Comprehensive Research Experience for Medical Students (CREMS)

2022 Supervisor and Project Information Form

Please complete and return via email ONLY to crems.programs@utoronto.ca by February 18, 2022.

Supervisor Information

NOTE: CREMS will not support pre-determined pairings of students and supervisors. Supervisors must agree to open their projects to all students and interview all that are interested.

Name: Houman Khosravani

Email: h.khosravani@utoronto.ca or houman@stroke.dev

Hospital/Research Institution: Sunnybrook Health Sciences Centre

Department: Division of Neurology, Department of Medicine

SGS Department(s) (if applicable):

ORCID ID (see https://orcid.org/ - If you do not have an ORCID ID we encourage you to sign up for one):

https://orcid.org/0000-0002-4059-9420

Location of Work:

Sunnybrook Health Sciences Centre

Field of Research (up to 4 keywords):

Quality improvement (QI) and patient safety in neurology, applications of machine learning to QI

Student contact time (number of hours per week YOU are available to the student for any concerns or to review progress):

10 hours per week fully - available to meet and support the student. Furthermore, given the computational nature of the project, the current pandemic, the project has significant components that can be performed virtually and away from the hospital environment.
Project Information

NOTE: If this project is selected, this information will be posted on CREMS website for interested student applicants to view research opportunities.

PROJECT TITLE:

Machine learning assisted swallowing assessment (MASA)

PROJECT DESCRIPTION:
Including background, aim(s), methodS and significance of the project. Maximum 300 words.

Is this project remote-capable (in case of new restrictions) or have an alternative remote option?
☑ Yes, remote capable ☐ No
☐ Yes, alternate remote option. Please specify (100 words max): Click or tap here to enter text.

If human subjects are involved, have the appropriate Research Ethics Board approvals been obtained?
☐ Yes ☐ No ☐ Not Applicable If yes, please list the application submission date: Jan. 2021

Do you expect this work will be published?
☑ Yes ☐ No ☐ Uncertain / Other

Background: One of the most common serious effects of strokes is dysphagia (difficulty swallowing) in up to 50% of patients. Stroke is also associated with dysarthria (facial weakness and difficulty with articulation of speech), which can often be subtle at times, and is associated with dysphagia due to common pathways involving oropharyngeal muscle weakness. Permitting safe oral intake of a stroke patient requires a swallowing screening assessment. Early swallowing assessment is crucial to prevent aspiration pneumonia and other complications. In the ED screening tests can be performed but often the individuals trained are not available especially during nights and weekends. One such “gold standard” ED screening bedside test is the Toronto Bedside Swallowing Screening Test (TOR-BSST); it involves a set of assessments (e.g. speech). However, TOR-BSST usually is done by a few trained people, and access to TOR-BSST requires training, cost, and is not readily available off hours.

Hypothesis: Machine learning analysis of audio recordings of speech can be used to screen for dysphagia with similar performance characteristics to the TOR-BSST screening assessment.

Methods: Audio recordings of speech, analyzed for spectral properties, and maps analyzed in a convolutional neural network for images generated. In our preliminary work, we have used a residual network with specific modifications to the layers to allow for learning. We will construct a data processing pipeline using deep learning and compare these methods to build upon initial pilot study work and improve the performance and robustness of the model to classify dysphagia using audio recordings alone. We will then attempt to prospectively test the trained model on a small set of patients (training n=20-30, validation=10-20 patients).

Expected Outcomes: Our work will lay the foundation for democratizing access to swallowing assessment using a ML-based audio processing pathway. Actual clinical implementation is not part of the scope of this project, but the scientific advancement and learning gained from both the patient level testing, and the machine learning algorithms may be applied prospectively to perform swallowing screening assessments in a small validation cohort. This work will culminate in a conference or journal publication.
Research Environment and Student Roles and Responsibilities

Please be specific as possible. Please describe the research environment, including availability of required facilities/equipment/expertise, supervisor’s experience and mentorship plans. Please clearly outline the student role(s) and responsibilities related to the project, potential educational value, and indicate who will serve as the student’s direct report for daily oversight (PI, PHD student, technician, etc.). Maximum 300 words.

The prospective student will be fully supported in his project by Dr. Khosrvani and members and colleagues of his research/QI (quality improvement) lab, which includes clinical neurology, quality improvement, and machine learning expertise and infrastructure.

From a clinical neurology perspective, Dr. Arjun Balachandar (PGY3, Neurology, U of T) will be helping with data collection and clinical familiarization. Arjun has already been a part of the preliminary data collection and analysis. He has close familiarity with patient registration, having registered the initial patients in the study, and vocal test administration. This work is directed towards improving the quality of care and thus NQIL (Neurology Quality and Innovation Lab) co-founded by Drs. Charles Kassadjian, Sara Mitchell, and Dr. Khosrvani (all faculty within the Division of Neurology) will provide clinical oversight from a neurology and patient care impact perspective.

From a machine learning perspective, the student will be supported by several individuals. Maitree Shah (recent MEng graduate student from University of Toronto), recently supervised by Dr. Khosrvani on the preliminary work on this project, will serve as a resource to the already existing data tools and code used on preliminary components of the project. Maitree’s project was also presented to Dr. Khosrvani’s collaborator (due to mutual interest in the care of stroke patients) Dr. Ian Goodfellow (Apple Research), where this project has been previously presented. Dr. Arjun Balachandar also has machine learning expertise and will help support the student with the existing codebase.

A proportion of the student's work will be done remotely and therefore, in collaboration with Dr. Brian Murray (Division Head, Neurology at Sunnybrook) another research student colleague will help with data collection.