

PETER MUNK CARDIAC CENTRE STRATEGIC PLAN 2023-2028

**EXCEPTIONAL
CARE**



**DISCOVERY
DRIVEN**



**EXEMPLARY
EDUCATION**

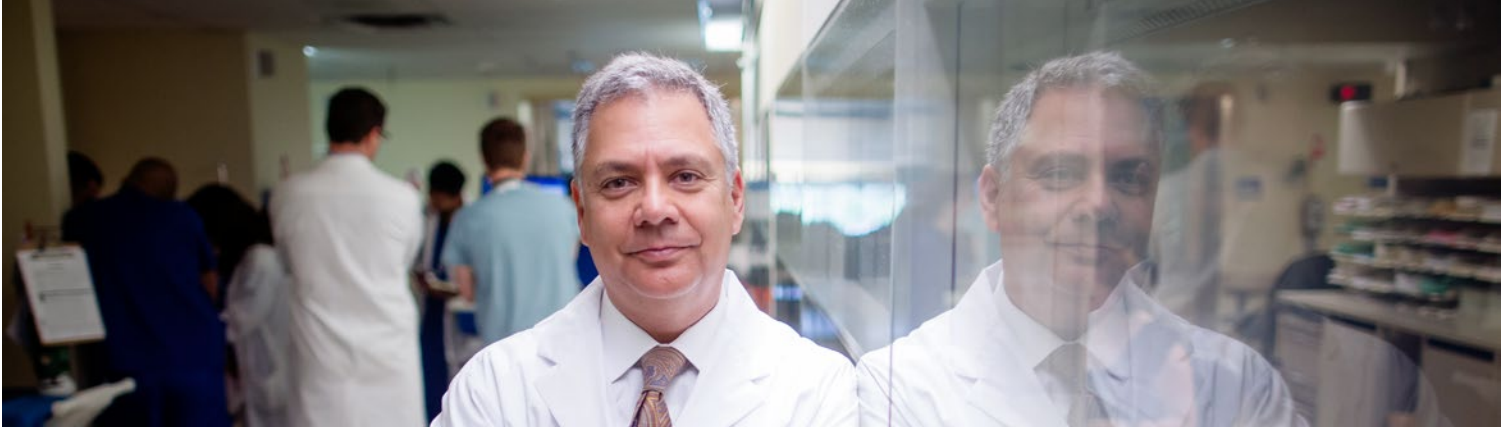


**PEOPLE-
CENTERED**



**DATA AND
AI ENABLED**





LEADING THE FUTURE

With great pride and a deep sense of responsibility, we continue our mission to provide the highest quality care to the patients we serve at the Peter Munk Cardiac Centre (PMCC) at University Health Network (UHN).

We are dedicated to fostering a team-based approach to patient care, where all team members work together towards a common goal of providing the best possible outcomes and experiences for every patient.

While there are challenges in today's healthcare environment, we remain steadfast in our commitment to persevere and continue to develop innovative therapies for those with cardiovascular disease. Our dedication to this goal stems from our belief that every patient deserves access to the most effective and advanced treatments. To this end, we will continue to explore new ways to improve patient care, such as minimally invasive heart surgery and remote monitoring devices that allow us to continuously assess the health status of patients wherever they may be.

In addition to providing the best possible care for our patients, we are committed to creating a positive, fulfilling, and mutually respectful work environment for our staff. We will promote joy in work by focusing on the well-being of our staff and patients, leading to better patient outcomes. To accomplish this, we will create healthcare environments that promote positive relationships, open communication, and a shared sense of purpose.

The PMCC will invest in data, the new currency of healthcare, and leverage our rapidly evolving expertise in artificial intelligence to personalize patient care, reimagine medical education, and advance cardiovascular research. Our team will continue to invest in state-of-the-art equipment at the forefront of medical innovation and remain committed to ensuring equitable access to healthcare for all patients, regardless of their background or circumstances.

UHN and the PMCC are committed to making meaningful gains in equity, diversity, inclusion, and reconciliation. While we have made significant progress, including the creation of a Social Medicine Program that offers Canada's first prescribable housing for high-needs and frequent health services users, we know that we have much more to do to see at-risk populations equitably access health and social services, and to see TeamUHN better reflect the patients we have the privilege of serving.

Finally, we believe in the importance of educating the next generation of healthcare professionals and instilling in them the values that we hold dear at the PMCC. Our learning environment will empower our students to care for patients with compassion, empathy, and expertise so they are well-prepared to take on future challenges.

As we move forward, we will be bold, embrace change, and set the worldwide standard for discovery, learning, and care. With a focus on providing the best possible treatment to our patients, fostering positive work environments, and enabling innovation, the PMCC will continue to be a leader in cardiovascular care for years to come.

DR. BARRY RUBIN

Medical Director and Chair
Peter Munk Cardiac Centre
University Health Network

“

You have to be *courageous*; you have to learn to take advantage of change. Be *non-conventional*; do not fritter your energies—be *focused*; remember to share. Most important, use the biggest weapon of all weapons, the least appreciated yet the most important tool for success, and this is *moral integrity*; and don't be afraid to dream and don't be afraid to *dream big*.

PETER MUNK





BACKGROUND

This strategic plan is the product of an extensive, collaborative, and interactive process in which many stakeholders were sought out and engaged for their unique perspectives. As a result, the voices of patients, learners, nurses, allied health professionals, researchers, physicians, and healthcare leaders from within the PMCC, across UHN, and at many sites around the globe are reflected in the PMCC's bold new strategic direction. This strategic plan will allow the PMCC at UHN to meet the current and future healthcare needs of the patients we serve and to realize our shared vision to be the world's leading heart and vascular centre.

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WHATEVER



TAKES.



OUR MISSION

The mission of the Peter Munk Cardiac Centre is to provide state-of-the-art, multidisciplinary, digitally enabled personalized care for patients with heart and vascular disease in Toronto, across Canada, and around the world. Through our unremitting focus on innovation, we will continue to lead the development, application, and evaluation of life-saving therapies that improve heart and vascular health. As part of Canada's largest academic hospital, University Health Network, we will continue to educate future generations of cardiovascular health care providers.



OUR VISION

The vision of the Peter Munk Cardiac Centre at University Health Network is to be the leading heart and vascular centre in the world. We will improve patient outcomes, generate new knowledge, and lead the development of innovative therapies by integrating evolving digital technologies and machine-learning approaches with outstanding care, teaching, and research.

OUR VALUES





DIVISIONS AND STAFF

The PMCC includes the Divisions of Cardiology, Cardiac Surgery, Vascular Surgery, Cardiovascular Anesthesia, Cardiovascular Imaging, Cardiovascular Pathology, and Cardiac Rehabilitation, as well as Cardiovascular Research, conducted through the Toronto General Hospital Research Institute.

Over
1,100
health care
professionals

including imaging technologists, nurses, nutritionists, occupational, physical, and respiratory therapists, pharmacists, and physicians provide care for 163,000 out-patients per year and the 10,000 patients per year that have cardiac and vascular procedures at the PMCC.

CORE OPERATING PRINCIPLES

The core operating principles of the PMCC are to:

1. **Ensure that the needs of the patients come first.**
2. **Use a data-driven approach to provide exemplary patient-centered care through interdisciplinary teams.**
3. **Use the best equipment in the world.**
4. **Create a culture and clearly defined processes that enable the development of innovative therapies for patients with cardiovascular disease.**
5. **Focus on equity, diversity, inclusion, and reconciliation to ensure that PMCC staff reflect the patients we are privileged to serve.**



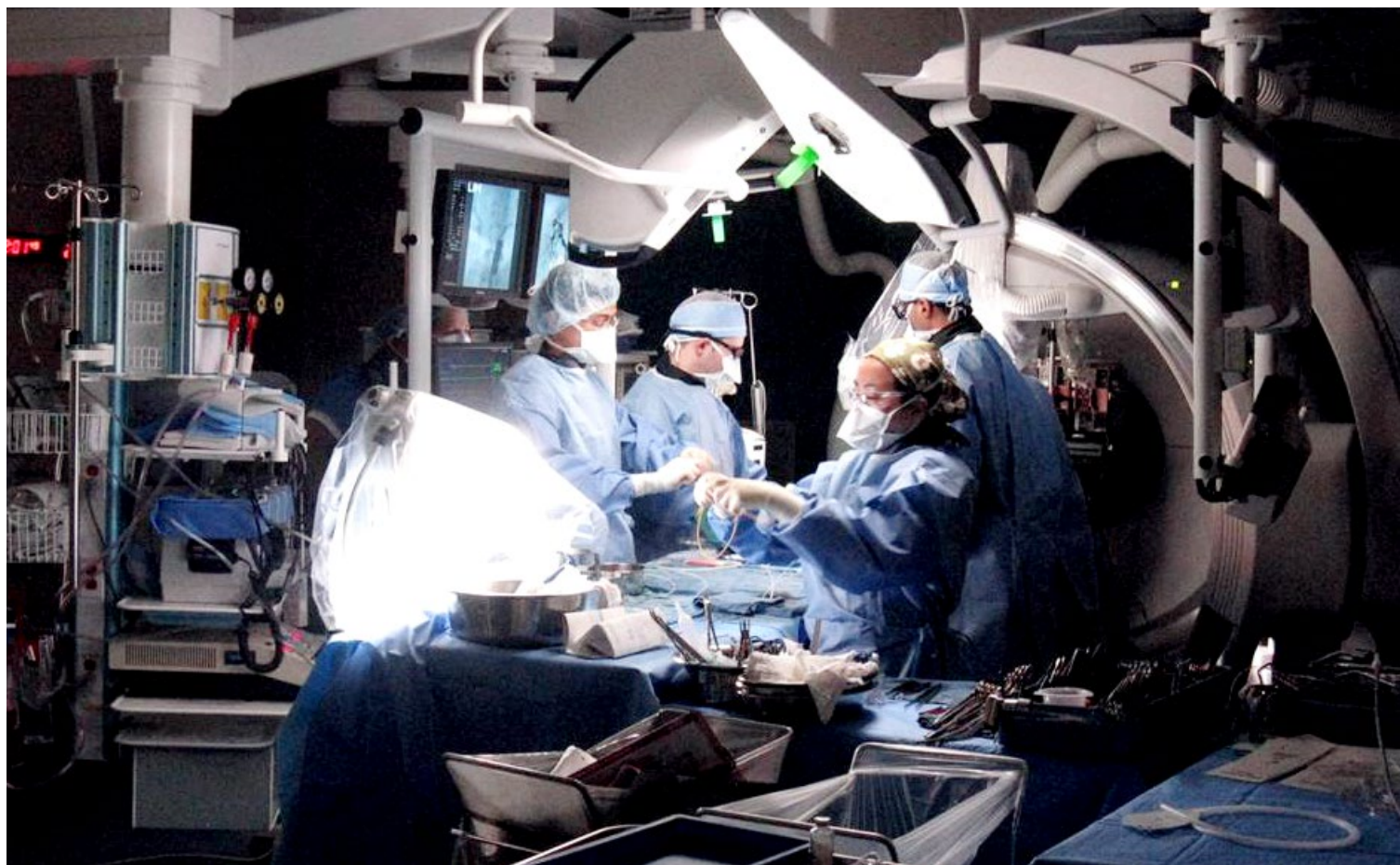
INFRASTRUCTURE AND BUDGET

The PMCC has five Cardiac Surgery, one Vascular Surgery, and two hybrid imaging-enabled operating rooms.

In addition, there are six cardiac catheterization laboratories at Toronto General Hospital (we renovated cath labs 4, 5, and 6 in 2021 – 2022 and will renovate cath labs 1, 2, and 3 this year), four vascular interventional radiology suites (to be renovated in 2023 – 2024), as well as a noninvasive vascular ultrasound laboratory and echocardiography laboratory, which conducts 35,000 echocardiographic imaging studies per year. We manage twenty-three critical care beds in the Cardiovascular ICU (nineteen Level Three and four

Level Two beds) and fourteen critical care beds in the Coronary Intensive Care Unit (four Level Three beds and ten Level Two beds). In addition, we manage twenty-six beds in the recovery area of the cath lab, four overnight stay procedure beds, and thirty-six cardiology, twenty-eight cardiac surgery, and twelve vascular surgery in-patient beds, respectively.

The annual operating budget of the PMCC is 106 million dollars, which does not include research.





CENTRES OF EXCELLENCE AND INTERDISCIPLINARY CLINICS

The PMCC has Centres of Excellence in complex aortic diseases, cardiac rhythm disorders, advanced cardiac therapeutics (including mechanical circulatory support and heart transplantation), valvular heart disease, cardiovascular rehabilitation, and heart function.

In addition, the PMCC operates thirteen interdisciplinary clinics ([Appendix A](#)) that focus on team-based management of patients with complex cardiovascular disease processes and offers interdisciplinary fellowships that provide advanced, team-based training opportunities, many in clinical areas unique to the PMCC.

OVERSIGHT

The Peter Munk Cardiac Centre is one of twelve [UHN Programs](#) that are governed by the UHN Board of Trustees, led by Board Chair Brian Porter.

Barry Rubin (Medical Director) leads the PMCC Executive Committee with Sheryl Alexandre (Clinical Director) and Fayez Quereshy (Vice President and Site Lead, Toronto General Hospital (TGH)).

The PMCC Executive Committee includes the PMCC's Leads for Finance (Natasha Hsu, Teresa Chu), Quality (Carolina Alba), Research (Phyllis Billia), Education (Sean Balmain), Public Relations and Communication (Rosa Kim), Nursing and Allied Health (Leanna Graham), Philanthropy (Shauna Seabrook) and Strategy / Special Projects (Ahlexxi Jelen), as well as the Heads of the Divisions of Cardiology (Heather Ross, also scientific lead for the Ted Rogers Centre for Heart Research at TGH), Cardiac Surgery (Maral Ouzounian), Vascular Surgery (Graham Roche-Nagle), Cardiovascular Anesthesia (Jane Heggie), Cardiovascular Imaging (Arash Jaber), Cardiovascular Pathology (Michael Seidman) and Cardiac Rehabilitation (Paul Oh). The PMCC Executive Committee meets weekly to monitor program finances and activity, quality initiatives, and reports, including critical incidents, and coordinates the implementation of new initiatives, the development of new partnerships, external communication, staff recognition events, and fundraising initiatives, among other things. The PMCC Executive Committee focuses on developing strategy and implementing policies that align with UHN priorities.

The PMCC Executive Committee reports to the Joint Medical Leadership Council / Clinical Operations Group, led by Marnie Escaf, Vice President Clinical and Brian Hodges, Executive Vice President Education and Chief Medical Officer. We also work closely with Kathryn Tinckam, Physician-in-Chief and Thomas Forbes, Surgeon-in-Chief, to ensure alignment of clinical, educational and research initiatives across the PMCC.

The PMCC Quality Committee (QC) reports quarterly to the PMCC Executive Committee. The PMCC QC monitors observed and risk-adjusted predicted outcome measures obtained through participation in national and international quality assessment (QA) registries,

identifies opportunities for improvement, develops specific quality improvement plans, and then reassesses risk adjusted predicted and observed outcomes. This continuous QA / QI cycle operates across all divisions in the PMCC.

The PMCC is proud to work with persons with lived experience who participate in many PMCC activities, including the process used to recruit staff to the PMCC, searches for Chairs, the development of clinical, research, and educational programs, and the workshops that led to the creation of this strategic plan. We present a list of persons with lived experience that have worked with the PMCC in [Appendix B](#).

The PMCC is led by:

BARRY RUBIN
Medical Director
and Chair



SHERYL ALEXANDRE
Clinical Director



FAYEZ QUERESHY
Vice President and
Site Lead, Toronto
General Hospital



The Munk Scientific Advisory Board members:

VICTOR DZAU

US National Academy
of Medicine (Chair)



MICHELLE ALBERT

University of California
San Francisco



PAUL ARMSTRONG

University of Alberta



ANDRE DEKKER

Maastricht Clinic,
Netherlands



PAUL DORIAN

University of Toronto



PAUL RIDKER

Harvard



DUNCAN STEWART

University of Ottawa



SCIENTIFIC ADVISORY BOARD OVERSIGHT

The Munk Scientific Advisory Board (SAB) advises on research conducted at the PMCC, monitors clinical and teaching activities, and evaluates the performance of the Peter Munk Chairs.

Kevin Smith, UHN Chief Executive Officer, Brad Wouters, UHN Executive Vice President for Research, and Tennys Hanson, President of the UHN Foundation are ex-officio member of the Munk SAB, and participate in all Munk SAB meetings. The Chair of the Munk SAB reports directly to the Chief Executive Officer of UHN.

The Ted Rogers Centre for Heart Research (TRCHR), a strategic partnership between the University of Toronto, The Hospital for Sick Children, and UHN, supports research and education in heart failure, and at UHN is a core component of the PMCC. The Ted Rogers Scientific Advisory Panel members include Shoumo Bhattacharya (Oxford, UK), Christopher Chen (Boston University), Karen Hirschi (University of Virginia), Mark Mercola (Stanford), Lynne Warner Stevenson (Vanderbilt) and Duncan Stewart (Chair, University of Ottawa).

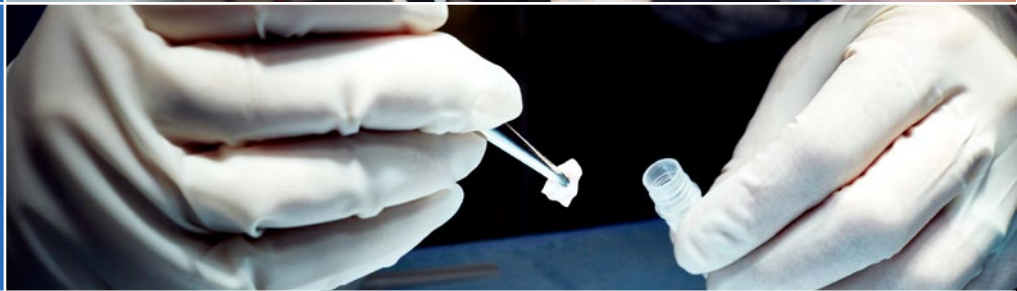
OUR STRATEGIC PRIORITIES

Objectives, Tactical Initiatives, Measures of Success

EXCEPTIONAL
CARE



DISCOVERY
DRIVEN



EXEMPLARY
EDUCATION



PEOPLE-
CENTERED



DATA AND
AI ENABLED



STRATEGIC PRIORITY

EXCEPTIONAL CARE

Pioneer and deliver the highest level of excellence for cardiovascular care.

Objectives

- Provide exceptional, seamless, team-based inter-professional care.
- Ensure exemplary patient experiences by engaging persons with lived experience (PWLE) as genuine partners.
- Care for patients with complex cardiovascular disease who cannot be treated elsewhere in Canada while maintaining the optimal volume of standard and high acuity cases.
- Provide equitable access to comprehensive care.
- Promote operational excellence and the efficient use of patient care resources.
- Deliver integrated, continuous care across the PMCC, UHN, and the communities we serve.
- Develop new approaches to treating cardiovascular disease that meet the needs of our patients.



STRATEGIC PRIORITY

EXCEPTIONAL CARE

Pioneer and deliver the highest level of excellence for cardiovascular care.

Tactical Initiatives

- Develop, disseminate, and evaluate the use of remote monitoring, virtual assessment, and other digital health solutions that promote equitable access to high-quality care.
- Create standardized practices and tools that healthcare workers can use to eliminate barriers to equitable access to patient care.
- Use patient-reported outcome and experience measures (PROMS and PREMS) and direct engagement of persons with lived experience and caregivers to develop and implement improvements in care pathways, leveraging Epic.
- Identify emerging health system needs to drive operational excellence and enhance quality of care.
- Leverage or collaboratively develop and implement evidence-based guidelines to direct the efficient use of healthcare resources and the patient journey.
- Optimize patient outcomes through participation in international quality assessment databases and continuous quality improvement initiatives.

Measures of Success

- 80% of PMCC out-patients with heart failure are monitored remotely with Medly.
- The PMCC has deployed 10 new PROMS and 10 new PREMS per year, and is using this information to optimize care pathways.
- Every area of the PMCC participates in an international quality assessment database, and major morbidity/mortality rates in each area are in the top 10% of all hospitals.
- The PMCC has started capturing patient demographic information and is correlating this with accessibility KPIs (appointment self-scheduling, wait times, no-show and cancellations, distance traveled).

STRATEGIC PRIORITY

DISCOVERY DRIVEN

Inspire cardiovascular research and innovation that improves patient lives.

Objectives

- Establish a clear focus across basic, translational, and clinical research that is novel, guided by our patient's needs, and deemed excellent by international standards.
- Translate discoveries into the development of new therapies that are assessed through clinical trials, focusing on innovative, multicentre, international trials.
- Promote basic and translational research excellence by leveraging interprofessional collaborations across UHN and the local, regional, and international scientific community.
- Continue to support a structured approach to cardiovascular research and innovation.



DISCOVERY DRIVEN

Inspire cardiovascular research and innovation that improves patient lives.

Tactical Initiatives

- Evaluate and integrate cardiovascular research at UHN that aligns with evolving PMCC research priorities.
- Optimize access to PMCC core research resources, including the PMCC Cardiovascular Biobank, AI Team, Clinical Trials and Translations Unit, Ted Rogers Computational Program, and Digital Cardiovascular Health Platform.
- Use a competitive process to support high-priority research projects through the PMCC Innovation Fund.
- Leverage existing investments to grow sustainable external revenue streams that will fund PMCC research.
- Help researchers navigate administrative process challenges (e.g., applications for grants or CRC chairs, contracts, budgets for clinical trials, REB submissions) and establish a process to disseminate curated funding opportunities to investigators.
- Increase the rate we identify patients as candidates for clinical trials (e.g., leveraging Epic, the DCHP, AI, and opt-out contact).
- Mentor junior interdisciplinary trainees and staff to support their research activities early in their careers.

Measures of Success

- Increase Tri-agency PMCC research funding by 30% (\$31.2 M, 2017 – 2022) by increasing the scope of grant applications and leveraging PMCC core research resources.
- Increase the percentage of patients in clinical trials and the number of clinical trials accruing patients in the PMCC, and ensure the start-up time for clinical trials is less than 6 months.
- Double the number of research studies supported by the PMCC Biobank (27 studies supported and 7,828 bio-samples withdrawn 2018 – 2022).
- Increase the number of publications indexed in Web of Science and PubMed by 30%, and increase the number of highly cited papers by 20%.
- PMCC is engaging patient partners in the planning, co-design, and or dissemination of all PMCC research studies.
- Diversified revenue streams are sufficient to sustain and expand PMCC research.

STRATEGIC PRIORITY

EXEMPLARY EDUCATION

Cultivate unique inter-professional training programs that provide comprehensive education.

Objectives

- Build a PMCC Academy that provides cutting-edge, inter-professional education for all learners across the full spectrum of cardiovascular disease.
- Broaden educational opportunities for persons with lived experience and caregivers.
- Expose learners to a high volume of complex and diverse cases, including those only managed at UHN.
- Establish Canada's first digital continuing education platform in partnership with The Institute for Education Research (TIER) and the University of Toronto.
- Expand partnerships that expose international trainees to PMCC educational opportunities.



STRATEGIC PRIORITY

EXEMPLARY EDUCATION

Cultivate unique inter-professional training programs that provide comprehensive education.

Tactical Initiatives

- Co-create educational materials with persons with lived experience and community partners that promote health advocacy in cardiovascular care and link these resources to the UHN patient portal.
- Increase inter-professional learner and staff utilization of simulation facilities in the Michener Institute and PMCC through improved awareness and training.
- Launch a formalized preceptorship program to allow visiting scholars to meet, engage, and mentor PMCC learners.
- Evaluate and implement accredited educational programs based on learner needs and PMCC expertise.
- Assess and establish competency training pathways and the optimal processes required to support the education of all learners and staff.
- Create designated physical spaces to maximize the educational experience at the PMCC.
- Enable learning beyond UHN at other internationally renowned cardiovascular centres and training programs.

Measures of Success

- Teacher effectiveness scores and rotation effectiveness scores across the PMCC are in the top 25% for University of Toronto teaching hospitals.
- In the TASHN Learner Experience Survey, $\geq 91\%$ of PMCC learners across all professions respond “yes” to the statement “I would recommend a placement here to my fellow students.”
- The educational activities of all learners are coordinated through the PMCC Academy.
- The hours of use of cardiovascular simulation facilities at the Michener Institute and Toronto General Hospital are measured and triple over the next five years.
- Persons with lived experiences are more informed about their care through increased use of relevant PMCC learning materials and courses.
- New partnerships provide PMCC learners and staff access to more unique educational opportunities, promoting specialized and continuous learning.

STRATEGIC PRIORITY

PEOPLE CENTERED

Provide unparalleled experiences and promote well-being for patients and PMCC team members.

Objectives

- Embrace a culture that promotes inclusion, diversity, equity, accessibility, and anti-racism (IDEAA) that aligns with UHN and Ontario Health initiatives.
- Build positive, flexible work environments that enable work-life balance and resiliency in teams to promote recruitment, retention, joy in work, and optimal patient experiences and outcomes.
- Support individual and team-based professional development and leadership training opportunities.
- Continuously measure health worker well-being and burnout, develop intervention strategies that prevent and reduce burnout, foster learner and staff well-being, and support quality care.
- Eliminate barriers and reduce the stigma of seeking services to address mental health challenges.
- Align patient and staff self-determination with Indigenous governance and cultural practice models.



STRATEGIC PRIORITY

PEOPLE CENTERED

Provide unparalleled experiences and promote well-being for patients and PMCC team members.

Tactical Initiatives

- Establish a PMCC IDEAA Working Group to identify and develop IDEAA strategies that are integrated into PMCC clinical care, education, and research.
- Support a mentorship program that promotes career development, guides the acquisition of new knowledge and skills, and helps staff build a sense of direction and purpose in their work.
- Create and implement a consolidated outreach program and intake process to attract and recruit top clinicians, researchers, and educators to the PMCC.
- Launch a Working Group, in partnership with the Michener Institute, to identify new professional roles in the PMCC that are required to support healthcare.
- Institute a recognition system that acknowledges and promotes awareness of the achievements of PMCC staff.
- Introduce programs and initiatives that differentiate PMCC from other places of employment to make it a more desirable workplace, in line with our Health Human Resource needs.

Measures of Success

- 80% of PMCC staff have taken the New Respect or San'yas cultural safety training module.
- Five new initiatives to decrease clinician burnout and improve well-being have been implemented across the PMCC (e.g., 1-on-1 support for using Epic, new safety huddles to enhance staff communication, and recognition programs).
- The Well-being Index survey is deployed every year across the PMCC, and the prevalence of burnout and distress scores have decreased by 10%.
- We have engaged 100 PMCC nurses in a mentorship program and reported the results of this intervention on nurse burnout, well-being, and retention.
- Every committee in the PMCC, including all search committees, has membership that aligns with the 50 – 30 Challenge.

STRATEGIC PRIORITY

DATA AND AI ENABLED

Optimize care, discovery and learning through the application of leading digital solutions.

Objectives

- Personalize clinical decision-making, enable research and discovery science, and improve health system operational efficiency through AI and other digital enablers.
- Inform the development of equitable healthcare policy and population health initiatives through partnerships that leverage PMCC clinical and digital expertise.
- Incorporate the use of data and AI-based decision-making into PMCC educational training programs.
- Be the partner of choice for public-private collaborations to develop and commercialize digital cardiovascular health solutions that align with governance, privacy, and data-sharing best practices.



STRATEGIC PRIORITY

DATA AND AI ENABLED

Optimize care, discovery and learning through the application of leading digital solutions.

Tactical Initiatives

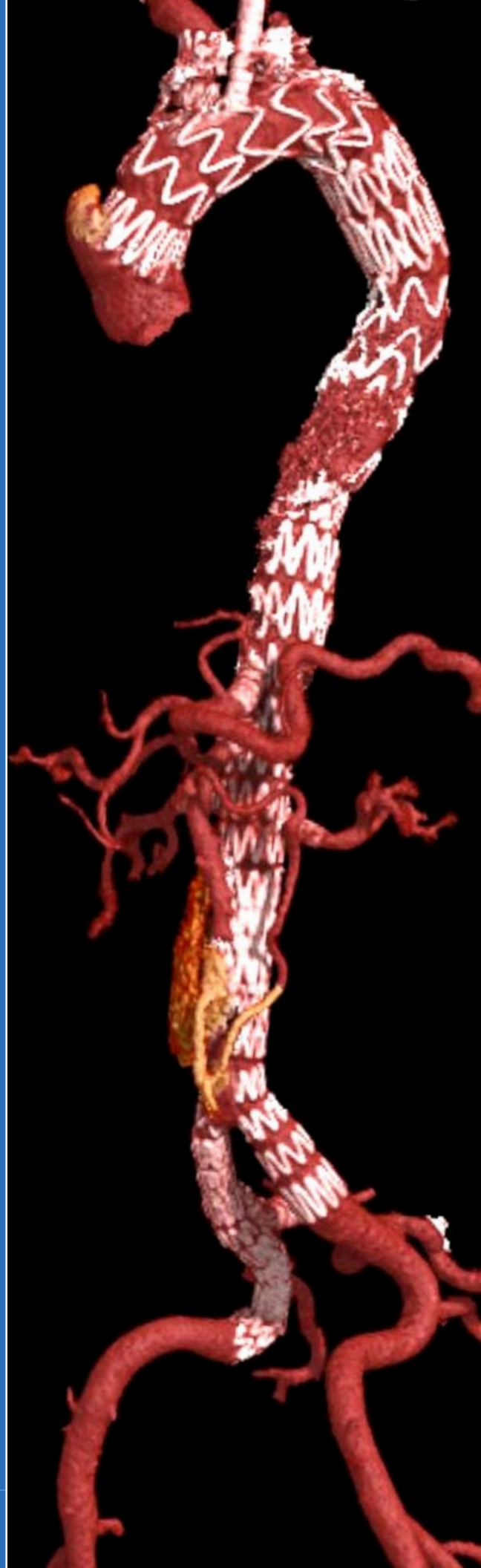
- Collect and integrate data from disparate sources to build a PMCC catalog of data sets to apply analytics and AI models.
- Deploy AI, including intelligent automation, to reduce the administrative burden on healthcare workers and drive efficiencies in healthcare delivery.
- Advance the development of innovative digital solutions in healthcare through an expanded partnership with Ontario Health.
- Leverage UHN data assets, including Epic, to develop dashboards and reports that inform operational and clinical decision-making.
- Develop educational programs that teach all PMCC learners and staff how to use AI to support research and inform clinical decision-making.

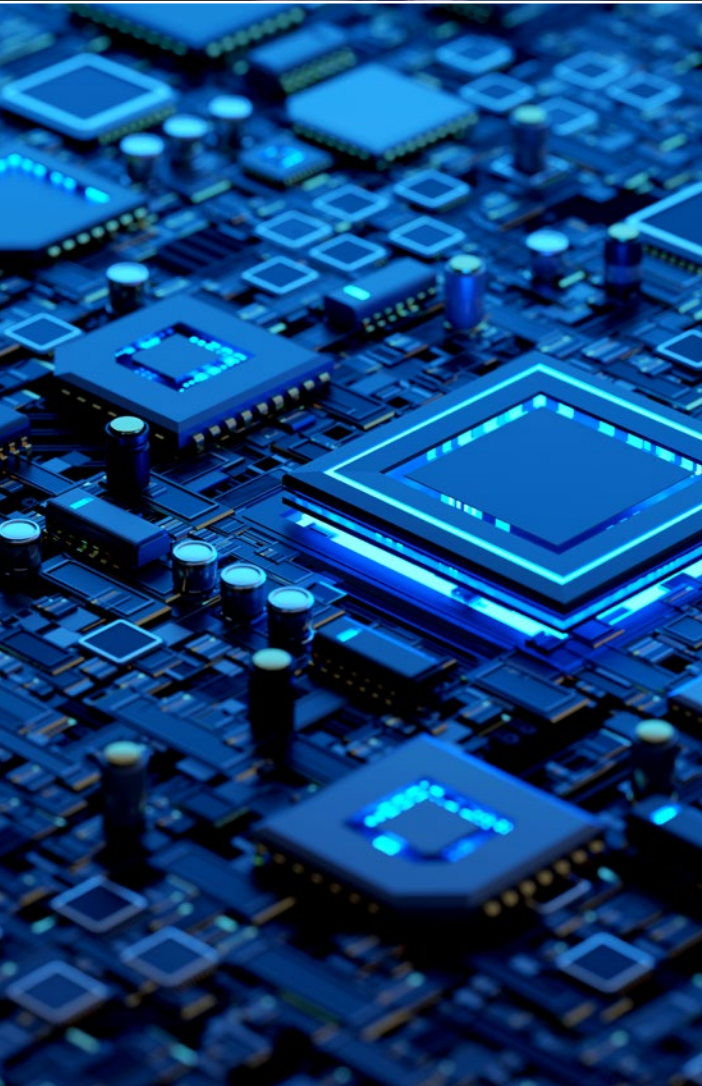
Measures of Success

- The PMCC (and UHN) are participating in a federated data network.
- The PMCC has used machine learning approaches to analyze data from Ontario Health and develop recommendations that inform healthcare policy.
- Revenue from the commercialization of AI algorithms exceeds 2 million dollars annually.
- The PMCC AI Team has five computer scientists and 40 team members, and has completed 120 AI projects (currently two scientists, 25 team members, and 60 AI projects).
- Use of data and AI has transformed clinical care, research, and education to progress toward a learning health system.

PMCC CORE RESEARCH AND INFRASTRUCTURE SUPPORT SERVICES

These core services, available to all PMCC investigators, include the Digital Cardiovascular Health Platform, PMCC Artificial Intelligence Team, Ted Rogers Computational Program, PMCC Clinical Trials and Translation Unit, PMCC Cardiovascular Biobank, Precision Medicine, and the PMCC Innovation Committee.





Digital Cardiovascular Health Platform

The PMCC and TRCHR developed the Digital Cardiovascular Health Platform (DCHP). This new, secure, high-performance data integration platform enables secondary use of clinical data that captures all patient information, including clinical notes, bloodwork, imaging studies (e.g., echocardiography, CT, MRI, PET), and proteomic and genomic information in a digital format. The DCHP includes two major components: a data ingestion and integration portal and a high-performance analytics platform capable of handling compute-intensive analytics methods performed on the HPC4Health Cloud. A managed data schema tracks the source, provenance, version, and custodians of data collected by the DCHP, which is structured to be amenable to the application of machine learning approaches. We present an overview of the DCHP, including a description of DCHP Governance, User Access and Controls, Privacy Protocols, Permission to Query, Read, Use and or Modify Data, as well as an explanation of the oversight of the DCHP by the UHN Digital Cardiac Program Steering Committee and roles of the UHN DCHP Implementation Team, DCHP Operations Team, and DCHP Systems Admin Team in [Appendix C](#).

Infrastructure that supports the DCHP:

40	Virtual Machines
514	Cores
2.8T	RAM
85T	Disk utilization, not inclusive of backup storage

The DCHP currently contains data from:

2.3M	Patients
31M	Hospital events
266M	Lab values
1.6B	Device readings

Every day, the DCHP is capturing:

127K	Hospital events
4M	Data points from patient monitoring devices (e.g., telemetry)
6.2M	Data points from wearable devices being used by PMCC patients every day



The PMCC Artificial Intelligence Team

The [PMCC Artificial Intelligence \(AI\) Team](#)¹ includes dedicated AI scientists that partner with data engineers and clinician-researchers to apply machine learning approaches to address three main areas of focus:

- a. Improve the efficiency of hospital operations.
- b. Develop precise treatment options for individual patients.
- c. Identify novel relationships in large data sets that lead to new research hypotheses.

The PMCC AI team consists of two AI scientists (Bo Wang, Chris McIntosh) and twenty-five trainees with expertise in traditional machine learning and advanced deep learning, an approach suited to analyzing large-scale multi-modal clinical data, including genomic and imaging data.

We will hire two more AI scientists in 2023 who will focus on network integration using convolutions and AI-enabled assessment of germline variants to meet the growing demand for research supported by AI in the PMCC.

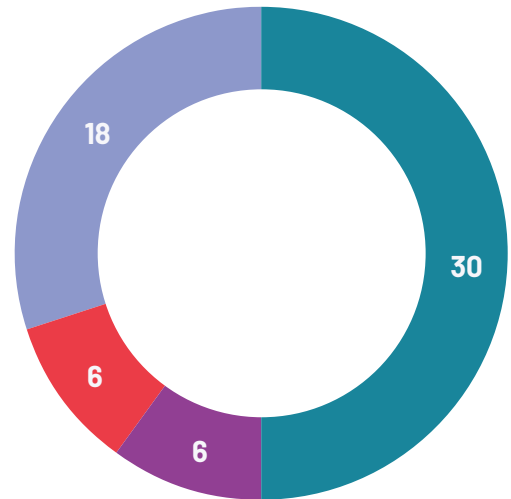
The computing infrastructure that supports the PMCC AI Team includes Compute Canada and HCP4Health, with access to thousands of CPUs and GPUs. In addition, the PMCC AI Team has access to multiple large-scale healthcare data sources such as the DCHP, GEMINI, ICES, MIMIC4, and the UK biobank. It is currently engaged in 60 AI projects co-led by AI scientists and clinician investigators at the PMCC and other UHN Programs.

These projects cover multiple cardiovascular areas of interest, using data from echo and MRI imaging, ECGs, hospital administrative data, and single-cell genomic data.

The PMCC AI Team has emerged as a national leader in AI for health. In collaboration with PMCC clinician investigators and scientists, the AI Team published 13 peer-reviewed scientific publications in 2022, including many in high-profile journals ([BIONIC: biological network integration using convolutions | Nature Methods](#)², [Colony stimulating factor-1 producing endothelial cells and mesenchymal stromal cells maintain monocytes within a perivascular bone marrow niche | Immunity](#)³, [Genotyping SARS-CoV-2 through an interactive web application | Lancet Digital Health](#)⁴). In addition, PMCC AI Team members received numerous prestigious awards in 2022, including a Google / DeepMind Fellowship, Gairdner Early Career Award, and a Canada Research Chair.

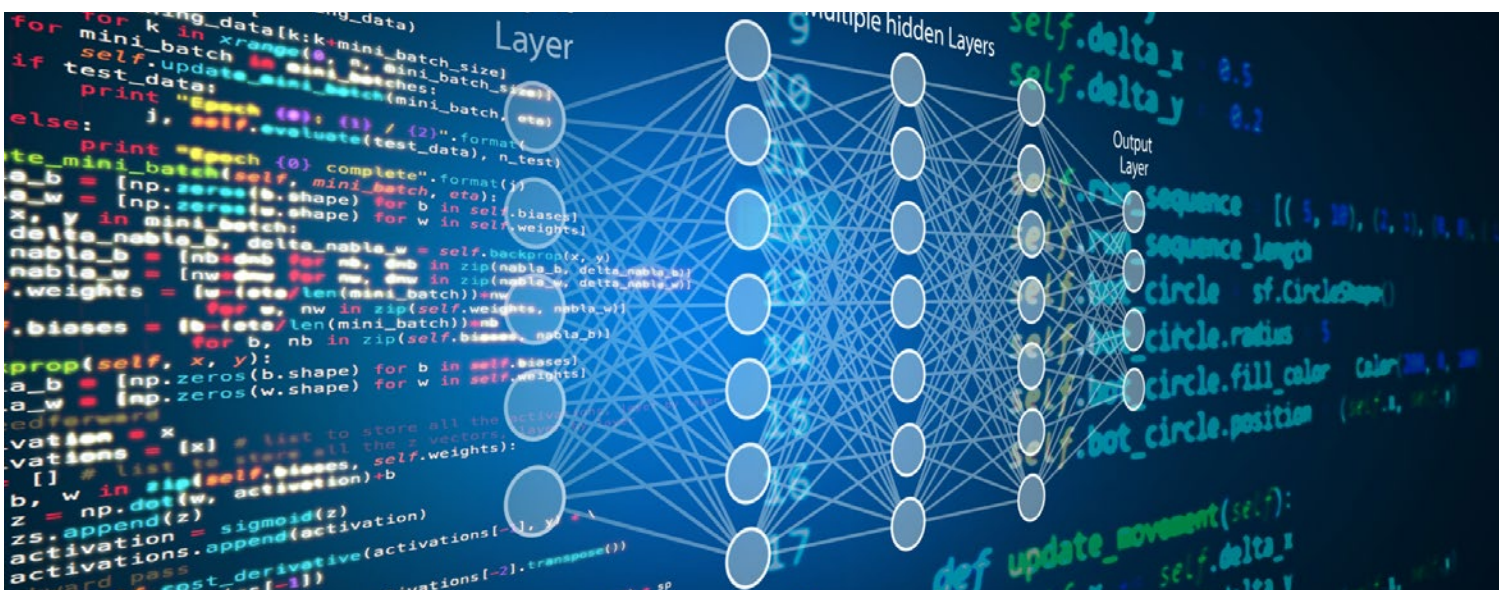
The PMCC AI Team has collaborated on AI-based projects with many Programs across UHN, including the Joint Department of Medical Imaging and the Sprott Department of Surgery. We have also established strong partnerships with external institutions such as the Vector Institute, the Institute for Clinical and Evaluative Sciences (ICES), and Ontario Health. In addition, the PMCC AI Team organized two international AI challenges in world-class conferences, including [Medical Image Computing and Computer Assisted Intervention](#)⁵ and [Neural Information Processing Systems](#)⁶ that attracted thousands of AI researchers from across the globe.

Summary of the current AI Team Projects



- Manuscript accepted for publication or published
- Experiments completed, manuscript in preparation
- Manuscripts submitted, under review or being revised after review
- Experiments or data collection in progress

We present a description of the 60 projects that the PMCC AI Team is currently involved in or is co-leading in [Appendix D](#), which includes hyperlinks to all publications.



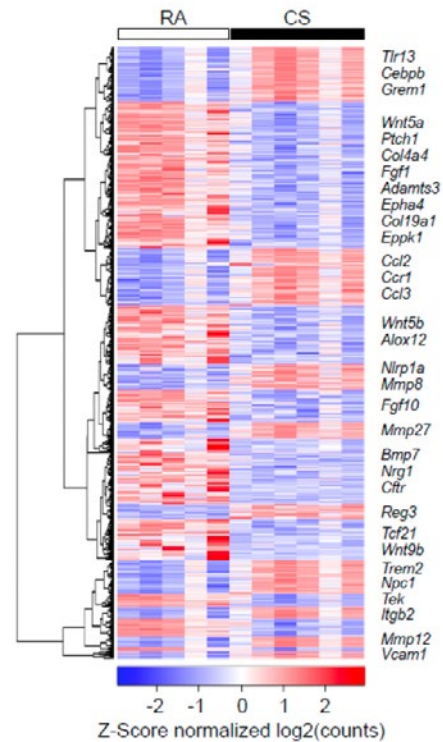
Ted Rogers Computational Program

The Ted Rogers Computational Program (TRCP) is the analytics, data management, and data science group in the Ted Rogers Centre for Heart Research at the PMCC that includes biostatisticians, data scientists, programmer analysts, data managers, and software and clinical research professionals, including international medical graduates.

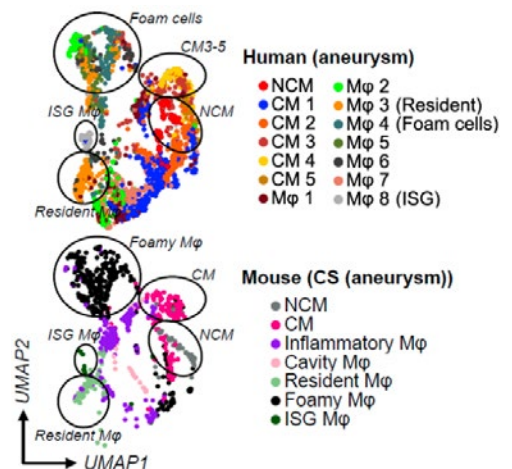
The TRCP provides research support in analytics (biostatistics), research methodology, software and database development, data management, database development and maintenance, and registry support. The team has extensive experience in adult and pediatric cardiac research and quality improvement projects. It is currently actively engaged in 53 analytics projects at the PMCC, led by 18 primary investigators and project leads. The project areas of focus include but are not limited to critical care, cardiogenic shock, cardiotoxicity, heart failure, surgery, transplant, virtual care, and mobile devices. In addition, three machine learning projects are currently underway, including a large-scale analysis of data from the UK Biobank to identify heart failure risk factors, an assessment of cardiopulmonary exercise testing for heart failure prognostication, and MRI image analysis to predict cardiotoxicity among patients that have received chemotherapy drugs.

The TRCP has also assisted with the spin-up of new REDCap databases for PMCC primary investigators, including new databases for studies on critical care, mobile devices, long-term surgical outcomes, mechanical circulatory support devices, combined interventional cardiology and minimally invasive cardiac surgery procedures, cardiac transplant, primary cardiac tumors, and cardiac risk factor modification in patients following chemotherapy and radiation therapy. In addition, the TRCP also participates in trainee education, hosting research data management and statistical seminars for fellows and one-on-one coaching.

Gene expression in aortic tissue after exposure to room air (RA) or cigarette smoke (CS)⁷



Inflammatory cells in aortic aneurysm, human vs mouse⁷



PMCC Clinical Trials and Translation Unit

The PMCC Clinical Trials and Translation Unit (CTTU) is a centralized clinical trial operations unit supporting PMCC investigators who lead cutting-edge clinical trials (locally, nationally, and internationally). The CTTU staff leads a standardized and centralized clinical trial review process through monthly meetings of the Protocol Review Committee to ensure that clinical trials are operationally feasible and financially viable, comply with institutional standards/policies, and meet all regulatory requirements. Specifically, the CTTU ensures that budgets for clinical trials capture all anticipated costs, including overhead and contingencies, and monitors predefined clinical and financial milestones for each trial. The CTTU tracks cost recoveries and study invoicing, which are matched with staff study workload to ensure financial oversight and validation of study budget estimates with real-world, actual staff workload. The CTTU negotiates clinical trial contracts and budgets with funding entities (granting agencies, private industry) in collaboration with primary investigators to ensure the financial sustainability of clinical trials. In addition, the CTTU coordinates the deployment of a core group of clinical trial coordinators, which

ensures that all clinical trials across the PMCC have appropriate study support while ensuring financial accountability and sustainability.

The leadership of the CTTU, which includes Michael Farkouh⁸ (Director), Jacob Udell (Associate Director), Patrick Lawler⁹ (Associate Director), and Kawalpreet Singh, (Clinical Research Manager) have established 3 objectives:

-
- Objective 1:* Expand PMCC's ability to conduct randomized clinical trials.
-
- Objective 2:* Continue the PMCC tradition of performing first-in-human studies.
-
- Objective 3:* Focus on clinical trials that will change how cardiac and vascular disease is managed globally, through engagement of the Worldwide Network for Innovation in Clinical Research (WNICER).



The CTTU is working synergistically with several internal and external stakeholders, including the UHN Clinical Trials Agreements (CTA) office, [Ozmosis Research](#)¹⁰ (a UHN Clinical Research Organization), and [Socar Research](#)¹¹ (an external Clinical Research Organization). To capture PMCC-wide Key Performance Indicators, the CTTU has implemented a Clinical Trials Management System for clinical research activity and is proactively developing tools to enable better and more granular reporting of PMCC clinical trial metrics.

The CTTU has emerged as a central resource for clinical trial operations support across the PMCC

and is currently supporting trial activities in heart failure, transplantation, myocardial infarction, electrophysiology, cardiovascular surgery, hypertrophic cardiomyopathy, and cardio-oncology. In addition, the CTTU enables efficient and cost-effective clinical trial operations through economies of scale.

The CTTU currently manages 47 clinical trials, with 18 open and accruing patients, 17 closed and in follow-up or the data analysis phase, and 12 in development, and played a leadership role in multiple recent high-profile publications. We present the clinical trials currently being run by the CTTU in [Appendix E](#).



The NEW ENGLAND
JOURNAL of MEDICINE

Oral Segamlutide and Cardiovascular
Outcomes in Patients with Type 2 Diabetes



The NEW ENGLAND
JOURNAL of MEDICINE

Therapeutic Anticoagulation with Heparin
in Critically Ill Patients with COVID-19



The NEW ENGLAND
JOURNAL of MEDICINE

Therapeutic Anticoagulation with Heparin
in Noncritically Ill Patients with COVID-19



The NEW ENGLAND
JOURNAL of MEDICINE

Trial of an Intervention to Improve Acute
Heart Failure Outcomes

JAMA The Journal of the
American Medical Association

Original Investigation | Caring for the Critically Ill Patient
Effect of Antiplatelet Therapy on Survival and Organ
Support-Free Days in Critically Ill Patients With COVID-19
A Randomized Clinical Trial

JAMA The Journal of the
American Medical Association

Original Investigation | Caring for the Critically Ill Patient
Long-term (180-Day) Outcomes in Critically Ill Patients
With COVID-19 in the REMAP-CAP Randomized Clinical Trial

JAMA The Journal of the
American Medical Association

Original Investigation
Effect of Genotype-Guided Oral P2Y12 Inhibitor Selection vs
Conventional Clopidogrel Therapy on Ischemic Outcomes After
Percutaneous Coronary Intervention
The TAILOR-PCI Randomized Clinical Trial

JAMA The Journal of the
American Medical Association

Original Investigation
Heterogeneous Treatment Effects of Therapeutic-dose Heparin
in Patients Hospitalized for COVID-19



PMCC Cardiovascular Biobank

The PMCC Cardiovascular (CV) Biobank, led by Phyllis Billia and Richard Weisel, is a core PMCC infrastructure that can support a wide range of cardiovascular research. To understand the underlying mechanisms that lead to cardiovascular disease, research involving the collection of human blood and tissue specimens, combined with other health data, is essential. In addition, the ability to analyze genetic and molecular information through research is critical to laying the foundation for the future development and testing of diagnostic and therapeutic approaches in translational studies. The vision of the PMCC CV Biobank is to enable innovative research into the discovery, causes, prevention, and treatment of cardiovascular disease through the standardized collection, storage, and utilization of high-quality biological specimens.

The PMCC CV Biobank is well-positioned to bank biological samples from a diverse population of patients with cardiovascular disease, which will help advance genetic/molecular research into clinical practice. The mission of the PMCC CV Biobank is to collect, store and disseminate high-quality biospecimens through standardized processes, with a deep commitment to enabling impactful change through engaged collaboration, integrity, and unwavering dedication to excellent cardiovascular science. Following industry best practices, the PMCC CV Biobank aims to provide access to diverse biospecimens and health data to UHN investigators. In addition, the PMCC CV Biobank continues to serve the scientific community locally, nationally, and internationally through partnerships and collaborations.

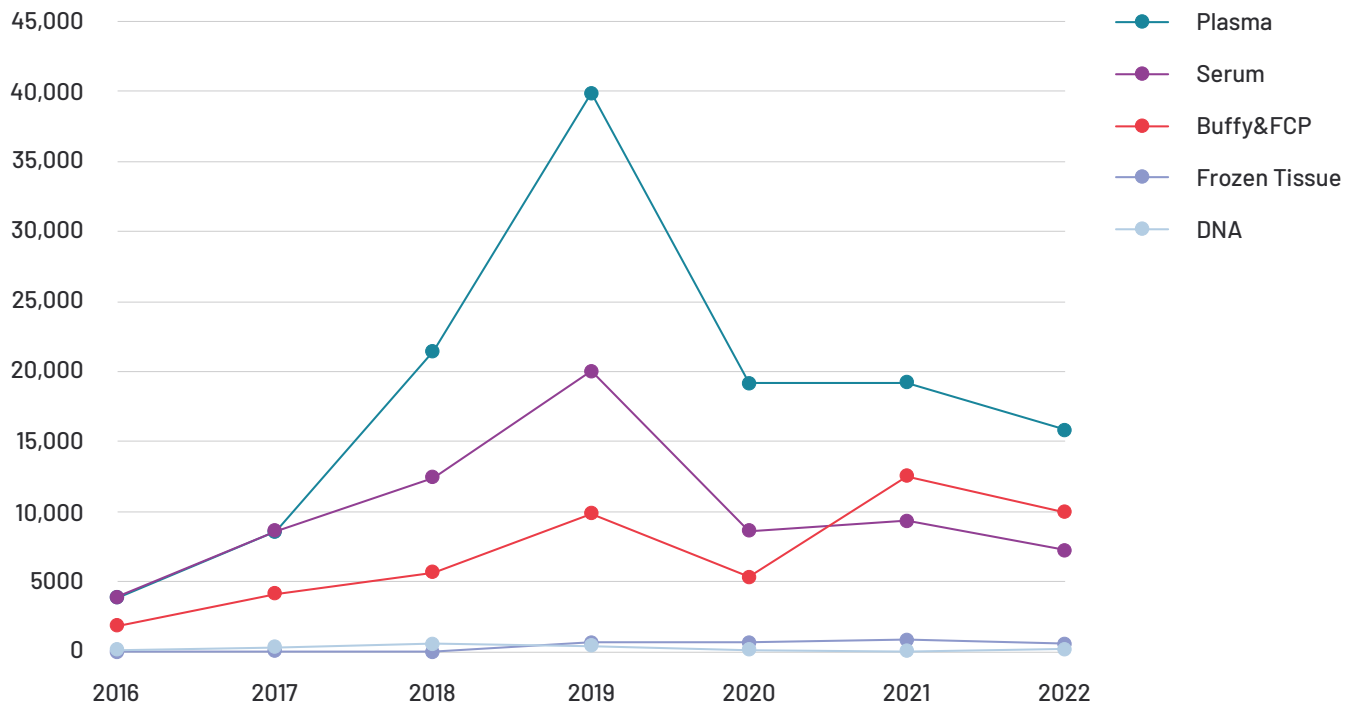
The PMCC CV Biobank offers the highest standard of ethics and best practices through the collection, storage, and dissemination of research biospecimens. It operates under Canadian federal, provincial, and institutional requirements pertaining to patient participation in research, as well as the collection and use of research biospecimens and accompanying clinical data. The UHN Research Ethics Board (REB) approved the PMCC CV Biobank, certified by the Canadian Tissue Repository Network (CTRNet) in 2020, ensuring quality biospecimens and data. CTRNet certification promotes interoperability through required operational practices, standard operating procedures, and biobanking data standards.

Over 18,000 participants have consented to participate in the PMCC CV Biobank, with an acceptance rate of roughly 85% and a retention rate of 99.97%.

We collect biospecimens from various clinics at the PMCC, including General Cardiology, Cardiotoxicity, Cardiovascular Surgery, Coronary Intensive Care Unit,

Congenital Heart Clinic, Hypertrophic Cardiomyopathy, Heart Function, Hearts and Minds Clinic (managing patients with Q22 deletion syndrome), Left Ventricle Assisting Device, Transplant, and Vascular Surgery. The graph below shows the number of biospecimens collected in the PMCC CV Biobank. Sample collection was negatively impacted by the COVID pandemic, in line with decreases in in-person clinic visits across UHN.

Specimens stored in the PMCC CV Biobank, by type and year



Year	Biobank Specimens Distributed	Study Requests
2018	134	5
2019	576	5
2020	1,106	4
2021	3,721	16
2022	2,291	8
Total	7,828	38

To date, 7,828 biospecimens have been distributed from the PMCC CV Biobank for 38 study requests to support 27 unique studies in the PMCC. PMCC investigators and their collaborators have accessed samples from 16% of patients that have contributed biospecimens to the PMCC CV Biobank.

In total, the PMCC Biobank currently holds 273,441 biospecimens, including DNA (1,900), frozen tissue (2,957), buffy coat (53,808), serum (76,405) and plasma (138,371).

We anticipate that withdrawals from the PMCC Biobank will increase significantly in 2023 as two next-generation sequencing units (NovaSeq X Plus) come online.



















Precision Medicine

UHN will be the first site in Canada to acquire the NovaSeq X Plus gene sequencing units, which will decrease the time required to complete whole genome sequencing (WGS, including genomes, epi-genomes, and transcriptomes) by 50% and reduce the cost of WGS to about 400 dollars per patient.

The PMCC has partnered with UHN Molecular Pathology (led by George Yousef) and will combine WGS analysis in groups of patients (e.g., hypertrophic cardiomyopathy, aortic aneurysm or dissection, congenital arrhythmia, heart failure) with clinical and biological data stored in the Digital Cardiovascular Health Platform to begin to study the role genetic variation plays in the evolution of these disease processes. The PMCC AI Team, which has developed a deep learning algorithm that makes it feasible to integrate numerous networks on the scale of the human genome, will play a central role in the analysis of the WGS data.



PMCC Innovation Committee members:

<p>HARRY RAKOWSKI Chair, Cardiologist</p> 	<p>LINDA BELFORD Nurse Practitioner</p> 	<p>SEAN CRAWFORD Vascular Surgeon</p> 	<p>ANTHONY DICENZO Founder and Principal, DCA Lawyers</p> 
<p>SACHA BHATIA Cardiologist</p> 	<p>PHYLLIS BILLIA Director of Research, Cardiologist</p> 	<p>JORDAN DERMER Co-CEO, Capital Developments</p> 	<p>VLAD DZAVIK Cardiologist</p> 
<p>MICHAEL FARKOUH Cardiologist</p> 	<p>RONNIE FAUST President, Ronald J Faust, Real Estate</p> 	<p>ANGELA FELDMAN Feldcorp Development</p> 	<p>MARTIN GOLDFARB Principal, Goldfarb Intelligence Marketing</p> 
<p>MARC LIPTON President and CEO, Cambridge Brain Sciences</p> 	<p>KIERAN MURPHY Radiologist</p> 	<p>SHARON RANSON The Ranson Group</p> 	<p>JEFF RUBENSTEIN CEO, Export Packers</p> 
<p>BARRY RUBIN Vascular Surgeon, PMCC Medical Director</p> 	<p>TERRY YAU Cardiovascular Surgeon</p> 		

PMCC Innovation Committee

The objective of the PMCC Innovation Committee is to provide seed funding for innovative projects. The Committee includes eight members from the business world and ten from the healthcare sector that meets quarterly to consider requests to fund the evaluation of innovative healthcare solutions from any of the 1,100 staff members in the PMCC. This funding allows investigators to develop preliminary data that they can use to support applications to external funding agencies.

Over the last ten years, the PMCC Innovation Committee has provided 8.9 million dollars through generous philanthropic support from donors to sponsor seventy-five unique projects, including

device evaluation, clinical trials, stem cell projects, mental health, and educational initiatives, across all PMCC Divisions, as described in the figure below. Of the seventy-five projects funded by the PMCC Innovation Committee, thirty-two are complete (including twenty-three with positive outcomes), and thirty-five are in progress. Investigators terminated eight projects before completion.

For example, Douglas Lee leveraged funding from the PMCC Innovation Committee to develop a point-of-care algorithm that he used to stratify patients presenting to an emergency room in acute heart failure according to their risk of death.

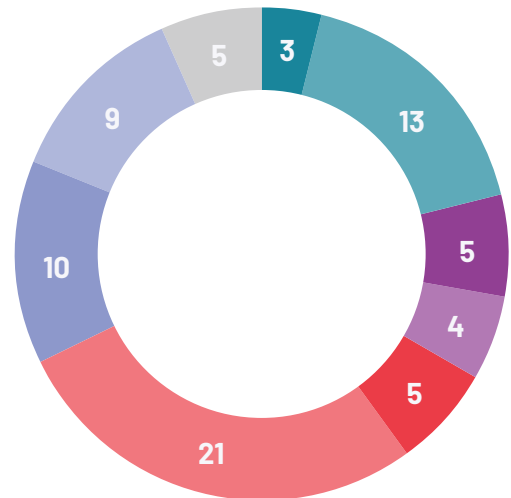
Low-risk patients were discharged early (in ≤ 3 days) and received standardized outpatient care, while high-risk patients were admitted to the hospital. This study protocol attracted 3 million dollars in additional support from the Heart and Stroke Foundation of Canada and led to a [publication in the New England Journal of Medicine](#)¹² which showed that use of this novel tool reduces 30-day all-cause death or cardiovascular hospitalization for patients in heart failure that present to an ER by 12%.

Patrick Lawler and Michael Farkouh used funding from the PMCC Innovation Committee to develop the framework for the ATTACC trial, which pragmatically defined regimens of either therapeutic-dose anticoagulation with heparin or usual-care pharmacologic thromboprophylaxis for patients with COVID-19 infection admitted to an in-patient ward or ICU environment. This framework led to the development of an international consortium and 13 million dollars in additional funding from the US National Institutes of Health and the Canadian Institute for Health Research. Drs. Lawler and Farkouh published this research in two separate articles in the New England Journal of Medicine.

In [Appendix F](#), we present a detailed list of all projects funded by the PMCC Innovation Committee and a summary of publications, patents and intellectual property, and additional funding realized by PMCC Investigators.

Based on the initial investment by the PMCC Innovation Committee:

Summary of the projects supported by the PMCC Innovation Committee, by subject (2012 - 2021)



- Artificial Intelligence
- Improved Care
- Clinical Trial
- Invention
- COVID-19
- Novel Imaging Technique
- Device Therapy
- Stem Cell Discovery
- Geonomics/Proteomics

INVESTED

\$8.9M → \$49.7M

Funding from other sources realized by investigators across twenty-eight projects, yielding a return on investment of 5.6 to 1.

RETURN

PROJECTS SUPPORTED BY THE PMCC INNOVATION COMMITTEE LED TO:

11

Patents or intellectual property rights.

105

Academic journal publications.

QUALITY

The PMCC uses a data-driven approach to ensure we provide high-quality patient care.

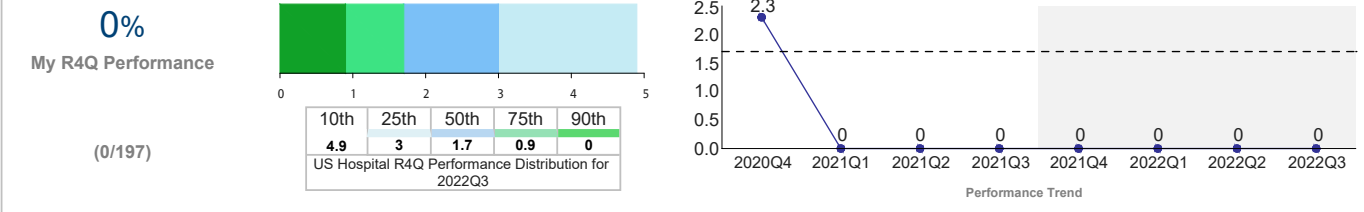
Partnerships with the UHN Medical Advisory Committee and the UHN Professional Advisory Committee ensure that PMCC quality initiatives align with UHNs focus on patient care and excellent outcomes.

We have established a PMCC Quality Committee that reports on quality initiatives to the PMCC Executive Committee and the UHN Safety and Quality Committee.

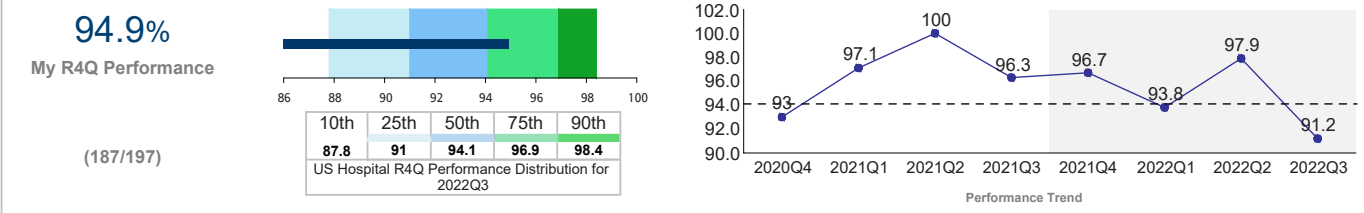


Informational - Outcome Metrics

9 - Proportion of patients undergoing atrial fibrillation ablation procedure who experience any adverse event intra or post procedure and prior to discharge



20 - Proportion of patients discharged in sinus rhythm



Through participation in national and international quality assessment (QA) registries, the PMCC monitors risk-adjusted patient outcome measures to confirm that they are the same or better than patient outcomes at international benchmark centers across all our Divisions. By knowing risk-adjusted, predicted outcomes for the procedures we carry out, PMCC physicians and surgeons can obtain informed consent from the patients who undergo these procedures.

The PMCC Quality Committee (QC) reports quarterly to the PMCC Executive Committee. The PMCC QC monitors observed and risk-adjusted predicted outcome measures, identifies opportunities for improvement, develops specific quality improvement plans, and then reassesses risk adjusted predicted and observed outcomes. This continuous QA / QI cycle operates across all Divisions in the PMCC.

Carolina Alba leads the PMCC QC. Committee members are leads of the QA databases that the PMCC participates in (listed below) and include Chris Feindel (Adult Cardiac Surgery - Society for Thoracic Surgery), Andrew Ha (Atrial Fibrillation Ablation, National Cardiovascular Data Registry

(NCDR), Cameron Gilbert (Electrophysiology Devices, NCDR), Alan Barolet (Cath PCI, NCDR), Maral Ouzounian and Eric Horlick (Transcatheter Valve Replacement and Repair - SVS/ACC TVT), Phyllis Billia (International Society for Heart and Lung Transplantation, ISHLT), Vivek Rao (Intermacs – mechanical circulatory support device to treat advanced heart failure) and Graham Roche-Nagle (Vascular Quality Initiative - Society for Vascular Surgery). We present the most recent report (September 2022) from the National Cardiovascular Data Registry Atrial Fibrillation Ablation Registry™ in [Appendix G](#) as an example of the reports we receive from the multiple international QA databases that the PMCC participates in.

UHN is currently the only hospital in Canada participating in any US National Cardiovascular Data Registries*. The PMCC supports data collection and participation in QA databases through philanthropic

support from the Peter and Melanie Munk Charitable Foundation, with an annual budget of approximately *750,000 thousand dollars per year.*

The PMCC currently participates in the following international QA databases

Quality Assessment Registry	Clinical Focus	National Medical Association
Atrial Fibrillation Ablation Registry™, NCDR	Procedures to treat atrial fibrillation	American College of Cardiology https://cvquality.acc.org/NCDR-Home/registries/hospital-registries/afib-registry
Electrophysiology Device Implant Registry™, NCDR	Pacemakers and automated defibrillators	American College of Cardiology https://cvquality.acc.org/NCDR-Home/registries/hospital-registries/ep-device-implant-registry
CathPCI Registry®, NCDR	Coronary artery angioplasty and stenting	American College of Cardiology https://cvquality.acc.org/NCDR-Home/registries/hospital-registries/cathpci-registry
STS/ACC Trans-Vascular Therapy (TVT) Registry™	Transcatheter cardiac valve replacement and repair	Society for Thoracic Surgeons and the American College of Cardiology https://www.ncdr.com/WebNCDR/tvt/publicpage
Society for Thoracic Surgery Adult Cardiac Surgery Database	Coronary artery bypass surgery and cardiac valve replacement and repair	Society for Thoracic Surgery https://www.sts.org/registries/sts-national-database/adult-cardiac-surgery-database
International Registry of Acute Aortic Dissections (IRAD)	Hospital outcomes of patients with acute aortic dissection	Coordinating Center: University of Michigan Health System https://www.iradonline.org/home
Interagency Registry for Mechanically Assisted Circulation (Intermacs)	Mechanical circulatory support devices to treat advanced heart failure	Society for Thoracic Surgeons www.sts.org/registries-research-center/sts-national-database/intermacs-database
Vascular Quality Initiative (VQI)	Aortic aneurysm repair, carotid artery repair, PVD	Society for Vascular Surgery www.vqi.org



STS National Database™
Trusted. Transformed. Real-Time.



Intermacs

SVS | VQI
VASCULAR QUALITY INITIATIVE

*Other than the Hospital for Sick Children, which participates in the NCDR Electrophysiology Devices Registry

The PMCC will join the following international QA databases in 2023

Quality Assessment Registry	Clinical Focus	National Medical Association
Chest Pain - MI Registry™, NCDR	Management of myocardial infarction (heart attack)	American College of Cardiology https://cvquality.acc.org/NCDR-Home/registries/hospital-registries/chest-pain-mi-registry
IMPACT Registry®, NCDR	Diagnostic and interventional catheterizations for adult congenital heart disease patients	American College of Cardiology https://cvquality.acc.org/NCDR-Home/registries/hospital-registries/impact-registry
PINNACLE Registry®, NCDR	Outpatient assessment of coronary artery disease, hypertension, heart failure and atrial fibrillation	American College of Cardiology https://cvquality.acc.org/NCDR-Home/Registries/Outpatient-Registries
Canadian Cardiac Transplant Network (CCTN) - Heart Transplant Registry ¹³	Advanced heart failure patients listed for heart transplant	Canadian Cardiac Transplant Network (CCTN) https://ccs.ca/canadian-cardiac-transplant-network/
Canadian Cardiac Transplant Network - Left Ventricular Assist Device (LVAD) Registry	Advanced heart failure patients supported with an LVAD	Canadian Cardiac Transplant Network (CCTN) https://ccs.ca/canadian-cardiac-transplant-network/
PROGRESS CTO Prospective Global Registry for the Study of CTO Interventions	Techniques and outcomes of chronic total occlusions	N/A - multicentre database housed at Minneapolis Heart Institute www.progresscto.org
Global cVAD Registry	Prospective Registry of Impella Percutaneous LVAD Outcomes	N/A - "real-world" multicentre database housed at Beth Israel Deaconess Medical Center and Yale University https://www.clinicaltrials.gov/ct2/show/NCT04136392



PMCC UNIQUE INITIATIVES





1 Integrate physical and mental health

Integrate physical and mental health through a partnership with UHNs Mental Health Program (led by Susan Abbey) and King's Health Partners (London, UK). We will prospectively assess anxiety, depression, and substance abuse (with the PSQ-9, GAD-7, and AUDIT-C patient-reported outcome measure surveys) among PMCC patients scheduled to undergo cardiac or vascular procedures. We will review survey results and implement a stepped care model (observation, counseling, psychiatric consultation) to improve health outcomes. In addition, by incorporating responses to mental health survey questions into the Digital Cardiovascular Health Platform, we can explore novel relationships between mental health and cardiovascular disease, using machine learning approaches to evaluate this large dataset.



2.

Improve clinician well-being and decrease burnout







PMCC initiative

We measured clinician burnout and distress in the PMCC before the onset of the COVID-19 pandemic using the Well-Being Index, a survey tool developed by the Mayo Clinic. We documented a high prevalence of burnout (Physicians – 65.4%, Nurses – 78%, Allied Health staff – 73%), and that the drivers of burnout were the perception of i) unfair treatment at work, and ii) insufficient staffing levels.^{14,15,16} We have completed an assessment of the impact of the COVID-19 pandemic and systemic racism on clinician burnout and distress at the PMCC and the Princess Margaret Cancer Centre. Subsequently, we used a co-design process (with the UHN Healthcare Human Factors group) to validate and implement intervention strategies designed to decrease clinician burnout and improve well-being.

Through our co-design process, PMCC nurses told us that their day-to-day patient care demands preclude their ability to meet with nursing leaders on a regular basis to discuss career planning and to have the time

required to learn and practice new techniques or approaches to nursing care. To address this issue, we developed the PMCC Nurse Mentorship Program in collaboration with Pam Hubley, UHN Chief Nursing Officer. Through this two-year program, we will randomly assign 100 nurses from across the PMCC significantly reduced clinical duties one day per week for 16 continuous weeks so that they can spend time with a senior nurse mentor to discuss and practice specific nursing techniques and engage in career planning. The Nurse Mentorship Program will provide nurses with paid time to relieve the constant pressure of direct clinical work, improve and deepen their knowledge and capabilities to care for PMCC patients, and satisfy their professional needs for growth and development.

Drivers of burnout and distress among PMCC clinicians

 Unfair workplace treatment Favouritism, respect, inclusiveness	 Poor community support Professional growth, performance reviews, social engagement	 Insufficient reward for effort Communicate successes, show appreciation, leadership opportunities
 Lack of communication and control Inter-professional relations, respect, transparency, gratitude, information sharing	 Lack of joy Exceptional patient care, work-life integration, meaning in work	 Unsustainable workload Distribution of workload, staffing shortages, time away from work

Nurses will complete the Well-Being Index survey before and after completing the Nurse Mentorship Program to determine if spending time with a nurse mentor decreases burnout and improves well-being. In addition, we will randomly assign a group of 100 PMCC nurses who do not participate in the Nurse Mentorship Program to complete the Well-Being Index survey over the same time interval to serve as the control group (there are 500 nurses in the PMCC).

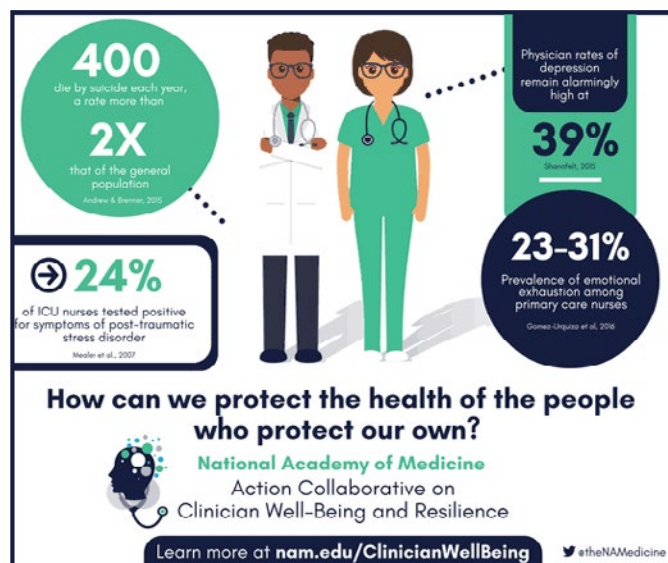
Concurrently, we will document how many nurses in these two groups, i.e., those who completed the nurse mentorship program and those who did not, remain at UHN after two years. This prospective cohort study will allow us to determine if the Nurse Mentorship Program improves the retention of nurses at UHN. If successful, UHN could offer the Nurse Mentorship Program to other clinical areas across UHN.

National Academy of Medicine (NAM) Action Collaborative on Clinician Well-Being and Resilience

Barry Rubin is Co-Chair of the NAM Implementation Working Group of the Action Collaborative on Clinician Well-Being and Resilience (with Christine Sinsky, American Medical Association, and Nancy Agee, Carillon Clinic, Virginia) that developed the [Compendium of Key Resources for Improving Clinician Well-Being](#)¹⁷. This compendium has over 80 peer-reviewed publications highlighting strategies and tools that healthcare leaders and workers can use

across practice settings to decrease burnout and improve clinician well-being. He is also a member of the Steering Committee of the NAM Action Collaborative on Clinician Well-Being and Resilience (Co-Chairs, Victor Dzau, President, National Academy of Medicine and Vivek Murthy, US Surgeon General) that developed the [National Plan for Health Workforce Well-Being](#)¹⁸ which was released on October 3, 2022.

Drivers of Clinician Burnout



Resources for Health Care Worker Well-Being





Partnership between the US National Academy of Medicine (NAM) and the Royal College of Physicians and Surgeons of Canada

The NAM and the Royal College of Physicians and Surgeons of Canada are finalizing a memorandum of agreement that will guide how these two entities will work together to develop a Canadian national plan to improve health workforce well-being, which would mirror the US national plan. This initiative represents the first international collaboration for the NAM Action Collaborative on Clinician Well-being and Resilience. The Royal College has engaged Barry Rubin as a Wellness Advisor who will work with the CEO, President, and staff of the Royal College to develop the Canadian national plan to improve health workforce well-being. In late 2022, Health Canada invited the Royal College to submit an application to support the development of a Canadian national plan to improve health workforce well-being. The Royal College submitted this grant, which includes a request for 3.5 million dollars to Health Canada on February 3, 2023.



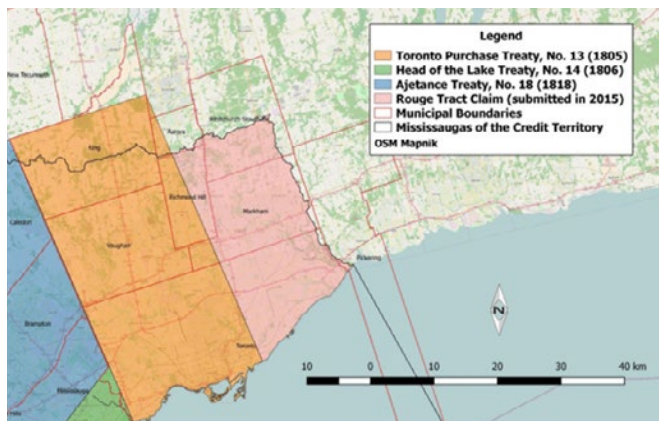
3.

Indigenous Health Program

Through collaboration with the UHN Indigenous Health Program, the PMCC supports planning for a 3,000 sq. ft. Indigenous Healing Space at the Toronto General Hospital that will enable Ceremonial Wise Practices for patients and staff across UHN. Further, all PMCC staff will have the opportunity to take cultural safety training through the New Respect module or San'yas Indigenous Cultural Safety Training course.

The PMCC provides heart failure clinical support for patients in the Weeneebayko Area Health Authority through a competitive award funded by Ontario Health and Boehringer Ingelheim. In addition, the PMCC / UHN executed a Relationship Accord in March 2021 with the Nishnawbe Aski Nation, a political organization representing 49 First Nation communities across Treaty 9 and Treaty 5 areas of Northern Ontario that acknowledges innovative approaches and technological advances are essential to improving the healthcare system for Nishnawbe Aski Nation communities. Consistent with the philosophy “Nothing About Us Without Us,” the Relationship Accord will support a community-led and community-driven process to improve healthcare delivery.

Municipal Boundaries Related to the Toronto Purchase Treaty, No.13 (1805)



Every Child Matters



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Inuit Tapiriit Kanatami



UHN Indigenous Health Program



Turtle Island



Mississaugas of The Credit First Nation



University of Toronto New Respect Cultural Safety Program



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Nishnawbe Aski Nation



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Weeneebayko Area Health Authority



4.

Climate Change and Healthcare Sustainability

Climate change is increasingly affecting people's health and the ability of our healthcare system to respond effectively to extreme weather events. The health ecosystem is responsible for approximately 8.5% of carbon emissions, so [healthcare delivery is a significant driver of the climate crisis](#)¹⁹. To help address this issue, the PMCC will focus on several initiatives to decrease carbon emissions and create a more sustainable future in medicine globally and locally within our hospital network.

Medical imaging is a significant contributor to carbon emissions in healthcare. In our cardiac catheterization laboratories, interventional radiology suites, and imaging-enabled operating rooms, waste from packaging and single-use devices is the most significant contributor to carbon emissions, followed by the energy required to operate imaging equipment and climate control. Initial initiatives within the PMCC, led by Kate Hanneman, will target these high-emission areas for maximum impact, including powering down medical imaging equipment when not in use, switching to reusable devices from disposable devices when feasible, and installing occupancy sensors in interventional suites so that climate control systems turn off when they are not occupied. We will also conduct a lifecycle assessment related to cardiac imaging to identify opportunities for further emission reductions within the PMCC.

PMCC PARTNERSHIPS





Apple

A partnership that will use aggregate biometric data from the Apple Watch combined with demographic, cardiac, and biomarker testing to determine if we can improve our ability to predict heart failure outcomes among a diverse ambulatory population of patients with heart failure. This project leverages a machine learning approach and has engaged the PMCC AI team.



Philips

Develop a curated dataset of patients with coronary disease that integrates all imaging studies (coronary angiography, intra-coronary imaging, CT, MRI, Echo, nuclear) with additional information in the Digital Cardiovascular Health Platform and co-develop machine learning-based algorithms that will augment clinical decision-making in the cardiac cath lab, in real-time.



McEwen Stem Cell Institute

Our vision is to transplant pluripotent stem cells that have been differentiated into electrically active pacemaker cells or ventricular myocytes by experts at the McEwen Stem Cell Institute (Gordon Keller, Mike Laflamme, Stephanie Protze) and TGH Research Institute (Sara Vasconcelos, Milica Radisic, Ren-Ke Li, Slava Epelman) in a series of first-in-human studies at the PMCC. Transplantation of cardiac stem cells has the potential to yield significant scientific, reputational, and commercialization success (e.g., through the UHN partnership with [BlueRock Therapeutics - Engineered Cell Therapy](#)).



Peterborough Regional Health Centre (PRHC)

The PMCC is developing a Memorandum of Understanding with PRHC that will establish a corridor of service between our hospitals to efficiently manage patients with cardiovascular disease that require advanced cardiac interventions or cardiac surgery. Together, the PMCC and PRHC are developing plans to build the facilities needed to establish a cardiac surgery unit in Peterborough and to recruit three cardiac surgeons to PRHC. In the future, PRHC will provide standard cardiac surgery procedures. Patients with complex cardiac disease or who require redo procedures will continue to be operated on at the PMCC and repatriated to PRHC for recovery.



Thunder Bay Regional Health Sciences Centre (TBRHSC)

The PMCC supported the development of cardiovascular services in Thunder Bay. We helped TBRHSC recruit 3 vascular surgeons to provide local elective and emergency vascular surgical care (previously, patients with a ruptured AAA or acute limb ischemia had to be transported over 700 miles to Toronto, Hamilton, or Ottawa for treatment). The PMCC also helped TBRHSC develop plans to build the facilities required to establish a cardiac surgery unit in Thunder Bay and to recruit three cardiac surgeons to TBRHSC. In the future, TBRHSC will provide standard cardiac surgery procedures. Patients with complex cardiac disease or who require redo procedures will continue to be operated on at the PMCC and repatriated to TBRHSC for recovery. We present a summary of current PMCC – Thunder Bay Health Sciences Center projects in [Appendix H](#).



Toronto Grace Hospital

Develop a partnership with the PMCC for rehabilitation and complex care to reduce the length of stay and improve patient outcomes.



St. Elizabeth Healthcare

Implement a partnership with the PMCC to support ventricular assist device (VAD)- and inotrope-dependent patients' transition home and remote monitoring in the community.



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www.pmcc.ai

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<https://www.sciencedirect.com/science/article/pii/S2589750020301400?via%3Dihub>

⁵Medical Image Computing and Computer Assisted Intervention

<http://www.miccai.org>

⁶Neural Information Processing Systems

<https://neurips.cc>

⁷Gene expression in aortic tissue after exposure to room air (RA) or cigarette smoke (CS)
Inflammatory cells in aortic aneurysm, human vs mouse

Thayaparan D et al. Atherosclerosis drives arterial damage and abdominal aortic aneurysm formation and rupture. Submitted for publication.

⁸Dr. Michael Farkouh (Director)

Has accepted the Vice Dean of Research of Research position at Cedars Sinai Hospital, Los Angeles.

⁹Dr. Patrick Lawler (Associate Director)

Has accepted the Lead, Coronary Care Unit position at McGill University, Montreal.

¹⁰Ozmosis Research

<https://ozmosisresearch.ca/>

¹¹Socar Research

<https://www.socar-research.com/>

¹²Trial of an Intervention to Improve Acute Heart Failure Outcomes | NEJM

https://www.nejm.org/doi/10.1056/NEJMoa2211680?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%20pubmed

¹³Canadian Cardiac Transplant Network (CCTN) – Heart Transplant Registry

The Canadian Cardiac Transplant Network (CCTN) will submit data to the International Society for Heart and Lung Transplantation (ISHLT) when the CCTN comes online, as the ISHLT has stopped accepting single centre data.

¹⁴Rubin B et al. Burnout and distress among physicians in a cardiovascular centre of a quaternary hospital network: a cross-sectional survey. CMAJ Open. 2021 Jan 11;9(1): E10-18.

¹⁵Rubin B et al. Burnout and distress among nurses in a cardiovascular centre of a quaternary hospital network: a cross-sectional survey. CMAJ Open. 2021 Jan 11;9(1): E19-28.

¹⁶Rubin B et al. Burnout and distress among allied health care professionals in a cardiovascular centre of a quaternary hospital network: a cross-sectional survey. CMAJ Open. 2021 Jan 11;9(1): E29-37.

¹⁷Compendium of Key Resources for Improving Clinician Well-Being

<https://nam.edu/compendium-of-key-resources-for-improving-clinician-well-being/>

¹⁸National Plan for Health Workforce Well-Being

<https://nam.edu/initiatives/clinician-resilience-and-well-being/national-plan-for-health-workforce-well-being/>

¹⁹<https://nam.edu/programs/climate-change-and-human-health/action-collaborative-on-decarbonizing-the-u-s-health-sector/>

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APPENDICES

APPENDIX A

PMCC Interdisciplinary Clinics

1. **Pregnancy and cardiac disease.**
Cardiology, Obstetrics, Neonatology.
2. **Cardio-Oncology.**
Medical, Surgical and Radiation Oncology, Medical Imaging, Cardiology.
3. **Thoraco-abdominal aortic aneurysm program and interdisciplinary aortic clinic.**
Vascular and Cardiac Surgery, Medical Imaging.
4. **Heart valve disease.**
Cardiology, Cardiac Surgery, Cardiac Anesthesia, Medical Imaging. Rapidly growing TAVI / MitraClip volumes.
5. **Adult congenital heart disease.**
Cardiology, Cardiac Surgery, Cardiac Anesthesia Medical Imaging.
6. **Dalglish Hearts and Minds Clinic (q22 Deletion Syndrome).**
Psychiatry, Endocrinology, Cardiology.
7. **Inherited arrhythmias.**
Medical Genetics, Cardiology.
8. **Hypertrophic cardiomyopathy.**
Cardiology, Cardiac Surgery, Cardiac Anesthesia.
9. **Heart function.**
Cardiology, Medical Imaging, Nutritional Science, Exercise Physiologists, Cardiac Surgery.
10. **Vascular malformations.**
Vascular Surgery, Medical Imaging.
11. **Thoracic outlet syndrome.**
Vascular Surgery, Medical Imaging.
12. **Complex coronary revascularization.**
Minimally Invasive Cardiac Surgery and Interventional Cardiology.
13. **Left ventricular assist devices.**
Cardiology, Cardiac Surgery, Anaesthesia, Nephrology, Palliative Medicine, Nutritional sciences.

APPENDIX B

Persons with lived experience partners that work with the PMCC

Persons with lived experience participate in many activities across the PMCC, including:

1. Governance: steering and advisory committees.
2. Content and program development: [The Heart Hub](#), Writing the Heart series, webinars.
3. Proposal development and project execution: CHF QBP demonstration project, UNEARTH CVD (the Heart Brain Connection Impact Award).
4. Recruitment of new staff to the PMCC, including all staff recruited to the Divisions of Cardiology, Cardiac Surgery and Vascular Surgery over the last 5 years.
5. Selection of Chairs and Professorships in the PMCC, including the Munk Chair in Advanced Echocardiography Imaging (search in progress), Ted Rogers and Family Chair in Heart Function (Phyllis Billia), Antonio and Helga De Gasperis Chair in Cardiovascular Surgery Clinical Trials and Outcomes Research (Maral Ouzounian), Angelo & Lorenza De Gasperis Chair in Cardiovascular Surgery Research (Piroze Davierwala), R. Fraser Elliott Chair in Vascular Surgery (search in progress), Munk Professorship Fund in Aortic Biomechanical Research (search in progress), Bitove Foundation Professorship in Adult Congenital Heart Disease (Rafael Alonso-Gonzalez) and Brompton Funds Professorship in Interventional Cardiology (search in progress).
6. Development of PMCC clinical, research, and educational programs.
7. The two workshops that led to the creation of this strategic plan.

The lived experiences of patients and caregivers are central to [The Heart Hub](#), our heart function and cardiotoxicity patient education site. Persons with lived experience led every stage of the Heart Hub guide content development.

The persons with lived experience partners (patients or caregivers) that work with the PMCC include the following individuals; each provided consent to be identified in this document.

- | | |
|-----------------------------|----------------------------|
| 1. Annie Smith | 14. Lori Constable-Smolcic |
| 2. Brad Pope | 15. Maddison Large |
| 3. Cindy Yip | 16. Marc Bains |
| 4. Dina Theodoropoulos | 17. Nancy Cunliffe |
| 5. Irving Abella (Deceased) | 18. Noli Mosquite |
| 6. Isabel Victal | 19. Paula Henderson |
| 7. Jackie Ratz | 20. Santa Cuda |
| 8. Jason Boland | 21. Sharon Bray |
| 9. Julie Vizza | 22. Shelagh Ross |
| 10. Katie Shea | 23. Todd Murray |
| 11. Kim Locke | 24. Tracey Bawtinheimer |
| 12. Kyle Litchman | 25. Wayne Sandvik |
| 13. Laurel Sproule | |

APPENDIX C

Digital Cardiac Health Platform

Digital Cardiac Health Platform Overview

The UHN Ted Rogers Centre for Heart Research (TRCHR), the Peter Munk Cardiac Centre (PMCC) and UHN Digital have collaborated to build the **Digital Cardiac Health Platform (DCHP)**, a secure high-performance data integration platform for research, QI and QA use of clinical data. In early 2022, a transition began to establish a UHN-wide Digital Health Platform (DHP) to provide services across the organization.

Permitted uses of this platform will be for the centralization of curated datasets, research, registry administration, business intelligence, as well as quality assurance, improvement, and monitoring. This platform will also eventually empower artificial intelligence, machine learning and complex statistical approaches to research, focusing on complex multilinear regression modelling and generating predictive analytics. Finally, it will be a catalyst for health care data science to better understand how data is used in the healthcare system. By utilizing meaningful data about patients, treatments, and outcomes, we aspire to employ evidence-based strategies to improve the delivery of care while maximizing the efficient use of resources around the hospital.

The DCHP/DHP will include three main technologies: data ingestion and integration workflows, user-facing tools to explore and request available data, and a high-performance analytics environment. The data ingestion and integration tools are designed to be able to ingest data from numerous distinct data sources in a multitude of formats. For example, the system can bring in general data from standard hospital HL7 messaging systems (e.g., Quadramed EPR and EPIC), as well as data pulled directly off specialized medical devices such as those used in cardiac stress testing. Data is then mapped to the FHIR standard (where possible) for integration across various sources, enabling cross-system querying. Data requests will follow appropriate institutional policy around de-identification prior to its release.

Program Mission & Goals

The Peter Munk Cardiac Centre (PMCC) and the Ted Rogers Center of Heart Research (TRCHR) aim to transform and dramatically improve the future of heart health for children, adults and families across Canada and around the world through an integrated program of research, education, and clinical care. Integral to this mission is the creation of a data rich environment for clinical metrics monitoring, quality improvement projects and the ability to create a central repository of data sources for research. The DCHP/DHP continues to incorporate new data sources over time and include new user groups. The expected benefits of this platform are to:

1. **Increase the speed of clinical research** through seamless integration of data from various sources to a single platform for static exports to research databases via REDCap.
2. **Individualize and improve patient care** by enabling data-driven clinical care and patient management throughout the care continuum.
3. **Improve decision support** by providing real time monitoring of key quality and performance indicators.
4. **Enable transformative research** by providing central, unified access to the wealth of data assets available across PMCC and UHN.

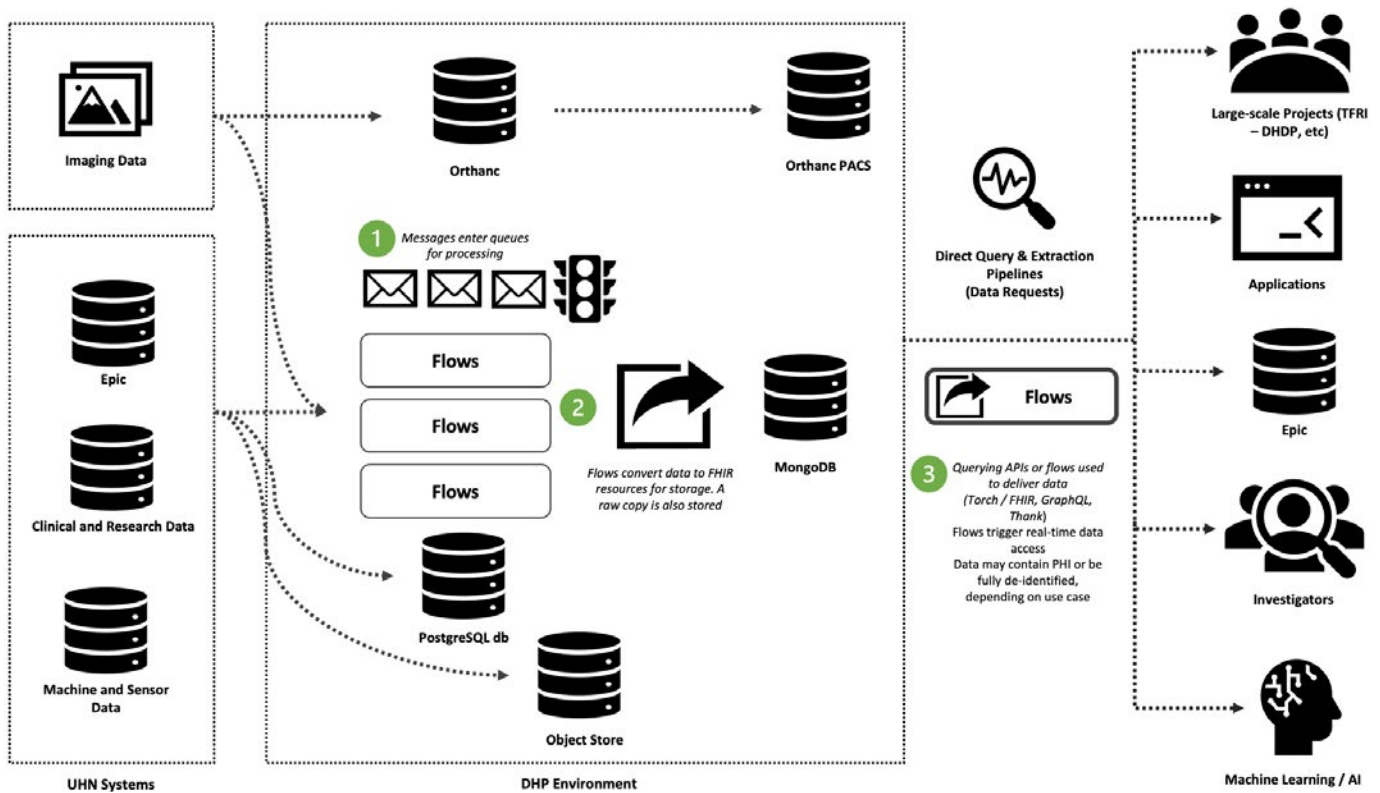
DCHP / DHP Scope & Goals

The overall goals of DCHP / DHP will allow UHN to:

1. Facilitate data integration across multiple data silos and support quality improvement reports and initiatives.
2. Allow real-time quality metrics and international benchmarking of UHN outcomes for quality and efficiency of clinical care delivery.
3. Facilitate clinical research projects as approved by a UHNs REB.
4. Support the long-term vision of integration with clinical applications that will collect data at the patient point of care.

Figure 1 illustrates the flow of data through the DCHP/DHP

Fig. 1: DCHP / DHP Data Flow



DCHP / DHP Governance

The purpose of this section is to define:

- **Governing bodies** and their responsibilities.
- **Data request** workflows and responsible parties.

Governing Bodies

This section outlines the access rights, roles, and responsibilities of each of the following bodies with a responsibility in the management and protection of data and DCHP/DHP. The DHP Manager will provide oversight and accountability for the Data and Core Technical teams, and reports into the UHN Digital Operations Executive Director with consultation provided by the DHP Steering Committee.

Digital Health Platform Steering Committee

The DHP Steering Committee is comprised of executive membership from UHN Digital, UHN Research, and executive & leadership representation from across UHN and is jointly led by UHN Digital and PMCC representation. The accountability of this group includes:

- Ensuring platform remains aligned with organizational strategy and up to date on evolving policies/standards.
- Identifying (and attempting to resolve) challenges that may impact the success of the DHP.
- Advising on the overall strategic direction of the DHP.
- Approving or rejecting large scale initiatives that impact established roadmaps/timelines.
- Advocating for the institutional use of the DHP and acting on opportunities to communicate positively about the project.

DHP Data Team

The DHP Data Team has the responsibility to enforce access management procedures, including:

- Authorizing the use of the Platform for approved research and QI projects.
- Ensuring appropriate institutional approval for data requests and validating alignment of requested data falls within the approved scope.
- Delivery of the data.

DHP Core Technical Team

The DHP Core Technical Team will be responsible for the implementation of access and configuration controls, as well as the technical development of onboarding new data sources, new tools, and platform infrastructure/maintenance. The Core Technical Team will monitor system logs for security and privacy risks, escalating to UHN Digital Security and/or UHN Privacy where necessary.

DCHP Technical Team

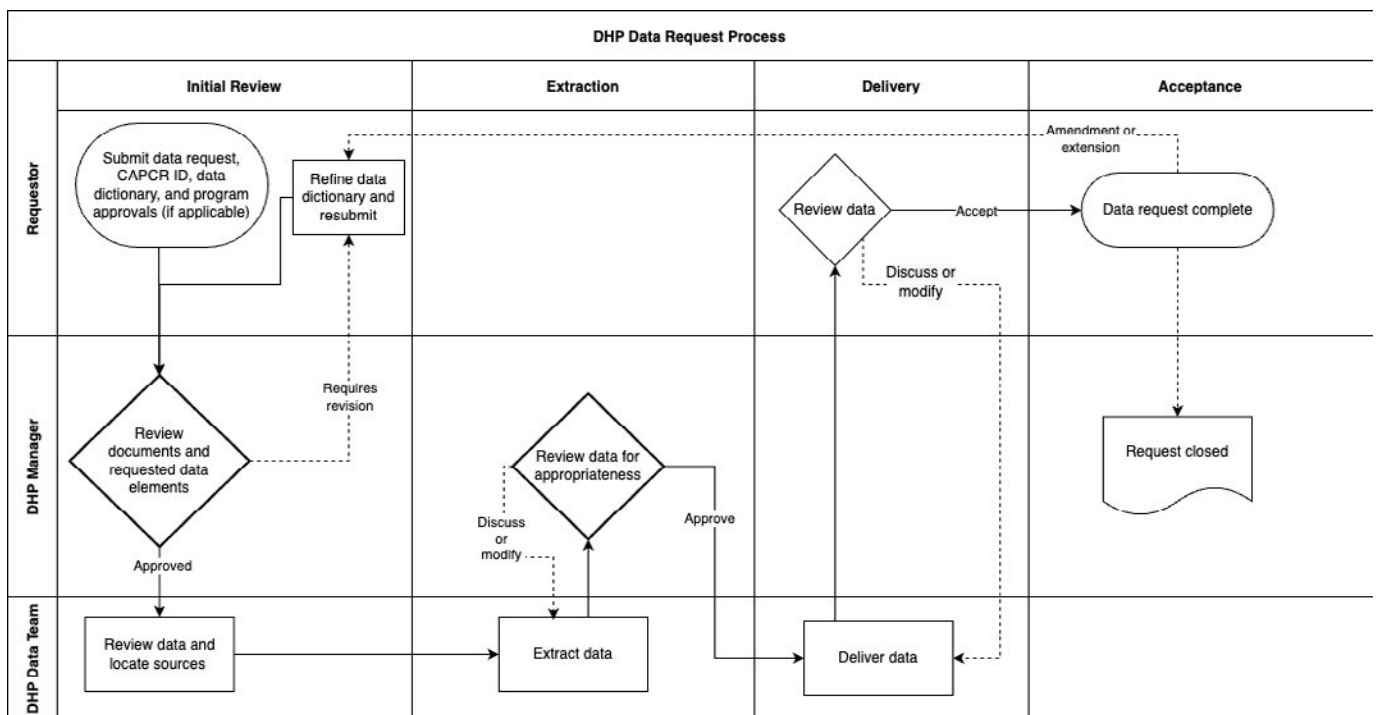
The DCHP Technical Team will focus on PMCC-related development initiatives, contributing to the overall platform direction as needed to advance the vision of PMCC and Cardiac researchers.

Data Requests Workflow and Responsibilities

Data requests made to the DHP are submitted via a central mechanism and each is subject to a standardized workflow. The data request workflow allows the DHP team to establish a systematic and equitable approach to assess the request and facilitate data delivery for researchers. Figure 2 shows an overview of the process. It is the responsibility of the DHP Manager to ensure compliance by the DHP team with relevant UHN policies and DHP SOPs.

The Manager may delegate these tasks to other qualified DHP team members, but they ultimately remain the responsible party.

Fig. 2: DCHP Data Request Process



The DHP Manager will have the responsibility to validate each DHP Data Request. Data requests will be tracked must be kept current throughout every stage of the workflow (new DHP data requests, amended requests, and request renewals) in an auditable and traceable manner by DHP Manager.

Screening

The DHP Manager will review data requests to ensure appropriate institutional approvals have been obtained and supporting documentation has been provided.

Assessment and Approval

Once all documents are obtained and verified, DHP Manager will notify the DHP Data Team Lead to perform initial technical review. The Manager will perform an initial governance and privacy review and escalate any concerns to UHN Privacy. The governance review for data requests ensures the requestor has provided the following documentation:

- CAPCR ID.
- REB Approval Letter.
- CAPCR Submission Document.
- Data dictionary or list of request variables, where possible.
- Fully executed data sharing agreement (DSA), if data is to leave the Institution.

For API/Service requests, Digital Security and/or Privacy approvals are required, and may be obtained as part UHNs Digital Demand Management (DDM) process managed by the Digital Business Partner (DBP) team.

Approval will be granted if the request satisfied if:

- They have agreed to provide funding or are a member of a program/department that contributes funding.
- The requested data aligns to what the requestor has been approved to obtain by appropriate institutional bodies.

The DHP Manager will escalate any concerns to UHN Privacy.

Prioritization and Sequencing

Upon approval, the request will be prioritized for fulfillment based on existing requests and the urgency of the request and completed in sequence.

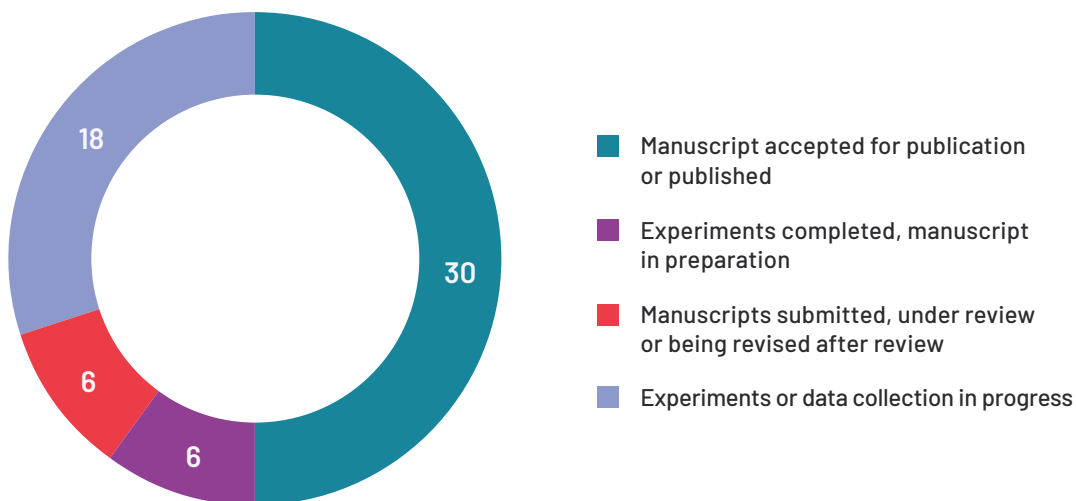
Delivery

Data will be delivered to Principal Investigator by the DHP Data Team Lead via a secure file transfer service. Deidentified data will be delivered separately from any linking lists to maintain privacy and security of the data. If the Principal Investigator provides written approval, large datasets may be transferred to a secure location that is managed by a member of their study team.

APPENDIX D

PMCC AI Team List of Current Projects

Summary of the 60 PMCC AI Team projects



Journals PMCC AI Team projects have been published in:

Bioinformatics, Canadian Journal of Cardiology, Circulation, Circulation Research, Current Opinion in Cardiology, Conference of the European Chapter of the Association for Computational Linguistics, European Respiratory Journal, European Society for Heart Failure, Frontiers in Physiology, Genome Biology (2 papers), Heart, Immunity, International conference on Medical Image Computing and Computer Assisted Intervention (2 papers), International Journal of Cardiology, Intensive Care Med Experimental, JACC Electrophysiology, Journal of Cardiac Surgery, Journal of the American Geriatrics Society, Lancet Digital Health (3 papers), Lancet Regional Health Americas, Nature Communications, Nature Medicine, Nature Methods, Nature Scientific Reports, PLOS Digital Health, Viruses.

Description of PMCC AI Team projects, including publication status

Project Key	Title Summary	PMCC AI Scientist	Collaborators	Affiliations	Current Status	Journal (Hyperlinked to publication if manuscript accepted or published)
PMCC AI-1	Development of an AI- biomarker tool for multi-modality image-based analysis focused on coronary artery and interstitial lung disease	Dr. Chris McIntosh	Dr. Heather Ross Dr. Patrick Veit- Haibach Dr. Bernd Wintersperger	PMCC JDMI	Experiments in progress	
PMCC AI-2	Development of an AI algorithm to provide tailored recommendations for individual treatment plans to Medly users	Dr. Bo Wang	Dr. Heather Ross, Dr. Joe Cafazzo Dr. Cedric Manhiot	PMCC e-Health	Manuscript under review	
PMCC AI-3	Prediction of cardiotoxicity of breast cancer patients	Dr. Bo Wang	Dr. Paaladinesh Thavendiranathan	PMCC	Experiments completed, manuscript in preparation	
PMCC AI-4	Comparison of machine learning and the regression-based EHMRG model for predicting early mortality in acute heart failure	Dr. Bo Wang	Dr. Douglas Lee	PMCC	Manuscript accepted	International Journal of Cardiology
PMCC AI-5	Development of a deep learning algorithm to predict long-term cardiovascular complications post liver transplantation	Dr. Bo Wang	Dr. Mamatha Bhat	Ajmera Transplant Centre	Manuscript accepted	Lancet Digital Health
PMCC AI-6	A semi-automated system to interpret angiographic images for coronary artery disease via artificial intelligence	Dr. Chris McIntosh	Dr. Barry Rubin Dr. Heather Ross Dr. Sanjog Kalra	PMCC	Data extraction / experiments in progress	
PMCC AI-7	Diversity in the Expressed Genomic Host Response to Myocardial Infarction	Dr. Bo Wang	Dr. Patrick Lawler	PMCC	Manuscript accepted	Circulation Research
PMCC AI-8	Machine learning for left ventricular segmentation and scar quantification in hypertrophic cardiomyopathy patients	Dr. Bo Wang	Dr. Wendy Tsang	PMCC	Manuscript accepted	Canadian Journal of Cardiology PLOS Digital Health (in press)
PMCC AI-9	Machine Learning to Improve Left Ventricular Scar Quantification in Hypertrophic Cardiomyopathy Patients	Dr. Bo Wang	Dr. Wendy Tsang Dr. Harry Rakowski	PMCC	Manuscript accepted	Circulation
PMCC AI-10	Use of AI to predict successful lung transplant	Dr. Bo Wang	Dr. Shaf Keshavjee	Sprott Surgery	Manuscript under revision	Nature Communication

Project Key	Title Summary	PMCC AI Scientist	Collaborators	Affiliations	Current Status	Journal (Hyperlinked to publication if manuscript accepted or published)
PMCC AI-11	Using Machine-learning and Image-recognition to improve automated ECG interpretation for patients with ST- Elevation Myocardial Infarction	Dr. Bo Wang	Dr. Sameer Masood	Emergency Room	Experiments in progress	
PMCC AI-12	Diversity in the Expressed Genomic Host Response to Myocardial Infarction	Dr. Bo Wang	Dr. Patrick Lawler, Brigham and Women's Hospital, Stanford	PMCC	Manuscript accepted	Intensive Care Med Exp.
PMCC AI-13	Development of an NLP model to improve Discharge Summary Coding of cardiac patients	Dr. Chris McIntosh	Dr. Barry Rubin Katherine Henning Elizabeth Chiu Dr. Mike Brudno	PMCC	Experiments in progress	
PMCC AI-14	Distinct CSF1 Micro- Environments Maintain Monocytes within a Perivascular Bone Marrow Niche (Single Cell)	Dr. Bo Wang	Dr. Clint Robbins	PMCC	Manuscript accepted	Immunity
PMCC AI-15	Conserved Endotypes of Leukocyte Genomic Host Response in Infectious and Sterile Critical Illnesses	Dr. Bo Wang	Dr. Patrick Lawler	PMCC	Experiments completed, manuscript in preparation	
PMCC AI-16	Use of AI to predict successful heart transplantation	Dr. Bo Wang	Dr. Mitesh Badiwala	PMCC	Experiments in progress	
PMCC AI-17	Validation and Prospective Quantification of Machine Learning Performance for the Design of Therapeutic Curative-Intent Radiation	Dr. Chris McIntosh	Dr. Tom Purdie Dr. Ale Berlin	RMP	Manuscript accepted	Nature Medicine
PMCC AI-18	COVID19-Novel diagnostic tools for early detection and surveillance of COVID-19 in the lung using artificial intelligence	Dr. Chris McIntosh	Dr. Patrik Rogalla Dr. Heather Ross Dr. Mike Brudno	JDMI PMCC	Experiments in progress	
PMCC AI-19	COVID19 Genetics: Genotyping SARS-CoV-2 through an interactive web application	Dr. Bo Wang	Dr. Samara Mubareka	Sunnybrook	Manuscript accepted	Lancet Digital Health
PMCC AI-20	A collaborative model for identifying genetic basis of heart failure in the whole-genome era	Dr. Bo Wang	Dr. Raymond Kim Dr. Maral Ouzounian	PMCC	Data collection in progress	

Project Key	Title Summary	PMCC AI Scientist	Collaborators	Affiliations	Current Status	Journal (Hyperlinked to publication if manuscript accepted or published)
PMCC AI-21	COVID19-OHDP: Development of machine learning models to predict COVID19 mortality in long-term care patient populations	Dr. Bo Wang	Dr. Doug Lee	PMCC	Manuscript accepted	Journal of the American Geriatrics Society
PMCC AI-22	Factors associated with SARS-CoV-2 test positivity in long-term care homes: A population-based cohort analysis using machine learning	Dr. Bo Wang	Dr. Doug Lee	PMCC	Manuscript accepted	Lancet Regional Health Americas
PMCC AI-23	COVID19-OHDP: Development of machine learning models developed for general populations using ICES data	Dr. Bo Wang	Dr. Doug Lee	PMCC	Manuscript submitted	Lancet Digital Health
PMCC AI-24	Using machine learning to automate Focal Source and Trigger (FaST) computational algorithm in atrial fibrillation	Dr. Bo Wang	Dr. Vijay Chauhan	PMCC	Manuscript accepted	Frontiers in Physiology (Cardiac Electrophysiology)
PMCC AI-25	Use of Wearable Technology and Deep Learning to Improve the Diagnosis of Brugada Syndrome	Dr. Bo Wang	Dr. Vijay Chauhan	PMCC	Manuscript accepted	JACC Electrophysiology
PMCC AI-26	Development and validation of a novel early warning system for detecting deterioration among adult hospitalized patients	Dr. Chris McIntosh	Dr. Yas Moayedi Dr. Patrick Lawler Joe Duhamel Dr. Heather Ross	PMCC	Data collection in progress	
PMCC AI-27	Using machine learning and to study outcomes of Cardiovascular Magnetic Resonance Imaging in COVID-19	Dr. Chris McIntosh	Dr. Paaladinesh Thavendiranathan	PMCC	Data collection in progress	
PMCC AI-28	Using machine learning, Apple HealthKit data, Apple Watch sensors, and CPET to predict and study heart failure patients (Apple partnership)	Dr. Chris McIntosh	Dr. Heather Ross Dr. Yas Moayedi Joe Duhamel	PMCC	Data collection in progress	
PMCC AI-29	Estimating prognosis among heart failure patients referred for advanced heart failure therapies	Dr. Chris McIntosh	Dr. Carolina Alba Dr. Heather Ross	PMCC	Planning stage	

Project Key	Title Summary	PMCC AI Scientist	Collaborators	Affiliations	Current Status	Journal (Hyperlinked to publication if manuscript accepted or published)
PMCC AI-30	Using Deep Learning to revolutionize the way we “see” carotid plaque to prevent stroke	Dr. Bo Wang	Dr. Kathryn Howe	PMCC	Experiments completed, manuscript in preparation	Conference abstract: JVS-Vascular Science
PMCC AI-31	Applying Machine Learning for SARS-CoV-2 Detection from full curve RT-PCR data	Dr. Bo Wang	Dr. Tony Mazzulli	Lab Medicine and Pathology (Mount Sinai)	Experiments in progress / ongoing data collection	
PMCC AI-32	Applying Machine Learning to KCCQ scores from the CHF-CePPORT trial	Dr. Chris McIntosh	Dr. Rob Nolan	PMCC	Experiments In progress / ongoing data collection	
PMCC AI-33	Machine Learning Compared with Conventional Statistical Models for Predicting Myocardial Infarction Readmission and Mortality: A Systematic Review	Dr. Bo Wang	Dr. Doug Lee	PMCC	Manuscript accepted	Canadian Journal of Cardiology
PMCC AI-34	Machine learning vs. conventional statistical models for predicting heart failure readmission and mortality	Dr. Bo Wang	Dr. Doug Lee	PMCC	Manuscript accepted	European Society for Heart Failure
PMCC AI-35	Artificial intelligence for the echocardiographic assessment of valvular heart disease	Dr. Bo Wang	Dr. Wendy Tsang	PMCC	Manuscript accepted	Heart
PMCC AI-36	Machine learning as a new frontier in mitral valve surgical strategy	Dr. Bo Wang	Dr. Wendy Tsang	PMCC	Manuscript accepted	Journal of Cardiac Surgery
PMCC AI-37	Comparison of machine learning and the regression-based EHMRG model for predicting early mortality in acute heart failure	Dr. Bo Wang	Dr. Doug Lee	PMCC	Manuscript accepted	International Journal of Cardiology
PMCC AI-38	A biomarker assay to risk-stratify patients with symptoms of respiratory tract infection	Dr. Bo Wang	Dr. Shaf Keshavjee	PMCC Sprott Surgery	Manuscript accepted	European Respiratory Journal
PMCC AI-39	simATAC: a single-cell ATAC-seq simulation framework	Dr. Bo Wang	Zeinab Navidi Lin Zhang	PMCC	Manuscript accepted	Genome Biology
PMCC AI-40	One Cell At a Time (OCAT): a unified framework to integrate and analyze single-cell RNA-seq data	Dr. Bo Wang	Chloe X. Wang Lin Zhang	PMCC	Manuscript accepted	Genome Biology

Project Key	Title Summary	PMCC AI Scientist	Collaborators	Affiliations	Current Status	Journal (Hyperlinked to publication if manuscript accepted or published)
PMCC AI-41	Develop a graph-based approach to measure the dynamics of single-cell state transitions from single-cell RNA-seq data	Dr. Bo Wang	Student: Haotian	PMCC	Manuscript under revision	Nature Methods
PMCC AI-42	BIONIC: biological network integration using convolutions	Dr. Bo Wang	Student: Duncan	Vector Institute	Manuscript accepted	Nature Methods
PMCC AI-43	DeCLUTR: Deep Contrastive Learning for Unsupervised Textual Representations	Dr. Bo Wang	Gary Bader	University of Toronto	Manuscript accepted	Conference of the European Chapter of the Association for Computational Linguistics
PMCC AI-44	SAUNet: Shape Attentive U-Net for Interpretable Medical Image Segmentation	Dr. Bo Wang	Student: Jesse	PMCC	Manuscript accepted	International conference on Medical Image Computing and Computer Assisted Intervention
PMCC AI-45	CDF-Net: Cross-Domain Fusion Network for Accelerated MRI Reconstruction	Dr. Bo Wang	Student: Osvald	PMCC	Manuscript accepted	International conference on Medical Image Computing and Computer Assisted Intervention
PMCC AI-46	Develop a systematic way of integrating various single-cell RNA-seq datasets when data is imbalanced	Dr. Bo Wang	Student: Hassan	PMCC	Manuscript under review	Nature Biotechnology
PMCC AI-47	A graph neural network approach for molecule carcinogenicity prediction	Dr. Bo Wang	Brendan Frey	Deep Genomics	Manuscript accepted	Bioinformatics
PMCC AI-48	Multiscale interactome analysis coupled with off-target drug predictions reveals drug repurposing candidates for human coronavirus disease	Dr. Bo Wang	Costin Antonescu	Toronto Metropolitan University	Manuscript accepted	Nature Scientific Report
PMCC AI-49	The cardiac surgeon's guide to artificial intelligence	Dr. Bo Wang	Dr. Bobby Yanagawa	PMCC	Manuscript accepted	Current Opinion in Cardiology
PMCC AI-50	A comparison of whole genome sequencing of SARS-CoV-2 using amplicon-based sequencing, random hexamers, and bait capture	Dr. Bo Wang	Samira Mubareka	SunnyBrook Research Institute	Manuscript accepted	Viruses

Project Key	Title Summary	PMCC AI Scientist	Collaborators	Affiliations	Current Status	Journal (Hyperlinked to publication if manuscript accepted or published)
PMCC AI-51	Single-cell profiling of healthy human kidney reveals features of sex-based transcriptional programs and tissue-specific immunity	Dr. Bo Wang	Sarah Crome	UHN	Manuscript accepted	Nature Communications
PMCC AI-52	UniCell: Universal Cellular Segmentation Models for Multi-Modality Microscopy Images	Dr. Bo Wang	Student: Jun	PMCC	Manuscript under review	Nature Machine Intelligence
PMCC AI-53	AI application in a large multi-omic data set of proteomics, post-translational modification omics, RNA, and whole genome sequencing DNA on aortic aneurysm and dissection patients	Dr. Bo Wang	Dr. Maral Ouzounian Dr. Tony Gramolini	PMCC	Data collection in progress	
PMCC AI-54	Atherosclerotic process drives arterial damage, abdominal aortic aneurysm formation, and rupture	Dr. Bo Wang	Dr. Clinton Robbins	PMCC	Manuscript under review	Nature
PMCC AI-55	AI-driven model for inferring mathematical rules of quorum sensing in an innate immune response	Dr. Bo Wang	Dr. Clinton Robbins	PMCC	Experiment in progress	
PMCC AI-56	AI-based waiting time prediction in emergency departments across Ontario	Dr. Bo Wang	Vahid, Saba	Ontario Health	Data collection in progress	
PMCC AI-57	AI for clinical trial design and patient recruitment	Dr. Bo Wang	Dr. Patrick Lawler	PMCC	Data collection in progress	
PMCC AI-58	AI-based prediction of dementia using MRI images	Dr. Bo Wang	Dr. Doug Lee Dr. Amit Singnurkar	ICES & Sunnybrook Research Institute	Experiments in progress	
PMCC AI-59	AI-based single-cell multi-omic data integration for AML patients	Dr. Bo Wang	Dr. John Dick	UHN	Experiments completed, manuscript in preparation	Nature Medicine
PMCC AI-60	Using Machine Learning to Identify Predictors of Survival Post Heart Transplant	Dr. Bo Wang	Dr. Mitesh Badiwala	PMCC	Experiments completed, manuscript in preparation	

OHDP – Ontario Health Data Platform

APPENDIX E

PMCC Clinical Trials and Translation Unit

A) Current status of clinical trial activity (December 2022)

Study Status	Total
Open to accrual	18
Accrual closed (in follow-up or data analysis)	17
Pre-Approval	12
Grand Total	47

B) Selected clinical trials currently being run through the PMCC Clinical Trials and Translation Unit

Study Status	Study Full Title	PMCC PI	Clinical Indication	Study Type	Study Phase	Lead Site	CTTU Role	Sponsor/ Funder
Open to Accrual	A Multicenter, Randomized, Double-Blind, Parallel Group, Placebo-Controlled Trial to Evaluate the Effect of In-Hospital Initiation of Dapagliflozin on Clinical Outcomes in Patients Who Have Been Stabilized During Hospitalization for Acute Heart Failure	Udell, Jacob	Heart Failure	IIT	III/IV	BWH	Local	TIMI-BWH/ AstraZeneca
Open to Accrual	A Phase IIB, Randomized, Double-blinded, Placebo-controlled, Parallel-design Study to Evaluate the Efficacy and Safety of MEDI6570 in Participants with a Prior Myocardial Infarction, Persistent Inflammation, and Elevated N-terminal Prohormone Brain Natriuretic Peptide	Farkouh, Michael	Coronary Artery Disease	Industry	II	BWH	International	AstraZeneca
Open to Accrual	Adverse Childhood Experiences in patients with coronary artery disease: a pilot randomized control trial (ACE Pilot RCT)	Farkouh, Michael	Heart Failure	IIT	Other	PMCC	Local	PMCC

Study Status	Study Full Title	PMCC PI	Clinical Indication	Study Type	Study Phase	Lead Site	CTTU Role	Sponsor/ Funder
Open to Accrual	Myocardial Ischemia and Transfusion	Dzavik, Vlad	Myocardial Infarction	Other	Other	SHSC	Local	NIH
Open to Accrual	The impact of diabetic microvascular dysfunction on late major adverse cardiac events post non-ST elevation acute coronary syndrome	Farkouh, Michael	Myocardial Infarction	IIT	Other	SHSC	Local	ICES
Open to Accrual	hs-cTn – Optimizing the Diagnosis of Acute Myocardial Infarction/ Injury in Women	Udell, Jacob	Myocardial Infarction	IIT	Other	UBC	National	CIHR
Open to Accrual	INVESTED COVID-19 Ancillary	Udell, Jacob	COVID-19	IIT	Other	BWH	Local	BWH
Open to Accrual	Early Initiation of Antiplatelet Therapy In Heart Transplantation: AERIAL trial	Ross, Heather	Heart Transplant	IIT	III	UOHI	Local	OHIRC-CIHR
Open to Accrual	Bariatric surgery for the Reduction of cardiovascular Events	Dash, Satya	Cardiovascular	Other	Other	PHRI-HHSC	Local	PHRI-CIHR
Data Analysis	Randomized clinical trial of Acai Palm Berry extract as an intervention in patients diagnosed with COVID-19	Farkouh, Michael	COVID-19	IIT	III	PMCC	International	PMCC-UofT
Closed to Accrual - Follow-up Ongoing	Semaglutide cardiovascular outcomes trial in patients with type 2 diabetes (SOUL)	Husain, Mansoor	Cardiovascular Disease	Industry	III	–	Local	Novo Nordisk
Data Analysis	Antithrombotic Therapy to Ameliorate Complications of COVID-19	Lawler, Patrick	COVID-19	IIT	Other	UofM	Provincial	NIH
Closed to Accrual - Follow-up Ongoing	A 2x2 factorial randomized controlled trial of Colchicine and spironolactone in patients with ST elevation myocardial infarction/SYNERGY Stent Registry Organization to Assess Strategies for Ischemic Syndromes	Dzavik, Vlad	Myocardial Infarction	IIT	III	PHRI	Local	PHRI-HHSC

Study Status	Study Full Title	PMCC PI	Clinical Indication	Study Type	Study Phase	Lead Site	CTTU Role	Sponsor/ Funder
Closed - Pending Site Close-out	A Phase 3, Multicentre, Double-blind, Randomized, Placebo-controlled, Parallel-group Study to Investigate the Efficacy and Safety of CSL112 in Subjects with Acute Coronary Syndrome	Dzavik, Vlad	Myocardial Infarction	IIT	III	KGH	Local	CSL Behring
Pre-Approval	Aggressive Smoking Cessation Therapy Post-Acute Coronary Syndrome (ASAP) Trial	Lawler, Patrick	Acute Coronary Syndrome	IIT	Other	JGH, McGill	Provincial	JGH-CIHR
Pre-Approval	A multicenter, international, randomized, active comparator-controlled, double-blind, double-dummy, parallel group, 2-arm Phase 3 study to compare the efficacy and safety of the oral FXIIa inhibitor asundexian (BAY 2433334) with apixaban for the prevention of stroke or systemic embolism in male and female participants aged 18 years and older with atrial fibrillation at risk for stroke	Udell, Jacob	Atrial Fibrillation	Industry	III	WCH	Local	Bayer
Pre-Approval	A Complex Coronary bifurcation Evaluation of Stenting Strategies (ACCESS)1	Dzavik, Vlad	Coronary Artery Disease	IIT	III/IV	PMCC	International	MedTronic
Pre-Approval	International Registry to Assess Cardiac Tumours	Cusimano, Robert	Cardiac Tumours	Other	Other	PMCC	International	Philanthropy

C) List of clinical trials led by PMCC Investigators that are being run outside of the PMCC Clinical Trials and Translation Unit

Cardiology

Dr. Abhishek Bhaskaran

- Co-Principal Investigator. StereoTactic Ablative RadioTherapy of Cardiac Arrhythmias (START-CA): a Phase II Trial of Non-Invasive Treatment of Medically Refractory Patients.

Dr. Vijay S. Chauhan

- Principal Investigator. Characterizing abnormal atrial substrate in patients undergoing atrial fibrillation catheter ablation. Johnson and Johnson. Investigator-initiated study. 2021 – 22.

Dr. John Floras

- Vice-Chair, Adaptive Servo Ventilation for therapy of sleep apnea in heart failure (ADVENT-HF) trial. 2009 – Present.

Dr. Diego Delgado

- Principal Investigator. Detection of TTR Amyloid Fibrils and Oligomers in Extracellular Vesicles (EV) and Blood Plasma of ATTR Amyloidosis using Combinatorial Immuno-gold Electron Microscopy and ELISA. Pfizer Inc. 2018 – 2020.

Dr. Sanjog Kalra

- Principal Site Investigator. Door to Unloading with IMPELLA CP System in Acute Myocardial Infarction to Reduce Infarct Size (DTU: The DTU STEMI Trial). Abiomed Inc. 2019 – 2020.

Robert Iwanochko

- Co-Principal Investigator. Canadian Fabry Disease Initiative. Randomized trial of Fabryzyme or Replagal in all Fabry's patients eligible for treatment in Canada. Government/Industry. 2014 – 2020.

Dr. Andrew Ha

- Principal Investigator. Post-Surgical Enhanced Monitoring for Cardiac Arrhythmias and Atrial Fibrillation (SEARCH-AF): A randomized controlled trial. Heart & Stroke Foundation of Canada. Grant-in-Aid. 2017 – 2020.

Dr. Eric Horlick

- Principal Site Investigator. Medtronic Low Risk TAVR Study. Medtronic. 2017 Oct – Present.
- Principal Site Investigator. SURTAVI - Safety and Efficacy Study of the Medtronic CoreValve® System in the Treatment of Severe, Symptomatic Aortic Stenosis in Intermediate Risk Subjects Who Need Aortic Valve Replacement. Medtronic Canada. 2014 – Present.
- Principal Investigator. Atrial Septal Defects in adults (Trio-ASD). CIHR. 2022 – 2024.

Dr. Michael McDonald

- Principal Investigator. PARTHENON Study: PATient RegisTry assessing effectiveness and safety of Heart failure treatment with LCZ696 acrOss CaNada. Novartis. 2015 – 2022.
- Site Investigator. Clinical Assessment of the SonR Algorithm in the PARADYM RF SonR CRT-D by Echocardiography. Sorin Group Canada. 2014 – 2017.

Dr. Heather Ross

- Module Principal Investigator. Using Novel Approaches for Early Recognition of TIA, Heart Failure and Connections with Vascular Dementia (UNEARTH CVD). Heart and Stroke Foundation of Canada (HSFC). Heart Brain IMPACT award. 2022 – 2026.

Dr. Danna Spears

- Principal Site Investigator. Avoid Transvenous Leads in Appropriate Subjects (ATLAS S-ICD). Canadian-Stroke Prevention and Intervention Network. 2014 – Present.

Dr. Dinesh Thavendiranathan

- Principal Investigator. HIMALAYAS Pilot Study. MSH UHN AMO Innovation Fund. 2021 – 2023.
- Principal Investigator. The Harmonized Interventions to Maintain health via Appropriate risk factor modification and Lifestyle changes in Pediatric, Adolescent & Young Adult Cancer Survivors (HIMALAYAS) Trial. Canadian Cancer Society / CIHR. 2021 – 2026.

Cardiovascular Surgery

Dr. Mitesh Badiwala

- Site Principal Investigator. A single centre pilot study of using Donation after Circulatory Death hearts for transplantation using normothermic machine perfusion for the preservation and evaluation of human hearts prior to transplantation. 2020 – Present.
- Site Principal Investigator. Evaluation the Benefit of Concurrent Tricuspid Valve Repair During Mitral Surgery. Cardiothoracic Surgery Trials Network (CTSN). 2016 – Present.

Dr. RJ Cusimano

- Principal Investigator. Left Atrial Appendage Occlusion Study III. Population Health Research Institute.

Dr. Piroze Davierwala

- Site Principal Investigator. Minimally Invasive coronary surgery compared to Sternotomy coronary artery bypass grafting. Ottawa Heart Institute.

Dr. Maral Ouzounian

- Principal Investigator. HEADSTART: Randomized trial in acute aortic dissection. Heart and Stroke Foundation – Grant-in-Aid. 2022 – 2027.

Dr. Vivek Rao

- Principal Investigator. Minimally invasive extracorporeal circulation versus conventional cardiopulmonary bypass in patients undergoing cardiac surgery. Aristotle University of Thessaloniki School of Medicine.
- Site Principal Investigator. Sub-study of ROMA trial, its aim is to determine the impact of CABG surgical technique on long-term cognitive function in an international cohort. Weill Cornell Medicine ROMa.
- Principal Investigator. The Direct Oral Anticoagulation versus Warfarin after Cardiac Surgery. Evaluating the safety of DOACs versus VKAs after cardiac surgery in patients with AF requiring oral anticoagulation. Population Health Research Institute.
- Principal Investigator. Randomized comparison of the clinical Outcome of single versus Multiple Arterial grafts. Weill Cornell Medicine ROMa. 2021 – 2023.
- Principal Investigator. PERIcardial SurGical AOrtic Valve ReplacemeNt Pivotal Trial A Multi-center, Non-randomized Trial to Determine the Safety and Effectiveness of the Model 400 Aortic Valve Bioprosthesis in Patients with Aortic Valve Disease. Medtronic. 2015 – 2027.
- Principal Investigator. Five-year outcome after use of CorMatrix extracellular matrix in Cardiac surgery. Investigator Initiated Trial.

Dr. Terrence Yao

- Principal Investigator. Anticoagulation for New-Onset Post-Operative Atrial Fibrillation after CABG. To evaluate the safety and effectiveness of adding oral anticoagulation (OAC) to background antiplatelet therapy. CTSM.
- Principal Investigator. A Phase 3, Multicenter, Open-Label, Single-Arm Study of PB2452 in Ticagrelor-Treated Patients with Uncontrolled Major or Life-Threatening Bleeding or Requiring Urgent Surgery or Invasive Procedure. Phase Bio.
- Principal Investigator. A phase 2, multi-centre, randomized, double-blind, to evaluate the efficacy and safety of botulinum toxin type A (AGN-151607) injections into the epicardial fat pads to prevent post-operative atrial fibrillation in patients undergoing open-chest cardiac surgery. Abvie. 2020 – 2023.
- Principal Investigator. Trifecta™ GT (Glide Technology) Post Market Clinical Follow-up (PMCF). Abbot. 2018 – 2023.

Vascular Surgery

Dr. Graham Roche-Nagle

- Collaborator. BEST-CLI Trial: Randomized, Multicenter, Controlled Trial to Compare Best Endovascular versus Best Surgical Therapy in Patients with Critical Limb Ischemia. National Heart, Lung, and Blood Institute (NHLBI), USA. 2016 – 2019.

Dr. Thomas Forbes

- National PI. Zenith Alpha Abdominal Endovascular Graft Post-Market Study. Cook Research.

Anesthesia

Dr. Keyvan Karkouti

- PI. Four-Factor Prothrombin Complex Concentrate Versus Frozen Plasma in Bleeding Adult Cardiac Surgical Patients: A multi-centre randomized controlled trial. CIHR 2021 – 24.
- Sponsor and Co-investigator. Prospective, multi-centre, randomized, parallel-control, superiority study comparing administration of clotting factor concentrates with a standard massive hemorrhage protocol in severely bleeding trauma patients. CIHR 2021 – 2024.
- Sponsor and Co-applicant. Prevention of persistent pain with lidocaine infusions in breast cancer surgery (PLAN): a multicenter randomized controlled trial. CIHR 2020 – 2024.

Cardiovascular Imaging / Interventional Radiology

Dr. Kate Hanneman

- Principal Investigator. Fabry cardiomyopathy: Identification of early myocardial subclinical tissue abnormalities using multiparametric MRI (FIESTA-MRI). CIHR 2021 – 2026.

Dr. Kong Teng Tan

- Principal Investigator. The R3 Vascular Drug-Eluting Bioresorbable Scaffold in Below the Knee Vessels Trial I (RESOLV I). R3 Vascular, Inc.
- Principal Site Investigator. IMPERIAL - A randomized trial coMParing the ELUVIA™ dRug-elutIng stent versus Zilver® PTX® stent for treatment of superficial femoral and/or proximal popliteal arteries. Boston Scientific Corporation.
- Principal Site Investigator. A Prospective, Multicenter, Single Blind, Randomized, Controlled Trial Comparing the Lutonix Drug Coated Balloon vs. Standard Balloon Angioplasty for Treatment of Below-the-Knee (BTK) Arteries (Lutonix BTK Trial). C.R. Bard.
- PI. Pilot Safety Study of Micronized SIS for Critical Limb Ischemia. Cook Biotech, Inc.
- Principal Site Investigator. The INPACT Global Clinical Study for the Treatment of Comprehensive Superficial Femoral and/or Popliteal Artery Lesions using Drug-Eluting Balloon. Medtronic Bakken Research Center.

Dr. Sebastian Mayfield

- Principal Site Investigator. PROSPECT multicenter trial for endovascular simulation. Collaboration with University of Ghent, Belgium.

APPENDIX F

PMCC Innovation Committee

Projects funded by the PMCC Innovation Committee, publications, patents awarded, and additional funding realized by PMCC Investigators.

A) Projects funded by the PMCC Innovation Committee (2012-2021)

Year	Principal Investigator	PMCC IC Project	Project Type	Award \$CAD
2012	Osten, Mark	TAVI: Aortic valve replacement	Device therapy	\$1,652,000
2012	Kovacs, Adrienne	Website to transition young congenital heart disease	Improved care	\$28,000
2012	Floras, John	Renal denervation procedures	Device therapy	\$344,000
2012	Lee, Doug	Smartphone application for heart failure	Invention	\$30,000
2012	Karkouti, Keyvan	Reducing blood transfusions in cardiac surgery by an algorithm-based personalized medicine approach to bleeding	Improved care	\$95,000
2013	Yau, Terry	Next generation stem cell therapy during bypass surgery	Stem cell discovery	\$89,993
2013	Tan, Kongteng	Image fusion of pre-procedural CTA with real-time fluroscopy to enhance EVAR repair	Novel imaging technique	\$53,926
2013	Murphy, Kieran	Radiation exposure reduction by vitamin treatment	Invention	\$54,403
2013	Paul, Narinder	Cardiovascular phantom for CT angiography	Invention	\$50,330
2013	Tan, Kongteng	Drug eluting balloons for refractory PVD	Improved care	\$54,276
2013	Weisel, Richard	Stem cell therapy for cardiac regeneration	Stem cell discovery	\$170,000
2013	Nanthakumar, Kumar	Personalized antiarrhythmic therapy using iPS cells in a novel arrhythmia in dish technique	Stem cell discovery	\$257,500
2013	Bhatia, Sacha	Educating physicians on appropriate use of echocardiography	Clinical trial	\$146,160
2013	Colella, Tracey	My cardiac recovery (MyCR): A clinical application for post cardiac surgery patients	Invention	\$120,420
2013	Nguyen, Elsie	Relaxation music to lower heart rate prior to cardiac CT	Improved care	\$21,300
2013	Tait, Gordon	Development of interactive online modules for learning 3D transesophageal echocardiography and the assessment of cardiac pathology with 3D and 2D transesophageal Echocardiography	Invention	\$201,414
2014	Rao, Vivek	Seville recovery unit: Improved blood conservation strategies in the CV OR	Invention	\$153,975

Year	Principal Investigator	PMCC IC Project	Project Type	Award \$CAD
2014	Paul, Narinder	Validation of a dynamic heart phantom: Stage 2 funding	Invention	\$62,300
2014	Crean, Andrew	Cardiovascular magnetic resonance compatible treadmill	Device therapy	\$0
2014	Chauhan, Vijay	FAST Mapping of Atrial Fibrillation	AI	\$19,273
2014	Nolan, Rob	Pilot study to improve heart failure patient engagement via e-counselling	Improved care	\$86,138
2014	Wintersperger, Bernd	Dual energy CT quantitation of myocardial fibrosis	Novel imaging technique	\$63,350
2014	Byrne, John	An investigation into the use of novel anti-diabetic drugs for the treatment of abdominal aortic aneurysm	Clinical trial	\$37,308
2014	Roche-Nagle, Graham	Prognostic value of perfusion angiography with indocyanine green fluorescence in patients with critical ischemia	Improved care	\$48,836
2014	Lok, Charmaine	PISCES Study	Clinical trial	\$186,232
2014	Fedorko, Ludwik	Effects of hyperbaric oxygen therapy on levels of circulating bone marrow derived endothelial progenitor cells in patients with ischemic heart disease	Improved care	\$68,843
2014	Strya, Rima	Validation of pre-operative risk assessment tool for delirium in vascular surgical patients	Improved care	\$53,224
2014	Tan, Kongteng	Foot perfusion in patients with critical limb ischemia	Improved care	\$5,360
2015	Billia, Phyllis	Novel therapies for hypertrophic cardiomyopathy with induced pluripotent stem cells	Stem cell discovery	\$200,000
2015	Ouzounian, Maral	Biomechanical and metabolic properties of proximal aortic aneurysms in patients with bicuspid aortic valves	Novel imaging technique	\$132,000
2015	Honjo, Osami	Fontan cannula project	invention	\$50,000
2016	Gollob, Michael	Genetics of sudden cardiac death	Genomics / proteomics	\$100,000
2016	Habal, Marlena	Nitric oxide in RV dysfunction	Improved care	\$25,000
2016	Hanneman, Kate	PET/MR in cardiac sarcoidosis	Novel imaging technique	\$65,450
2016	Karkouti, Keyvan	Hyperbaric oxygen for acute kidney injury after cardiac surgery	Improved care	\$76,400
2016	Domanski, Michael	Arterial stiffness and Alzheimer's	Novel imaging technique	\$89,108
2016	Horlick, Eric	Tricuspid and Mitral percutaneous valve replacement	Clinical trial	\$171,500
2016	Mak, Susanna	The BREATH Program: Breathlessness Revealed using Exercise to Assess the Hemodynamic response	Improved care	\$74,875

Year	Principal Investigator	PMCC IC Project	Project Type	Award \$CAD
2016	Lee, Doug	MONITOR HF study	Clinical trial	\$103,000
2016	Charla, Pradeepkumar	Use of Biphasic Cuirass Ventilation	Device therapy	\$76,858
2017	Spears, Danna	PET/MR in ARVC	Novel imaging technique	\$40,000
2017	Murphy, Kieran	Development of a dual sensor device that will be able to quantitate oxygenation as well as carotid pressures and assist in improving the quality of CPR	Invention	\$40,000
2017	Heggie, Jane	PMCC Risk Prediction tool for ACHD surgery	Improved care	\$149,640
2018	Lawler, Patrick	Molecular phenotyping of cardiogenic shock	Genomics / proteomics	\$102,840
2018	Dzavik, Vlad	TOSCA-6	Clinical trial	\$153,396
2018	Rubin, Barry	Healthcare provider burnout	Improved care	\$269,308
2018	Kuo, Kevin	TICATS study for iron overload cardiomyopathy	Clinical trial	\$80,878
2018	Thavendiranathan, Dinesh	Clonal hematopoiesis and cardiovascular disease in cancer survivors	Improved care	\$35,625
2018	Lawler, Patrick	Mapping conserved immunophenotypes in response to infectious and Non-infectious pro-inflammatory stimuli: Towards the development of a novel In vitro diagnostic test	Stem cell discovery	\$183,236
2019	Murphy, Kieran	Novel tissue biopsy transport media for DNA/RNA integrity	Invention	\$39,731
2019	Tan, Kongteng	Use of autologous peripheral blood mononuclear cells in the treatment of critical limb ischemia in renal failure diabetic and transplant patients	Improved care	\$32,498
2019	Howe, Kathryn	Novel therapeutic targets and potential biomarkers: Identifying extracellular vesicle-derived microRNA governing human abdominal aortic aneurysm progression	Genomics / proteomics	\$85,839
2019	Wang, Bo	AI for tissue characterization on cardiac imaging	AI	\$144,500
2019	Roche-Nagle, Graham	First in man endovascular imaging using a scanning fiber angioscope	Novel imaging technique	\$33,908
2019	Tan, Kongteng	Comparison of carbon dioxide flush to standard saline flushing in TEVAR and TAVI procedure to reduce cerebral ischemia	Novel imaging technique	\$60,000
2019	Moreno, Jacobo	Nurse-performed lung ultrasound versus chest radiography for detection of pneumothorax after mediastinal drainage removal post cardiac surgery	Novel imaging technique	\$52,000
2019	Thavendiranathan, Dinesh	Integrative diagnostic approaches for the prediction of cancer related therapy-related cardiac dysfunction in HER2+ breast cancer patients	Clinical trial	\$202,952
2019	McIntosh, Chris	AI automatic coronary artery interpretation	AI	\$125,706

Year	Principal Investigator	PMCC IC Project	Project Type	Award \$CAD
2020	Dzavik, Vlad	Semaglutide to reduce Myocardial injury in patients with COVID-19 (SEMPATICO) An exploratory randomized controlled clinical trial	COVID-19	\$175,000
2020	Lawler, Patrick	Prevention of Thromboembolic Complications in COVID-19 Patients (ATTACC)	COVID-19	\$250,000
2020	Lee, Doug	Analytic approaches to understanding COVID-19 infections and outcomes in the population	COVID-19	\$120,000
2020	Luk, Adrianna	Citywide cardiogenic shock initiative	Improved care	\$67,610
2020	Thavendiranathan, Dinesh	Cardiovascular disease and outcomes among patients with COVID-19 during hospital admission and post-discharge	COVID-19	\$250,000
2020	Thavendiranathan, Dinesh	HIMALAYAS (young cancer survivors)	Clinical trial	\$89,000
2020	Rao, Vivek	A decision analysis model to aid resource utilization during pandemics	COVID-19	\$128,125
2020	Chung, Jennifer	SPAReD (reducing distal dissections)	Clinical trial	\$74,836
2020	Horlick, Eric	CAPPRESS (PFO closure to reduce stroke risk in non-cardiac surgery)	Clinical trial	\$101,775
2020	Forbes, Thomas	Engineering tools for personalized thoracic endovascular aortic repair	Clinical trial	\$57,935
2021	Tan, Kongteng	A prospective, single-centre study investigating the clinical use and safety of the Jetstream atherectomy with drug coated balloon (Ranger) for the treatment of dysfunctional arterio-venous graft stenosis	Clinical trial	\$31,000
2021	Chow, Chung-Wai	Screening for presence of co-existing COPD in patients with acute exacerbation of CHF: determining its prevalence and impact on 30-day readmission rates	Improved care	\$65,870
2021	Alba, Carolina	Rapid digital platform for hemodynamic phenotyping of RV function	Improved care	\$29,700
2021	Ouzounian, Maral	Hemiarch vs extended arch in aortic dissection: HEADSTART	Improved care	\$57,500
2021	Billia, Phyllis	Clonal hematopoiesis drives fibrosis in patients with HCM	Genomics / proteomics	\$158,889
2021	Billia, Phyllis	Evaluation of inflammatory cytokines in advanced heart failure	Genomics / proteomics	\$48,333
2021	Luk, Adrianna	VANQUISH SHOCK	Improved care	\$55,609
Total funding awarded (\$CAD)				\$8,910,990

B) Additional funding obtained by primary investigators, from granting agencies, industry or venture capital, following completion of projects funded by the PMCC Innovation Committee (2012 -2021)

Principal Investigator	PMCC IC Project	Funder	Funding Obtained (\$CAD)
Floras, John	Renal denervation procedures	Heart and Stroke Foundation	\$70,000
Lee, Doug	Smartphone application for heart failure	CIHR Strategy for Patient-Oriented Research (\$1,800,000); TRCHR (\$100,000)	\$1,900,000
Karkouti, Keyvan	Reducing blood transfusions in cardiac surgery by an algorithm-based personalized medicine approach to bleeding	500K CIHR; 400K In-Kind industry support	\$900,000
Yau, Terry	Next generation stem cell therapy during bypass surgery	NIH, CIHR	\$5,000,000
Murphy, Kieran	Radiation exposure reduction by vitamin treatment	\$100K Mitacs; \$4M Venture Capital funding	\$4,110,000
Tan, Kong Teng	Drug eluting balloon for refractory PVD	\$65K Boston Scientific; 100K CR Bard; \$60K Medtronic; \$160K BIOTRONIK; \$50K BIOTRONIK Unrestricted grant	\$435,000
Weisel, Richard	Stem cell therapy for cardiac regeneration	\$599,685 Accelerating Clinical Translation Agreement; \$2,470,000 Ontario Institute for Regenerative Medicine; \$204,866 Medicine by Design / Canada First Research Excellence Fund. Clinical Translation/Commercialization Fund Award); \$7,032,431 BlueRock Therapeutics.	\$10,306,982
Bhatia, Sacha	Educating physicians on appropriate use of echocardiography	Funder not reported	\$614,557
Tait, Gordon	Development of interactive online modules for learning 3D transesophageal echocardiography and the assessment of cardiac pathology with 3D and 2D TEE	\$10,574 Goldman Sachs; \$4K Jackman Foundation; \$9K crowdfunding	\$23,574
Chauhan, Vijay	FAST Mapping of Atrial Fibrillation	MaRS Innovation	\$250,000
Lok, Charmaine	PISCES Study	\$281,405 HSFC; \$1,076,284 Australian Government National Health and Medical Research (NHMR)	\$1,357,689
Strya, Rima	Validation of pre-operative risk assessment tool for delirium in vascular surgical patients	Funder not reported	\$168,960
Billia, Phyllis	Novel therapies for hypertrophic cardiomyopathy with induced pluripotent stem cells	\$1M TRF; \$2.5M CIHR and Natural Sciences and Engineering Research Council of Canada	\$3,500,000

Principal Investigator	PMCC IC Project	Funder	Funding Obtained (\$CAD)
Ouzounian, Maral	Biomechanical and metabolic properties of proximal aortic aneurysms in patients with bicuspid aortic valves	\$108,000 Thoracic Surgery Foundation	\$108,000
Habal, Marlana	Nitric oxide in RV dysfunction	Mallinckrodt	\$40,000
Hanneman, Kate	PET/MR is cardiac sarcoidosis	JDMI Academic Incentive Fund	\$52,000
Horlick, Eric	Tricuspid and Mitral percutaneous valve replacement	Edward Life Sciences (\$272,430 SPACER Trial, \$50,092 RELIEF Trial)	\$322,433
Mak, Susanna	The BREATH Program: Breathlessness Revealed using Exercise to Assess the Hemodynamic response	\$3M Ontario Research Fund; \$266,806, HSFC	\$3,366,806
Murphy, Kieran	Development of a dual sensor device that will be able to quantitate oxygenation as well as carotid pressures and assist in improving the quality of CPR	Mitacs	\$55,000
Thavendiranathan, Dinesh	Clonal hematopoiesis and cardio-vascular disease in cancer survivors	Princess Margaret Hospital Collaborative Grant	\$300,000
Howe, Kathryn	Novel therapeutic targets and potential biomarkers: Identifying extracellular vesicle-derived microRNA governing human AAA progression	Wylie Scholar award from Vascular Cures	\$188,000
Moreno, Jacobo	Nurse-performed lung ultrasound versus CXR for detection of pneumo-thorax after mediastinal drainage removal post cardiac surgery	Dr. Earl Wynands Research Award	\$10,000
Thavendiranathan, Dinesh	Integrative diagnostic approaches for the prediction of cancer related therapy-related cardiac dysfunction in HER2+ breast cancer patients	\$50K HSFO; \$830K CIHR	\$880,000
Dzavik, Vlad	Semaglutide to reduce Myocardial injury in patients with COVID-19 (SEMPATICO) An exploratory randomized controlled clinical trial	CIHR, Ted Rogers	\$6,250,000
Lawler, Patrick	Prevention of Thromboembolic Complications in COVID-19 Patients (ATTACC)	CIHR, NIH, LifeArc, Government of Ontario	\$6,600,000
Lee, Doug	Analytic approaches to understanding COVID-19 infections and outcomes	CIHR	\$400,000
Luk, Adrianna	Citywide cardiogenic shock initiative	Not reported	\$15,000

Principal Investigator	PMCC IC Project	Funder	Funding Obtained (\$CAD)
Thavendiranathan, Dinesh	HIMALAYAS (young cancer survivors)	\$80K CIHR; \$140K AFP; \$2.26M industry RCT	2,480,000
Total Funding Leveraged (\$ CAD)			\$49,704,001

Overall return on investments made by the PMCC Innovation Committee:

Invested = \$8,910,990

Return = \$49,704,001

Return on Investment = 5.6 to 1

C) Publications arising from PMCC Innovation Committee funded projects (2012 -2021)

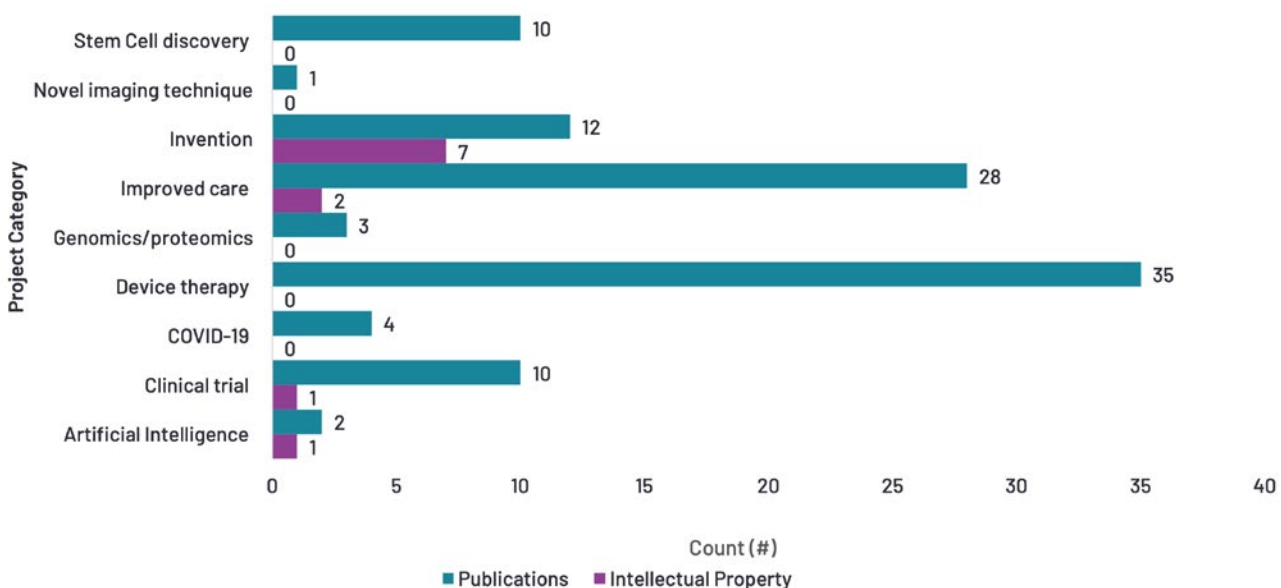
Principal Investigator	PMCC IC Project	Publications
Osten, Mark	TAVI: Aortic valve replacement	32
Kovacs, Adrienne	Website to transition young congenital heart disease	1
Floras, John	Renal denervation procedures	2
Lee, Doug	Smartphone application for heart failure	4
Karkouti, Keyvan	Reducing blood transfusions in cardiac surgery by an algorithm-based personalized medicine approach to bleeding	4
Yau, Terry	Next generation stem cell therapy during bypass surgery	2
Tan, Kong Teng	Image fusion of preprocedural CTA with real-time fluoroscopy to enhance EVAR repair	1
Murphy, Kieran	Radiation exposure reduction by vitamin treatment	5
Tan, Kong Teng	Drug eluting balloons for refractory PVD	4
Weisel, Richard	Stem cell therapy for cardiac regeneration	5
Nanthakumar, Kumar	Personalized antiarrhythmic therapy using iPS cells in a novel arrhythmia in dish technique	2

Principal Investigator	PMCC IC Project	Publications
Bhatia, Sacha	Educating physicians on appropriate use of echocardiography	8
Nguyen, Elsie	Relaxation music to lower heart rate prior to cardiac CT	1
Paul, Narinder	Validation of a dynamic heart phantom: Stage 2 funding	3
Chauhan, Vijay	FAST Mapping of Atrial Fibrillation	1
Nolan, Rob	Pilot study to improve heart failure patient engagement via e-counselling	1
Byrne, John	An investigation into the use of novel anti-diabetic drugs for the treatment of abdominal aortic aneurysm	1
Roche-Nagle, Graham	Prognostic value of perfusion angiography with indocyanine green fluorescence in patients with critical ischemia	1
Strya, Rima	Validation of pre-operative risk assessment tool for delirium in vascular surgical patients	2
Tan, Kong Teng	Foot perfusion in patients with critical limb ischemia	1
Billia, Phyllis	Novel therapies for hypertrophic cardiomyopathy with induced pluripotent stem cells	1
Mak, Susanna	The BREATH Program: Breathlessness Revealed using Exercise to Assess the Hemodynamic response	7
Lee, Doug	MONITOR HF study	1
Charla, Pradeepkumar	Use of Biphasic Cuirass Ventilation	1
Heggie, Jane	PMCC Risk Prediction tool for ACHD surgery	1
Lawler, Patrick	Molecular phenotyping of cardiogenic shock	1
Rubin, Barry	Healthcare provider burnout	3
Howe, Kathryn	Novel therapeutic targets and potential biomarkers: Identifying extracellular vesicle-derived microRNA governing human abdominal aortic aneurysm progression	2
Wang, Bo	AI for tissue characterization on cardiac imaging	1
Lawler, Patrick	Prevention of Thromboembolic Complications in COVID-19 Patients (ATTACC)	2
Lee, Doug	Analytic approaches to understanding COVID-19 infections and outcomes in the population	2
Luk, Adrianna	Citywide cardiogenic shock initiative	2
Total Publications		105

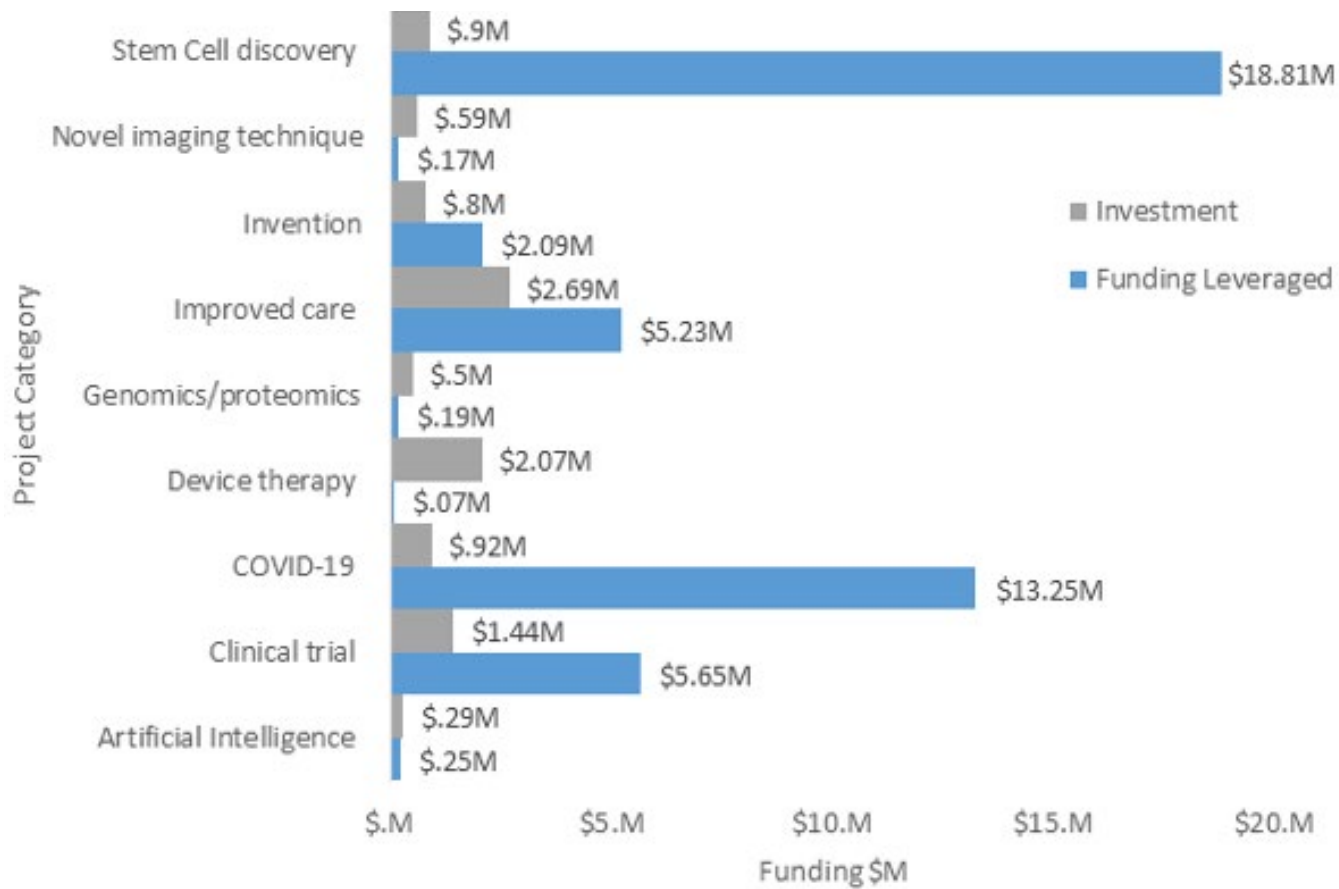
D) Intellectual Property arising from PMCC Innovation Committee funded projects (2012 -2021)

Principal Investigator	PMCC IC Project	IP Type	IP #
Kovacs, Adrienne	Website to transition young congenital heart disease	Website: for transition of youth to ACHD http://www.iheartchange.org	1
Lee, Doug	Smartphone application for heart failure	IP being discussed with HIS: Software and IT platform for heart failure detection	1
Murphy, Kieran	Radiation exposure reduction by vitamin treatment	DNA halo: 3 issued patents, 1 pending Product proven to protect Mitochondrial DNA	4
Tait, Gordon	Development of interactive online modules for learning 3D transesophageal echocardiography and the assessment of cardiac pathology with 3D and 2D transesophageal Echocardiography	Websites: training module websites for 3D TEE and Assessment of Cardiac Valves	1
Chauhan, Vijay	FAST Mapping of Atrial Fibrillation	AI algorithm for Atrial Fibrillation	1
Nolan, Rob	Pilot study to improve heart failure patient engagement via e-counselling	e-counselling platform	1
Murphy, Kieran	Novel tissue biopsy transport media for DNA / RNA integrity	Patent filed; Immunohistochemistry stains	1
Thavendiranathan, Dinesh	Integrative diagnostic approaches for the prediction of cancer related therapy-related cardiac dysfunction in HER2+ breast cancer patients	Patent filed; Novel bio marker chip with micro-RNA to predict Heart risk in cancer patients getting chemotherapy	1
Total Intellectual Property			11

E) Breakdown of publications and intellectual property arising from projects supported by the PMCC Innovation Committee, by project type (2012 -2021)



F) Investment in PMCC projects and additional funding obtained by PIs, by project type (2012 -2021)



APPENDIX G

National Cardiovascular Data Registry, Atrial Fibrillation Ablation report for the PMCC (September 2022)



AFib Ablation Registry™
 Ending Timeframe : 2022Q2
 Executive Summary Metrics
 eReports Dashboard

Data Submission Status - Base		Catheter Ablation Strategies	R4Q	Intra or Post Procedure Events	R4Q
2022Q3		Complex fractionated atrial electrogram	3	Cardiac arrest	0
2022Q2	Aug 29, 2022 10:36 AM	Convergent procedure	0	Myocardial infarction	0
2022Q1	May 27, 2022 01:19 PM	Cryoablation	94	Air embolism	0
2021Q4	Feb 25, 2022 02:41 PM	Empiric LA linear lesions	8	Bradycardia adverse events	0
2021Q3	Nov 26, 2021 05:23 PM	Focal ablation	3	Bradycardia requiring permanent pacemaker	0
2021Q2	Aug 28, 2021 01:15 PM	Ganglion plexus ablation	0	Cardiac thromboembolic event	0
		Pulmonary vein isolation	124	Heart failure	0
		Rotor based mapping	0	Heart valve damage	0
		Segmental PV ablation	2	Left atrial thrombus	0
		Wide area circumferential ablation	1	Pericardial effusion resulting in cardiac tamponade	0
				Pericardial effusion requiring intervention	0
				Cardiac surgery	0
				Anaphylaxis	0

Participant : 410024 - Peter Munk Cardiac Centre Category : All



AFib Ablation Registry™

Ending Timeframe : 2022Q2
Executive Summary Metrics
eReports Dashboard

Participant : 410024 - Peter Munk Cardiac Centre

Category : All

		Intra or Post-procedure Events	R4Q
		Hemorrhage (non access site)	0
		Sepsis	0
		Acute renal failure	0
		Genitourinary bleeding	0
		Gastrointestinal hypomotility	0
		Phrenic nerve damage	0
		Peripheral nerve injury	0
		Stroke	0
		Transient ischemic attack (TIA)	0
		Access site bleeding requiring transfusion	0
		Arterial thrombosis	0
		Arteriovenous fistula requiring intervention	0
		Deep vein thrombosis	0



AFib Ablation Registry™

Ending Timeframe : 2022Q2
Executive Summary Metrics
eReports Dashboard

Participant : 410024 - Peter Munk Cardiac Centre Category : All

		Intra or Post Procedure Events	R4Q
		Hemotoma at access site	0
		Pseudoaneurysm requiring intervention	0
		Vascular injury requiring surgical intervention	0
		Hemothorax requiring drainage	
		Pneumothorax requiring drainage	
		Respiratory failure	0
		Pleural effusion	0
		Pneumonia	0
		Pulmonary embolism	0
		Pulmonary vein damage/dissection	0
		Deceased at discharge	1

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Executive Summary - Process Metrics

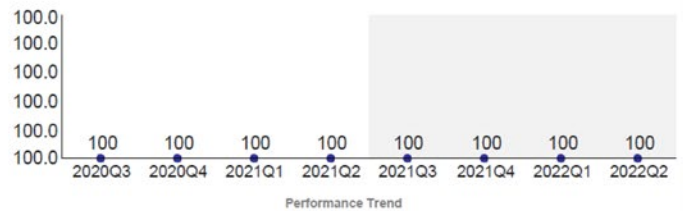
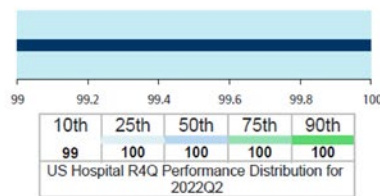
1 - Proportion of patients undergoing an atrial fibrillation procedure with Class I or Class II guideline based indications

97.9%
My R4Q Performance
(190/194)



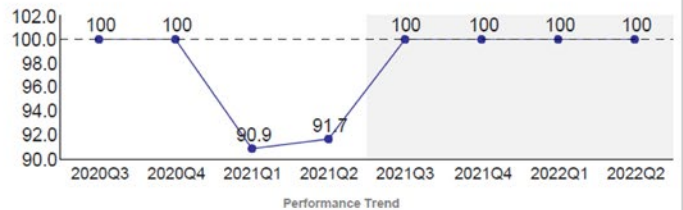
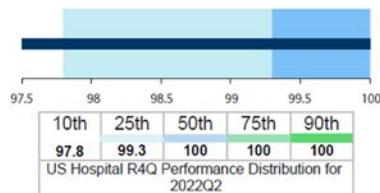
2 - Proportion of patients undergoing an atrial fibrillation procedure screened for stroke risk using CHA₂DS₂-VASc score

100%
My R4Q Performance
(194/194)



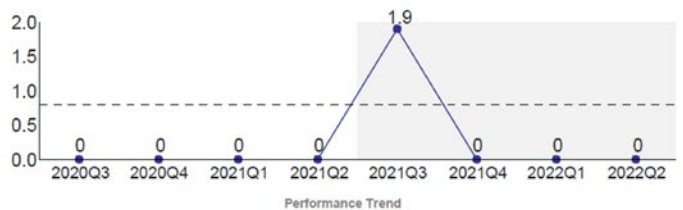
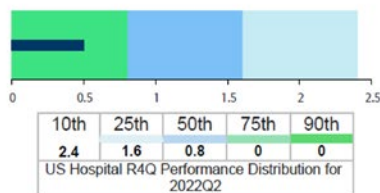
3 - Proportion of patients undergoing an atrial fibrillation procedure with CHA₂DS₂-VASc score ≥ 2 treated with warfarin or DOAC

100%
My R4Q Performance
(97/97)



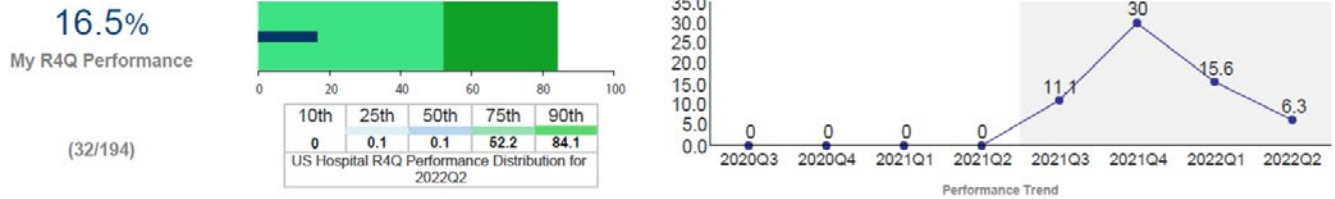
4 - Proportion of patients undergoing an atrial fibrillation procedure who experience death or a major adverse event intra or post-procedure and prior to discharge

0.5%
My R4Q Performance
(1/194)

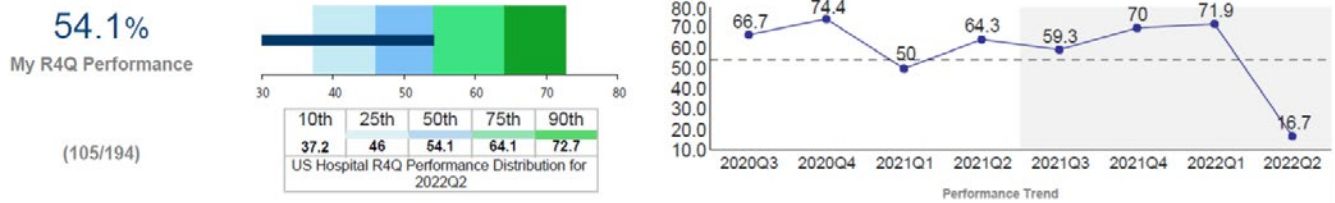


Informational - Process Metrics

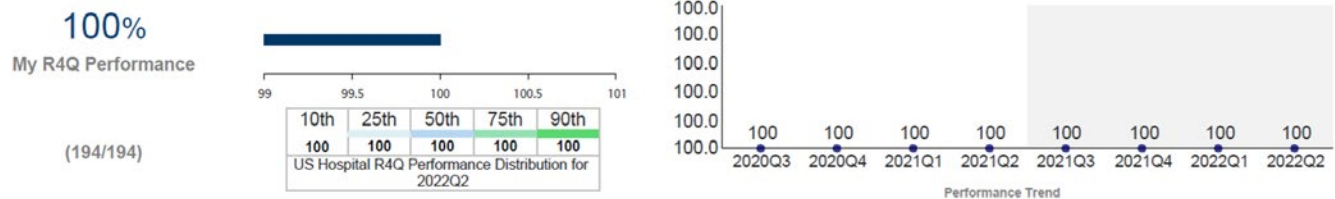
5 - Proportion of patients with a completed Atrial Fibrillation Effect on QualiTy-of-life (AFEQT) Questionnaire



6 - Proportion of patients with a prior attempted atrial fibrillation termination using an ablation procedure



7 - Proportion of procedures where intraprocedure anticoagulation therapy was provided



8 - Proportion of patients with a documented discharge atrial rhythm

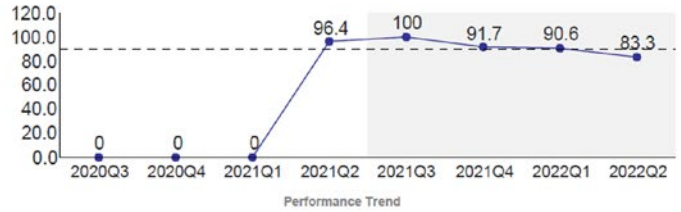
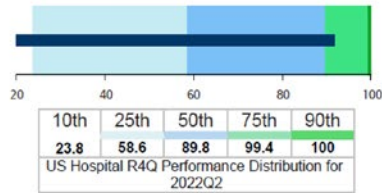


16 - Proportion of procedures with a documented radiation dose of cumulative air kerma and/or cumulative dose area product

91.8%

My R4Q Performance

(178/194)



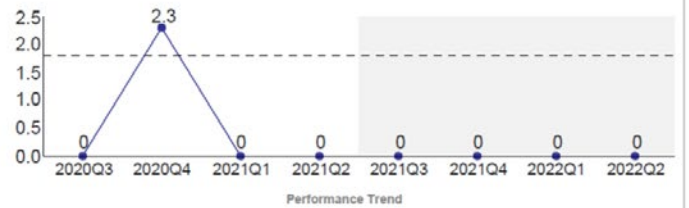
Informational - Outcome Metrics

9 - Proportion of patients undergoing atrial fibrillation ablation procedure who experience any adverse event intra or post procedure and prior to discharge

0%

My R4Q Performance

(0/194)

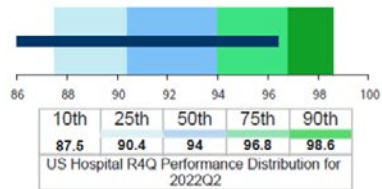


20 - Proportion of patients discharged in sinus rhythm

96.4%

My R4Q Performance

(187/194)

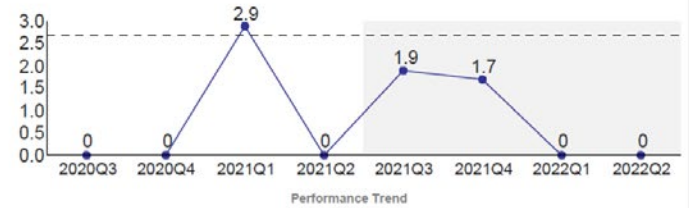


22 - Proportion of patients discharged in atrial paced rhythm

1%

My R4Q Performance

(2/194)

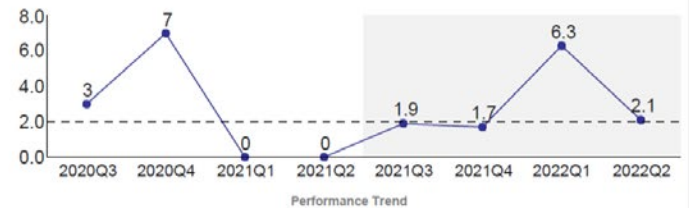


24 - Proportion of patients discharged in a rhythm other than sinus or atrial paced

2.6%

My R4Q Performance

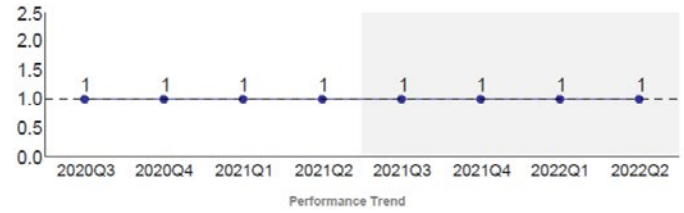
(5/194)



Informational - Utilization Metrics

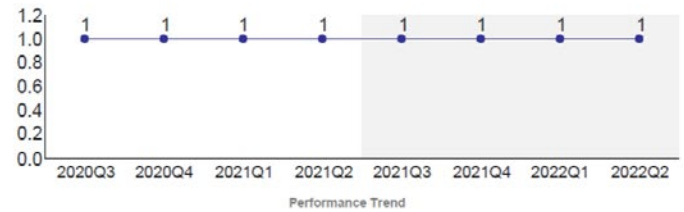
10 - Mean Length of Stay (days) for all patients reported from your hospital

1
My R4Q Performance



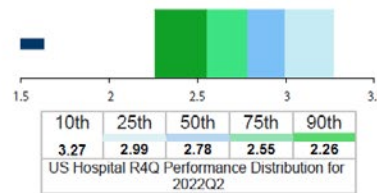
11 - Median Length of Stay (days) for all patients reported from your hospital

1
My R4Q Performance



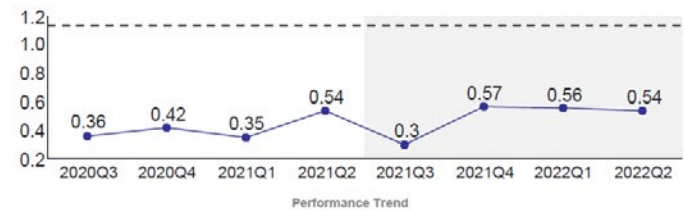
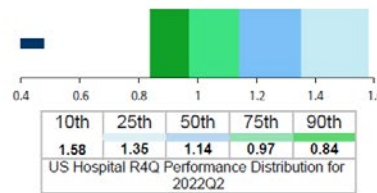
12 - Patients average CHA₂DS₂-VAsC score

1.63
My R4Q Performance



14 - Patients average HAS-BLED score

0.48
My R4Q Performance



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APPENDIX H

Summary of Current PMCC – Thunder Bay Health Sciences Center Joint Projects

Implement a new cardiovascular program governance at TBRHSC

- The Cardiovascular program does not include the ICU. Who will manage post op cardiac and vascular patients in the ICU?

Fundraising

- Desire to have PMCC help with fundraising activities at TBRHSC.
- Request to redirect some Phase IV PMCC funds to TBRHSC.

Relationship between TBRHSC and UHN

- Jean Bartkowiak, TBRHSC CEO noted that TBRHSC sends patients to many different hospitals for sub-specialty care, and wondered if UHN could become a preferred partner, expanding the “one program on two sites model” for cardiovascular care to other programs.
- Noted this was a discussion that should take place at the CEO level.

Remote patient monitoring

- Roll out of Medly for heart failure patients supported by the TBRHSC Board of Directors.
- MOU being developed between CorHealth and UHN to inform deployment of Medly.
- TBRHSC has recruited a basic scientist with an interest in remote patient monitoring.
- Potential first site in Thunder Bay for Medly deployment via the hospital or through its dedicated cardiology clinic. There is also a clinic close to TBRHSC that manages > 500 patients from the Indigenous community with heart failure that is interested in Medly.

Joint research projects

- TBRHSC already participating in INVESTED and TAILOR-PCI.
- Opportunity to participate in other clinical trials.
- Conference call between TBRHSC VP Research Dr. Abraham Rudnick, Jay Udell and Heather Ross to identify potential collaborations with the PMCC Clinical Trials Unit.

Quality assessment

- Outcomes for vascular surgery patients at TBRHSC, PMCC, in Canada and across North America, reported through the Vascular Quality Initiative presented to the TBRHSC Board of Directors.
- Plan to explore participation of TB Cardiology in the National Cardiovascular Data Registry (pending funding support from the MOHLTC).

Human Resources

- Two vascular surgeons recruited to TBRHSC, third to go on staff July 2018.
- Full complement of cardiac perfusionists for TBRHSC being trained at Michener.
- Plan to recruit 3 cardiac surgeons once relevant infrastructure is near completion.

Political engagement. Strong support for this initiative from:

- Hon Bill Mauro. Mayor, Thunder Bay.
- Dr. Robert Bell, Former Deputy Minister of Health, Ontario.

APPENDIX I

PMCC Phase IV Plan (March 2017)

The strategic goals of the Peter Munk Cardiac Centre, put forward in the PMCC Phase IV Plan that was supported by a \$100,000,000 commitment from the Peter and Melanie Munk Charitable Foundation, were to:

1. Develop an integrated digital cardiovascular health platform that will enable the use of predictive analytics through artificial intelligence and machine learning.
2. Expand our ability to generate new knowledge through clinical trials, real world evidence and first-in-human studies.
3. Grow the precision cardiovascular medicine program.
4. Increase support for innovation, quality assurance and commercialization of intellectual property.

Executive Summary

The executive summary of the PMCC Phase IV Plan appears below.

The Peter Munk Cardiac Centre (PMCC) aims to be a pioneer in integrative, digitally enabled strategies for the prevention, treatment, and support of those suffering from cardiovascular disease. We will accomplish this goal by creating a globally unique ecosystem that attracts the best talent from diverse fields, including cardiovascular imaging, medicine and surgery, computer science, engineering, and healthcare economics. This ecosystem will promote excellence in patient care and will drive high impact basic science and education research.

The PMCC was established in 1993. Over the last 24 years, unwavering and continuous support from the Peter and Melanie Munk Charitable Foundation has enabled recruitment of world leading academic clinicians and investigators, upgrades of critical infrastructure, an unremitting focus on innovation, multiple first-in-human therapies, and significant expansion of the PMCC brand. This proposal describes our vision for the evolution of the PMCC over the next ten years.

We will develop a Digital Cardiovascular Health Platform (DCHP, Specific Aim 1) that will integrate all PMCC patient information, including clinical notes, blood tests, pathology results, imaging studies and genetic information into a single environment, while simultaneously maintaining data security and privacy. Mobile health technologies and real-time, secure data streaming will be integrated into the DCHP so that we can monitor and care for the patients that we serve, both inside and outside of UHN. The DCHP will enable real-time data processing and decision support through high performance computing and machine learning platforms that bring artificial intelligence (AI) methods to life. The PMCC AI Team, in collaboration with the Vector Institute in MaRS will develop predictive models and decision support that will tailor the care of patients to their unique clinical and genomic traits, thereby improving the efficiency of healthcare delivery, clinical outcomes and patient satisfaction. Partnerships with Google, Apple and athenahealth are being developed, which along with implementation of Blockchain technologies in collaboration with SecureKey will allow the PMCC to evolve into a secure, digitally-enabled and highly efficient clinical and research enterprise. Specific Aim 2 will expand our ability to generate new knowledge through clinical trials, real world evidence and first-in-human studies. We will augment our capacity to coordinate and lead clinical trials by engaging dedicated trial coordinators, epidemiologists, and statisticians, developing a data management centre and core lab capabilities for statistical analysis and medical imaging, and consolidating all clinical trials activity into one 5,000 square foot location.

Full-service clinical research organizations (the Applied Health Research Centre at the University of Toronto and SOCAR in Nyon, Switzerland) will support the design, management and conduct of clinical trials, registries and observational studies. We will fund research fellows with an interest in trials, which will focus on our areas of strength, including heart failure, cardiomyopathy, adult congenital heart disease, complex aortic disease, cardiovascular imaging, and novel device evaluation, with a new and growing focus on the primary prevention of heart disease. Our leadership of the Worldwide Network for Innovation in Clinical Research, which includes 10 clinical trial hubs on five continents, will enhance our ability to develop and coordinate clinical trials. Embedding health technology assessment into clinical trials will allow us to analyze the cost effectiveness, cost utility, net benefit, and budget impact of these trials, and to demonstrate value for money and return on investment for the healthcare system and society. The DCHP will allow us to analyze real world evidence from data that originates from heterogeneous sets of patients in real life practice settings in the PMCC and will align healthcare decision making more closely with the imaging, genomic and socioeconomic characteristics of individual patients. The PMCC's clinical care and research platforms are consistent with the Institute of Medicine's Learning Health System framework, which focuses on continuous knowledge development, application, and outcome improvement.

The expanded precision cardiovascular medicine program (Specific Aim 3) will use genetic information to personalize healthcare decisions, and to inform genetic counselling for patients and at-risk family members, with the goal of enhancing patient care and preventing disease development in genetically at-risk individuals. We will build a PMCC Genomics Team that includes a critical mass of clinician-scientists with expertise in genomic medicine, researchers with deep proficiency in biobanking and bioinformatics, and genetic counsellors. This team will focus on patients with inherited arrhythmias, hypertrophic cardiomyopathy, aortopathies and valvular heart disease, and will study the genetic make-up of these patients and their families. This approach will allow members of the PMCC Genomics Team to gain insight into the genetic factors that predispose to cardiovascular disease, elucidate disease pathways based on this knowledge and develop novel treatment strategies that will counteract individual patient's genetic susceptibility to disease. We will define the future of cardiovascular clinical practice by teaching our fellows how to work with this new information and these new approaches.

We will create a world-class ecosystem for medical innovation (Specific Aim 4). In collaboration with UHNs TECHNA Institute, which employs a suite of approaches and business models, we will support productization of both investigator and industry-initiated health technologies. This approach will accelerate the translation and commercialization of intellectual property developed in the PMCC and will lead to new revenue streams that will decrease our dependency on government funding.

To enable quality assurance, all elements of the PMCC will contribute to international quality assessment databases. Participation in these databases will make it possible to compare patient outcomes at the PMCC with hundreds of other cardiovascular care centres across North America and allow us to identify opportunities for improvement. This will ensure that the PMCC is at the forefront of patient care and will increase the efficiency of the care that we provide. The DCHP will enable automated data entry into international quality databases.

All elements of the Phase IV proposal have been reviewed and endorsed by UHNs Executive Vice Presidents for clinical operations, science and research, medical affairs and quality, technology and innovation, education, patient experience and human resources. This approach will ensure the seamless integration and implementation of the progressive initiatives described in Specific Aims 1 – 4 of this proposal. These Specific Aims are highly consistent with UHNs purpose, values and principles, and align closely with UHNs strategic objectives. In addition, these initiatives will positively impact patients that have cardiovascular comorbidity in other Programs at UHN and the population outside of the hospital that we serve. This longitudinal coordination of cardiovascular disease management will help realize the integrated healthcare system that we envision and will bring true value for the support from the Peter and Melanie Munk Charitable Foundation on a provincial and national scale.

APPENDIX J

PMCC Current and Planned Activities

Clinical, infrastructure, research, operations, education, quality, recruitment, fundraising and staff engagement

LEGEND:

A – Completed/Operational

B – In progress

C – Planned

D – Area for potential collaboration with Thunder Bay Regional Health Sciences Centre

Clinical Initiatives

1. Fast-track program for early extubation after cardiac or vascular surgery. **A**
2. Implement a Heart Team approach for decision-making for patients with coronary artery, valvular or adult congenital heart disease. **A, D**
3. Integrate physical and mental health in the PMCC. **B**
4. Deploy the Medly platform for remote patient management* at multiple locations in Ontario for remote management of patients with heart failure. **A, D**
5. Develop PMCC anticoagulation standards. **B**
6. Develop a strategic human resources and infrastructure plan. **B**
7. Standardize discharge planning and follow up processes. **B**
8. Implement integrated care to enable improved transitions of care from in-patient to out-patient across all areas of the PMCC, with a focus on same day discharge for TAVI, MitraClip, Atrial Fibrillation Ablation (cryo), ASP / PFO closure and percutaneous pulmonary valve replacement. **B**
9. Expand the rehabilitation and prevention programs for cardiac, stroke and vascular disease across PMCC. **B**

Infrastructure

1. Renovate and upgrade the imaging equipment in the cath labs we use to manage patients that require structural heart disease or electrophysiology procedures (cath labs 4, 5 and 6), and expand the cath lab recovery area from 12 to 26 beds. **A**
2. Renovate and upgrade the imaging equipment in cath labs 1, 2 and 3, where we manage patients with coronary artery disease (funding secured – RFP closed January 6, 2023). **B**
3. Renovate the 13-bed Coronary Intensive Care Unit, with 2 new procedure rooms (planning grant secured from UHN). **B**
4. Renovate the 24-bed Coronary Intensive Care Unit (CVICU), and expand the CVICU into the 7 beds immediately west of the CVICU (planning grant secured from UHN). **B**
5. Build a new 10 room out-patient Cardiology Clinic at Toronto Western Hospital. **A**
6. Upgrade imaging equipment and renovate the multi-purpose OR (MPOR, for advanced EVAR and TAVI). **A**
7. Establish a real time linkage of all critical care monitors in the PMCC to the Digital Cardiovascular Health Platform (DCHP). **A**

*Over 1,000 patients with heart failure currently being remotely monitored.

8. Co-localize the PMCC Clinical Trials and Translation Unit, PMCC AI Team, PMCC Digital Cardiovascular Health Platform Team and Ted Rogers Computational Unit in one contiguous space (65 desks, collaboration space, 2 conference rooms). **A**
9. Install the EggNest Radiation Protection System in the cath lab, vascular interventional radiology suites and the multi-purpose OR. **A**
10. Create a dedicated 3,000 square foot space for Indigenous Healing Practices with a 700 square foot Gitigan – a healing space to grow Indigenous medicines and an educational garden where community engagement and teaching can take place (planning grant secured from UHN and supported by the PMCC and TRCHR). **C**

Research

1. Recruit a PMCC AI Team Lead (Bo Wang) and implement weekly PMCC AI Team meetings (the PMCC AI Team is a core component of the Phase IV Plan). **A**
2. Create a program-wide PMCC CV Biobank. **A**
3. Move the Ted Rogers Computation Program from Sick Kids to TGH. **A**
4. Deploy the first 3 versions (minimal viable product, certified stable and expansion) of the Digital Cardiovascular Health Platform (DCHP) infrastructure. **A**
5. Complete the integration of 60 PMCC data sources into the DCHP. **A**
6. Develop a new software developer job classifications at UHN, A and recruit software engineers required to fully staff the DCHP. **B**
7. Prospectively measure clinician burnout and distress across the PMCC. **A**
8. Partner with the UHN Human Factors group and the UHN People and Culture program to develop interventions that will decrease clinician burnout in the PMCC. **B**
9. Hire a business manager for the PMCC Clinical Trials and Translation Unit (KP Singh). **A**
10. Hire a manager for the Digital Cardiovascular Health Platform (Krista Pace). **A**
11. Hire a lead for PMCC special research projects (MaryBeth Carpenter). **A**
12. Screen patients scheduled for CV procedures for mental health disorders, and integrate all data into the DCHP, in partnership with Kings College, London (UK). **B**
13. Develop a PMCC core imaging lab for clinical trials. **B**
14. Develop a clinical research organization (CRO) that can house and analyze data from large, multinational clinical trials. **B**

Operations

1. Hire a manager for PMCC special clinical projects (Ahlexxi Jelen). **A**
2. Hire a procurement manager for the PMCC (Alana Christie). **A**
3. Create a digital nursing record for the CICU and CVICU (Epic implemented). **A**
4. Identify appropriate funding for critical care beds in the Coronary Intensive Care Unit, and for VA – ECMO, Impella, open and endovascular TAA repair, TAVI and MitraClip cases. **B**
5. Develop a PMCC strategic plan to address PMCC ICU and ward capacity. **B**
6. Implement NP-run rapid access and follow up clinics. **A, B**
7. Introduce new cardiac QBPs that include Patient Reported Outcome Measures and Patient Reported Experience Measures (PROMS / PREMS). **B**

Education

1. Establish unique interdisciplinary fellowships e.g., advanced aortic surgery (Cardiac Surgery, Vascular Surgery, Medical Imaging), advanced coronary interventions (Minimally Invasive Cardiac Surgery, Interventional Cardiology), Valvular heart disease (Interventional Cardiology, Cardiac Surgery) that emphasize the PMCC approach to inter-disciplinary care. **A** In the PMCC, training programs are based on anatomy rather than physician specialty, so cross-disciplinary training programs have been developed to deliver this education. For example, we will train aortic specialists, rather than vascular or cardiac surgeons or interventional cardiologists to manage complex aortic disease. This approach will differentiate the PMCC from other training Centres, and will attract top international trainees.
2. Purchase and install a simulation unit for use across the PMCC. **A** Increase utilization of simulation in the PMCC and leverage the training resources that are available at the Michener. **B** Implement simulation for interdisciplinary teams, modeled on the TGH ER. **B**
3. Develop a multilevel, multidisciplinary PMCC Academy model that supports teaching from the undergraduate to the continuing medical education level, with central resources to coordinate applications from international Fellows. Incorporate nursing educators (Advance Practice Nurse Educators) into the PMCC Academy model to promote a shared educator role; this approach would differentiate the PMCC as a Centre that supports a true inter-professional, collaborative educational model. **C**
4. Provide Indigenous Cultural Competency Training* across the PMCC. **C**
5. Identify funding for physician extenders. Make rotations attractive for residents and fellows by decreasing the amount of service work that trainees are asked to do. **C**
6. Support Collaborative Academic Practice (CAP) fellowships to leads practice, research and education across the health professions, and create a fund to support continuing medical education for nurses and allied health professionals in the PMCC. Highlight existing funding for nursing preceptor support (UHN preceptorship workshops through the CAP) throughout the PMCC. **C**
7. Identify funding to support additional nurse educators and preceptors. **C**

Quality

1. Identify an overall Quality Lead for the PMCC (Carolina Alba) and establish a PMCC Quality Committee that reports quarterly to the PMCC Executive Committee. **A**
2. Identify a Quality Lead for each Division in the PMCC. These PMCC Quality Committee members include Dr. Andrew Ha (Atrial Fibrillation Ablation), Dr. Cameron Gilbert (Electrophysiology Devices), Dr. Alan Barolet (Cath PCI), Drs. Maral Ouzounian and Eric Horlick (SVS/ACC TVT – transcatheter valve replacement and repair), Dr. Phyllis Billia (International Society for Heart and Lung Transplantation, ISHLT), Dr. Vivek Rao (Intermacs – mechanical circulatory support device to treat advanced heart failure) and Dr. Graham Roche-Nagle (Vascular Quality Initiative). **A**
3. Hire an operational lead for all QA databases that the PMCC participates in (Kate Westcott). **A**
4. Every element of the PMCC participates in international quality assessment programs, posts results on the UHN website, and publishes results in peer-reviewed journals. **A, B**
5. Begin entering data in the National Cardiovascular Data Registry (NCDR) A Fib Ablation, EP Devices, Cath PCI and SVS/ACC TVT Registries, **A** and the NCDR Chest Pain – MI and IMPACT (ACHD procedures) Registries. **B**
6. Implement NCDR at Thunder Bay Regional Health Sciences Centre, if supported by the MOH. **C**
7. Reduce CLI, VAP and pressure injury rates in our CICU and CVICU (renewal of focus). **B, D**

*<https://ofifc.org/training-learning/indigenous-cultural-competency-training-icct/>

PMCC recruitment over the last 5 years

Machine Learning

1. Bo Wang, PhD. Computer Science.
Role: Lead, PMCC AI Team.
2. Chris McIntosh, PhD. Computer Science.
Focus: Integrating use of AI into clinical practice.
3. Senthujan Senkaiahliyan, MHSc (Healthcare administration), M.Mgt (AI).
Focus: PMCC AI Project Manager.

Clinical / Education / Research

1. Carolina Alba, MD PhD. Cardiology.
Focus: Predictive modeling and advanced heart failure therapies.
2. Rafa Alonso, MD. Cardiology.
Focus: ACHD.
Lead: ACHD program.
3. Arnon Adler, MD. Cardiology.
Focus: Genetics of Hypertrophic Cardiomyopathy.
4. Abhishek Bhaskaran, MD PhD. Cardiology.
Focus: complex ablation for atrial and ventricular arrhythmias.
5. Sacha Bhatia, MD MBA. Cardiology.
Focus: Digital Health, Quality Improvement, Health Care System Governance.
6. Jennifer Chung, MD PhD. Cardiac Surgery.
Focus: advanced aortic interventions, aortic biomechanics.
7. Sean Crawford, MD PhD. Vascular Surgery.
Focus: AI based surgical planning algorithms and computational fluid dynamic simulations.
8. Piroze Davierwala, MD. Cardiac Surgery.
Focus: minimally invasive cardiac surgery.
9. Kathryn Howe, MD PhD. Vascular Surgery.
Focus: role of microRNA in atherosclerotic plaque development and progression.
10. Sanjog Kalra, MD. Cardiology.
Role: Lead, complex coronary intervention program.
11. Arash Jaber, MD MSc. Interventional Radiology.
Focus: Medical Education.
12. Patrick Lawler, MD MPH. Cardiology.
Focus: Clinical trials, translational medicine CICU.
13. Adriana Luk, MD MSc (Quality). Cardiology.
Role: Lead for and Education, CICU.
14. Juane Duero Posada, MD MSc (Quality). Cardiology.
Role: QI Lead and Fellowship Director, Heart Function.

15. Sebastien Mayfield, MD. Interventional Radiology.
Focus: Medical device evaluation, endovascular simulation, vascular application of PET/MR and development of temporary embolic agents.
16. Yas Moayedi, MD MSc. Cardiology.
Focus: Heart transplant, ventricular assist devices, digital health.
17. Chris Morgan, MD. Cardiovascular rehabilitation.
Focus: stress echocardiography.
18. Miranda Witherford, MD PhD. Vascular Surgery.
Focus: Thoraco-abdominal aneurysm repair.

Planned Recruits

1. Carolina Carvalho, MD MEd PhD. Cardiovascular rehabilitation.
Focus: Medical education. Recruitment 2022.
2. Fernando Rivera MD. Cardiovascular rehabilitation.
Focus: Cardio-oncology rehabilitation. Starting MSc (education) September 2021. Recruitment 2023.
3. Duncan Forster, completing his PhD in Computer Science at the University of Toronto in March 2023.
Focus: Artificial Intelligence.
4. Valli Subasri, completing his PhD in Computer Science at the University of Toronto in April 2023.
Focus: Artificial Intelligence.

Fundraising

1. Complete the list of PMCC Fundraising priorities. **A**
2. Launch the \$250M PMCC Fundraising Campaign (60% completed). **A**
3. Establish and develop a fund to defray the cost of devices not currently funded by the Ministry of Health. **A**

Staff Engagement

1. Staff recognition awards. **B**



Dedicated to the patients we serve.

Photographs by Tim Fraser, KITE Studio / UHN

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Peter Munk
Cardiac Centre 