Executive Summary –

Artificial Intelligence in Cancer Care:

An Environmental Scan

CANADIAN **PARTNERSHIP** AGAINST **CANCER**

PARTENARIAT CANADIEN CONTRE LE **CANCER**

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INTRODUCTION

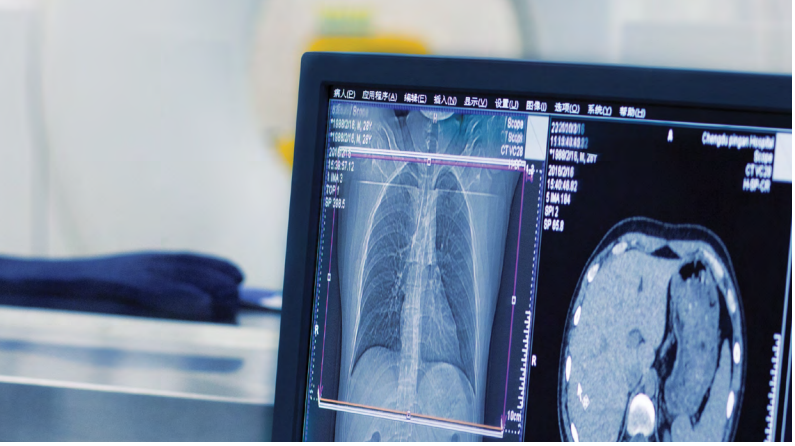
Health care in Canada faces geographic barriers to access such as large distances between health care delivery centres, population concentrated in the southern part of the country, and a federated health care system. As the number of Canadians diagnosed with cancer increases, new models of care delivery that improve access and efficiency and reduce costs are needed. The Canadian Partnership Against Cancer (the Partnership) is the steward of the recently refreshed 2019-2029 Canadian Strategy for Cancer Control (the Strategy), which articulates that technology needs to play a more prominent role in accelerating the improvement of cancer outcomes for Canadians. New technological approaches such as artificial intelligence (AI) have the potential to offer solutions to these geographic challenges, as well as other challenges in the system.

While there is no standard definition of AI, it can be understood as computer programs and technologies that use processes that resemble human intelligence (e.g., reasoning, learning and adaptation, sensory understanding, interaction). AI includes machine learning (ML) and deep learning (DL), where machines provide the analytic power to analyze large amounts of data and can make predictions or decisions based on the patterns the machine identifies in the data. In order to learn more about how AI is being used in cancer care in support of potential future work in this area, the Partnership has undertaken this environmental scan. This report presents findings from a review of the grey and academic literature and interviews with five Canadian key informants.

FINDINGS: AI IN CANCER CARE

Technology is increasingly being used across the health care system to improve the quality and efficiency of care. AI is one of these important technologies and has the potential to change the way cancer care is delivered. In recent years, there has been an explosion of research exploring the use of AI in health care, and the AI market in health care is expected to grow exponentially going forward. Overall in the health sector, some of the largest areas of expansion for AI technologies are expected to be:

- Process optimization (particularly for back-end processes like procurement and scheduling, as well as clinical flow processes)
- Preclinical research (e.g., drug discovery)
- Clinical decision support, especially in the areas of diagnosis and prognostication
- Using AI to interact directly with patients through patient-facing applications
- Using AI to analyze population-level data to identify health trends and changes (e.g., monitoring disease spread)



While system-wide adoption of AI technologies appears to be somewhat limited, there are many examples of AI being used by individual health care organizations. The areas of radiology, pathology, and dermatology seem to be the furthest advanced in implementing AI technologies. For example, in a small survey of people working in radiology in the US, over half reported they were already using AI technology or planning to use it within the next two years. Data collection and data processing tasks are the most susceptible to being transformed with technology, including AI, to improve automation and efficiency.

Within cancer care specifically, the key areas in which AI is being used or explored include:[i]

- Analyzing data in support of **detecting cancer earlier** and/or **identifying those at higher risk** of cancer. Some of these approaches use methods that are less invasive than traditional imaging and biopsies (e.g., extracting and analyzing data from blood such as genetic markers or basic blood work results like complete blood count).
- Using AI to **support the cancer diagnosis process**, potentially making it more efficient and enhancing access, through:
  - Reviewing diagnostic and clinical images (e.g., MRI, CT, x-ray, endoscopy images, images of skin lesions, etc.), segmenting images, highlighting suspicious regions in images for pathologist/radiologist review, and/or classifying findings as benign or malignant. In some cases, research has reported performance of AI algorithms that is comparable to or better than experienced clinicians in making a diagnosis.
  - Classifying pathology findings and identifying biomarkers that can be associated with imaging features (radiomics) for the purposes of diagnosis.
- Supporting **cancer treatment planning and decision-making** by:
  - Assembling and reviewing patient clinical data, published literature, and/or other medical evidence (e.g., past treatment plans) to inform individualized treatment.
  - Supporting the delivery of precision medicine (i.e., a personalized approach to cancer treatment and follow up care) through the ability to predict disease progression, survival, and treatment response, and adapt patient care based on these factors. In the area of precision medicine AI is also being used to support drug development.
- **Better identifying and proactively managing symptoms and complications** cancer patients may experience (e.g., depression/anxiety, hospital readmission after surgery, clinical deterioration).
- Making the **care process more efficient by automating tasks** that were previously done by humans (e.g., radiotherapy planning, scheduling for health care providers and patients, capturing hands-free documentation from providers in real time using AI-powered natural language processing).
- **Supporting quality improvement** by extracting data and real-world evidence from electronic health records (EHRs) to inform quality indicators and monitoring (e.g., assessing actual care delivery against standards established in guidelines) and drive treatment decisions and system change.
- **Improving patient experience** by more easily providing patients with information and tailoring support to their specific needs.

Each of these areas are explored in more detail in the report with explanations of how AI technologies and algorithms are being used in each area. The report also includes examples of specific AI innovations in the above categories that are being used or tested in clinical practice. These examples help to illustrate the possibilities for using AI in real-world contexts.

i There is also extensive work taking place in drug development using AI but this area is outside the scope of this environmental scan.

FINDINGS: CONSIDERATIONS FOR IMPLEMENTATION

Extensive research and development is happening in AI and cancer care, and AI technologies have the potential to enhance cancer care. While the specific conditions for successful implementation of AI technologies are not yet known, criteria are likely to vary based on the technologies being implemented and the context in which they are being used. However, this environmental scan identified many important elements that need to be considered and addressed to support widespread implementation of AI technologies as AI moves from research into practice.

Ethical Issues

- **Context and Challenges:** There are many potential ethical issues associated with AI such as legal and medical accountability for AI decision-making, potential for bias and inequity, access to and privacy of data, impact on patients and health care providers, etc.
- **Solutions:** The Canadian government recently issued a *Directive on Automated Decision-Making* that requires all automated decision systems used by the federal government to undergo a detailed impact assessment before they are implemented and lays out the required evidence and monitoring for a given technology based on its expected impact. This directive could provide a framework for assessing ethical issues and concerns within cancer care. Internationally, the Institute of Electrical and Electronic Engineers (IEEE) is developing standards for ethical use of AI, and other countries (e.g., UK) are also starting to implement guidance and standards. Engaging patients in the process of addressing ethical questions associated with using AI is also critical.

Access to Data, Patient Privacy and Data Security

- **Context and Challenges:** AI needs access to very large amounts of high-quality data to be developed (trained) and tested. Small datasets, datasets that are not connected, data that is not accessible, and data that is incomplete or includes errors/inconsistencies can affect the quality of AI development. Access to data also influences which AI technologies are developed as data availability is a prerequisite for testing new AI algorithms. There are also concerns about how patient privacy and security will be addressed.
- **Solutions:** Collaborative efforts are needed to create integrated and secure data sources that can be used for AI development, and improve the accuracy and consistency of these datasets. Building trust in AI among patients, providers and the public; engaging patients in the data governance and management process and educating them about how data will be used, collected and stored; and developing appropriate regulations and security requirements could help to improve acceptance of AI access to health data. Government regulators will play a critical role in this process.

Equity

- **Context and Challenges:** AI algorithms could create inequity through biases in the training datasets used to develop the algorithm (e.g., if certain populations are excluded or not well-represented), and biases in those who develop the algorithms. Barriers to accessing technology (e.g., inability to afford technologies, discomfort or resistance to using technologies, poor technological literacy) could also create inequity.
- **Solutions:** Considerations of diversity and equity should be at the forefront of AI development and implementation, and it may be helpful to establish criteria for training datasets in terms of the equity/inclusiveness of the patient cohort.

Transparency, Replication, Validation, and Testing

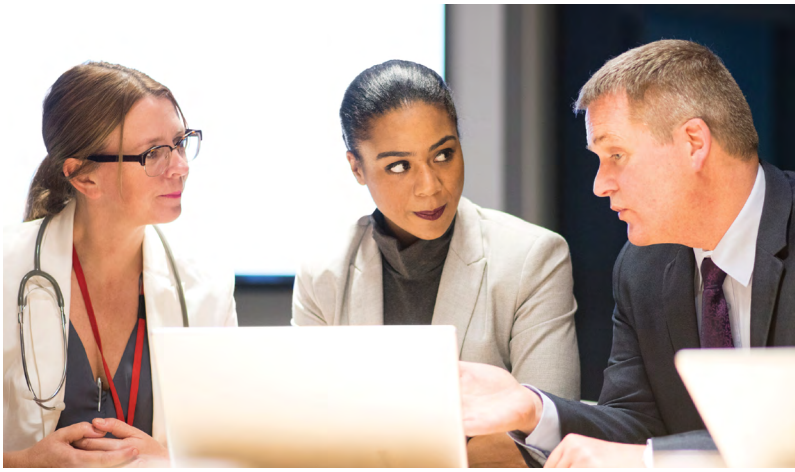
- **Context and Challenges:** Many AI approaches are too complex for humans to understand, and it can be unclear exactly how an algorithm arrived at a decision. This leads to difficulty replicating decisions and may hide problems with the decisions that are made, such as errors or bias.
- **Solutions:** In addition to educating and building trust in AI, it will also be important to establish validation and testing standards, define a threshold or requirements for when technology is ready to be tested in real-world settings, and provide a controlled environment for initial testing and validation. Standards that ensure consistent reporting of bias in research, and increasing emphasis on interpretable AI may also be beneficial, as well as having a continued human presence to review the outcomes from AI algorithms.

Impact on the Health Workforce

- **Context and Challenges:** Widespread implementation of AI technologies could have an impact on the overall composition of the health care workforce, as well as the specific skills and expertise needed by health care providers.
- **Solutions:** Health care providers have essential abilities that AI tools are not able to reproduce (e.g., compassion, understanding of patient context), and clinicians will still be needed to interact with patients and complete higher value work. The most likely scenario is for providers to work in cooperation with AI tools, not be replaced by them. However, some changes to training/education may be needed, and engaging and building buy-in among health care providers will be critical.

Costs and Cost-effectiveness

- **Context and Challenges:** There is currently very little publicly available evidence on the costs and cost-effectiveness of AI. Direct costs of implementation include hardware and software costs, training, and adapting workflows to accommodate new technology. Larger health system impacts may also occur based on how AI changes the care process. For example, a technology that identifies those at high risk of developing cancer earlier may increase upstream costs (e.g., costs for primary care providers and screening), but decrease the costs of treatment and follow up.
- **Solutions:** Understanding the costs and cost-effectiveness of different technologies will be critical in determining which AI tools should be widely implemented. Appropriate costing studies should assess costs and short- and long-term benefits and include a range of perspectives (e.g., patients, clinicians, administrators, experts, etc.) in the economic evaluation process.



CONCLUSION

AI technologies for cancer care is an expanding area of research and development, with exciting possibilities for improving cancer care. AI for cancer care is already being tested or implemented in real-world contexts on a smaller scale in areas such as diagnostics, treatment planning, and process efficiencies. However, more work is needed to support the shift of AI from research into practice. As AI technologies continue to move towards more widespread use in Canada, AI developers, governments, and health system partners and stakeholders must work collaboratively to address the factors that could pose roadblocks to implementation. To continue to support moving research into practice, more collaboration between organizations to develop, test, and implement AI is needed, starting first with smaller manageable AI projects that have the potential to be scaled up. Conversations among health system stakeholders about the challenges and benefits of using AI more widely in cancer care are also critical, and this is an area in which the Partnership will provide support as an enabler of the refreshed Strategy.

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