Measurement and Manipulation of the Environment: High-tech Resources for the Study of Motor Behavior and Recovery at MUSC

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Research program

- Multidisciplinary research program combines state-of-the-art behavioral measurement techniques, detailed engineering analyses and novel investigations into nervous system function and plasticity in order to improve lower-extremity function in persons with neurological injury and disorders.
Overall goal of research program

The overall goal is to provide researchers and clinicians with:

• a comprehensive framework for understanding impaired function (biomechanical models, neuromotor control models, physiological investigations into underlying mechanisms)

• an associated measurement toolbox (enhanced movement analysis techniques, patient assessment techniques, imaging techniques)

• an associated intervention toolbox (specialized mechanical devices, investigations into neural plasticity and motor learning)
Neurorehabilitation Research Resources in CHP Research Building

World-class research resources for the measurement of dysfunction and testing of novel interventions.
Locomotor Energetics and Assessment Laboratory

12 camera active marker motion capture system (PhaseSpace, Inc.)
Instrumented Split Belt Treadmill (Bertec, Inc.) with incline
Custom-made balance perturbation system
16 channel EMG system (Motion Labs)
Metabolic cart (Cosmed)
Balance Perturbation System

Servo controlled device to apply a precise perturbation (timing and magnitude) during treadmill walking

![Diagram of Balance Perturbation System]

![Graphs showing control and perturbed steps]

![Graphs showing hemi and perturbed steps]
ZeroG mobile body weight support system (only the 6th one installed nationally) designed to create a permissive environment for retraining walking ability over a treadmill (customized Woodway split-belt treadmill with integrated therapist seating) and also over level ground, environmental obstacles, up a set of several steps, or even on exercise equipment such as a Precor elliptical trainer.
Zero-G Overground Gait and Balance System

http://www.bioness.com/For_Professionals/ZeroG.php
Upper Extremity Motor Function Laboratory

Aims at developing, refining and implementing cutting edge, theoretically grounded, rehabilitation interventions to improve functional upper extremity motor recovery after neurologic injury/disease. This 762 square foot lab includes one room for neuromechanical assessment and two separate rooms for treatment. This Lab is equipped with an 8 camera 3-D active marker Motion Capture System (PhaseSpace, Inc.), a 16 Channel EMG System, two AMTI force plates for assessment of ground reaction forces during standing reach, and ActiGraph Upper Extremity Activity Accelerometers.
Neuromuscular Assessment Laboratory

Investigates the neuromuscular mechanisms underlying abnormal muscle function, including influence of disease processes and rehabilitative interventions on muscle architecture. The 914 square foot laboratory is equipped with a diagnostic ultrasound machine (GE Logiq i), a Biodex Pro System 4 isokinetic dynamometer to assess muscular performance, 8 channel EMG system (Motion Lab Systems), multi-gym, and various other exercise equipment.
Voice and Swallowing Laboratory

Is designed to facilitate a wide range of investigations into voice and swallowing impairments. The overarching goal is to improve the diagnostic accuracy and treatment effectiveness of voice and swallowing disorders. This research relies on technologies such as: laryngeal endoscopy with stroboscopy, high-speed videoendoscopy, magnetic resonance imaging, and videofluoroscopy. The 144 square foot laboratory is equipped with 3 workstations for data collection and analysis. This laboratory has a close relationship with the MUSC Evelyn Trammell Institute for Voice and Swallowing providing access to patients and fully-equipped diagnostic suites and treatment rooms.
Newly Awarded CHP Neurorehabilitation Projects

Intermuscular Coordination of Hemiparetic Walking (Kautz NIH R01)

Development of a Passive Elastic Exoskeleton for Gait Rehabilitation (Dean NIH R21)

Task-specific propulsion training after neurological injury (Bowden NIH R24)

Peripheral muscle properties and the metabolic cost of walking post-stroke (Gregory VA CDA2)

A Toolbox for Measuring Post-Stroke Upper Extremity Motor Ability (Woodbury VA CDA2)

Propulsive Training in Incomplete Spinal Cord Injury (Bowden SC SCI Fund)

Development of a rehabilitation research program to study the biomechanics of walking following incomplete spinal cord injury (Gregory SC SCI Fund)

Impact of acute stroke brain lesion and swallowing impairment on short-term swallowing outcomes (Bonilha SCTR Pilot)

Standardizing laryngeal endoscopy (Bonilha SCTR KL2)
Summary and Possible Collaborations

**Summary**: CHP Center for Rehabilitation Research in Neurological Conditions has world class resources.

**Research Problem**: We want to develop theory-based measurement and interventions based on plasticity and motor learning principles.

**Collaborations**: Parallel animal models for human studies.

Imaging and electrophysiological assessment of neural substrates – damaged and intact that promote rehabilitation.

High tech applications to measurement and motor learning.

Novel manipulations of environment and variability (robotics, virtual reality, etc.).

Physiological stimulation of neural pathways (TMS, FES, tDCS, peripheral nerve stimulation).