**Title of project:** Home Transcranial Magnetic Stimulation for Post-Stroke Recovery

**Principal Investigator:** Brian Silver, MD

**Co-Investigators:** Ying Sun, PhD; Tanya Wang

**Scientific summary of Clinical Problem:** Over 800,000 Americans suffer a stroke each year, with the number continually increasing as the population ages. The number is expected to double by 2050. Approximately 50% of patients who suffer a stroke are left with residual disability, which may include problems with limb function (e.g. arm weakness), speech impairment (speaking or understanding), or swallowing difficulties. Currently proven treatments include physical therapy, occupational therapy, and speech therapy. Treatment with selective serotonin reuptake inhibitors has shown promise for improvement in arm strength in one small randomized trial. Transcranial magnetic stimulation (TMS) ([https://www.youtube.com/watch?v=qkNbYHu_STU](https://www.youtube.com/watch?v=qkNbYHu_STU)), which is FDA-approved for the treatment of depression, has shown preliminary efficacy in small studies of stroke patients with arm weakness, speech impairment, and swallowing difficulties. Transcranial magnetic stimulation, as currently delivered, requires 5 days per week treatment for 6 weeks at a hospital. A large machine with a single wand delivers the treatment to the affected hemisphere.

Currently, only one hemisphere can be treated at a time i.e. excitation of injured hemisphere through high frequency TMS or inhibition of uninjured hemisphere through low-frequency TMS.

**Transcranial Magnetic Stimulation (TMS)**

- Based on Faraday Principle
- Rapidly fluxing magnetic field
- Induces current in underlying cortex
- Noninvasive
- Permits focal manipulation of cortical activity


Development of an at-home system to deliver transcranial magnetic stimulation would represent an easier and cost-effective way to deliver treatment, and also allow bi-hemispheric TMS treatment.
Preliminary data
A prototype home TMS helmet, under provisional patent through the University of Rhode Island, has been developed with components that include a framework mounted on top of a bicycle helmet base (A), two motor-units containing rotating disc magnets (B), and a switch and speed control circuit for each of the motor-units (C). Each of the two disc magnets is 1/4-inch thick and 1 inch in diameter, made of NS2 neodymium (a rare earth metal) having a magnetic strength of 0.33 Tesla on the surface.

For the treatment of depression, the following paradigm was used: a magnetic field intensity of 120% of the patient’s observed motor threshold, at a repetition rate of ten magnetic pulses per second. Pulses were grouped in 30 second cycles with a stimulation on-time of 4 seconds, and an off-time of 26 seconds. A treatment session lasted for 37.5 minutes for a total number of 3000 magnetic pulses per session. Motor threshold was determined weekly by visual observation of thumb or finger movement using MT Assist®, which is a standardized mathematical algorithm that provides an iterated estimate of the motor threshold. The treatment location was over the left prefrontal cortex, determined by a standard convention of movement of the TMS coil 5 cm anterior to the motor threshold location along a left superior oblique angle.

Hypothesis
Delivery of home-based TMS over 6 months will: 1) be well tolerated by patients with stroke, 2) result in greater arm function as measured by the Action Research Arm Test (ARAT) (https://www.youtube.com/watch?v=bhkCB0oqoZk) in patients with limb weakness, 3) result in improved Mississippi Aphasia Screening Test function among those with aphasia, and 4) result in faster recovery of normal swallowing function in those with swallowing dysfunction, compared with sham treatment.

Additional expertise required for project to move forward
Specific needs at this time are:

- A quieter motor, which will result in noise that is tolerable enough that the helmet can be worn for at least 30 minutes daily
- Motor speeds that allow rotational speeds up to 100 rpm
- Phantom tests that measure field strength and dispersion up to 5 cm from the magnet in a simulated environment i.e. scalp, bone, brain

investigators, facilities, and resources at the other campus that could be utilized for the project
Engineering at UMass Lowell