Platform for Regulatory Science, Innovation, and Equitable Health Systems

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Scientific abstract

Background and rationale. In Canada, patient access to precision oncology is variable and limited to a few centres. Equitable patient access will depend on the design of healthcare systems that integrate genomics data with other health information to support evidence generation and intervention evaluation. This can be considered an application of a learning healthcare system.

Objectives. Our Platform for Regulatory Science, Innovation, and Equitable Health Systems (PRISm) will accelerate precision oncology data curation and evidence development using our life-cycle health technology assessment (LCHTA) framework. Working with the MOHCCN, we will augment existing BC data infrastructure to enable timely outcomes research linked to discovery. We will validate large language models (LLM) for automating extraction of prioritized data elements and will advance real-world evidence generation.

Our specific aims are:

(1) *NLP and generative AI-based data augmentation:* Deploy and evaluate LLMs for extracting data elements, initiating with a case study of British Columbia's Personalized OncoGenomics (POG) program.

(2) *Decision-grade real world evidence:* Validate causal inference-enabling real-world evidence (RWE) that accelerates the optimal, equitable, and acceptable translation of precision oncology innovations into patient health.

Methods and Results. Our LLM validation study addressing Aim 1 includes POG patients diagnosed with metastatic breast or advanced lung cancer between July 2012 and August 2017. We obtained Provincial Health Services Authority and BC Cancer electronic health record (EHR) documents for care received between 1981 and 2021. The final cohort consisted of 211 POG patients with 113,024 EHR documents across 194 distinct document types. Without additional feature processing or fine-tuning, our first LLM found 13 of 24 prioritized features achieved benchmark accuracy of at least 85%. After adjustment, the remaining 11 features achieved an accuracy score of at least 87%. Ongoing work validates additional MOHCCN-prioritized features.

Our index RWE followed a target trial emulation framework using patient-level linked administrative health databases. All BC residents with an advanced cancer diagnosis who received next generation panel sequencing (NGS) or single-gene tests between 2016-2018 were included. We emulated random assignment via genetic algorithm-based 1:1 matching. We matched 1,055 patients receiving multi-gene panel sequencing to single-gene controls, achieving balance on all 21 covariates. Incremental costs in the primary analysis were $2,479 (95% CI: -$3,211, $8,153) and incremental life years gained were 0.11 (95%CI: 0.00, 0.19). There was a 79% probability of NGS being cost-effective. PRISm will continue generating precision oncology evidence over the life cycle using POG and NTRK case studies.

Conclusions. LLMs can streamline data curation and capture precision oncology outcomes, facilitating timely evidence generation supporting discovery, reimbursement and implementation. Our causal RWE - LCHTA framework establishes the outcomes necessary for reimbursement decisions in LHS.

Impact. We have developed, operationalized, and demonstrated the utility of downstream translational and regulatory science frameworks to curate and produce evidence for timely access to valued and cost-effective precision oncology. Continued science-focused development and expansion of LCHTA in health systems facilitates equitable access to precision oncology.

Plain-language abstract

Canada's Marathon of Hope Cancer Centres Network is poised to turn research into health solutions for addressing health threats. There is a central challenge: existing practices, policies, and processes delay patient access to precision medicine. To realize the promise of precision medicine in Canada, we must fix this.

Partnering with governments, industry, Canadians, and international experts, our team is working to rapidly transform research into policy and practice. Our Platform for Regulatory Science, Innovation, and Equitable Health Systems (PRISm) brings together scientists from different fields to collaborate in an innovative way.

Together, our research is:

1. Simplifying data capture and access, finding new ways to share crucial information across health systems.
2. Fast tracking precision medicine applications, producing clinical, economic, and equity evidence that makes downstream healthcare decisions easier.
3. Quickly transitioning innovations to health systems, focusing on equity, safety, value, and sustainability.

Our project benefits all Canadians. Experienced and connected to healthcare systems, our team endeavours to meet the needs of patients and families when developing evidence that changes healthcare policy. Collaborations with governments and industry will guarantee the feasibility and use of our evidence for accelerating patient access to new technologies. Through knowledge mobilization, we will help Canada develop equitable precision oncology healthcare that can address health threats and improve population health.