Exoskeletons: Insights into the Future of Robotic Ambulation

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Shepherd Center

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  - Ask “All Panelists” and click “Send”
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Advances in Spinal Cord Injury Management

New treatment regimens may change the face of treatment for spinal cord injuries.

Cutting-edge treatments now in development include:

- Functional Electrical Stimulation (FES) interventions
- Surgically-implanted stem cells
- Ambulation/activity-based treatment
- Epidural stimulation
- Exoskeletons

Tomorrow’s technology will soon become reality. Be prepared to make educated decisions about SCI treatment.
Today's Webinar Objectives

Our conversation centers on three primary goals.

1. **Describe the four main types of exoskeletons being studied today**

2. **Discuss the types of injured workers for whom an exoskeleton may be appropriate**

3. **Describe potential health and rehab benefits of exoskeletons**
Our Presenter

Ms. Hartigan and Shepherd Center are leaders in the field of exoskeletons with deep experience that includes clinical trials.

Clare Hartigan, PT, MPT

- Program Manager and Clinical Research Coordinator at Shepherd Center
- 25 years of clinical experience with focus on locomotor training for patients with neurological injury or disease
- Led Shepherd Center trials for three exoskeleton devices
Exoskeletons: Where Are We Now and What’s to Come?
Objectives

- Why robotics?
- What criteria are used to determine who is a good candidate for an exoskeleton?
- What is the goal of incorporating one of these devices into a rehabilitation plan?
Why Robotics?

- **Cutting-edge technology**: It’s the wave of the future.

- **Upright mobility**: Offers mobility for persons with spinal cord injury and other neurological disorders who are unable to walk or who can walk for only limited distances.

- **Productivity**: Fewer staff required to get people moving soon after injury and an opportunity for more therapy time.

- **Data rich**: Provides objective measurements of performance (step number, muscle responses, distance, walking time, kinematics) beyond common functional gait assessments.

- **Functional**: Provides activity-based walking, learning.

- **Multi-system impact**: Stimulates many systems: motor, sensory, nervous, brain, cardiac, digestive.

- **Integrates multiple interventions**: Ability to combine robotics with other interventions.
Who Qualifies to Use These Devices?

**Generally all exoskeleton devices have similar criteria.**

- Persons with SCI or other neurological disorders
- Must have medical clearance for full weight bearing and walking activity from MD
- Persons who are 5’1” to 6’3” tall, some variation per device
- Persons who weigh 220lbs or less, some variation per device
- Adults ages 18 and older who are not osteoporotic or at increased risk for fracture
Who Qualifies to Use These Devices?

- Must have adequate range of motion without tightness at hips, knees and ankles
- Minimal to moderate levels of spasticity are tolerated by all
- Must tolerate being upright without getting lightheaded (standing frame, tilt table etc.)
- Skin must be intact where it interfaces with the device
- Some persons may require a bone scan to confirm bone health prior to use
What’s the Goal, if Not to Replace a Wheelchair?

*Studies show that walking is a key component to a healthy lifestyle.*

- Health, wellness, socialization and psychological benefits of being able to stand up and walk.
- 1/3 of US adults are obese; 57% higher rate for those with disabilities. Obesity costs $150 billion each year; $1,500 higher costs per person.¹
- Surgeon General: “Encouraging Americans to add walking to their daily routine has enormous long term health benefits and can help reach physical activity goals.”²
- CDC currently conducting a study on breaking down barriers to using walking as exercise for diverse communities including persons with chronic disabilities.

1. From CDC Fact sheet on Obesity and Disability
Rehabilitation and Health Benefits of Exoskeleton Devices

The benefits continued to be studied, but here are some of the hypotheses.

- **Potential to facilitate neurological recovery**
  - Potential for supporting functional and/or neurological recovery for acute SCI, incomplete SCI and other diagnoses.

- **Useful therapeutic modality**
  - Activity-based modality that may promote greater strength, range of motion, balance and mobility.

- **Improved function**
  - Promotes greater independence and accessibility in the home, community, and at work.

- **Avoidance of medical complications**
  - Improves bowel/bladder functioning, spasticity, pain, circulation, and bone density.

- **Facilitation of health and wellness**
  - Encourages weight loss, increased muscle mass, improved cholesterol and glucose, improved self-reported quality of life, motivation to exercise and overall health and wellness.
Shepherd Center robotic exoskeleton trials for Ekso, ReWalk, and Indego began in 2010

Small percentage of applicants who had been injured for over two years met criteria for trials

Criteria that the applicants had difficulty meeting:

- Weight under 220 lbs.
- Range of motion: WFL for walking
- Bone density: Osteopenia expected not osteoporosis
- Skin intact
- Lack of orthostasis (lightheadedness upon standing)

Message to patients: Focus on your health!

Patient in Ekso at tourist spot
An In-Depth Look at the Devices
Exoskeletons: What’s Available Today?

In this presentation, we’ll discuss the four most notable devices developed in Europe and the United States.

<table>
<thead>
<tr>
<th>Device</th>
<th>Maker</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ekso</td>
<td>EksoBionics</td>
<td>Eksobionics.com</td>
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<tr>
<td>Indego</td>
<td>Parker Hannifin</td>
<td>Indego.parker.com</td>
</tr>
<tr>
<td>ReWalk</td>
<td>Argo Medical</td>
<td>Rewalk.com</td>
</tr>
<tr>
<td>Rex</td>
<td>RexBionics</td>
<td>Rexbionics.com</td>
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</tbody>
</table>

- Ekso and ReWalk are being used in rehab centers with patients and also under research/clinical trials.
- Indego and Rex are being used for research/clinical trials.
- How can you get your patients involved? Visit company websites noted above for information.
Ekso

Developed by EksoBionics, more information at Eksobionics.com.

- Weight approximately 50 lbs., “one piece”; fully adjustable for sizing
- Backpack style and subjects stand on foot platform
- Variable robotic assist used with SCI and other diagnoses (adaptive or fixed)
- Used with walker or forearm crutches for stability aid (level surfaces/inclines)
- How steps are initiated:
  - First Step: new users with skilled physical therapist push button assist
  - ActiveStep: user takes control of push button on stability aid
  - ProStep: user activates with weight shift lateral and forward
  - ProStepPlus: user activates via weight shift + forward leg motion
- Speed: functional for inside or outside home at 0.4 m/s +/-
Ekso Video

*Video from EksoBionics.*

Let’s see the Ekso in action...
Indego

Developed by Parker Hannifin, more information at Indego.parker.com.

- Weight approximately 27 lbs.; modular so breaks down into pieces and stored in duffle bag for transport; fully adjustable for sizing in sections
- Only exoskeleton device small enough to wear in wheelchair or car; walks all surfaces including stairs
- No backpack; uses carbon fiber AFO for foot support in shoe in Generation 1 device; Generation 2 device will have AFO attached to lower leg section of device
- Variable robotic assist for SCI and other diagnoses (pre-set or changes w/effort)
- Preliminary trials incorporating FES with Indego very promising
- Used with platform walker, walker, forearm crutches or canes as stability aid
- How steps are initiated:
  - Posture based “legged segway”; device leads
  - muscle initiation from the user; device follows
  - Can work in combination with Functional Electrical Stimulation at trunk/legs
- Speed: functional for inside or outside home at 0.4 m/s +/-
Indego Video

*Video from Parker Hannifin.*

Let’s see the Indego in action...
ReWalk

Developed by Argo Medical Technologies, more information at rewalk.com.

- Weighs approximately 50 lbs; “one piece”; fully adjustable
- Backpack style with foot piece that inserts into the shoe
- Full robotic assist for persons with SCI using watch-style controller for standing, walking, sitting
- Used with forearm crutches as stability aid; can walk on all surfaces/stairs
- How steps are initiated:
  - Watch-style control for modes
  - Posture based tilt mechanism
- Speed: functional for inside or outside home at 0.4 m/s +/-
ReWalk Video

Video from Argo Medical Technologies.

Let’s see the ReWalk in action...
Rex

Developed by RexBionics, more information at Rexbionics.com.

- Weighs approximately 84 lbs; “one piece”; fully adjustable
- No backpack, feet placed on platform
- Full robotic assist for SCI and other diagnoses
- Requires no stability aid, uses joystick controller; only device researching Brain Machine Interface (BMI) control
- How steps are initiated:
  - Joystick; all surfaces/stairs
  - BMI with skull cap, electrodes and gel
- Speed: functional for inside, generally much less than 0.4 m/s +/-
Rex Video

*Video from Rexbionics.*

Let’s see the Rex in action…
This is the data collected from “Mr. K,” a T7 complete paraplegic, from his eighth time using the Indego.

<table>
<thead>
<tr>
<th>Data measurement</th>
<th>“Mr. K’s” data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of steps</td>
<td>1,376</td>
</tr>
<tr>
<td>Average speed</td>
<td>0.3 m/s</td>
</tr>
<tr>
<td>Exact distance walked</td>
<td>½ mile</td>
</tr>
<tr>
<td>Total walking time</td>
<td>45 minutes</td>
</tr>
<tr>
<td>User’s contribution versus device contribution</td>
<td>Device contributed 100% (Mr. K is a complete para)</td>
</tr>
<tr>
<td>Force generated by user’s muscles</td>
<td>Mr. K’s muscle force provided as much as 95% from quadriceps and 27% from hamstrings with FES alternating 10 steps on/10 steps off</td>
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How much do the devices cost?
- Varies for each device. Has been a moving target from as much as $150,000 for purchase to $35,000 per year for rehab center rental.

Have any of them been approved for personal use in the United States?
- No, but all companies are working towards approval for private purchase and home use. Ekso and ReWalk are approved for private purchase in Europe.

When is private purchase in the US expected to be approved?
- Unclear, will be up to the FDA. Perhaps 2016?

How can I find a rehab center near me that is using these devices?
- Check the individual websites for each device; the web addresses were provided earlier in presentation.
Case Management Considerations

Laurie Anderson
Future Considerations

What should case managers or claims professionals consider?

- **Rapidly evolving technology**: exoskeleton devices will continue to be enhanced in the years ahead.
- **Eligibility criteria**: not everyone will have the capability to use or benefit from the devices.
- **Accessibility**: improved access to the technology and trained therapists across the U.S.
- **Improved function and independence**: devices must facilitate increased independence in the home, community and vocational setting.
- **Pricing**: what are the goals of incorporating an exoskeleton into a treatment plan, and what is the return on investment?
- **Adoption**: does the potential user have a track record for compliance and follow through?
- **Outcomes**: growing body of evidence that these devices contribute to fewer medical complications, improved health/wellness, psychological adaption and improved independence.
Question and Answer Session

Submit your questions in the Q&A panel on the right of your screen.

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