Collaboration between Occupational Therapists, Engineers, and People with Neurological Conditions in the Development of Wearable Robotic Devices

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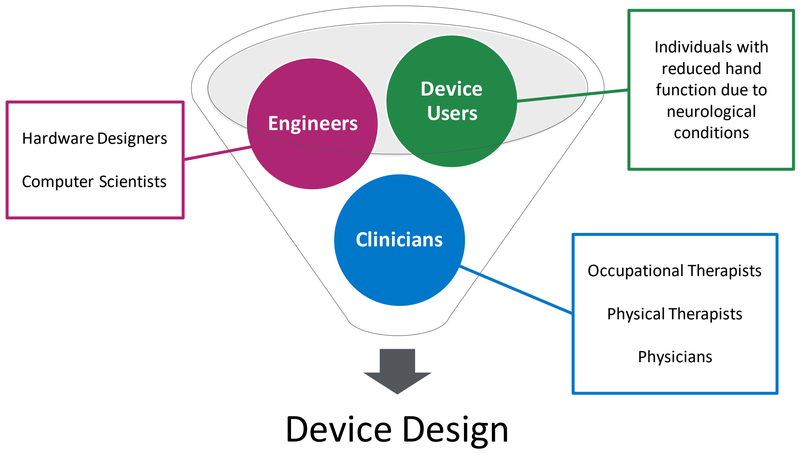
Background

- Wearable robotic devices for the upper limb are currently being developed to enhance arm and hand function for individuals with neurological conditions such as stroke and spinal cord injury (Xu et al., 2022; Yurkewich et al., 2022).
- Historically, upper limb orthotic devices have often been developed with minimal input from potential consumers and are abandoned at high rates (Sugawara et al., 2018).
- Incorporating the needs and values of consumers during the development of such devices is crucial and can help ensure these devices are useful and acceptable (Torricelli et al., 2020).
- Occupational therapists can contribute to this process through collaboration with engineering teams and people with disabilities by centering stakeholder voices and driving device design to support end-user goals for pragmatic application.



Methods

- We conducted two qualitative research studies with individuals with upper limb impairment due to stroke and spinal cord injury (SCI) to learn about their priories for a wearable robotic device:
  1. Semi-structured interviews (up to 90-min) were conducted with 8 adults with significant arm and hand impairment following stroke using Zoom. Participants were asked about their experience with upper limb devices and their rehabilitation goals. After being shown a short video about the MyHand device, they were asked about their thoughts on the device and their priorities for important design features.
  2. Two 90-minute focus groups were conducted over Zoom with a total of 6 adults (3 per group) with reduced hand function due to C6-C7 SCI. Participants were asked about challenging daily activities and their thoughts on using a wearable robotic device during the day. They were shown a picture of a prototype device and asked for feedback.
- Recordings were transcribed and coded by independent raters to develop themes. Specific methodologies differed between the two studies.
- All research procedures were approved by the Columbia University IRB.

Results

Design Priorities

- Easy to use
- Able to don/doff independently
- Able to wear the device during daily activities
- Improves hand function during daily activities
- Comfortable for multi-hour use
- Low profile and light weight
- Aesthetic appeal
- Waterproof (for use during bathing, hand washing, etc.)
- Offers positive reinforcement for continued device use

"I couldn't see that it would be so difficult not to be able to have a prototype… that we would be able to put on and off ourselves to eliminate people from helping us. I think that would be really important" - **Participant with SCI**

"I love to be able to wash my hair or to put my hair in a ponytail. That would be a great, great hurdle… if I could get over that one… oh, wash my right arm, that would be a godsend if I could wash… the right side of my body with my left arm" - **Participant with stroke**

Functional Goals

- Stroke
  - Open the fingers to be able to grasp objects
  - Participate in bimanual activities such as cutting food, folding laundry, cooking, etc.
- C6-C7 Spinal Cord Injury
  - Lift objects that are too heavy for tenodesis grasp
  - Maintain a tight grasp when opening bottles/ squeezing levers and during fine motor activities such as writing or painting

"Like if I need to open a door, or let's say, grab something or use something, or zip-up a jacket. I think that will help because [it] would help to open up my fingers, so I could open up my coat and then to zip it up" - **Participant with stroke**

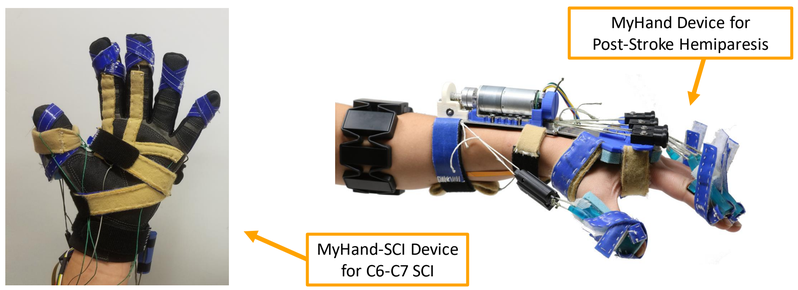
"I would really love to write with my hand and draw…That requires being able to hold something tightly enough to apply pressure" - **Participant with SCI**

Barriers to Use

- Lack of insurance coverage
- Causes pain or is uncomfortable
- Improper fit
- Lack of mechanical support
- Does not match level of hand function
- Does not function as intended
- Bulky, cumbersome, too heavy
- Too confusing or complicated

"You just don't want it to look clunky… people are gonna already look at it. I don't want them looking at it too long" - **Participant with stroke**

"So I was thinking if it's a bit heavy, even though I could grasp things and do stuff, my arms might weaken very quickly and not be able to do stuff" - **Participant with SCI**



Acknowledgments

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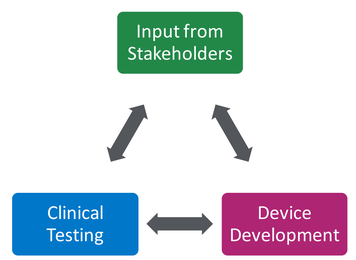
Implications for Occupational Therapy

- Occupational therapists can play a key role in the development of wearable robotic devices:
  - Engage potential device users in research to determine design priorities
  - Collaborate in clinical device testing with intended populations
  - Provide feedback to the design team on clinical utility
  - Help link the priorities of device users and their caregivers with device design goals
- It may not be feasible to incorporate all user needs into a single device:
  - Goals are often individualized based on the unique needs of the user
  - It is challenging to create advanced technologies with high functionality that are also lightweight and easy to use
  - The potential for device customization may help increase adoption
- Collaboration is needed to develop solutions that meet the complex needs of device users

Future Directions

- Individuals with neurological conditions should be included not only as research participants but also as members of advisory panels for research in the development of wearable robotic devices for the hand
- Device development is a complex, iterative process that requires multidisciplinary collaboration
- Future work should continue to engage key stakeholders in the development of device design goals and clinical testing strategies to ensure that resulting devices meet consumer goals and needs.



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