mutations, such as those occurring in cancer, may interact improperly, thereby leading to detrimental changes in cellular behaviour. The ability to monitor abnormal protein interactions could therefore help identify molecular level changes occurring in cancer cells. In Nature Methods, Dr Igor Stagljar and his team reported on a new method they developed to both detect protein interactions on cell surfaces, and monitor subtle changes in them resulting from mutations. His group specifically showed how this method could be used to study mutant proteins from lung cancer cells. This is an important step towards developing new diagnostic tools and treatments for cancer based on the molecular changes found in cancer cells.61

A prognostic test for prostate cancer

Dr Jeremy Squire, University of São Paulo (formerly Queen’s University)

The gene PTEN has been shown to play an important role in protecting normal cells from becoming cancer cells. The loss of PTEN is found in about 40% of human prostate cancers and is associated with aggressive disease and poor prognosis. Using a technique called fluorescence in situ hybridization (FISH), Dr Jeremy Squire and his team at Queen’s University mapped the PTEN loss to a region of the DNA that is highly unstable, providing a mechanism for PTEN loss in prostate cancer. He further developed the FISH tool to help tell the difference between less aggressive and more aggressive forms of cancers so that doctors can make the best treatment choices. This team has applied for patents of this innovative prognostic tool in Japan, China, Europe, United States and Brazil. It has been used by commercial labs across the United States to conduct thousands of prognostic tests.
Studying an online support group for breast cancer survivors

**Dr Joanne Stephen**, British Columbia Cancer Agency

Throughout the journey from detection to after treatment, a person with cancer will likely require support beyond what their medical team can provide. In research funded by the former Canadian Breast Cancer Research Alliance, Dr Joanne Stephen and her team conducted a large-scale online cancer support study, recruiting over 200 young breast cancer survivors to participate in a forum called CancerChatCanada. Over 2.5 years, 84% of individuals who started the study were still participating, a testament to the value of this type of e-health support system. Along with receiving positive responses from participants and the support services community, this study garnered considerable media attention across the country. The success of this initiative directly contributed to the formation of a national, internet-based psychosocial service for Canadians affected by cancer.

Standardizing the treatment of dangerous side effects for children undergoing chemotherapy

**Dr Lillian Sung**, Hospital for Sick Children

Fever and neutropenia, conditions that weaken the body’s ability to fight bacterial infections, are 2 of the most common and dangerous side effects of chemotherapy for children with cancer. Until recently, no guidelines have existed to help doctors manage or prevent these effects. Dr Lillian Sung and her team convened an expert group and, following standard procedures for rigorous guideline development, produced a set of principles to guide clinical practice for these conditions. These guidelines were published in 2012 and have now been endorsed by the American Society of Pediatric Hematology/Oncology, the Multinational Association for Supportive Care in Cancer, the Pediatric Oncology Group in Ontario and the Canadian CI7 Network. Endorsements from these bodies mean that the guidelines are improving care for children undergoing cancer treatment in Canada and internationally.

Dr Lillian Sung (front row, far right) with her team, Hospital for Sick Children
Revealing the genome of a childhood brain tumour

Dr Michael Taylor, Hospital for Sick Children

Ependymomas are common childhood brain tumours. Unlike other brain tumours, they are usually treated by surgery followed by radiation, but not chemotherapy, as it hasn’t been shown to be effective in clinical trials. In the prestigious journal Nature, Dr Michael Taylor and his team reported on their analysis of the entire genome sequence for ependymomas. Surprisingly, they found that the genome was essentially genetically normal, which may explain why chemotherapy – which targets abnormalities in cancer cells – doesn’t work on ependymomas. They did discover changes to the DNA not directly related to the gene sequence – termed epigenetics – revealing new therapeutic targets for this childhood cancer.63

Developing a new tool to understand drug interactions in cells

Dr Marc Therrien, Université de Montréal

Mutations in a molecular communication pathway that uses the proteins RAF and ERK can contribute to tumour development. Drugs that block this pathway have been developed, but one of these drug types – RAF inhibitors – unexpectedly has had the opposite effect of activating RAF. Current work is focused on understanding how these inhibitors stimulate this unwanted pathway in cancer, in the hopes of modifying these drugs to provide new therapeutics. Dr Marc Therrien and his team developed a new detection tool that was capable of providing a snapshot of how RAF inhibitors interacted with their target protein in living cells. In the journal Nature Chemical Biology they reported on this tool’s ability to reveal important details of how this interaction leads to the activation of RAF. The researchers have patented the tool as a means to discover valuable insights on drug interactions in cells. In the journal Nature Structural and Molecular Biology, they further uncovered key structural features of the RAF molecule that control its activation. These findings shed light on how to design drugs to block RAF, rather than detrimentally activate it.64 65

Dr Marc Therrien (back row, middle) with his team, Université de Montréal
Helping standardize colonoscopies to improve colorectal cancer detection

**Dr Jill Tinmouth**, Sunnybrook Research Institute

Colonoscopy can be an effective tool to reduce the burden of cancer and save lives through early detection. However, there can be variability in how they are performed between the endoscopists who perform them. Dr Jill Tinmouth and her team developed and tested an audit and feedback tool to help Ontario endoscopists who perform colonoscopies refine their practices and ensure that all colonoscopies meet the same high standard. This work has been presented to the Quality Management Partnership, a collaboration between the College of Physicians and Surgeons of Ontario and the provincial cancer agency Cancer Care Ontario. It is referenced in the Establishing Comprehensive Quality Management Programs for Mammography, Colonoscopy and Pathology in Ontario: Quality Management Partnership 2013/14 Report to the Ministry of Health and Long-Term Care, showing an impact on both policy recommendations and how colonoscopies are performed.

Mapping the causes of lung cancer

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

Lung cancer kills more Canadians than any other cancer. The ability to identify molecular patterns that predict survival in cancer patients will result in more individualized treatment plans. Dr Ming-Sound Tsao and Dr Michael Moran have been using powerful technology to collect information on the entire set of proteins found in human lung cancer samples and link them to the genes that code for them. Published in Nature Communications, they showed that patterns in the set of proteins and their genes predicted patient survival. In addition, the proteins that were predictive of survival all related to cellular metabolism. Linking all of this information together can help more accurately predict outcomes for patients with lung cancer, and help clinicians determine the best course of treatment.

Two new options for fighting pancreatic cancer

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

Pancreatic cancer has a poor prognosis, highlighting the need to better understand the disease - including the genes driving its progression - to develop new therapies. Dr Ming-Sound Tsao and his team have been investigating the genetics of pancreatic cancer in order to discover new drug targets. In the journal Oncogene, they published 2 papers reporting the discovery of 2 tumour suppressor genes - CCDC68 and SOX15 - that, when absent, allowed cancer cells to grow. Identification of cancer-causing genes will ultimately lead to an improved understanding of this disease - an exciting advance in fighting one of the hardest cancers to treat.
A new model to study the most common form of ovarian cancer

Dr Barbara Vanderhyden, Ottawa Hospital Research Institute

The most common form of ovarian cancer is high-grade serous ovarian cancer (HGSC), which is considered hard-to-treat. A critical debate is how and where this cancer originates, which is difficult to address without an experimental model that closely mimics human disease. Dr Barbara Vanderhyden and her team found that when they cultured ovarian cells in a dish under specific conditions, they spontaneously transformed into cells appearing very similar to cancer cells. When they tested these cells in a mouse model, they spontaneously turned into a version of HGSC. They have produced a valuable mouse model that will allow researchers to study how HGSC initiates and how normal ovarian cells may transform into tumour-initiating cells.69

A potential new drug to tackle lymphomas

Dr Tania Watts, University of Toronto

Understanding molecular events that keep cancer cells alive may lead to new targets for treatment strategies. Dr Tania Watts and her team have been studying a molecule called TRAF1 which is expressed above normal levels in lymphomas and promotes cell survival. Greater understanding of the role of TRAF1 in lymphomas has led to the identification of a drug target whose inhibition is predicted to lower levels of TRAF1 and sensitize cells to conventional therapy. The potential of this therapy is so promising that Dr Watts’ project was selected as one of 14 winning proposals, chosen from 428 entries from 26 different countries for the GlaxoSmithKline Discovery Fast Track Challenge, which is designed to accelerate the translation of academic research into novel therapies.

Dr Tania Watts (back row, left) with her team, University of Toronto
New tool to improve the care of pancreatic cancer patients

Dr Alice Wei, University Health Network, Princess Margaret Cancer Centre

Treatment for pancreatic cancer can involve complex and potentially dangerous surgery. Dr Alice Wei and her team have developed a pancreatic cancer patient care “roadmap” that incorporates evidence-based recommendations into an easy-to-use bedside tool to help guide medical teams. This tool is already in use at a pilot site and Dr Wei is in the process of implementing it in hospitals across Ontario. These guidelines will help standardize and improve the quality of care for pancreatic cancer patients undergoing surgery.

Improving radiation regimens to provide better pain control for bone metastases

Dr Rebecca Wong, Queen’s University, NCIC Clinical Trials Group

When a primary cancer resists treatment and spreads to the bone, it can be extremely painful. These metastases are usually treated with radiation, but there is little evidence to help doctors determine the optimal radiation doses and schedules. Dr Rebecca Wong of the Society-funded NCIC Clinical Trials Group conducted a trial with patients across 9 countries to compare 2 radiation protocols for reducing pain associated with bone metastases. This trial showed that a dose administered in a single treatment was just as effective, but less toxic, than a series of lower-dose radiation treatments. All patients receiving radiation treatment reported less pain or less need of pain medication, and better quality of life. These findings have important implications for the clinical treatment of bone metastases.

Improving treatment for the most challenging form of breast cancer

Dr Eldad Zacksenhaus, University Health Network, Toronto General Research Institute

Triple-negative breast cancers (TNBC) are associated with a poor prognosis due to lack of specific therapies and their high potential to spread. One trademark of many TNBCs is that they lack activity of 2 important tumour suppressor genes - PTEN and p53 – which help control the aggressiveness of cancers. Dr Eldad Zacksenhaus and his team have been investigating this form of cancer to uncover new drug targets. They identified a panel of 24 genes that could predict clinical outcome for patients with a TNBC subtype. They went on to discover that drugs targeting eEF2K, a molecule that regulates the production of proteins, are more effective against tumours lacking PTEN and P53 than many other current therapies. Their research has identified not only a prognostic signature for a specific type of breast cancer, but also a therapeutic approach more likely to work with this subset.
Exploring breath analysis as a diagnostic tool for cancers

Dr Haishan Zeng, British Columbia Cancer Agency

Health problems can change the molecules present in a person’s breath. Technological advances in the last 15 years have enabled the detection of these clues to disease, including many cancers, through breath analyzers. Dr Zeng and his team have been advancing the science of breath analysis by combining 2 existing technologies: Raman spectroscopy and hollow core-photonic crystal fiber (HC-PCF). This makes it possible to identify gaseous particles (such as those found in breath) based on how they interact with light. They compared this relatively inexpensive method with the one credited to be the most accurate to date, and found it to be 100 times more sensitive at detecting particles. This significant improvement in the science of breath analysis has the potential to lead to simple, inexpensive methods to detect cancer.72

A test to help predict which patients will benefit from bone marrow transplants

Dr Li Zhang, University Health Network, Toronto General Research Institute

Bone marrow transplants, also known as grafts, are a common treatment for leukemia, where transplanted white blood cells bolster the patient’s immune system to fight cancer. While graft-versus-leukemia (GVL) is the desired effect, these transplanted cells can also attack healthy cells. This unwanted effect known as graft-versus-host disease (GVHD) can be disabling or even fatal. Dr Li Zhang and her team have been studying a type of white blood cell called double-negative T (DNT) cells, which have anti-cancer and anti-GVHD effects. They have shown that a molecule on DNT cells called MFAP4 promotes DNT cell function in mice. Over the course of this research they have obtained 2 patents related to the MFAP4 marker and their method of detection.73 74
Improving quality of life for cancer patients through early palliative care

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

Patients with advanced cancer can work with their health team and caregivers to create a plan of care that will maximize their quality of life. Dr Camilla Zimmermann and her team have been leading a clinical trial to study the impact of early palliative care for patients with advanced cancer. In a paper published in The Lancet, she and her team reported that participants who had an outpatient palliative care team involved in their care earlier experienced a better quality of life, reduced symptom severity and greater satisfaction with care, versus those who received standard care. These findings could lead to changes in palliative care to improve the experience for cancer patients, their caregivers and families.
References


Lung cancer kills twice as many Canadians as breast and prostate cancer, combined.

It 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 26,100 Canadians were diagnosed with lung cancer in 2014, and 20,500 died from the disease. Tobacco use is the leading cause of lung cancer; radon exposure is the 2nd known cause, accounting for an estimated 3,000 lung cancer deaths in Canada every year.

Thirty years ago about 14% 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 Research Institute (CCSRI)
support of lung cancer research

Thanks to our donors, the Canadian Cancer Society invested $2.2 million in lung cancer research through our Research Institute in 2014. This supported 37 lead investigators across Canada exploring the biology behind the causes of lung cancer and new ways to detect it, treat it and prevent it before it starts.

The Society-funded NCIC Clinical Trials Group is the only Canadian cancer trials group that conducts the entire range of clinical trials across all cancer types. In 2014, 10 lung cancer clinical trials were active that have involved 1,328 patients in cities across the country including Kelowna, Vancouver, Edmonton, Regina, Saskatoon, Winnipeg, Hamilton, London, Ottawa, Toronto, Thunder Bay, Montreal, Quebec City, Sherbrooke, St John’s, Saint John and Moncton. In 2014 the NCIC Clinical Trials Group announced a large, cutting-edge lung cancer trial testing a new class of drug for non–small cell lung cancer.

This is the first trial in the world to test this new drug in the setting of early lung cancer treatment.

Dr Janet Dancey, Director of the NCIC Clinical Trials Group

Twenty-five Canadian institutions will participate in this international trial that includes the United States, France, Australia, New Zealand, Spain, the Netherlands, Poland, Hungary, Italy, Singapore, South Korea and Taiwan.

As a 3-time lung cancer survivor and a proud volunteer with the Canadian Cancer Society peer support program, I know first-hand and through supporting others, the critical need to have trials of this calibre.

Carol Gething, lung cancer survivor

We’re making progress! Society-funded researchers continue to bring new insight and approaches to tackling lung cancer. In 2014 the Canadian Cancer Society supported key research findings, including:

- Dr Rayjean Hung from Mount Sinai Hospital uncovered new genetic risk factors for lung cancer. BRCA2 and CHEK2 gene variants were associated with squamous cell lung cancer in people of European ancestry, and a gene variant only previously reported in Asian populations was associated with lung adenocarcinoma.

- Dr David Dankort from McGill University found that the KRAS gene, mutated in about 1 in 5 lung cancer adenocarcinomas, could in some situations suppress cancer – important knowledge for the development of new cancer treatments.

- Dr Michael Chaiton from the University of Toronto showed that smokers trying to quit were less likely to succeed after being exposed to tobacco smoke on patios, revealing an additional benefit of public smoking bans originally designed to reduce second-hand smoke exposure.

- Dr Haishan Zeng from the British Columbia Cancer Agency advanced breath analysis to detect signs of disease. By combining 2 technologies, he established a more sensitive method that could lead to new, simple and inexpensive ways to detect cancer.

- Dr Steve Manske of the Propel Centre for Population Health Impact at the University of Waterloo found that over half of Canadian youth tobacco users chose flavoured tobacco, providing the evidence to support bans of these products in many provinces.

- Dr Stuart Peacock, Co-director of the Canadian Centre for Applied Research in Cancer Control at the British Columbia Cancer Agency, analyzed the cost-effectiveness of lung cancer screening by computed tomography (3D imaging). He and his colleagues in the Pan-Canadian Early Detection of Lung Cancer Study found that the costs of screening high-risk individuals and treating discovered cancerous nodules were lower than the costs of treating advanced lung cancer patients, highlighting the economic benefits of lung cancer screening for those at high-risk.

Stay tuned! In 2014 the Canadian Cancer Society invested in 14 new research grants and awards, testing new approaches for lung cancer and representing $2.3 million in new funding for the next 4 years.
Celebrating Research Excellence

Dr David Hammond (centre) and his team, University of Waterloo
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 scientists for their contributions to our understanding of how cancers arise, how they work and how to defeat them.

**Robert L. Noble Award**
The Robert L. Noble Prize is given to a Canadian 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 vincristine, a widely used anticancer drug.

Awarded to

**Dr Shoukat Dedhar**, University of British Columbia and the British Columbia Cancer Agency, in recognition of his contributions to the areas of cancer biology, cell adhesion mechanisms and signal transduction. Dr Dedhar’s research led to the discovery of Integrin Linked Kinase (ILK), one of the greatest advances in the field of integrin-mediated adhesion, and now a major drug target for cancer, cardiovascular disease and inflammation.

**Bernard and Francine Dorval Award**
The Bernard and Francine Dorval Award is given to a Canadian investigator permanently residing in Canada who began their independent research career within the previous 10 years. They must be the principal investigator of activities conducted in Canada, which are judged to be outstanding contributions to basic biomedical research and that have the potential to lead to, or have already led to, better understanding of cancer, improved cancer treatments and/or cures. It honours Bernard and Francine Dorval who are dedicated supporters of the Society’s research programs.

Awarded to

**Dr Andrew Weng**, University of British Columbia and British Columbia Cancer Agency, in recognition of his contributions to advancing scientific understanding of the processes driving the onset of leukemia. Dr Weng’s work on Notch signalling has transformed our view of Notch’s role in leukemias and lymphomas.
O. Harold Warwick Award

The O. Harold Warwick Prize is given to a Canadian 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.

Shared by

**Dr William Foulkes**, McGill University, for his contributions to our understanding of cancer genetics, in particular in hereditary breast and ovarian cancers. Dr Foulkes was one of the first to show that most BRCA1-related tumours are estrogen receptor negative and the first to publish on the impact of BRCA1 mutations in breast cancer outcomes.

and

**Dr Christine Friedenreich**, University of Calgary and Alberta Health Services, in recognition of her international leadership on the association between physical activity, cancer etiology and survival. Dr Friedenreich has conducted over 35 studies of physical activity and cancer, including the ongoing BETA trial, which is investigating the influence of physical activity on biomarkers associated with breast cancer risk.

William E. Rawls Award

The William E. Rawls Prize is given to a Canadian investigator permanently residing in Canada who began their independent research career within the previous 10 years. They must be the principal investigator of activities conducted in Canada, which are judged to be outstanding contributions to research that have the potential to lead to, or have already led to, new 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 David Hammond**, University of Waterloo, for his internationally recognized contributions to the area of tobacco control. Dr Hammond has served as an advisor for tobacco control policies and guidelines in Canada and around the world, and as an expert witness in legal challenges brought by tobacco companies against public health laws in Canada, the United Kingdom and Australia.
Dr Igor Stagljar (fifth from the right) with his team, University of Toronto
Pancreatic cancer has one of the lowest survival rates of any cancer.

It is estimated that 4,700 Canadians were diagnosed with pancreatic cancer in 2014, and 4,400 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 Research Institute (CCSRI)
support of pancreatic cancer research

Thanks to our donors, the Canadian Cancer Society invested almost $1.2 million in pancreatic cancer research through our Research Institute in 2014. This supported 17 lead investigators across Canada exploring the biology behind the causes of pancreatic cancer, and new ways to detect and treat it.

The Society-funded NCIC Clinical Trials Group is the only Canadian cancer trials group that conducts the entire range of clinical trials across all cancer types. In 2014, 2 pancreatic cancer clinical trials were active that have involved 57 patients from cities across the country including Vancouver, Regina, Ottawa, Toronto, Kingston, St Catharines, Barrie, Hamilton, Sherbrooke, Montreal, Halifax and Moncton. The 7 Days in May Foundation cycled 1,100 km in 2014 to raise funds to support one of these important trials looking for a better treatment for pancreatic cancer.

For us, it’s all about trying to give hope and raise awareness.

Gord Townley, Founder of the 7 Days in May Foundation

We’re making progress! Society-funded researchers continue to bring new insight and approaches to tackling pancreatic cancer. In 2014 the Canadian Cancer Society supported key research findings, including:

- Dr Ming-Sound Tsao and Dr Wan Lam from the University Health Network, Princess Margaret Cancer Centre discovered 2 tumour suppressor genes, which when absent, allowed pancreatic cancer cells to grow. Understanding the genetics of pancreatic cancer will help develop new drug targets and treatment approaches.

- Dr Alice Wei from the University Health Network, Princess Margaret Cancer Centre developed a patient care “roadmap” to help guide medical teams treating pancreatic cancer patients undergoing surgery. This tool is already in use at a test site and is being implemented in hospitals across Ontario to help standardize and improve the quality of care for pancreatic cancer patients.

Stay tuned! In 2014 the Canadian Cancer Society invested in 8 new research grants testing new approaches for pancreatic cancer, representing $3.7 million in new funding for the next 5 years. These include:

- Dr Steven Gallinger from Mount Sinai Hospital is testing BRCA gene mutations in pancreatic cancer to improve treatment strategies for this hard-to-treat cancer.

- Dr Steven Lewis from the University of Moncton, in partnership with the New Brunswick Health Research Foundation and Craig’s Cause Pancreatic Cancer Society, is developing a blood test to detect pancreatic cancer at an early stage.

- Dr John Bell from the Ottawa Hospital Research Institute is targeting oncolytic viruses, which selectively destroy cancer cells, for pancreatic cancer.

In 2014 we joined forces with Pancreatic Cancer Canada, the Canadian Institutes of Health Research, provincial health authorities, pancreatic cancer experts, patients and caregivers to develop a Pancreatic Cancer Research Strategy for Canada. Due in 2015, this strategy will provide a framework to enhance collaborative investment in research and accelerate progress in pancreatic cancer.
Society-funded Research in the Media: 2014 Highlights
Society-funded research gets attention. Below are some of the major outlet headlines we received in the past year.

**New Innovation Grant**: Metformin and microarrays: an innovative approach to treating and monitoring drug resistant canine lymphoma (Investigator: Dr Troy Harkness, University of Saskatchewan)

- Saskatchewan researchers study new cancer treatment on dogs
  - Global News

- Cancer treatments tested on dogs
  - Huffington Post

**New Innovation Grant**: Development of a noninvasive method for early colorectal cancer detection (Investigators: Dr Yingfu Li and Dr Bruno Salena, McMaster University)

- Glowing poop could be a simple, accurate test for colorectal cancer
  - Hamilton Spectator

- New McMaster colon cancer test makes poop glow
  - CHCH TV

- Poop that glows: McMaster researchers developing colorectal cancer test
  - cbc.ca Hamilton

- Fluorescent feces test may detect colorectal cancer
  - UPI

- Glowing poop will identify cancer, Canadian researchers hope
  - canoe.ca, Ottawa Sun, London Free Press

- Des selles fluo pour détecter le cancer colorectal
  - ici.radio-canada.ca
New Innovation Grant: Evaluation of hyaluronidase 2 as a target for cancer prevention (Investigator: Dr Barbara Triggs-Raine, University of Manitoba)

- Naked rat could hold key to cancer cure
  - The Times
- Naked mole rat could hold key to cancer cure
  - The Australian
- Naked mole rat offers new hope for cancer researchers
  - o.canada.com

New Quality of Life Grant: Improving the quality of oncofertility decision-making for women at risk of infertility during cancer survivorship (Investigator: Dr Nancy Baxter, St. Michael’s Hospital)

- New hope for patients who want kids after cancer
  - The Toronto Star

New Impact Grant: Hallmarks and therapeutic implications of “BRCAness” in pancreatic cancer (Investigator: Dr Steven Gallinger, Mount Sinai Hospital)

- The mystery of pancreatic cancer and its treatment prevails
  - The Globe and Mail

Dr Steven Gallinger, Mount Sinai Hospital

Study results: Molecular markers in breast tissue and breast cancer prevention (Prevention Initiative Junior Investigator Award: Dr Caroline Diorio, Centre hospitalier affilié Universitaire de Québec)

- Four sugary drinks each week raises breast cancer risk
  - The Express (UK)
- Is sugar intake linked with breast cancer risk?
  - Biomed Central
- The scary thing sugar does to your breasts
  - Prevention
It is wonderful to be part of the CCSRI and I hope more of our work and that of others funded by Canadian Cancer Society donors leads to getting people out of the hospital sooner and having an impact on both survival and quality of life.

Dr Mick Bhatia, McMaster University
Canadian Cancer Society Research Institute

impact / ideas / research / grants and awards
knowledge / gold standard in peer review
innovation / discovery / prevention / quality of life
patients and families

1 888 939-3333 | cancer.ca
TTY 1 866 786-3934

© Canadian Cancer Society 2015