

# ONCOLOGY PROJECTS

## NOT-FOR-CREDIT UNDERGRADUATE PROJECT IN ONCOLOGY

### Segmentation Research in Radiation Oncology

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#### PROJECT OUTLINE:

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Over the past two decades, there have been significant improvements in the ability of oncologists and medical physicists to deliver radiotherapy with extreme precision and accuracy. In the mid-1990's, most radiotherapy treatments were designed in only two dimensions, by taking conventional x-rays of the patient and placing the radiotherapy beams based on those x-rays.<sup>1</sup> Since then, major advances have reshaped the field of radiation oncology. First, the advent of CT-based radiation planning allowed for prescription of radiotherapy in three dimensions, followed by Intensity-Modulated Radiotherapy (IMRT), allowing for complex beam fluence patterns for avoidance of normal structures and coverage of complex tumour target volumes.<sup>2</sup>

Most recently, the widespread adoption of "4-dimensional" CT planning (4D-CT) has allowed for the incorporation of tumour movement.<sup>3</sup> With appropriate immobilization of the patient (e.g. thermoplastic mask for head-and-neck tumours), radiotherapy can be delivered with an accuracy within 1-3 mm or less in selected circumstances.<sup>4</sup> This ability to deliver precision radiotherapy has allowed oncologists to prescribe radiotherapy doses much higher than would have been safe in previous eras, and these higher doses are associated with improved patient survival and reduced toxicity.<sup>1, 2, 5-7</sup> However, the stakes are higher: when larger doses are used, radiotherapy delivery errors can have disastrous consequences (ranging from acute toxicities to mortality) especially when dose fractionation schemes are based upon inaccurate contour planning.<sup>8</sup>

Despite these technological advances, the modern enterprise of radiation oncology still requires human observer inputs at critical stages in the radiotherapy process.<sup>9</sup> As a consequence, radiation oncologists are increasingly cognizant that although the accuracy of radiotherapy *delivery* has improved significantly, there is substantial variability in the accuracy of *target delineation* by radiation oncologists. Target delineation is performed by radiation oncologists and technologists using pre-treatment imaging to outline the tumour, the areas at risk of tumour spread, and the normal tissues to be spared (termed Organs at Risk, OARs).<sup>10</sup>

Recent studies have documented significant levels of inter- and intra-physician contouring variability across a variety of clinical scenarios including lung<sup>11</sup>, breast<sup>12</sup>, prostate<sup>13</sup>, bladder<sup>14</sup>, and head and neck<sup>15</sup> malignancies. Such variability can have a major impact on the anatomical regions treated, the chance of cure, and the risk of toxicity. While advances in imaging technology (such as PET scans) can provide new insights into biologically significant tumour volumes to refine target volumes, they still currently rely upon target delineation performed by a human observer.<sup>16</sup> Thus as a result, the major rate-limiting step in optimizing the therapeutic ratio in radiation oncology (i.e. maximizing tumour control while minimizing side effects), has become accurate and reproducible target delineation.

Various contouring consensus statements and atlases exist in literature for a variety of cancer sites in order to attempt to standardize contouring practices, but some provide conflicting and/or insufficient information for accurate delineation.<sup>17, 18</sup> In addition, they do not fully address how to practically assess and adjust for intra- and inter-physician contouring uncertainties. In addition, some examples of prospective investigation into contouring ergonomics<sup>19</sup> and contouring trainee instruction<sup>9</sup> do exist in the literature.

A significant barrier to progress in minimizing targeting uncertainties and evaluating target delineation has been the lack of a gold standard by which to assess the quality and acceptability of various target and normal tissue contours. Recently, the ability to generate consensus contours from cases contoured by multiple expert radiation oncologists has been described and has often been used as a proxy gold standard in evaluative studies.<sup>10, 17, 20, 21</sup> Such databases can be useful to allow the definition of an expert consensus contour, but also to assess the acceptable level of variability.<sup>22</sup>

Although target delineation is a crucial skill set to the modern radiation oncologist, no national or international systematic reviews exist with regards to contouring, reporting on contouring studies, or ensuring effective knowledge translation.<sup>9, 11-15, 18-20</sup> Furthermore, much of the available literature has been restricted to narrative reviews, highly specific contouring scenarios (i.e. non-generalizable) and/or failed to incorporate the input from key stakeholders and knowledge users. Computerized contouring software tools (either semi-automated or fully automated) are now available and are starting to be deployed clinically and in research settings.

In order to commission and use such contouring aids, methodologically rigorous procedures and consensus-based endpoints are required to effectively “commission” computer-generated contours in the same way other treatment planning tools are evaluated.<sup>20</sup>

### **Possible Longitudinal Projects**

1. Conducting a systematic review to define best practices regarding contouring atlases, contouring variation, and contouring outcome measures/gold standards.
2. Evaluation of available autocontouring algorithms versus available gold standard contours in a variety of clinical cancer scenarios.
3. Construction and validation of atlas libraries for future clinical trial, education, and autocontouring assessments.

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REQUIRED TRAINING LEVEL: Undergraduate medical training

REIMBURSEMENT: no reimbursement

TIME COMMITMENT TO COMPLETE THIS PROJECT: to be discussed

COMPUTER ACCESS / SOFTWARE REQUIREMENTS: to be discussed

Academic year: 2011-2012