
**Exoskeletons and Their Role in Enhancing both Patient Experience and Functional Outcomes**

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## Objectives

- Discuss benefits of exoskeletons in both therapy settings and personal home use
- Identify and discuss applications for 4 specific exoskeletal devices
- Identify appropriate candidates for exoskeletal physical therapy sessions and personal home use
- Video examples and case studies of exoskeletal devices in use both clinically and in home setting

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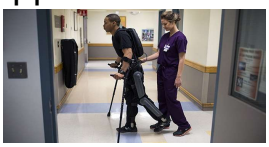
## Exoskeletal Applications

- Exoskeletons are currently being used in research, therapeutic clinical settings, and personal home use
- It is expected that over the next several years more exoskeletal devices will be available for clinical use and as a home mobility device.



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## Why use robotics in physical therapy?

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## Clinical Applications of Robotics

Provides those who have experienced paralysis or weakness the opportunity to stand and participate in:

- Early mobilization / ambulation – leading to improved functional outcomes
- Postural activities in weight bearing positions - leading to increased therapeutic motivation and outcomes
- Gait retraining – leading to improved gait quality and safety

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## Early Mobilization / Ambulation

- Ability to ambulate with lower level patients earlier and more efficiently leading to improved functional outcomes

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## Alex
### Inpatient – nonambulatory days

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## Alex
### Discharge Home

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## Alex
### Outpatient Progress Post Ekso

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## Provide a Walking Experience

- Everyone wants to walk!
- Addressing postural activities in weight bearing positions can improve therapeutic motivation and help patients link their therapy experience with their goals

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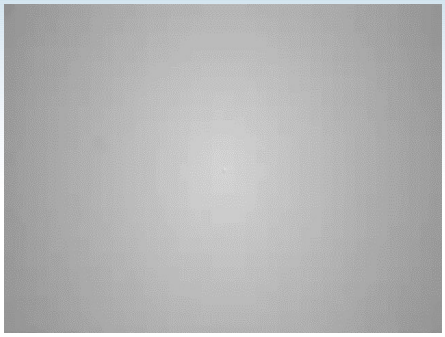

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## Gait Retraining

- High reps of higher quality steps within robotic gait sessions can lead to improved gait quality and safety over ground

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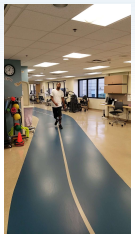
## Stephen
Pre Ekso



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## Stephen
Ekso Gait Session

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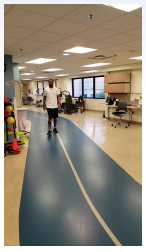
## Stephen
Post Ekso



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## Efficiency

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## Why use personal exoskeletal devices?

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## Experience More than Walking Health & Fitness Considerations

- Social & psychological well being
- Maintenance of bone mass
- Improved seated balance
- Better sleep and reduced fatigue
- Reduced pain
- Improved body conditioning and cardiovascular health
- Improved skin integrity and decreased incidence of pressure wounds
- Improved bowel & bladder functioning

Published study in Medical Devices: Evidence and Research "Clinical effectiveness and safety of powered exoskeleton-assisted walking in patients with spinal cord injury: systematic review with meta-analysis" March 2016

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## Exoskeletal Devices

- There are currently several exoskeletal devices being used in the United States including EKSO Bionics, ReWalk, Rex Bionics, and Indego.

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## Ekso (Ekso Bionics)

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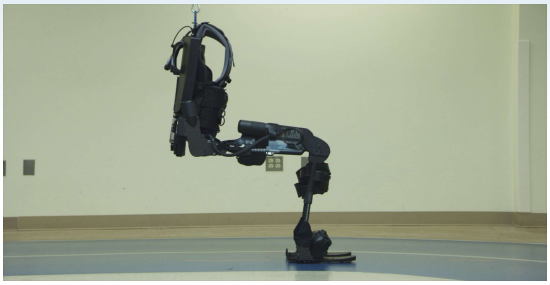
## Ekso



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## Ekso Bionics

- Ekso is a wearable, battery-operated bionic exoskeleton that enables patients with lower extremity weakness or paralysis to stand and walk on level surfaces.
- Motors power the hip and knee joints, and the motion is initiated through the use of an external controller operated by the therapist.

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## Ekso Remote


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## Ekso Considerations

- Ekso is used clinically in a therapeutic setting for early mobilization and early ambulation as well as for improving a client's gait quality even if they are functional ambulators already (wide spectrum of appropriateness)
- Currently no personal unit available

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## Variable Assist Software Programming

- Steps are initiated when the user achieves the necessary weight shift position
- Variable assistance features allow the client to utilize as much of their own motor power as possible
- Real time adaptive assistance



## Smart Assist Technology Widened the Ekso Spectrum

- Addresses higher functioning patients previously thought to be “too good” for Ekso with 2-Free option
- Ability to challenge with resistance and interval training

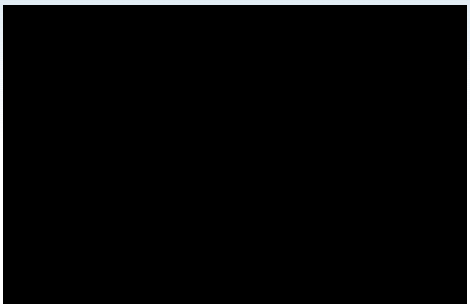


## Patients who may be appropriate for EKSO

- Current FDA approval (on label uses) for SCI & CVA
- TBI
- Guillain-Barré
- MS
- Generalized weakness caused by other neurological conditions leading to gait impairment



## Ekso in Use



## Ekso Inclusion Criteria

- Heights approximately 5' – 6'4" (actual leg length determines suitability)
- Weight less then 220 pounds
- Hip measurement less than 18" in standing position
- Functional upper extremity strength to manage an assistive device in stance

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## Inclusion Continued

- Near normal range of motion in all leg joints (ability to program up to 12 degrees hip or knee flexion into device but must achieve a neutral ankle)
- Proficient sitting balance and transfers into Ekso
- Involvement in standing program

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## Exclusion Criteria

- Range of motion restrictions that would limit client from achieving a normal walking pattern or completing sit-to-stand or stand-to-sit transitions
- Inability to achieve a neutral ankle
- Upper extremity strength deficits that limit the ability to balance using an assistive device in stance
- Spinal instability
- Deep vein thrombosis
- Orthostatic hypotension

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## Exclusion Continued

- Uncontrolled autonomic dysreflexia
- Uncontrolled spasticity
- Skin integrity issues over areas that are in contact with Ekso device
- Upper leg length discrepancy greater than 0.5" or lower leg length discrepancy greater than 0.75"(device must be measured symmetrically)
- Cognitive impairments resulting in motor planning or impulsivity concerns (must be able to follow simple commands and basic communication)
- Pregnancy
- Bone Density Considerations

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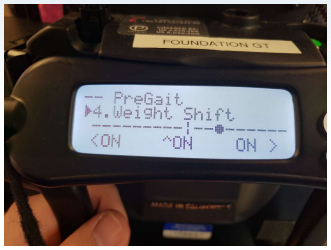
## Ideal for Users with Hemiplegia

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## Mary
Pre Ekso

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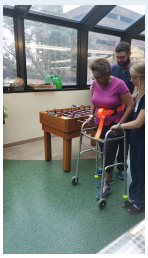
## Mary



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## Mary
Ekso Sit → Stand

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## Mary
1st Ekso Gait Session

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## Mary
1st Ekso Gait Session

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## Mary
Post Ekso Training at Discharge (2 weeks later)

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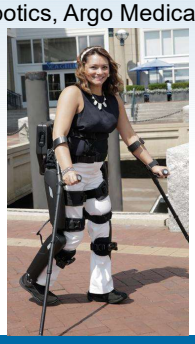
## ReWalk
(ReWalk Robotics, Argo Medical Technologies)



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## ReWalk

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## ReWalk

- Enables walking in multiple environments, as well as ability to sit, stand, and turn
- Light, wearable exoskeleton designed for all-day use
- User-initiated walking, powered by patented tilt-sensor technology
- Supports its own weight; user does not expend unnecessary energy while walking
- Rechargeable battery power
- Total assistance
- First FDA approved home unit

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## Indications for ReWalk

- Designed to assist persons with lower extremity weakness or paralysis to walk over level ground.
- Patients who may be appropriate for ReWalk Home unit:
  - Complete or incomplete SCI

  (FDA approved for levels T7 and below with companion)
  - Other non functional ambulators with UE function

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## ReWalk in Use

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## ReWalk Inclusion Criteria

- Fair or better upper extremity strength
- Good upper extremity ROM
- Fair or better trunk control
- Good sitting posture and body awareness
- Between 5'3" to 6'2" tall
  (dependent on femur length)
- Weighs 220 lbs or less
- Minimal Lower extremity spasticity

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## Inclusion Continued

- Able to tolerate standing and gait program
- Sufficient LE ROM to allow ambulation
- Patient demonstrates motivation to walk again
- Funding to purchase

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## Exclusion Criteria

- Uncontrolled spasticity or clonus
- Infection, pressure sores or DVT
- Pregnancy and/or lactating females
- Severe concurrent medical conditions
- Psychiatric or cognitive issues
- Bone density considerations

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## ReWalk Clinic

- There are rehab centers that partner with ReWalk to hold monthly clinics
- Patients are able to trial the device and it is then determined if patient is suitable to pursue home unit (or 90 day trial)
- Patient returns for training once personal device is secured

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## REX (REX Bionics)

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## REX Bionics

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## Rex Bionics

- First hands free, self supporting robotic device to allow persons with paralysis or weakness to stand and allow for mobility.
- Used with patients with T4 complete spinal cord injury and higher and any other neurological conditions that result in inability to stand
- Total assistance
- Backwards and side shuffle steps

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## REX Rehab & REX P

- REX Rehab
- Designed for rehab centers and hospitals, rapidly adjustable for each user
- Marked and registered in the US for use under the supervision of a healthcare professional

- REX P
- Custom fitted to each user enabling use at home, work, and community
- Not registered in the US

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## REX in Use



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## Rex Bionics Inclusion Criteria

- Height between 4’8” to 6’4”, but is dependent on leg length
- Weight between 88 and 220 pounds
- Sufficient ROM at hip, knee, and ankle
- Calf and thigh diameters within REX range

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## Rex Bionics Exclusion Criteria

- Impaired skin integrity
- Uncontrolled orthostatic hypotension
- Unhealed fractures / hip subluxation
- Severe contractures
- Uncontrolled autonomic dysreflexia
- Severe cognitive impairment
- Bone density considerations

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## Clinical Applications of REX

- NOT a gait retraining device and therefore used for nonfunctional ambulators
- Can provide a standing and walking experience for patients while focusing on head and trunk control and postural awareness in a weight bearing position
- Ability to include patients with limited upper extremity function

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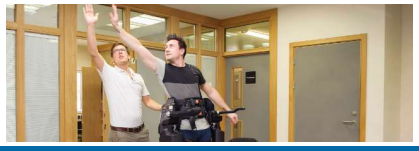
## REX in Therapy





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## Indego (Parker Indego)

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## Indego

- Designed to be light weight (26 pounds) and modular (breaks down into 5 pieces for easy transport and donning / doffing)
- Options for both variable robotic assist and FES
- Compact profile allows wearing device in personal wheelchair or even standard chair
- Used with a stability aid
- Has total assist or variable assist programming options

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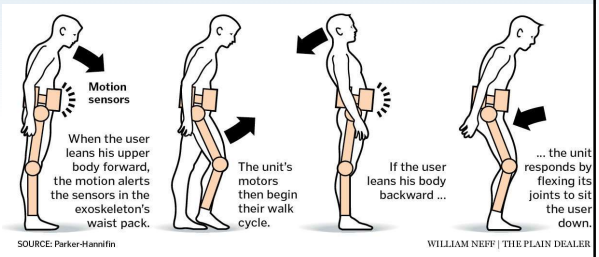
## Indego mechanics

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## Indego modular design

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## Indego Primary Indications

- Non-ambulatory individuals – Mobility Mode (provides legged mobility and associated health and wellness benefits)
- Ambulatory individuals – Therapy Mode (enables over ground locomotor training for neural re-education and functional recovery)
- Now FDA approved for clinical and personal use (SCI & CVA)

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## Indego in Use

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## Robotic Programs

- There are a number of robotic programs throughout the U.S.
- Use of robotics is expanding through research programs, clinical therapeutic settings, and as personal devices that serve as mobility aides and enhance health and wellness programs
- Devices will continue to advance and become more and more prevalent in the realm of neurological recovery and function

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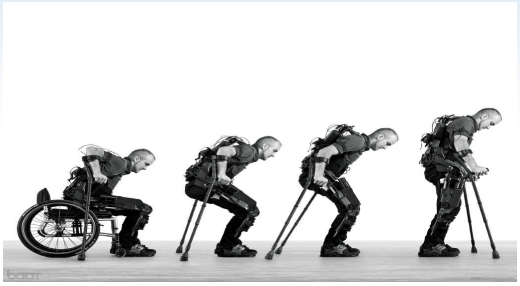
## The Future Is Here



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