Consequences of Cardiac Arrest: Brain Injury (neuroengineering instrumentation)

Background: Cardiac arrest (CA) has devastating consequences, with very low survival rates and high levels of brain injury among survivors. Our long-term research program studies effects of global ischemia resulting from CA. In this project we havecreated a laboratory of the CA/brain injury. In the first research phase, we developed and extensively validated measures of brain injury, including neurological deficit scores (NDS), quantitative electroencephalography (qEEG), and histopathology and other outcome measures. The key instrumentation development needed is for brain monitoring, imaging, and therapy through stimulation.

Moving forward, laying the foundation for this proposal, is to develop brain blood flow, oxygenation and imaging devices. The first device is a laser speckle imaging microscope. This optical device measures brain oxygenation and blood flow. The second device is an ultrasound stimulatio device, including a transducer and an imaging probe, for stimulating the brain and acquiring the response of the brain to stimultion. Therefore, crucially this project is a team effort between

- Drs. Arvind Pathak, Hanzhang Lu (Radiology: speckle and magnetic resonance imaging, respectively), ultrasound imaging and stimulation (Dr. Manbachi, BME)
- BME (Prof Nitish Thakor) and Neurology researchers (Dr. Romer Geocadin).

Goal of the project: Our first aim is to develop a laser speckle imaging optical bench and associated microscope. This work has been carried out in the past by a former PhD/current post doctoral fellow, Dr. Janaka Senarathna. The goal is to develop the optics, imager, and assemble the microscope and test in the experiments. Our secon daim is to develop and assemble an ultrasound array of transducers and receivers for brain blood flow measurements as well as for brain stimulation.

Benefits to the student: The opportunity to get hands on experience in the development of brain monitoring (imaging, stimulation) instrumentation, conducting experiments with animal models in a clinically relevant problem, and the potential for journal publication. This project may be particularly suited for students considering advanced degrees (with focus on instrumentation, neuroengineering) or industry career path through demonstrating skills with optical and ultrasound instrumentation development.

Skills/Experience:

- *Fundamental knowledge in neurobiology:* the student must have an understanding of brain monitoring and basic instrumentation for experimental studies.
- *Intermediate experience in instrumentation:* The student should be able to work with a team of post doctoral fellows who will do experiments, but provide instrumentation support for EEG, brain imaging, ultrasound stimulation etc. Optical/ultrasound instrumentation skills (or acquiring for further development) would be highly desirable.
- *Experimental animal model lab skills:* The student with background in the instrumentation development. The experimental studies will be carried out in rodent models of brain injury and the experimental leadership will be provided by senior experimentalists,
- *Self-motivation and the ability to conduct independent work:* The student should take the take suitable courses, e.g. in sensors/instrumentation and physiology, acquire relevant lab skills, and then collaborate and work in the team, bringing technical skills and aptitude. This will take a great deal of interdisciplinary skill building, collaboration. New ideas and independent work are highly encouraged and valued in the lab. Interactions with clinical scientists is encouraged.

Expectations: Motivation to translate the technology for research needs. Publication of the original work would be a highly desirable outcome.