Neuroimaging and fluid biomarkers for neurodegenerative disease

Course Description

Biomarkers are increasingly being used to detect the presence and monitor the progression of neurodegenerative and cerebrovascular diseases that cause dementia. Additionally, biomarkers play a significant role in the design of clinical trials by providing insight into treatment efficacy, target engagement, and enriching criteria for patient selection. Given the multitude of biomarkers that are currently available, researchers require a comprehensive understanding of how biomarkers are acquired and the analytical methodologies that are available to study them. The use of biomarkers in clinical and research settings will improve early diagnosis, intervention, symptom management, and outcomes for persons living with neurodegenerative and cerebrovascular diseases that cause dementia.

The aim of this course is to provide working knowledge about commonly used circulatory (blood-based) and neuroimaging-based (MRI & PET) biomarkers for neurodegenerative and cerebrovascular diseases. Through this course, students will gain an understanding of the range of biomarkers available and how they can be applied in a clinical-research setting to study pathology and the sequence of pathologic events. Students will also learn about emerging techniques that probe novel biomarkers and accelerate drug discovery. This gained knowledge will then be applied to design a biomarker-based study and write a scientific abstract.

Dates: Classes will be held every Tuesday 12:30-2:30 PM, January 10th - March 14th, 2023.

Target Audience: The course is targeted towards a graduate-level (MSc/Ph.D.) audience at the beginner or intermediate level. However, undergraduates, post-doctoral fellows, and research staff are welcome to join.

Format: Hybrid: in-person (M6 Sunnybrook Bayview Campus) or via zoom. Each class (lectures/practicums) will be 2 hours/week (20 hours total). This 10-week course is divided into four sections:

Section I: FLUID (Weeks 1-3): Dr. Myuri Ruthirakuhan
This module will focus on blood-based biomarkers which have established value in predicting and monitoring cognitive and functional decline in neurodegenerative diseases. This module includes three lecture components: 1) Overview of validated and promising blood-based biomarkers of neurodegenerative diseases, 2) Understanding the importance and differences in diagnostic, predictive, and monitoring biomarkers, and 3) Practicum: Design of a biomarker study.

Section II: MRI (Weeks 4-6): Dr. Joel Ramirez
Students will be provided with a comprehensive overview of how structural Magnetic Resonance Imaging (MRI) can be used to visualize and measure cerebrovascular lesions and brain atrophy. This will include a crash course on visualization, quantification, and application in clinical research. If possible, we will also have a hands-on session where students will have the opportunity to interact with MRI from patients with chronic stroke lesions and cerebral small vessel disease imaging markers.

Section III: PET (Weeks 7-8): Dr. Julie Ottoy
This module will focus on Positron Emission Tomography (PET) as a molecular brain imaging method - from the research lab to the clinical use. The module is divided into two lectures, including one theoretical lecture and one practicum. In the theoretical lecture, the student will gain a basic understanding of PET physics and will become familiar with applications of PET imaging in both clinical practice and clinical research with a focus on Alzheimer's disease. In the practicum, the student will learn the important steps of PET image processing and how to quantify pathology based on a PET scan in a clinically relevant situation.

Section IV: MULTI-MODAL (Week 9-10) Dr. Min Su Kang
The last section will showcase the latest literature applying multimodal biomarkers to investigate various neurological or neurodegenerative diseases. The first lecture will introduce several studies integrating various multimodal biomarkers to show a new understanding of disease processes and/or mechanisms. This will also be an example of how to read multimodal biomarker papers. The last lecture will focus on methodological/statistical considerations when conducting multimodal biomarker studies. If possible, we will also have a hands-on session with a mock example dataset to analyze multimodal biomarkers to answer a research question.