Why should Clinicians design Robots? Expediting Stroke Recovery with a Wearable Robot.

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(1) Introduction
Rehabilitation Robots are currently being used by clinicians in Stroke Rehabilitation. This paper aims to outline how a clinical-led design process of a wearable rehabilitation robot, could expedite stroke recovery.

(2) Methods
Literature review, Hypothetico-deductive reasoning

(3) Exoskeletons
"An exoskeleton is a wearable robot with joints and links corresponding to those of the human body"[5]. Exoskeletons can help patients with neurological disabilities improve their motor function and performance by providing task specific practice [6].

(4) Clinical Hypothesis
During the acute phase of Stroke, if a patient if fitted with an exoskeleton which could sense the patient’s motor and sensory ability and assist the patient in performing task oriented practice with both the affected arm and leg, and then this may expedite recovery.

As the patient is the main part of this wearable robot, if the design process is initiated and led from a clinical perspective, then this may lead into an ideal wearable robot which would assist the clinician in expediting Stroke Recovery.

(5) Why should Clinicians design Robots?
Although some of the published literature has Clinicians as co-authors, and notify the importance of users [7], evidence of detailed Patient centric, Stroke-specific Clinical Reasoning processes are not found, in the design process of most of these rehabilitation robots. When Clinical reasoning and patient specific feedback [8] are taken into account and if the design process is initiated and led from a clinical perspective, then this may lead into an ideal wearable robot which would expedite Stroke Recovery.

"It is not yet clear what characteristics should be incorporated in a therapeutic robotic assistant platform"[9].

The review of Literature also suggests that pre-existing clinical conditions such as Diabetes, Rheumatic diseases are not taken into consideration during the design process of Rehabilitation Robotic tools for Stroke. As the use of robot may increase Cardiac Output, cardiac monitoring mechanisms and ease-of access for Cardio-Pulmonary Resuscitation should be incorporated into the Design [10].

To facilitate more intensive task-oriented training practice, the wearable robot needs to be ergonomic, light and closer to the skin similar to an Orthotic device. As the wearable robots usage increases there could be repetitive shearing on the skin and repetitive movements of the Musculoskeletal system.

Sensory Neuropathy and Autonomic Neuropathy should be taken into account and pressure monitoring mechanisms should be developed and incorporated into the wearable rehabilitation robot.

The presence of sensory neuropathy or tissue viability issues does not contraindicate the use of an intimately fitting Ankle Foot Orthosis provided the fit is optimal [11]. Should the Robot be intimately fitted, then neurobiomechanical considerations should be taken into account, similar to Orthotic Devices such as Ankle-Foot Orthosis and Saebo-Reach.

The function of the wearable robot is beyond an Orthotic device. The robot should sense the patient’s motor and sensory ability and vital signs constantly and should alert the Physiotherapist, if the threshold parameters for skin ulceration, preset-joint range of motion and normal ECG, exceed.

Since Hemiplegia / Hemiparesis, is very specific to every patient, Clinicians can lead in the design of a wearable robot for Stroke using translational clinical knowledge such as Neurosceince of Stroke, Task oriented practice, biomechanics, gait rehabilitation etc.

Formulating guidelines combining current treatment strategies such as Constraint Induced Movement Therapy, Mirror Feedback Therapy and devising clinical pathways from the design phase can help personalize the robot according to the patient need.

As the wearable robots evolve with Neuroprosthetics and Brain-Computer Interfaces, their clinical usage would increase. Planning for clinical and ergonomic considerations during the initial design stage, will eliminate therapeutiic bottlenecks in the future; Clinicians are well poised to do the same.

References: