Surgical Simulation Metrics

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NRC-GHI-4 Research Program: Patient-Specific Virtual Reality Systems for Surgical Oncology

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This study is part of a program aiming to develop a simulator for training neurosurgeons to perform brain tumour resections. The "see one, do one, teach one" apprenticeship model currently used in residency programs can no longer be relied on as the sole method for teaching. Alternative tools must be developed that allow some of the training to be done outside of the operating room and without the requirement for a mentoring experienced surgeon to be present at all times. Virtual Reality (VR) simulators have a number of advantages. In addition to allowing trainees a way to develop surgical skills outside of the operating room without any risk to the patient, they can provide objective and timely feedback in the form of performance metrics.

Metrics are "scores" that provide the training resident with feedback on errors and proficiency demonstrated during performance. In order for metrics to be useful for training, certification and re-certification, they must deliver useful, valid and reliable feedback akin to that of a mentoring surgeon. Commercially available surgical simulators use metrics such as: 1) time to accomplish a full procedure or a basic task; 2) path length of tool tip; 3) errors, including occurrence of bleeding, damage to critical anatomical structures, etc. These metrics do not always discriminate between novice and experienced users.

The focus of this study is to define surgical simulation metrics to help the trainee develop skills ranging from basic motor skills to decision making, for both microscopic and endoscopic neurosurgery. The simulator will include basic neurosurgical scenarios and patient case scenarios to train on, with associated metrics. This work includes the definition and implementation of metrics for the simulator. The metrics used for the evaluation of performance during a basic task include: 1) amount of tumour and healthy tissue removed; 2) damage to critical structures; 3) distance to target; 4) forces used; 5) bleeding time. To our knowledge, metrics for scoring performance during procedures does not exist for neurosurgery. As such, the proposed procedural metrics are inspired from a global rating scale developed for general surgery [1]. The metrics will be implemented in the simulator such that a score will provide feedback in real-time during training. To ensure their relevance, these metrics will be validated against expert evaluations of performance of trainees in both the operating room and on the simulator.

1. Reznick R, et al. Testing technical skill via an innovative bench station examination. *Am J of Surg,* 1997; 173;226-230.