THE HARTWELL FOUNDATION

2017 Individual Biomedical Research Award

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Point-of-Care Biomechanical Device for Quantitative Assessment of Spasticity

When a portion of the brain or spinal cord that controls voluntary movement is damaged, certain muscles undergo spastic contraction, with the ensuing stiffness often limiting normal movement, speech and gait. The observed impairment is most frequently a result of cerebral palsy, trauma, stroke, or diseases that cause brain or nerve damage, with some level of spasticity estimated to affect well over 200,000 US children. Spasticity may occur in the arms, but mostly occurs in the legs, producing painful, uncontrollable spasms. Adverse effects include muscle and joint deformities and inhibition of longitudinal muscle growth, which if ignored during early childhood will lead to permanent disability. While not curable, relieving symptoms of spasticity by appropriate intervention can reduce the pain and frequency of muscle contractions and often improve voluntary motor functions. Treatment decisions regarding medication or surgery for spasticity are based on severity; and whether or not it is stable, improving or worsening over time. Evaluation of spasticity symptoms by a medical professional is essential because excessive drug therapy can result in severe side effects like respiratory depression, hypothermia, seizures, loss of consciousness and coma. To judge the severity of spasticity, clinicians manually perform standardized maneuvers such as limb extension and flexion to gauge the muscular resistance to movement (stretch reflex). The condition is then categorized symptomatically as tonic (sensitivity to length of stretching) or phasic (sensitivity to velocity-dependent stretching). The current benchmark is a 6-point subjective rating scale; a methodologic approach with low sensitivity (correct identification) and poor specificity (correct exclusion) that attempts to limit the safety margin of administered medication and the ability to accurately monitor patient progress. A more robust alternative that provides an accurate quantitative and reproducible assessment of spasticity is urgently needed. In this regard, Tina proposes to develop a point-of-care biomechanical device configured as a "smart glove" that can be worn conveniently by the examining physician during clinical evaluation. An array of sensors in the glove will detect force (pressure) and a gyroscope will measure acceleration and range of motion. Movement by the hand of the physician against resistance offered by a spastic limb will reflect the amount of work (force) to maneuver a patient's extremities and therefore the tonic component of the stretch reflex. Similarly, resistance to motion acceleration (power) will reflect the phasic component of the stretch reflex. If Tina is successful, her "smart glove" sensor system will represent an improvement over existing assessment methods for spasticity by providing reliable objective metrics, which will enable timely and accurate treatment decisions to relieve the physical symptoms of the condition and benefit the many children who must endure the condition.