

## Research Questions: Industrial Exoskeletons and Return to Work

Submitted by Delia Treaster on behalf of the Exoskeleton Advisory Committee\*

**Disclaimer:** The information provided is for general informational purposes only. All information is provided in good faith, however DOSH, Labor and Industries, and the Exoskeleton Advisory Committee make no representations or warranty, express or implied, on behalf of any manufacturer, including but not limited to any warranty of merchantability or fitness for a particular purpose of any item. DOSH, Labor and Industries, and the Exoskeleton Advisory Committee shall have no liability to you whatsoever for any loss or direct, indirect, incidental, or consequential damage incurred as a result, in whole or in part, in reliance on any information provided herein.

Note: Some of the questions that were raised by the Advisory Group relate to the use of exoskeletons in general and are not unique to RTW situations. The following questions are specific to RTW issues.

### Appropriateness of exoskeletons for IW (injured worker):

- Are exoskeletons appropriate for returning IW to work? Is so, under what conditions?
  - As aid in rehabilitation?
  - For work hardening?
  - While performing regular job or another (i.e. light duty) job?
- What is the nature of the exoskeleton benefits for IW?
  - Protect against re-injury?
  - Assist with recovery by reducing fatigue and stress, thus promoting faster healing?
  - Serve more as a splint, supporting a joint while reducing the likelihood of motions that could cause re-injury?

### Prescribing an exoskeleton for an IW

- Are there particular types of injuries for which exoskeletons would be well suited, and other type of injuries where they should not be used?
  - Is there a “sweet spot” for specific exoskeletons, for specific types of injuries?
  - If so, how to determine sweet spot?
  - How to “translate” sweet spot into exoskeleton prescription?
- How to assign *type* of exoskeleton with *type* of injury? Can an algorithm be developed to assist in “mapping” exoskeleton to injury?

- What are the counter-indications for use (if any), and does this vary by exoskeleton model and/or RTW need (i.e. shoulder vs back injury)?
- What are the contraindications for exoskeleton use other than type of injury?
  - Are there comorbidities that contraindicate prescription of exoskeletons for IW?
  - If so, what are the comorbidities?
  - Traits of IW that contraindicate exoskeletons? (ex: catastrophizing? History of injuries?)
- What are the factors related to job tasks that make them more or less suitable for use of exoskeletons?
- If there is an increased metabolic load when wearing exoskeleton, how does this affect the prescription of exoskeleton for the IW?

### **Assessing efficacy of exoskeleton for IW**

- How to measure efficacy?
  - Reductions in muscle activity or co-activation?
  - Reduction in spinal compression?
  - Reduced pain?
  - Increased range of motion?
  - Increased endurance?
  - Subjective measures?
- Do measures of efficacy change with increased exoskeleton use?
  - Are the measures either time- or recovery-dependent?
  - Is there a point (beyond recovery) when wearing an exoskeleton becomes counterproductive or harmful? Does efficacy follow an inverted V-shaped curve?
- Does donning/doffing affect injured part? If so, what to do?

### **Unintended consequences:**

- Can use of an exoskeleton result in negative effects such as muscle deconditioning, loss of range of motion, or changes in movement patterns that affect the IW differently than a non-IW?
- Does exoskeleton transfer the load to other joints that then are at risk for injury? If so, is the risk of injury greater (or different) for IW than for non-IW?
- Does exoskeleton affect balance, gait or fatigue and create a fall risk? Are these risks different for IWs and non-IWs?
- An exoskeleton might reduce back muscle activity by 50%, but would that allow a worker to lift a load that would otherwise be above their work restrictions? How to prevent this?

- Will IW become physically dependent on exoskeleton? If so, how can this be prevented?
- Will the IW compensate or protect injured part by offloading one POB (part of body) and increasing load in another POB and increase risk of injury? Consciously? Subconsciously?

### **Acceptance of exoskeletons in workplace**

- What are the barriers to acceptance of exoskeletons
  - By IW?
  - By management?
  - By co-workers/team members (uninjured)
- What factors can facilitate acceptance of exoskeletons?
  - By IW?
  - By management?
  - By co-workers/team members (uninjured)
  - Is there a “tipping point” of acceptance?

### **Psychological factors**

- Can exoskeletons help some IWs overcome fear of re-injury?
- Or will IW feel a “false sense of security” when wearing exoskeletons, increasing risk for further injury?
- Will IW become psychologically dependent on exoskeletons? If so, how should this be handled?
- Social acceptability of exoskeletons
  - Conspicuous or embarrassing to wear?
  - IW unwilling to wear exoskeleton, fears being labeled as “weak”?
- Cognitive workload
  - What, if any, is the cognitive workload on the worker wearing an exoskeleton?
  - Can exoskeletons be enough of a distraction to the worker that they should not be used for tasks that require sustained attention?
  - Does the cognitive workload change as worker acclimates to the exoskeleton?

## **Training/Acclimatization**

- How to determine appropriate training time for an IW before using exoskeleton on the job?
- What is the appropriate acclimatization time for an IW?
- How to determine when training/acclimatization is sufficient and thus can be ended for IW?
- Is there a specific wearing schedule when initiating exoskeleton use for IW?
- Is there a “taper off” schedule for discontinuing exoskeleton use when IW no longer needs it?
- How to manage or oversee training and acclimatization for IW?
- How often should the exoskeleton-IW system be evaluated? By whom? HC provider? Management? Combination of HC & management?

## **Healthcare Provider/WC Insurance**

- Who are the HC providers who are involved and need to be informed?
  - Doctors -- GP? Specialists (e.g. orthopedics?)
  - PT/OTs
  - TPAs (third party administrators)?
  - WC insurance
    - How do new treatment modalities become covered by WC?
    - Are WC & TPA involved in prescribing exoskeletons to IW for RTW? If so, how?
- How to tailor information so it is relevant for HC/insurance providers?
  - What information (level of specificity) to provide that is meaningful for them?
  - Potential benefits and pitfalls of exoskeletons
  - What kind of research data would be convincing?
  - Create evidence-based Best Practice guidelines for prescription?

\*The Exoskeleton Advisory Committee is:

Stephen Bao, PhD, CPA, CCPE, Labor & Industries, SHARP

Kendra Betz, MSPT, ATP, National Center for Patient Safety, Veterans Affairs

William Billotte, PhD, National Institute of Standards and Technology, Vice Chairman ASTM F48 Committee on Exoskeletons and Exosuits

Rich Gardner, MS, PE, CPE, Boeing Research & Technology

Rick Goggins, CPE, Labor & Industries, DOSH

Pete Johnson, PhD, Occupational and Environmental Exposure Sciences, University of Washington

Jim Lin, PhD, CPE, Labor & Industries, SHARP

Matt Marino, PT, MSPT, CPE, CWcHP, CSCS, TSAC-F, CPT, SFMA, FMS, Briotix Health

Sarah Martin, OTR/L, Labor & Industries, Return to Work Partnerships

Keith Osborne, CEAS, CWS, Seattle City Light

Donald Peterson, PhD, College of Engineering and Engineering Technology, Northern Illinois University

June Spector, MD, MPH, Department of Environmental & Occupational Health Sciences and Medicine, University of Washington

Chris Reid, PhD, Boeing Environment Health & Safety

Ornwipa Thamsuwan, PhD, Canadian Centre for Health and Safety in Agriculture, University of Saskatchewan

Catherine Trask, PhD, Canadian Centre for Health and Safety in Agriculture, University of Saskatchewan

Delia Treaster, PhD, CPE, Ohio Bureau of Workers' Compensation