FROM MOBILITY TO MEANING: PHYSICAL, COGNITIVE, AND FUNCTIONAL OUTCOMES OF EXOSKELETON USE IN THE HOME

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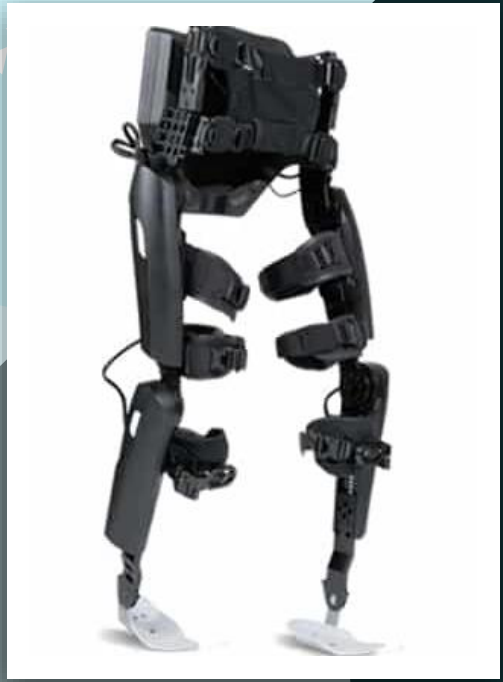
Agenda

- Introductions & Intro to Exoskeleton
- Medical benefits of using an exoskeleton
- Exoskeleton functional outcome measures
    - Preliminary results
- Exoskeleton use in OT and potential home use
- Exoskeleton Demonstration and Exo-Interview

Learning Objectives

- Recognize how individuals with spinal cord injuries can regain independence with functional activities in their home and communities by using a lower extremity robotic exoskeleton.
- Describe the physical and mental health benefits associated with the use of lower extremity exoskeletons for individuals with paraplegia, including improvements in cardiometabolic health, enhanced physical endurance, improved functional pain scores, improved bowel/bladder function, and other health benefits.



Wake up Trivia- Exoskeleton

1. How many established exoskeleton companies are on the market today?
2. What was the main challenge with early exoskeleton designs?
3. What was the first known concept of an exoskeleton, and who proposed it?
4. What company invented one of the first powered exoskeletons?
5. How fast in mph is the fastest walking exoskeleton on the market?

Ghost Walking and Iron Man's Story

Why Occupational Therapy & Exoskeletons?

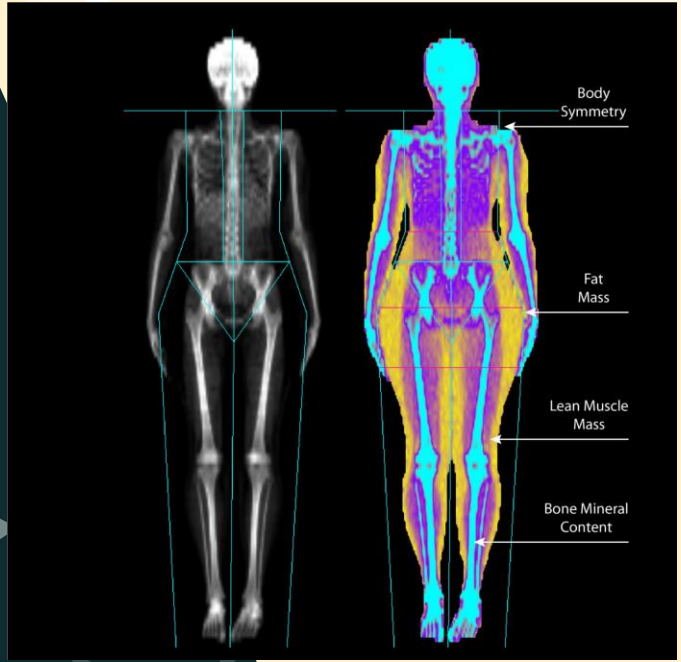
- Meaningful tasks equals improved quality of life
  - Social interaction with family, friends, and strangers
  - Exoskeleton users report they feel ‘normal’ during tasks
  - Improved Strength and Endurance in standing
  - Functional tasks and mobility are the best exercises
  - Improved bowel and bladder function means more control of life
  - Reduction in pain
  - Improved endurance and quality of task

Exoskeleton use in the ATSU-ASHS Center for Occupational and Physical Therapy

Home Evaluation Video - Foosball

Secondary Complications of Spinal Cord Injury

- Bone density loss - Osteopenia/Osteoporosis
- Pressure related injuries
- Autonomic dysreflexia
- Bowel and bladder dysfunction
- Spasticity
- Emotional/Mental health and well-being

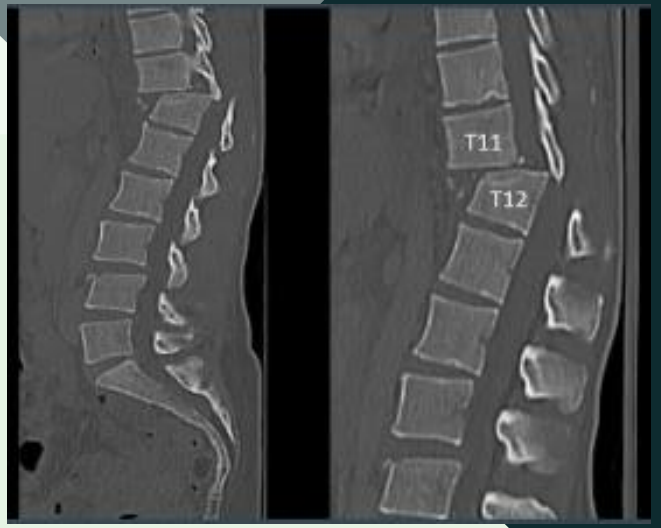


SCI Physical Activity Statistics

- 50% of all individuals with SCI report no physical activity
- Only 12% meet SCI activity guidelines
- 67% of persons with SCI are either overweight or obese

Spinal Cord Injury (SCI) Demographics

- 18,000 new spinal cord injuries occur each year in the U.S.
- More than 300,000 people with SCI in the U.S.
- Average age at time of injury is 43 years old
- Male 79%, Female 21%
- Average hospital stay: 11 days ICU/acute care, 31 days in rehabilitation
- Most common causes: Vehicle accidents, falls, violence, sports injuries, surgical complications, diving accidents



SCI Physical Activity Guidelines

Health Benefits of Physical Activity

- Improved cardiometabolic health
- Improved bowel/bladder function
- Improved bone health
- Decreased pain and spasticity
- Improved mental health and lower risk of depression
- Decreased risk for DM II, MI, CVA, etc

Benefits in Daily Activities

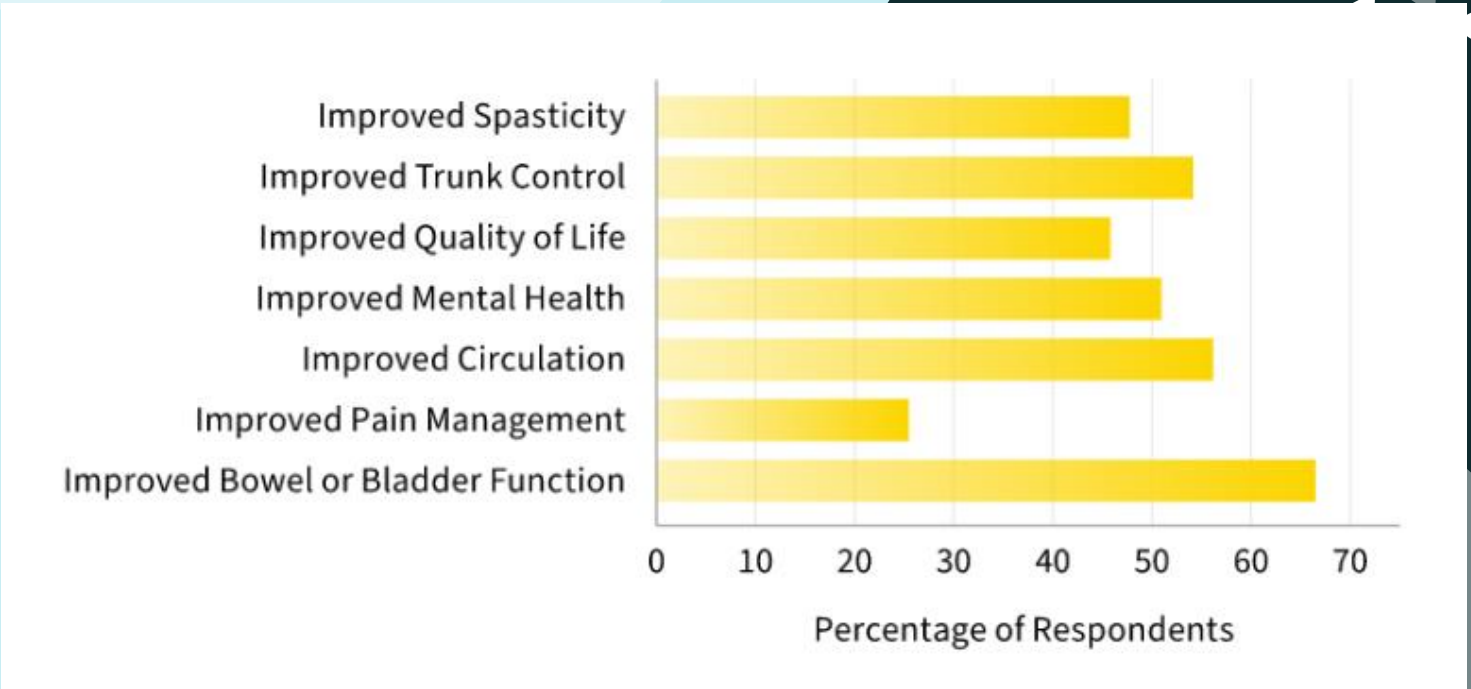
- Improved endurance for wheeling or walking longer distances
- Easier transfers in and out of the wheelchair
- Enhanced self-care and mobility
- More energy and less fatigue
- More social interaction opportunities
- Improved ability to play with your kids

A Functional Tale of Three Exoskeleton Users

These people use their exoskeleton for :

- Farming
- Standing/grooming at bathroom sink
- Shopping in the grocery store

What Exoskeleton Users Report



The first step is the referral!

- ApexNetwork PT - Sierra Vista, AZ
- Barrow Neurological Institute - Phoenix, AZ
- Neuro & Brain Performance Centers - Mesa, AZ
- Touchstone Rehabilitation - Phoenix, AZ
- Veterans' Administration Medical Center - Phoenix, AZ

Research Questions

- Which ADLs are possible at the exoskeleton level?
- How does use of the exoskeleton during daily tasks affect pain?
- How important is it to exoskeleton users to complete daily tasks using the exoskeleton?

Methods

Exoskeleton Participants
12 exoskeleton users from all over the United States participated

Exoskeleton Observations
Completed via Zoom (4)
OR In-Person (8)

Data Analysis
Analysis of qualitative and quantitative data

Project Development
Interdisciplinary Team of PA s, OT s & PT s developed Initial pilot study

Outcome Measures
Canadian Occupational Performance Measure (COPM)
Return to Normal Living Index (RNLI)
Numeric Pain Reporting Scale (NPRS)

Home Evaluation
Exoskeleton users completed:
basic meal prep (counter level, stove, microwave), grooming tasks, small item transport, cleaning tasks

Results

100% completed **meal preparation** and **housekeeping** tasks

42% completed **laundry** tasks

33.3% of the men were able to **urinate while standing**

92% were able to **exercise** in standing

75% had completed or reported **community mobility**

Results

92% of participants reported completing **daily tasks** in the exoskeleton is

"***Quite or Extremely Important"*** *to them*

Results

75% of participants reported **less pain** while in the exoskeleton

67% of participants reported a **lasting reduction** in pain

67% reported improved **bowel and bladder function**

Results

“How do you feel when you are completing daily tasks using the exoskeleton?”

- **Emotional & Psychological Empowerment:**
  “Feels good [getting the mail in exoskeleton] feels like I’m accomplishing something and doing it in a way that feels normal.”

- **Physical & Therapeutic Benefits:**
  “Gives me the opportunity to get out of my wheelchair and exercise my muscles”.

- **Practical Constraints and Context-Driven Use:**
  “The need for a companion is very limiting”.

Results

"Are there tasks you would like to do with the exoskeleton that you can't do with it now?

- **Independence and Social Integration:**
  "…have people see me as "tall and/or less-disabled" would make me feel even more confident/powerful which could lead to better employment opportunities."

- **Device and Environmental Barriers:**
  "It's challenging to load/unload from vehicle".

- **Return to Active and Outdoor Lifestyles:**
  "I would like to be able to go off the sidewalk and complete more outdoor activities".

Results

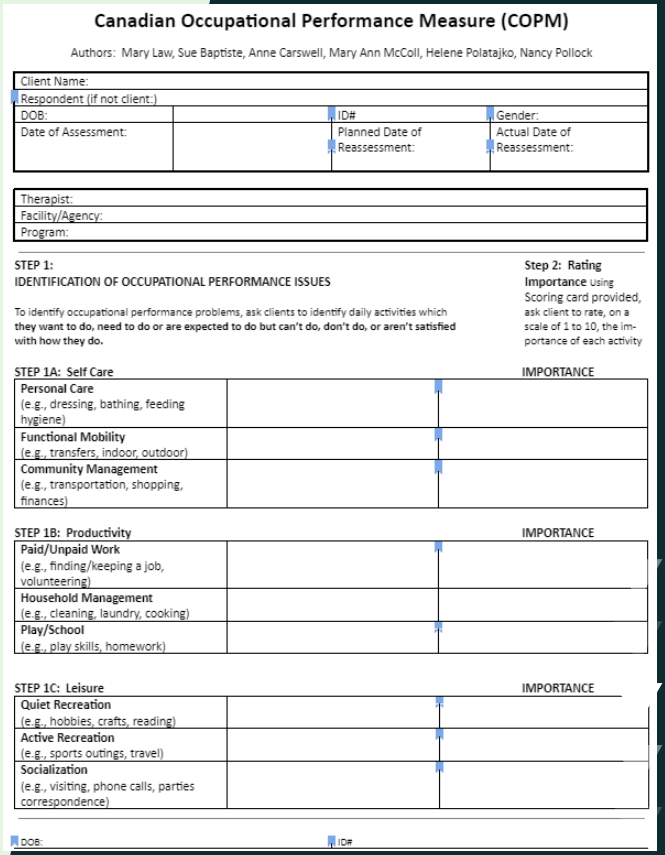
“Other reasons I don’t use the exoskeleton for tasks in my home are…”

- **Companion Requirement:**
  “It is not self-sufficient. I always have to have someone else with me. I don’t like asking people for help”.

- **Setup Complexity & Time Burden:**
  “Getting in and out of the expo is more of a project”.

- **Safety & Physical Limitations:**
  “It is not the right height for any seat other than the bench we use with it”.

Canadian Occupational Performance Measure (COPM)



Canadian Occupational Performance Measure (COPM)

Authors: Mary Law, Sue Baptiste, Anne Carswell, Mary Ann McColl, Helene Polatajko, Nancy Pollock

Client Name:			
Respondent (if not client:)			
DOB:		ID#	Gender:
Date of Assessment:		Planned Date of Reassessment:	Actual Date of Reassessment:

Therapist:
Facility/Agency:
Program:

STEP 1:
IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES

To identify occupational performance problems, ask clients to identify daily activities which **they want to do, need to do or are expected to do but can't do, don't do, or aren't satisfied with how they do.**

Step 2: Rating Importance using Scoring card provided, ask client to rate, on a scale of 1 to 10, the importance of each activity

STEP 1A: Self Care		IMPORTANCE
Personal Care (e.g., dressing, bathing, feeding hygiene)		
Functional Mobility (e.g., transfers, indoor, outdoor)		
Community Management (e.g., transportation, shopping, finances)		

STEP 1B: Productivity		IMPORTANCE
Paid/Unpaid Work (e.g., finding/keeping a job, volunteering)		
Household Management (e.g., cleaning, laundry, cooking)		
Play/School (e.g., play skills, homework)		

STEP 1C: Leisure		IMPORTANCE
Quiet Recreation (e.g., hobbies, crafts, reading)		
Active Recreation (e.g., sports outings, travel)		
Socialization (e.g., visiting, phone calls, parties correspondence)		

DOB: ID#

STEP 3: SCORING
Confirm with the client the 5 most important problems and record them below. Using the scoring cards, ask the client to rate each problem on performance and satisfaction, then calculate the total scores. Total scores are calculated by adding together the performance or satisfaction scores for all problems and dividing by the number of problems.

STEP 4: RE-ASSESSMENT
At an appropriate interval for re-assessment, the client again scores each of the problems selected for performance and satisfaction.

Initial Assessment:			Reassesement:	
Occupational Performance Problems	PERFORMANCE 1	SATISFACTION 1	PERFORMANCE 2	SATISFACTION2
1. Social access to friends homes				
2. Community access to restaurants/shops				
3. cleaning items above counter height (dusting)				
4. social events (ASL/5k)				
5. hanging a sign/outside work				

SCORING:		PERFORMANCE SCORE 1	SATISFACTION SCORE 1	PERFORMANACE SCORE 2	SATISFACTION SCORE 2
Total Score =	Total performance or satisfaction scores				
	Numbers of problems (1-5)	=	=	=	=

STEP 5: COMPUTING CHANGE SCORES

CHANGE IN PERFORMANCE = Performance Score 2		-	Performance Score 1		=
CHANGE IN PERFORMANCE = Satisfaction Score 2		-	Satisfaction Score 1		=

ADDITIONAL NOTES AND OBSERVATION:
Initial Assessment:
Reassessment:

Modified Reintegration to Normal Living Index (RNLI)

Reintegration to Normal Living Index - Modified for Exoskeleton

There are 9 items in the Reintegration to Normal Living Index. Each of these items is accompanied by verbal label choices with phrases reflecting how important the situation described is to the patient as it relates to using the exoskeleton. It allows the patients to determine the extent to which the statement in question applies to their specific situation.

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important
1	2	3	4	5

1= not important at all
5= extremely important

Max score - 45
Min score - 9

There are 9 items in the Reintegration to Normal Living Index presented in a Likert style format. Each of these items is accompanied by verbal label choices with phrases reflecting how important the situation described is to the patient as it relates to using the exoskeleton. It allows the patients to determine the extent to which the statement in question applies to their specific situation.

1= not important at all
5= extremely important

Max score - 45
Min score - 9

Reintegration to Normal Living Index Worksheet – Modified for exoskeleton use:

Patient Name:_____ Date: _____

Consider these statements in the context of when you are wearing the exoskeleton – with adaptive equipment or strategies as needed.

How important is it to you to be able to:

1. move around your living quarters in the exoskeleton.

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

2. move around your community in the exoskeleton.

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

3. use your exoskeleton when you take trips out of town.

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

4. complete self-care needs involving standing and transferring (e.g. meal preparation, toileting, hygiene tasks).

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

5. complete work activities using the exoskeleton (Work activity could be paid employment, housework, volunteer work, school, etc.)

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

6. complete recreational activities using the exoskeleton (e.g. hobbies, crafts, sports, reading, television, games, computers, etc.)

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

7. participate in social activities with family, friends, and/or business acquaintances.

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

8. participate in my personal relationships.

Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

8. use the exoskeleton when I am in the company of others.

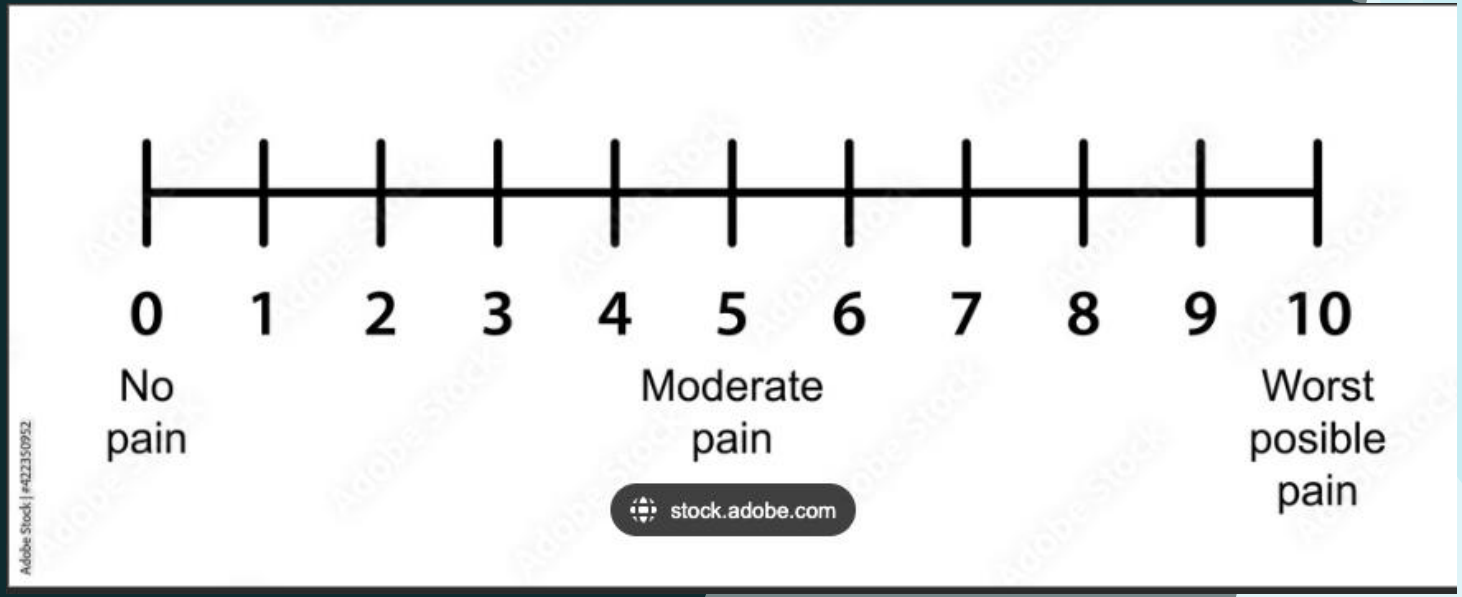
Not at all important	Slightly important	Somewhat important	Quite important	Extremely important

Total Score: _____

10. How do you feel when you are completing daily tasks using the exoskeleton?

11. Are there tasks you would like to do with the exoskeleton that you can't do with it now?

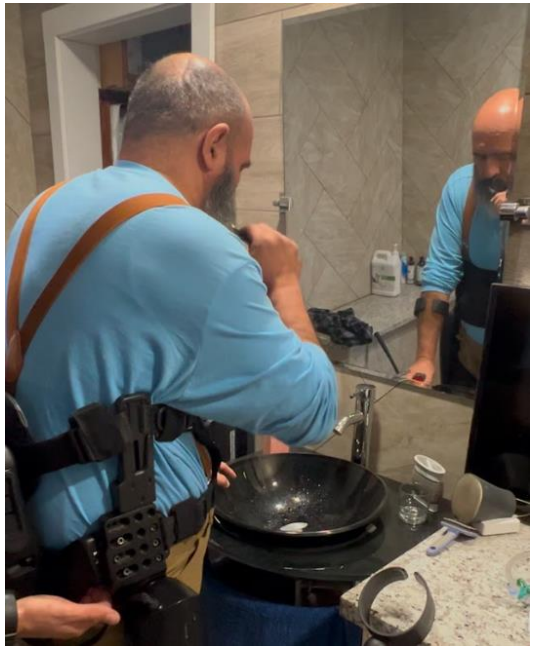
Numeric Pain Rating Scale



Using an Exoskeleton for ADLs/IADLs

Activities that the exo is used for is dependent upon each **individual's** preferences & priorities

Using an Exoskeleton for ADLs/IADLs: Self Care



Using an Exoskeleton for ADLs/IADLs: Self Care

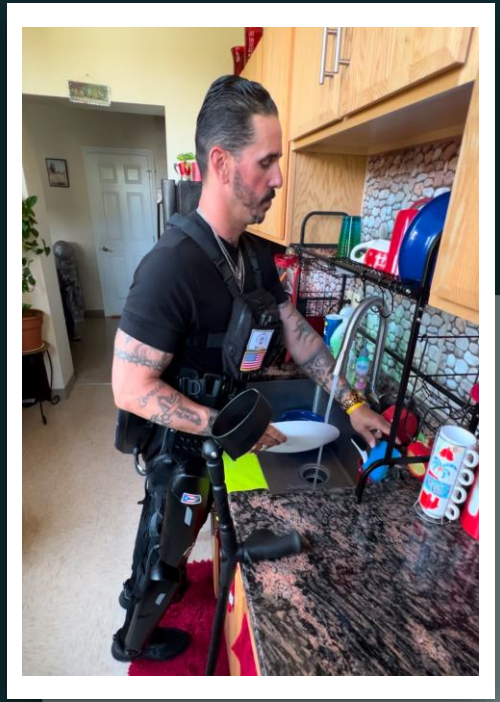
"This is the *first time* I've stood and looked at myself in the mirror in 9 years!"

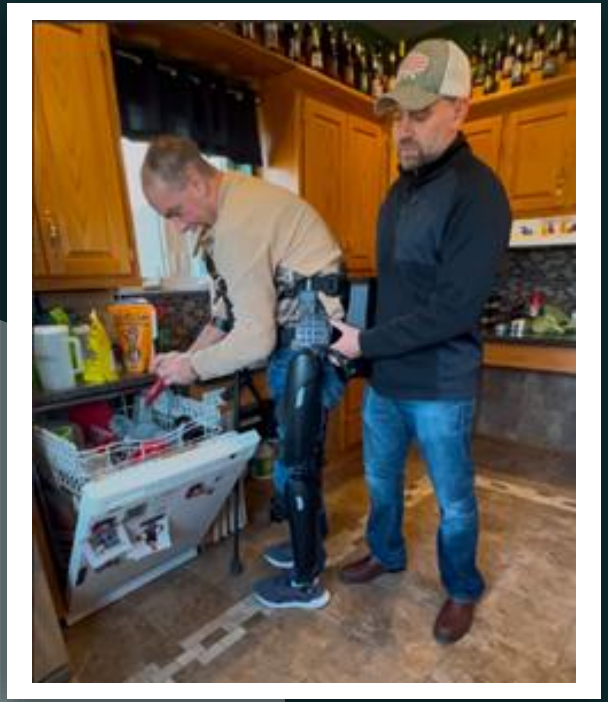
Home Evaluation Video - Brushing Teeth

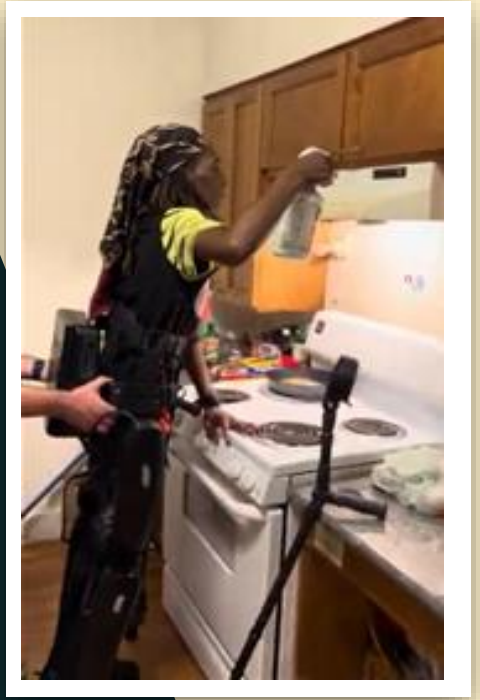
Using an Exoskeleton for ADLs/IADLs: Meal Preparation

Home Evaluation Video - Cooking

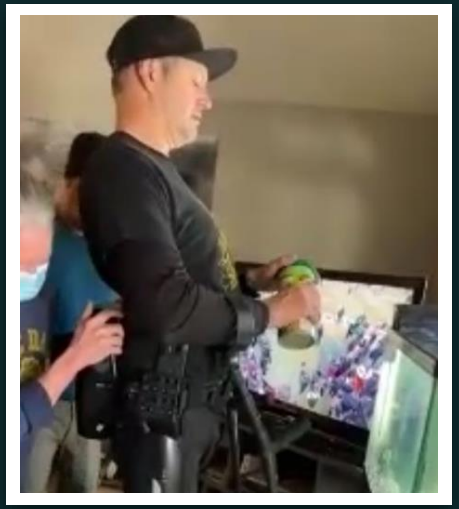
Using an Exoskeleton for ADLs/IADLs: Home Management

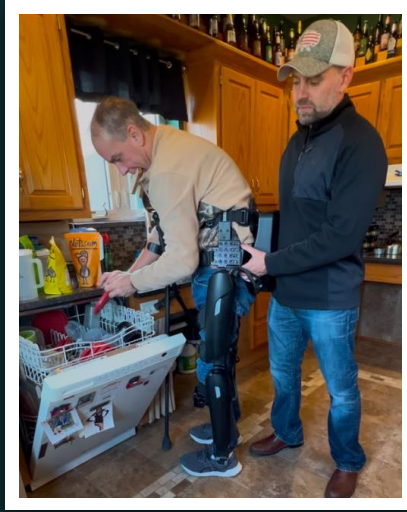






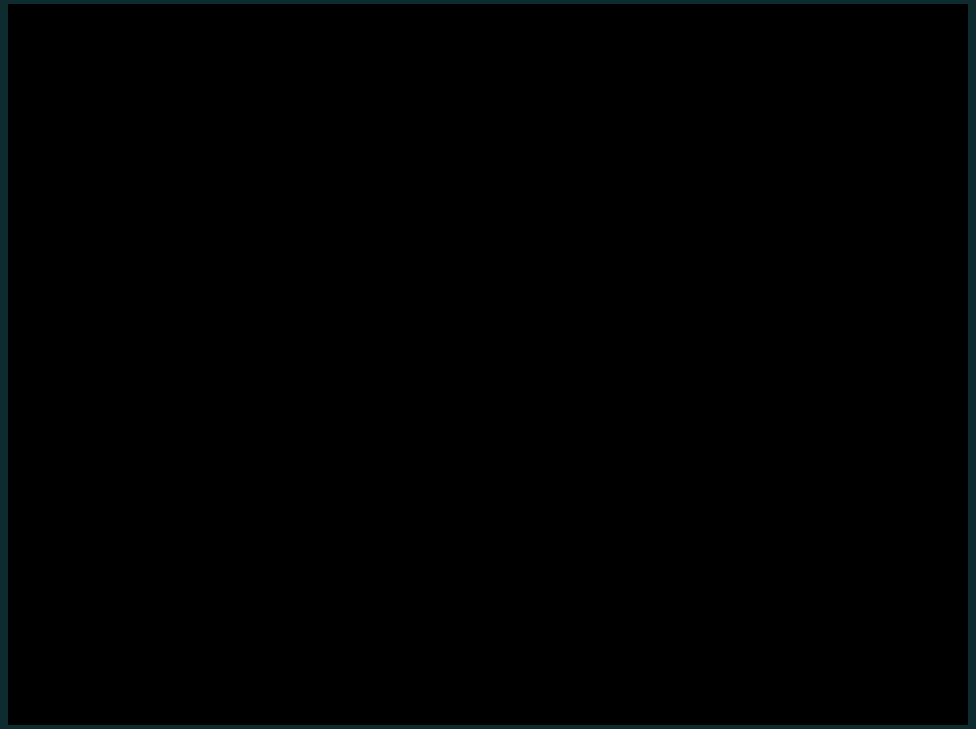
Using an Exoskeleton for IADLs: Home Management





Home Evaluation Video - Vacuuming

Home Evaluation Video - Laundry



Using an Exoskeleton for ADLs/IADLs: Shopping

Home Evaluation Video - Shopping

Using an Exoskeleton for ADLs/IADLs: Social Participation

"It feels **fabulous**" to look at people in the eye when speaking to them

Using an Exoskeleton for ADLs/IADLs: Leisure

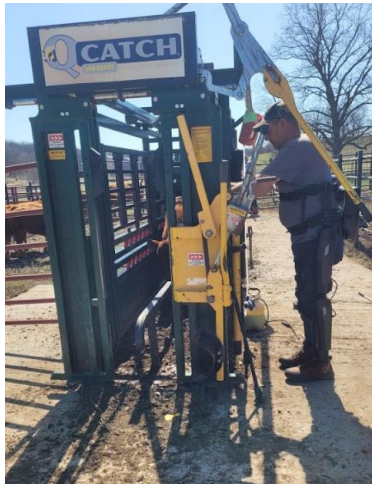
Home Evaluation Video- Exercise

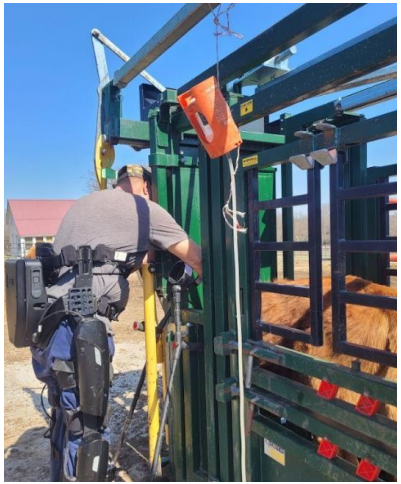
Home Evaluation Video - Exercise

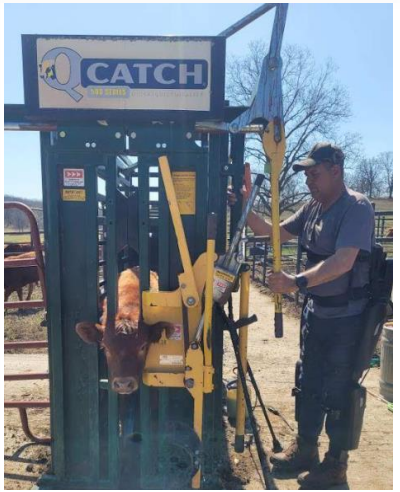
Home Evaluation Video - Stick Manipulation

Using an Exoskeleton for ADLs/IADLs: Social Participation

Using an Exoskeleton for ADLs/IADLs: Work







What Can You Do To Help?

The first step is the referral!

Home Evaluation Video - Stairs

Home Evaluation Video - Walking in the Home

Home Evaluation Video - Walking Outside

Home Evaluation Video - Curbs

Home Evaluation Video - Doffing Device

Conclusion

- Exoskeleton use for individuals with SCI improves functional independence, bowel/bladder function, and reduces pain.
- Recommend early use with increased training and guidance in the home environment.
- Advocate for more funding and support to improve access, referrals, and dosing instructions.

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QUESTIONS

ATSU
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FIRST IN WHOLE PERSON HEALTHCARE