First Steps Towards a PET/CT-based Radiomics Program at BC Cancer

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1. Specific Aims

1. **Harness untapped potential of BC Cancer patient data to discover and validate PET/CT-based radiomics imaging biomarkers.**

   - Standardize PET/CT imaging protocols in British Columbia (BC)
   - Investigate validity of radiomic features extracted from different scanners
   - Build tools to access patient data from various provincial databases
   - Develop radiomics database linking image features to phenotypes or molecular signatures

2. **Promote translational science partnerships between BC Cancer clinical medical physicists & BC Cancer Research Centre (BCCRC) investigators.**

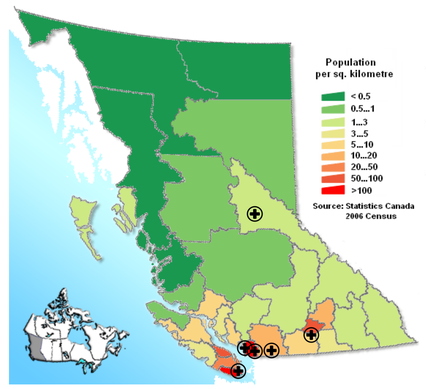
   - Formulate provincial strategy & funding to collaborate with the BCCRC's Department of Integrative Oncology, Imaging Unit
   - Develop processes that integrate research seamlessly into clinical workflow

2. Significance

PET/CT radiomics for prognostication, disease progression tracking, and treatment response assessment is not well established due to lack of standardization and limited patient data in early radiomic studies[1].

- BC Cancer has 6 centres (Fig. 1) but one integrated Aria database that can be leveraged for PET/CT radiomics. Over 12,500 radiation therapy (RT) courses are delivered per year.

- Combining radiomic, genomic, and patient data into a clinical decision support system (Fig. 2) allows for personalized therapy. Cancer is becoming a chronic disease with cancer survivors projected to increase to 240,000 by 2020 in BC[2]. Better surveillance and follow-up care is needed.



- 25,400 diagnosed cancer cases in 2015
- Will to rise to more than 37,000 by 2030[4]
- ~50% of cancer patients receive RT[5]

Fig 1. Map with locations of the 6 RT cancer centres.

Example Radiomic Application – Earlier identification of palliative patients

- Only 1,600 of >6,000 palliative RT patients/yr. access BC Cancer's Pain and Symptom Management Palliative Care Program. Those receiving integrated palliative care have fewer hospitalizations, fewer oncology treatments in the final few weeks of life, reduced health care costs, and improved caregiver-rated outcomes[3].

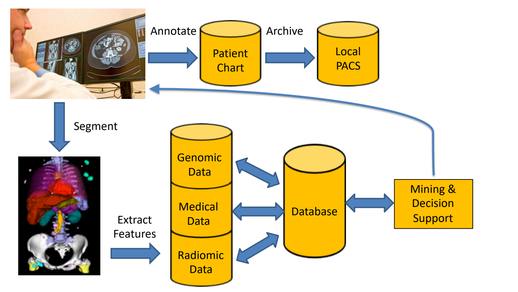


Fig 2. Radiology reading room of the future

3. Innovation

Patients benefit when new research findings can be validated and implemented in the clinic.

BC Cancer has the large databases for data mining/machine learning and the clinical infrastructure to prospectively validate generated prediction models.

However, in RT we lack a concerted province-wide effort to bring this research to the clinic. Specifically needed are clinical physicists who:

- Understand RT data storage infrastructure
- Have influence on various committees: Electronic Health Records, Clinical Workflow, IT infrastructure

The radiomics collaboration between BCCRC and BCCA will:

1. Develop new relationships and workflow tools that could be used for other translational research
2. Expand the scope and impact of clinical medical physicists beyond their own department

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4. Approach

I) Steps to developing & validating a predictive model (Fig. 3)

1. **Image Acquisition**
   - Currently 1 cyclotron and 2 PET/CTs in Vancouver
     - 2-yr transition to 4 new GE Discovery MI's spread across 3 centres
   - Must standardize/harmonize PET provincial protocols
     - Follow EANM/EARL (FDG) PET/CT accreditation[6]

2. **Computation of Radiomic Features**
   - Standardized Environment for Radiomics Analysis (SERA)[7]
     - Matlab packaged developed at John's Hopkins University
     - Compliant with Image Biomarker Standardization Initiative (IBSI)[8]

3. **Statistical Analysis and Machine Learning (ML)**
   - Retain and recruit ML specialists to BC Cancer/ BCCRC
   - Develop tools to access various provincial databases
     - Varian Aria RT database
     - CERNER/Cancer Agency Information System (CAIS)
     - Personalized Oncogenomics Program

4. **Prospective Evaluation of Model**
   - Extra resource: Prospective Outcomes and Support Initiative (POSI)
     - Patient portal for self-reporting quality of life, toxicity, symptom improvements, etc.

II) Potential challenges

1. Obtaining REB Approval for access to databases
2. Maintaining patient privacy while linking data sources
3. Navigating provincial IT security rules
4. Accessing data in old antiquated information systems

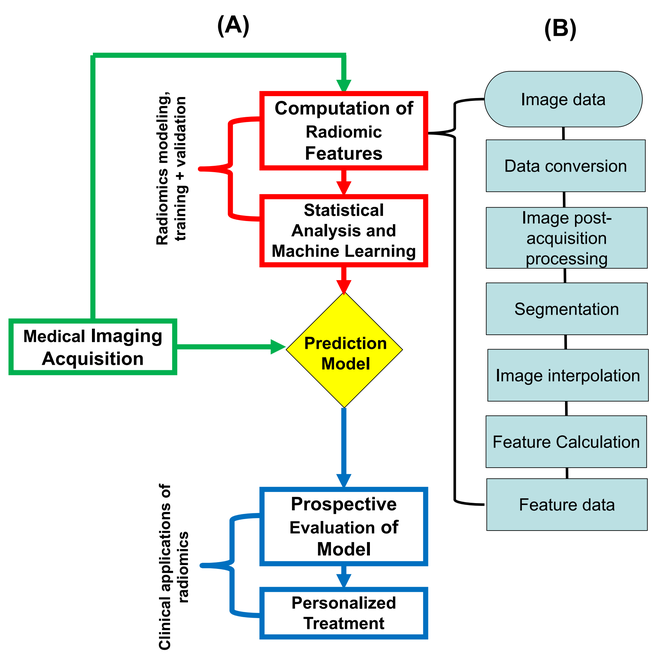

Fig 3. A) Workflow from medical image acquisition to treatment personalization
B) Workflow for computation of radiomic features. Adapted from (8)