Sensing technologies and robotics
redefining physical therapy practice
FIRST: Sensing technologies and robotics
redefining physical therapy practice

APTA

Genomics

Tele-Health

Physical Therapy

Regenerative Rehabilitation

Sensing Technologies and Robotics Technologies
Leadership Team
Multidisciplinary & International
Comprised of administrators, bioethicist, biomedical engineers, computer scientists, electrical engineers, mechanical engineer, neurophysiologists, physical therapists, physician, and roboticists
Sensing technologies and robotics

redefining physical therapy practice

The Sensing and Robotics Group first came together in 2013 with Drs. Trumbower, Rymer, Duetsch, and Dhaher. Since then the number of members has quadrupled. This group, along with all the other groups, had a major goal of having the sensing and robotics technologies be understood by the physical therapy community, both through changing education programs and also in practice.

For a list of resources:

The goal is to prepare physical therapists as expert consumers and co-developers of advancing sensing and robotic technologies in order to enhance evidence-based practice.
Overwhelming need and interest to incorporate sensing technologies and robotics into physical therapy practice

Dobkin et al., Neurorehab Neural Repair 2015
What are the clinical uses of sensing technologies in physical therapy?
Sensing technologies and robotics

redefining physical therapy practice

Augment
Assess
Assist
What are the clinical uses of wearable technologies in SCI rehabilitation?

**Wearable robotic** technologies aim to promote functional independence through interactions with devices that can move in response to commands.

**Assistive-based Strategies**  
(Marchal-Crespo et al., 2009)

**Challenge-based Strategies**  
(Guadagnoli et al 2004)  
(Nef et al., 2007; Trumbower et al., 2010)

Human-machine interactions rely on various types of control architectures.
What are the clinical uses of wearable technologies in SCI rehabilitation?

**Wearable robotic** technologies aim to promote functional independence through interactions with devices that can move in response to commands.

*Challenge-based Strategies*  
(Guadagnoli et al 2004)

*Assistive-based Strategies*  
(Marchal-Crespo et al., 2009)

(Krebs et al 1998; InMotion II, USA)  
(Schwartz, Boninger et al., PITT)
What are the clinical uses of wearable technologies in SCI rehabilitation?

**Exoskeleton** technologies aim to promote functional independence through human-robot interfaces that assist movements in response to commands.
What are the clinical uses of wearable technologies in SCI rehabilitation?

**Exoskeleton** technologies aim to promote functional independence through human-robot interfaces that assist movements in response to commands.
Are there clinical barriers to using HAL wearable technology for treatment of persons with SCI?
There are challenges to incorporate exoskeleton technology in SCI rehabilitation

Some clinicians express skepticism

Challenges

Opportunities

unsafe
There are challenges to incorporate exoskeleton technology in SCI rehabilitation.

Some clinicians express skepticism.

- Challenges
  - cannot match therapists' expertise and skill
  - unsafe

- Opportunities
There are challenges to incorporate exoskeleton technology in SCI rehabilitation

Some clinicians express skepticism

- expensive
- cannot match therapists' expertise and skill
- unsafe
There are challenges to incorporate exoskeleton technology in SCI rehabilitation

Some clinicians express skepticism

- Expensive
- Cannot match therapists' expertise and skill
- Unsafe

Is there also fear that these technologies may be used to cut back services and reduce human contact?
Is this wrong?
There are challenges to incorporate exoskeleton technology in SCI rehabilitation.

Challenges:
- No user feedback
- Expensive
- Cannot match therapists’ expertise and skill
- Unsafe

Opportunities:

How does the technology promote beneficial changes in neural circuity and subsequently improve walking after SCI?

For example, how does the technology prevent compensatory strategies or overcome involuntary co-activity signaling?
There are tremendous research opportunities to improve benefits of exoskeleton technology for SCI rehabilitation.
Advances in technology can replace missing or damaged parts in human
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Targeted re-innervation (Kuiken et al., Lancet 2007)
Advances in technology can replace missing or damaged parts in human brain-machine interfacing.
Sensing technologies to enhance exoskeleton robots in physical therapy

**Sensing** technologies aim to promote functional independence through interactions with devices that can provide **feedback** to user in response to commands.

- Automate
- Motivate
- Monitor
- Treat
- Reduce Cost
- Personalize

Low-cost, energy-efficient wireless sensing and processing platforms is a long-awaited opportunity for health care services, clinical practice, and research.
Virtual reality provides a medium that simulates real-world experiences in a clinical/home setting.

Virtual Reality technologies aim to promote functional independence through interactions with devices that can provide feedback in response to commands.

Purpose-based gaming
(Deutsch et al., 2010; Zijlstra et al 2011)
Augmented reality provides a medium that enhances one’s current perception of the world.

**Augmented reality** is a live view of a physical, real-world environment whose elements are *augmented* by computer-generated sensory input.

Information about the environment and its objects is overlaid on the real world.

*Includes an IMU (accelerometer, gyroscope, and magnetometer)*
There is overwhelming need to advance physical therapy education in sensing technology and robotics.
Resources that enable clinicians and students to learn the clinical utility of sensing and robotic technologies

IISART is dedicated to advance and promote modern healthcare technology in rehabilitation for the benefit of the patient and society at large. The main focus is on Robotics, Virtual Rehabilitation and Therapeutic Electrical Stimulation.
Future success or failure of wearable technology in physical therapy will depend on collaborative research effort from engineers, scientists, and clinicians to develop, prescribe, and administer evidence-based applications.
Cross-disciplinary training of engineering technology and rehabilitation

Funding: Emory Innovative Teaching Grant
Cross-disciplinary training of engineering technology and rehabilitation

Robotic technologies aim to promote functional independence through interactions with devices that can move in response to commands.

Funding: NSF-NRT RG083-G1
What are the clinical uses of sensing and robotic technologies in SCI rehabilitation?

**Sensing** technologies aim to promote functional independence through interactions with devices that can provide sensory feedback in response to commands.

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<th>Automate exercise guidance</th>
<th>Improve motivation and compliance through games (purpose gaming)</th>
<th>Change behavior through progress monitoring</th>
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<td>Augment sensory feedback</td>
<td>Enable home-based therapy &amp; exercises</td>
<td>Enable remote clinical follow-up</td>
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<td>Reduce treatment costs</td>
<td>Promote personalized sensing in real-time</td>
<td>Capture continuous data streams outside clinic</td>
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