Intensive Therapy After Spinal Cord Injury: What's the Return on Investment?

Meghan Joyce, PT, DPT, NCS

Clinical Supervisor NeuroRecovery Network

Craig Hospital

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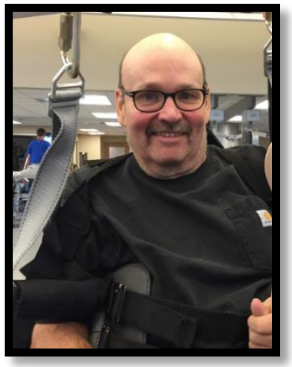
Objectives:

- Participants will describe the impact of intensive therapy after SCI to promote lifelong recovery and health.
- Participants will describe the key areas of return on investment associated with intensive therapy after SCI.
- Participants will review case studies demonstrating the positive impact of utilizing intensive therapy to promote lifelong term health, wellness and independence after neurologic injury.
- Participants will review current literature focused on the use of intensive therapy after SCI and the impact on life care planning.
- Participants will discuss the future of technological advancements that may play a critical role in the evolution of neurorehabilitation over the next 5-10 years.



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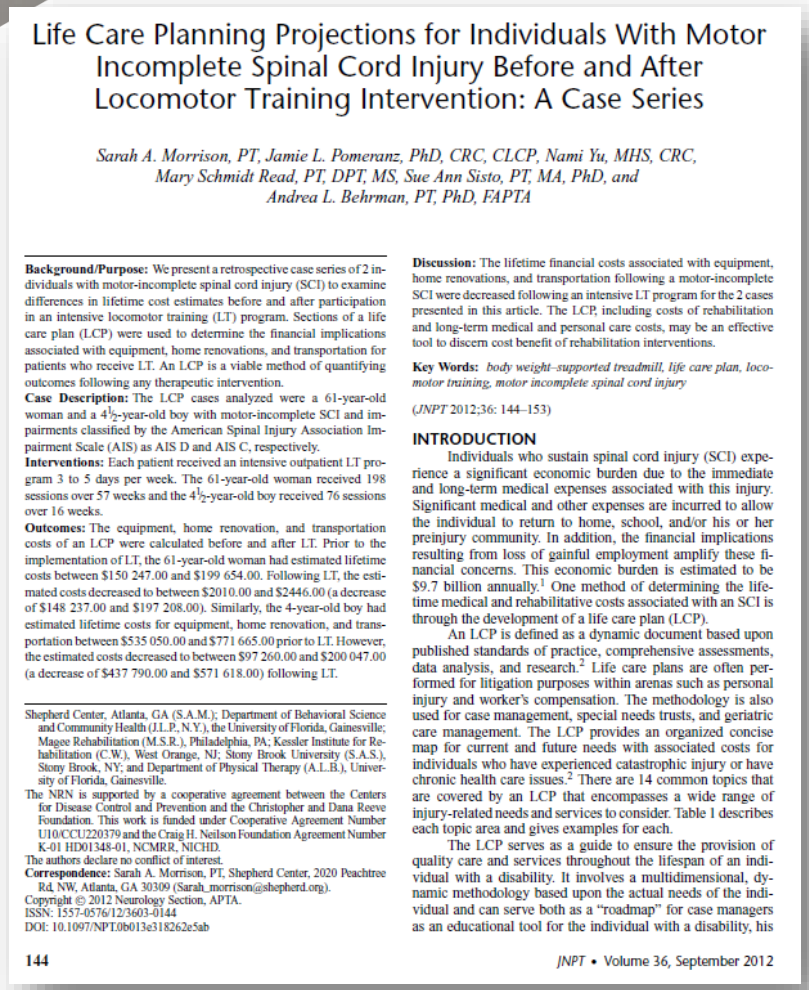
So What?

ROI: Lifetime Cost



Life Care Planning Projections for Individuals With Motor Incomplete Spinal Cord Injury Before and After Locomotor Training Intervention: A Case Series

Sarah A. Morrison, PT, Jamie L. Pomeranz, PhD, CRC, CLCP, Nami Yu, MHS, CRC, Mary Schmidt Read, PT, DPT, MS, Sue Ann Sisto, PT, MA, PhD, and Andrea L. Behrman, PT, PhD, FAPTA

Background/Purpose: We present a retrospective case series of 2 individuals with motor-incomplete spinal cord injury (SCI) to examine differences in lifetime cost estimates before and after participation in an intensive locomotor training (LT) program. Sections of a life care plan (LCP) were used to determine the financial implications associated with equipment, home renovations, and transportation for patients who receive LT. An LCP is a viable method of quantifying outcomes following any therapeutic intervention.

Case Description: The LCP cases analyzed were a 61-year-old woman and a 4½-year-old boy with motor-incomplete SCI and impairments classified by the American Spinal Injury Association Impairment Scale (AIS) as AIS D and AIS C, respectively.

Interventions: Each patient received an intensive outpatient LT program 3 to 5 days per week. The 61-year-old woman received 198 sessions over 57 weeks and the 4½-year-old boy received 76 sessions over 16 weeks.

Outcomes: The equipment, home renovation, and transportation costs of an LCP were calculated before and after LT. Prior to the implementation of LT, the 61-year-old woman had estimated lifetime costs between $150 247.00 and $199 654.00. Following LT, the estimated costs decreased to between $2010.00 and $2446.00 (a decrease of $148 237.00 and $197 208.00). Similarly, the 4-year-old boy had estimated lifetime costs for equipment, home renovation, and transportation between $535 050.00 and $771 665.00 prior to LT. However, the estimated costs decreased to between $97 260.00 and $200 047.00 (a decrease of $437 790.00 and $571 618.00) following LT.

Discussion: The lifetime financial costs associated with equipment, home renovations, and transportation following a motor-incomplete SCI were decreased following an intensive LT program for the 2 cases presented in this article. The LCP, including costs of rehabilitation and long-term medical and personal care costs, may be an effective tool to discern cost benefit of rehabilitation interventions.

Key Words: *body weight–supported treadmill, life care plan, locomotor training, motor incomplete spinal cord injury*

(*JNPT* 2012;36: 144–153)

INTRODUCTION

Individuals who sustain spinal cord injury (SCI) experience a significant economic burden due to the immediate and long-term medical expenses associated with this injury. Significant medical and other expenses are incurred to allow the individual to return to home, school, and/or his or her preinjury community. In addition, the financial implications resulting from loss of gainful employment amplify these financial concerns. This economic burden is estimated to be $9.7 billion annually.[1] One method of determining the lifetime medical and rehabilitative costs associated with an SCI is through the development of a life care plan (LCP).

An LCP is defined as a dynamic document based upon published standards of practice, comprehensive assessments, data analysis, and research.[2] Life care plans are often performed for litigation purposes within arenas such as personal injury and worker's compensation. The methodology is also used for case management, special needs trusts, and geriatric care management. The LCP provides an organized concise map for current and future needs with associated costs for individuals who have experienced catastrophic injury or have chronic health care issues.[2] There are 14 common topics that are covered by an LCP that encompasses a wide range of injury-related needs and services to consider. Table 1 describes each topic area and gives examples for each.

The LCP serves as a guide to ensure the provision of quality care and services throughout the lifespan of an individual with a disability. It involves a multidimensional, dynamic methodology based upon the actual needs of the individual and can serve both as a "roadmap" for case managers as an educational tool for the individual with a disability, his

Shepherd Center, Atlanta, GA (S.A.M.); Department of Behavioral Science and Community Health (J.L.P., N.Y.), the University of Florida, Gainesville; Magee Rehabilitation (M.S.R.), Philadelphia, PA; Kessler Institute for Rehabilitation (C.W.), West Orange, NJ; Stony Brook University (S.A.S.), Stony Brook, NY; and Department of Physical Therapy (A.L.B.), University of Florida, Gainesville.

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The authors declare no conflict of interest.

Correspondence: Sarah A. Morrison, PT, Shepherd Center, 2020 Peachtree Rd, NW, Atlanta, GA 30309 (Sarah_morrison@shepherd.org).

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Outcomes: The equipment, home renovation, and transportation costs of an LCP were calculated before and after LT. Prior to the implementation of LT, the 61-year-old woman had estimated lifetime costs between $150 247.00 and $199 654.00. Following LT, the estimated costs decreased to between $2010.00 and $2446.00 (a decrease of $148 237.00 and $197 208.00). Similarly, the 4-year-old boy had estimated lifetime costs for equipment, home renovation, and transportation between $535 050.00 and $771 665.00 prior to LT. However, the estimated costs decreased to between $97 260.00 and $200 047.00 (a decrease of $437 790.00 and $571 618.00) following LT.

Severity of Injury	Estimated Lifetime Cost if Injured at 25 yo
High Tetraplegia (C1-C4) AIS ABC	$4,724,181
Low Tetraplegia (C5-C8) AIS ABC	$3,451,781
Paraplegia AIS ABC	$2,310,104
Motor functional at Any Level D	$1,578,274

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Life Care Planning Projections

- 3 case studies modeled after what was published in the literature (Morrison et al 2012)

  - Certified life care planner did not assist in developing this information
- 3 specific components of the LCP were chosen for this report
  - Equipment Needs/Transportation
  - Architectural renovation: VA guidelines
  - Personal Care

[a]According to the Veteran's Administration, an individual who sustains a loss of use of one lower extremity together with other disabilities that preclude locomotion without the aid of braces, crutches, canes, or a wheelchair qualifies for up to $50 000 in architectural renovations.

Sherown

Age: 31
Diagnosis: C4 AIS C SCI as a result of wrestling accident.
Goals:

- Play with kids
- Independent with ADLs
- Walk Independently
- Return to work

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Discharge from Inpatient Rehabilitation

Functional Independence Measure

Task	Score	Assist
Grooming	3	Mod A
Bathing	3	Mod A
UE Dressing	3	Mod A
LB Dressing	2	Max A
Toileting	1	Total A
Bed/wheelchair	2	Max A
Toilet	2	Max A
Tub/shower	2	Max A
Walk	1	Total A
Stairs	1	Total A

Pre-Intensive Therapy

Assumptions:

- Life Expectancy: 31y + 47.5y = 78.5y

Equipment

Item	Freq of Replacement (yrs)	Cost
Hospital Bed	3-12.5 y	$2000-2700
Air Mattress	1-6 y	$250-800
Portable Lift	1-5 y	$3,000
Manual w/c	5-7 y	$2000-3500
Power w/c with tilt	5-7 y	$20,000
Shower Chair	5-7 y	$3000
w/c cushion	1-3 y	$450-550
w/c parts	1 y	$575-2000
Total		**$362,893-381,453**

Transportation

Item	Freq of Replacement (yrs)	Cost
Driving Evaluation	1 x	$1,000
Wheelchair Accessible Van	1 x	$45,000
Van maintenance & Adaptation	1y	$28,500
Total		**$74,500**

Architectural Needs

Item	Freq of Replacement (yrs)	Cost
Renovation	1 x	$50,000
Total		**$50,000**

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Total: $487,393 – 505,953

Pre-Intensive Therapy

Assumptions:

- **Ave personal care hours for motor incomplete SCI: 39.9 hours/week**
  (French et al 2007)

Personal Care

Item	Hours/week & cost/hour	Cost
Personal Care	39.9 hours/week at $13/hour	$26972.4
Total	*47.5y	$1,281,189

Totals

Equipment, Architecture, Transportation	**$487,393**	**$505,953**
Personal Care	**$1,281,189**	**$1,281,189**
Total	**$1,768,582**	**1,787,142**

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French, D. D., Campbell, R. R., Sabharwal, S., Nelson, A. L., Palacios, P. A., & Gavin-Dreschnack, D. (2007). Health care costs for patients with chronic spinal cord injury in the Veterans Health Administration. *The journal of spinal cord medicine*, *30*(5), 477-481.

Locomotor Training

Evaluation

55 min Treadmill Training BWS

30 min Community Mobility

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Upper Extremity Training

NMES to trunk and UEs

Task Specific Training with NMES

Community Integration

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Intensive Therapy Outcomes

80 PT and OT Sessions

Functional Independence Measure

	Inpatient D/C FIM	FIM D/C NRN	Assist Level
Grooming	3	6	Modified Indep
Bathing	3	3	Mod A
UE Dressing	2	6	Modified Indep
LB Dressing	2	6	Modified Indep
Toileting	2	3	Mod A
Bed/wheelchair	1	6	Modified Indep
Toilet	1	6	Modified Indep
Tub/shower	1	5	Supervision
walk	1	6	Modified Indep
Stairs	1	5	Supervision

120 PT and OT Sessions

Outcome Measure Improvement

Outcome Assessment	Initial Assessment	Discharge Assessment
10 Meter Walk Test	Non-Ambulatory	0.43 m/s
6 Minute Walk Test	Non-Ambulatory	500 ft
Berg Balance Measure	3/56	42/56
Neuromuscular Recovery Scale	1B	2C

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Post Intensive Therapy

Assumptions:

- **Life Expectancy: 31y + 47.5y = 78.5y**

Equipment

Item	Freq of Replacement (yrs)	Cost
Hospital Bed	3-12.5 y	NA
Air Mattress	1-6 y	NA
Portable Lift	1-5 y	NA
Manual w/c	5-7 y	NA
Power w/c	5-7 y	NA
Padded Bench	**5-7 y**	**$300**
W/c cushion	1-3 y	NA
w/c parts	1 y	NA
Rollator	**1y**	**$150**
Forearm Crutches	**1y**	**$130**
Total		**$13,420 - $24,072**

Transportation

Item	Freq of Replacement (yrs)	Cost
Driving Evaluation	**1 x**	**$1,000**
Wheelchair Accessible Van	1 x	NA
Van maintenance & Adaptation	1y	NA
Total		**$1,000**

Architectural Needs

Item	Freq of Replacement (yrs)	Cost
Renovation	1 x	NA
Total		**NA**

Total: $14,420 – $25,072

Post Intensive Therapy

Assumptions:

- **Life Expectancy: 31y + 47.5y = 78.5y**
- **Ave personal care hours for bathing/toileting: 2 hours/day**

Personal Care

Item	Hours/week & cost/hour	Cost
Personal Care	14 hours/week at $13/hour X 1 year	$6,760
Total	*47.5y	$449,540

Totals

Equipment, Architecture, Transportation	$13,420	$24,072
Personal Care	$449,540	$449,540
Total	$463,960	$474,612

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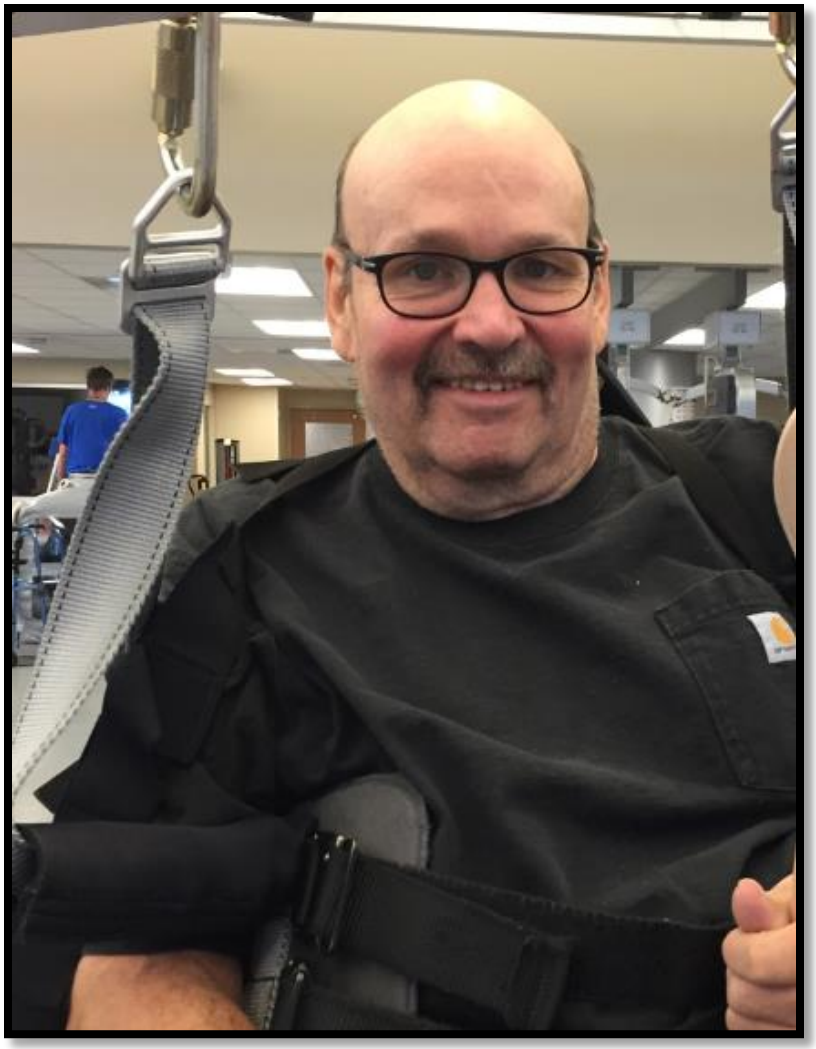
Return on Investment

	Pre Intensive Therapy	Post Intensive Therapy
Total Cost	$1,787,142	$474,612

Cost Reduction ~ $1,312,530
Outpatient Therapy Costs: $150k
Total Savings: ~$1.16 million dollars

Pete

- 54 y.o. Boilermaker, Rural Montana
- C4 AIS C: Fall in the home
- Goals
  - Return to his home vs. SNF
  - Stand up and walk independently
  - Transfer into a car
  - Use a manual WC vs. Power WC



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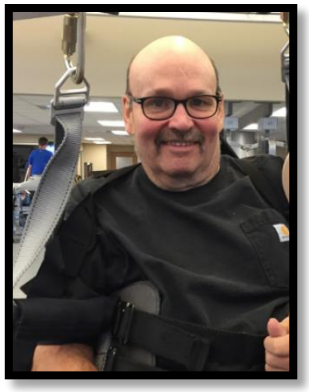
Discharge from Inpatient Rehabilitation

Functional Independence Measure

Task	Score	Assist
Grooming	6	Mod I
Bathing	2	Max A
UE Dressing	2	Max A
LB Dressing	1	Total A
Toileting	1	Total A
Bed/wheelchair	2	Max A
Toilet	2	Max A
Tub/shower	2	Max A
Walk	1	Total A
Stairs	1	Total A

Pre-Intensive Therapy



Assumptions:

- **Life Expectancy: 54y + 22.7y = 76.7**

Equipment

Item	Freq of Replacement (yrs)	Cost
Hospital Bed	3-12.5 y	$2000-2700
Air Mattress	1-6 y	$250-800
Portable Lift	1-5 y	$3,000
Manual w/c	5-7 y	$2000-3500
Power w/c with tilt	5-7 y	$23,000
Shower Chair	5-7 y	$3000
W/c cushion	1-3 y	$450-550
w/c parts	1 y	$675-2100
Total		**$179,366-206,539**

Transportation

Item	Freq of Replacement (yrs)	Cost
Driving Evaluation	1 x	$1,000
Wheelchair Accessible Van	1 x	$45,000
Van maintenance & Adaptation	1y	$28,500
Total		**$74,500**

Architectural Needs

Item	Freq of Replacement (yrs)	Cost
Renovation	1 x	$50,000
Total		**$50,000**

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Total: $303,866-$331,039

Pre-Intensive Therapy

Assumptions:

- **Ave personal care hours for motor incomplete SCI: 39.9 hours/week**
  (French et al 2007)

Personal Care

Item	Hours/week & cost/hour	Cost
Personal Care	39.9 hours/week at $13/hour	$26972.4
Total	*22.7	$612,273

Totals

Equipment, Architecture, Transportation	$303,866	$331,039
Personal Care	$612,273	$612,273
Total	$916,139	$943,312

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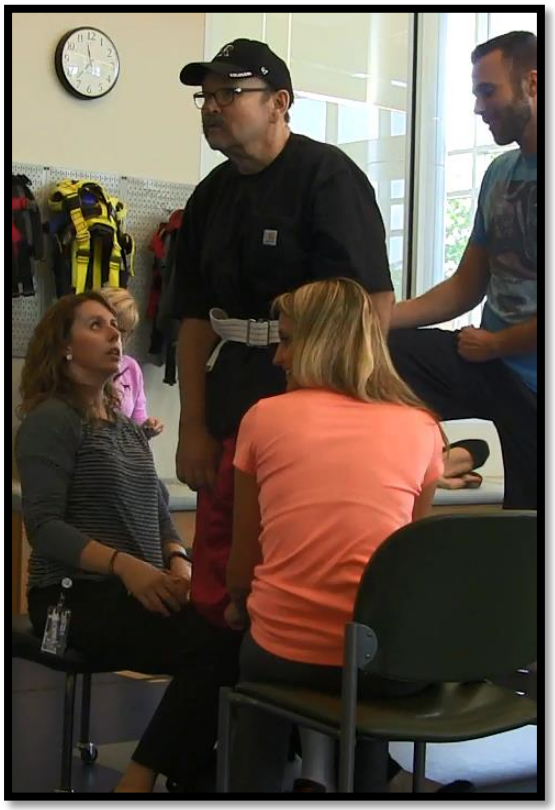
French, D. D., Campbell, R. R., Sabharwal, S., Nelson, A. L., Palacios, P. A., & Gavin-Dreschnack, D. (2007). Health care costs for patients with chronic spinal cord injury in the Veterans Health Administration. *The journal of spinal cord medicine*, *30*(5), 477-481.

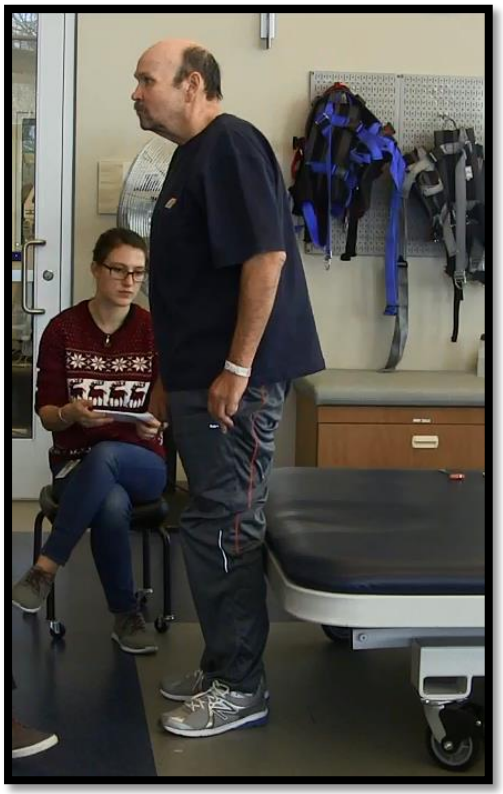
Standing Progression

Initial Eval
6/1/15

1st Re-eval (20 sessions)
7/2/15



Discharge eval (120 sessions)
12/11/15



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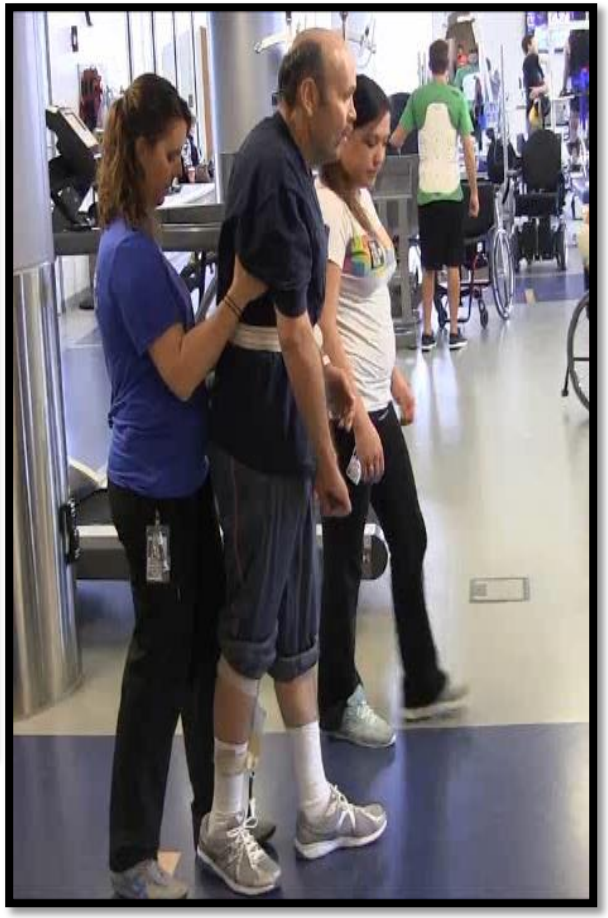
Locomotor Training Progression

Inpatient DC

Outpatient Therapy

Outpatient Therapy



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Discharge Outpatient Therapy

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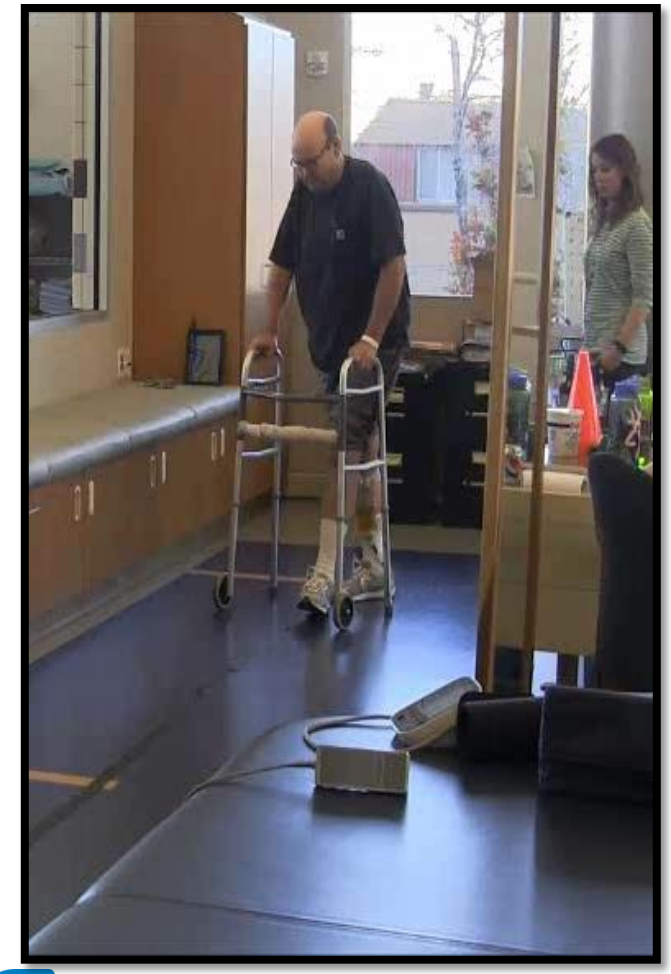
Discharge Intensive Therapy

120 PT and OT Sessions



Functional Independence Measure

	Inpatient D/C FIM	FIM D/C NRN	Assist Level
Grooming	6	6	Modified Indep
Bathing	2	4	Min A
UE Dressing	2	4	Min A
LB Dressing	1	6	Modified Indep
Toileting	1	3	Mod A
Bed/wheelchair	2	6	Modified Indep
Toilet	2	6	Modified Indep
Tub/shower	2	5	Supervision
walk	1	6	Modified Indep
Stairs	1	5	Mod A

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Outcome Measure Improvement

Outcome Assessment	Initial Assessment	Discharge Assessment
10 Meter Walk Test	Non-Ambulatory	0.61m/s
6 Minute Walk Test	Non-Ambulatory	662 feet
Berg Balance Measure	4/56	36/56
Neuromuscular Recovery Scale	1C	2C

Discharge Disposition: Home

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Post Intensive Therapy

Assumption:

- **Life Expectancy: 54y + 22.7y = 76.7y**

Equipment

Item	Freq of Replacement (yrs)	Cost
Hospital Bed	3-12.5 y	NA
Air Mattress	1-6 y	NA
Portable Lift	1-5 y	NA
Manual w/c	5-7 y	$2,000-3,500
Power w/c	5-7 y	NA
Activaid 202	**5-7 y**	**$500**
W/c cushion	1-3 y	$450-550
w/c parts	1 y	$675-2,100
Rolling Walker	**1y**	**$150**
Forearm Crutches	**1y**	**$130**
Total		**$43,402-67,442**

Transportation

Item	Freq of Replacement (yrs)	Cost
Driving Evaluation	**1 x**	**$1,000**
Wheelchair Accessible Van	1 x	NA
Van maintenance & Adaptation	1y	NA
Total		**$1,000**

Architectural Needs

Item	Freq of Replacement (yrs)	Cost
Renovation	1 x	NA
Total		**NA**

Total: $44,402-68,442

Post Intensive Therapy

Assumptions:

- **Ave personal care hours for bathing/toileting: 2 hours/day**

Personal Care

Item	Hours/week & cost/hour	Cost
Personal Care	14 hours/week at $13/hour X 1 year	$9464
Total	*22.7y	$214,832

Totals

Equipment, Architecture, Transportation	**$44,402**	**$68,442**
Personal Care	**$214,832**	**$214,832**
Total	**$259,234**	**$283,274**

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Return on Investment

	Pre Intensive Therapy	Post Intensive Therapy
Total	$943,312	$283,274
Cost Reduction: $660,038 Outpatient Therapy Costs: $150k Total Savings: ~$510,038		

**Planned skilled nursing facility discharge before Intensive outpatient therapy program

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Evidence: SCI

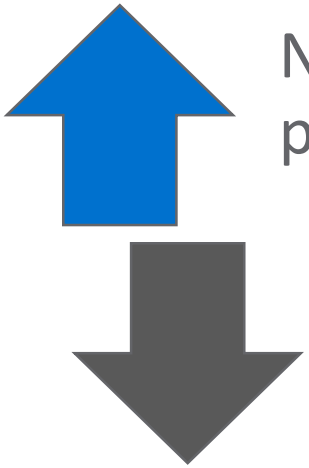
Walking improvements demonstrated in acute and chronic SCIs using various forms of locomotor training…

Cochrane Conclusion (2012): There is insufficient evidence to conclude that any one approach to locomotor training is more effective than another for improving walking function in people with spinal cord injury.

Meta-Analysis Conclusion (Cheung 2017): Lower limb robotic training was also found to be as effective as other types of body-weight-supported training

SCI Model Systems Data
One Year Mobility Outcomes: N=144

Self-Care FIM Categories	Mobility FIM Categories
1. Eating 2. Dressing–Upper Extremity 3. Dressing–Lower Extremity 4. Grooming 5. Bathing 6. Toileting	*Locomotion* 1. Walk, Wheelchair 2. Stairs *Transfers* 1. Bed, Chair, Wheelchair 2. Toilet 3. Tub, Shower



NRN +11.5 points

Standard Care

NRN patients had statistically significant higher mobility scores at 1 year than matched controls who received traditional therapy.

5 point FIM change = $25k savings 1st year and $4k each year after (Miller et al 2016)

NRN Savings: $50k first year and $8k each additional year

NRN Lifetime Saving: $330k x 72 people = $24 million dollars

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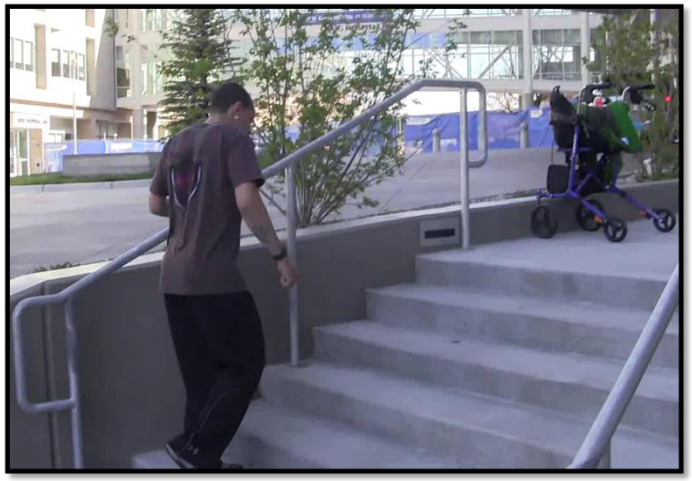
Odds of Walking Independently

Cases vs. Controls	*N*	Odds Ratio	95% CI	*p*-value
Walk 150ft In the Home	113	5.065	(1.435, 17.884)	0.013*
Walk 1 Street Block	113	2.933	(0.868, 9.910)	0.082
Walk 1 Flight of Stairs	113	5.817	(1.424, 23.756)	0.015*



NRN 5x more likely to walk independently in the home at 1 year than matched controls

NRN 3x more likely to walk 1 street block independently at 1 year than matched controls

NRN 6x more likely to walk 1 flight of stairs independently at 1 year than matched controls

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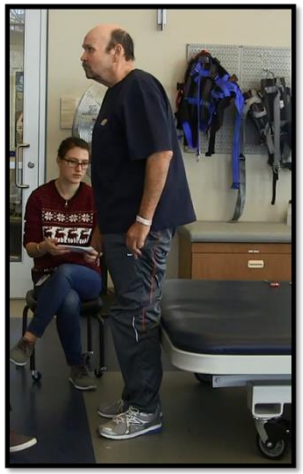
One Year Life Satisfaction Outcomes

The Satisfaction with Life Scale

DIRECTIONS: Below are five statements with which you may agree or disagree. Using the 1 -7 scale below, indicate your agreement with each item by placing the appropriate number in the line preceding that item. Please be open and honest in your responding.

1 = Strongly Disagree
2 = Disagree
3 = Slightly Disagree
4 =Neither Agree or Disagree
5 = Slightly Agree
6 = Agree
7 = Strongly Agree

___ 1. In most ways my life is close to ideal.
___ 2. The conditions of my life are excellent.
___ 3. I am satisfied with life.
___ 4. So far I have gotten the important things I want in life.
___ 5. If I could live my life over, I would change almost nothing.



NRN +4 points

Standard Care

NRN patients had statistically significant higher Life Satisfaction scores at 1 year than matched controls who received traditional therapy.

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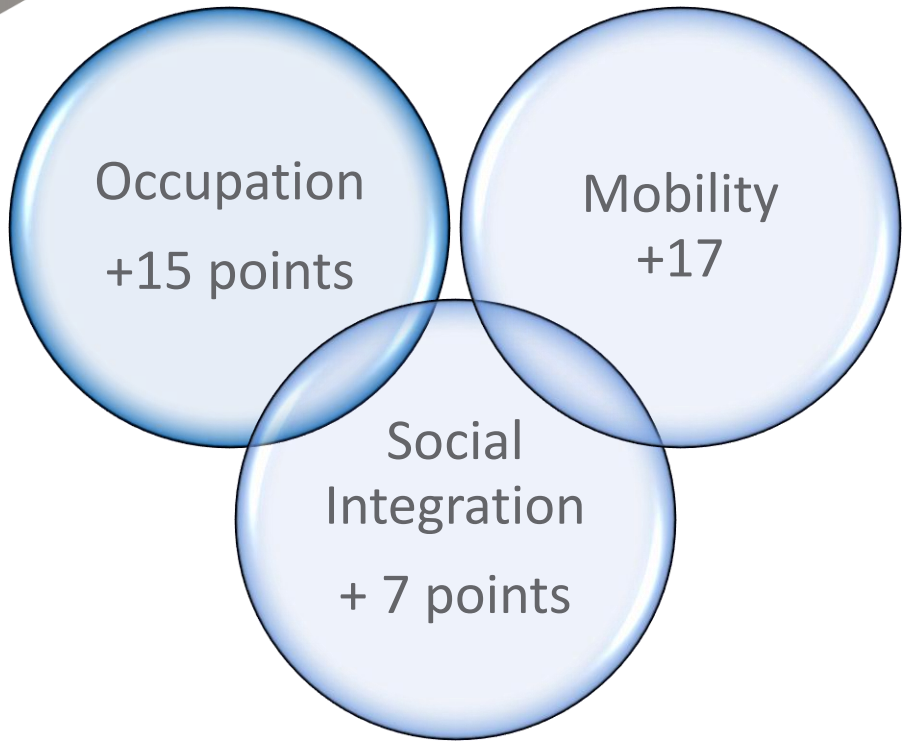
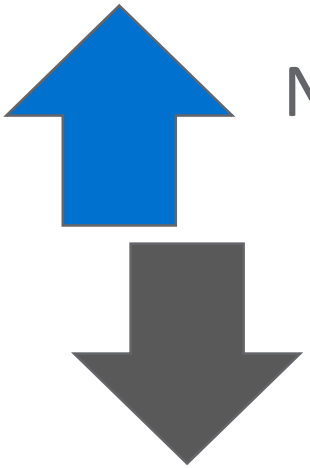
One Year Community Participation Scores





NRN

Standard Care

NRN patients had statistically significant higher Community Participation Scores at 1 year than matched controls who received traditional therapy.

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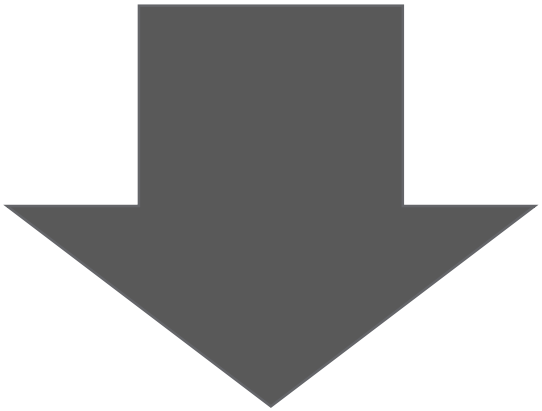
One Year Re-Hospitalization Data

NRN

Each Hospitalization = $40k
NRN: $400k
Standard of Care: $880k



Standard of Care 2.2x more likely to be re-hospitalized during the first year of injury.

	1st year Re-hospitalization	Total Re-hospitalizations
NRN Group	8	10
Standard of Care	16	22

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Is Walking Important?

Shavelle et al 2015

- Model Systems Data
- AIS Ds
- Independent walking associated with **longer survival**
- ↑ Mortality associated with incontinence and being non-ambulatory
- **Life Expectancy ~90% of normal for Independent walking and continent vs. < 75% of normal**

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ROI: Health Care Costs

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2013;94(4 Suppl 2):S87-97

ORIGINAL ARTICLE

Rehospitalization in the First Year of Traumatic Spinal Cord Injury After Discharge From Medical Rehabilitation

Conclusions: Re-hospitalization rates among individuals with SCI in the first post-injury year remain high….. Re-hospitalization risk was associated with younger age, being a woman, unemployment, retirement, and
Medicaid coverage.
Those who had more intensive physical therapy had lower odds of re-hospitalization.

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So What…

- Research supports intensive therapy interventions may facilitate recovery after neurologic injury
- Intensive therapy may reduce life time care costs:
  - Sherown: ~$1.15 million dollars
  - Pete: ~ $500,000
- NRN vs. Standard of Care: 24 million dollars (n=72)
- Decreased 1 year re-hospitalization rates and health care costs associated with intensive therapy
- What about individuals who are motor complete….New technologies on the horizon….

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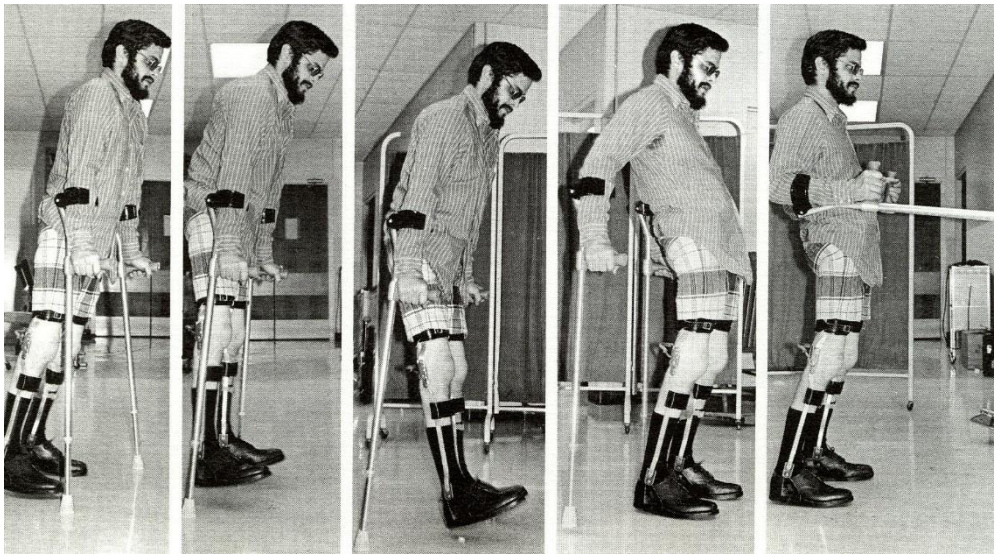
“I Want to Walk”……



KAFOs and RGOs

Considerations:

- Shoulder ROM & strength
- Shoulder joint integrity
- Hip ROM (extension)
- Physiological cost of walking
- Walking speed

Rejection Rates ~75%

- Energy expenditure
- Applied UE forces

Swing Through Pattern

Reciprocating Gait Orthosis (RGO)

Karimi, Mohammad Taghi, and Francis Fatoye. "Evaluation of the performance of paraplegic subjects during walking with a new design of reciprocal gait orthosis." *Disability and Rehabilitation: Assistive Technology* 11.1 (2016): 72-79.

Arazpour, M., et al. "The physiological cost index of walking with mechanical and powered gait orthosis in patients with spinal cord injury." *Spinal Cord* 51.5 (2013): 356-359.

Leung, Aaron KL, et al. "The physiological cost index of walking with an isocentric reciprocating gait orthosis among patients with T12–L1 spinal cord injury." *Prosthetics and orthotics international* 33.1 (2009): 61-68.

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Exoskeleton Survey of Stakeholder Perspectives

- Online survey of wheelchair users and health care professionals
  - 481 responses analyzed
    - 354 wheelchair users and 127 healthcare professionals
    - Mostly highly rated reason to recommend an exoskeleton: Health Benefits
    - 4 most important design features:
      - Minimization of fall risk
      - Comfort
      - Independence with donning/doffing
      - Purchase Cost

Wolff, Jamie, et al. "A survey of stakeholder perspectives on exoskeleton technology." *Journal of neuroengineering and rehabilitation* 11.1 (2014): 169.

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Emerging Devices

Rex™

- Weight: 84 lb
- Control: Joystick/BMI
- No AD needed
- Slopes/Stairs

Ekso™

- Weight: ~ 50 lb
- Control: trigger on assistive device and torso tilt
- Variable Assist mode
- Crutches/Walker
- FDA: Rehab use only

ReWalk™

- Weight: ~56 lb
- Control: Wrist pad and torso tilt
- Available in Rehabs
- Gait all surfaces
- Crutches only
- FDA: Home Use

Indego™

- Weight: 27 lb
- Control:Postural
- Addition of FES
- Modular
- Variable power assist
- Gait all surfaces
- Crutches/Walker
- FDA: Home Use

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Exoskeleton Literature

- Walking speed .03-.45m/s (max .51m/s) Esquinazi 2012, Yang 2015, Louie 2015
- Reports of improvements in pain, bowel, bladder function and spasticity Esquinazi 2012, Miller 2016
- Subjects reported they enjoyed training Esquinazi 2012
- Metabolic cost of walking 3.5-4.3 METS/light to moderate exercise Evans 2015, Kozlowski 2015
- Training completed with CGA/close supervision Esquinazi 2012, Kozlowski 2015
- Efficacy has not been demonstrated Lajeunesse 2015
- Exoskeleton generally did not meet subjects' high expectations in terms of perceived benefits Benson et al 2016

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Community Wellness Center

T3 AIS A x 20 years

- 2-3x/week x 3 years
- Walking without physical assist 72 visits
- Paying out of pocket for all sessions
  - ↓ Bowel program time
  - ↓ # of UTIs
  - ↓ Spasticity
  - ↑ Feeling of Health
- Research

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Out Patient Integration

T4 AIS A/TBI

- 40 exoskeleton sessions in the community fitness program
- Purchased ReWalk independently
- Pays “companion” to walk with him 3-4x/week for health and wellness benefits
- 36 PT visits to achieve Min A level with companion
- Consistent follow through X 2 years

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Out Patient Integration

T4 AIS A:

- Received Home Unit through foundation grant
- 28 sessions (~6 weeks)
- CGA ~16-18 sessions level ground
- Supervision: Sit→Stand; transfers; donning/doffing
- Companion needed more training with follow up after return to home
- Follow up: Not utilizing at 1 year

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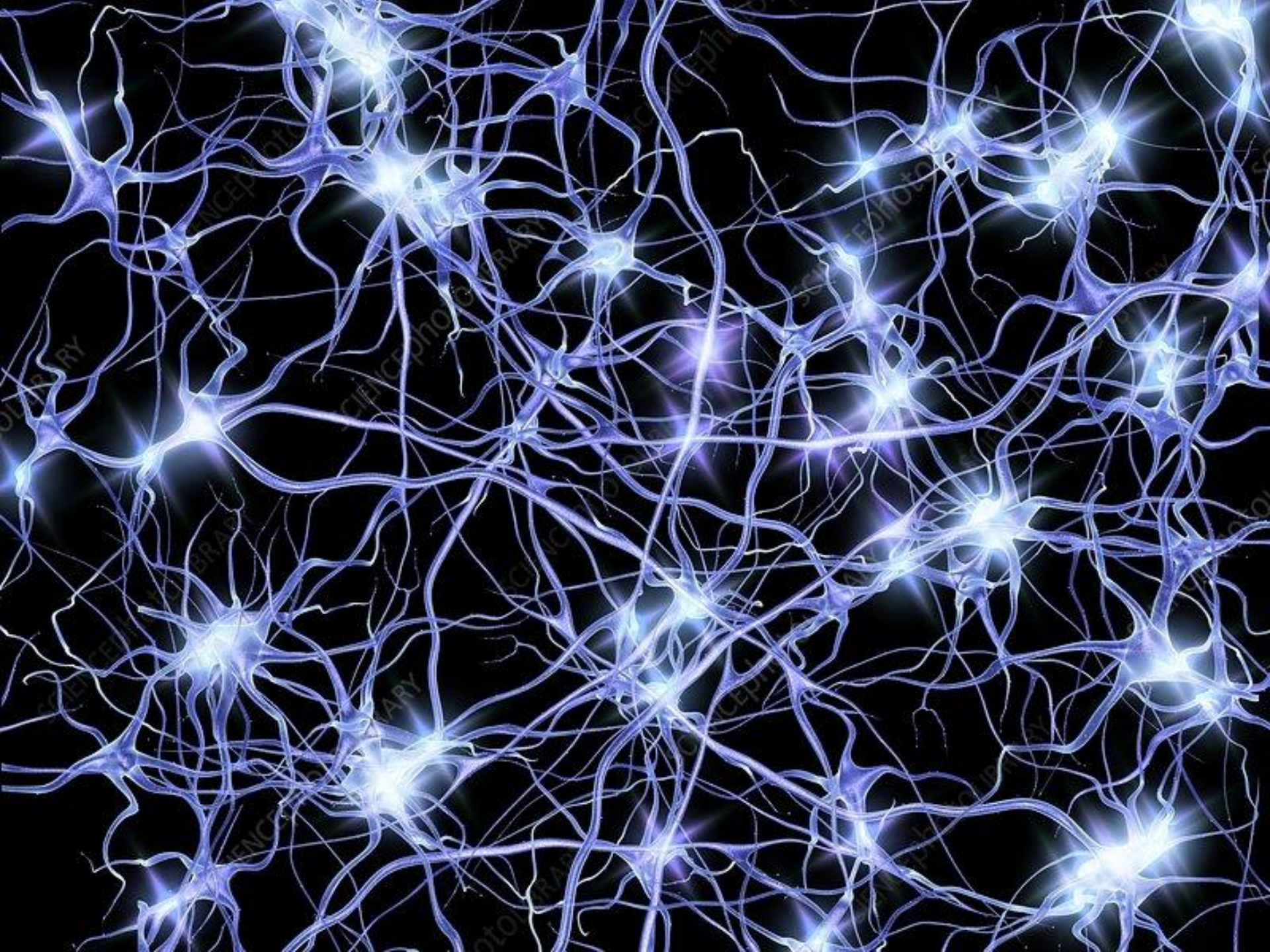
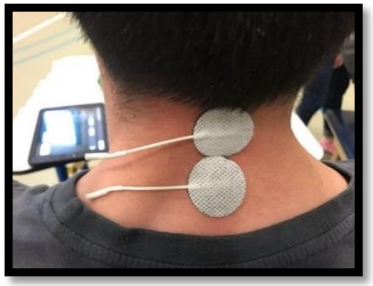


Neuromodulation



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Archives of Physical Medicine and Rehabilitation

CLINICAL NOTE

Preliminary Guidelines for Safe and Effective Use of Repetitive Transcranial Magnetic Stimulation in Moderate to Severe Traumatic Brain Injury

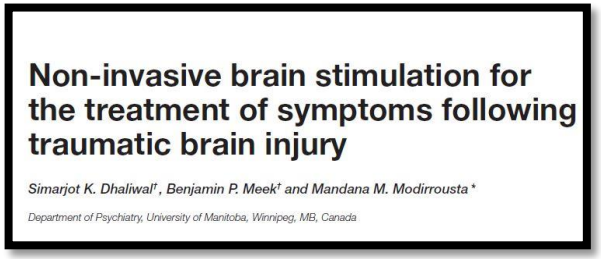
Dylan M. Nielson, BS,[a] Curtis A. McKnight, MD,[b] Riddhi N. Patel, BS,[c] Andrew J. Kalnin, MD,[c] Walter J. Mysiw, MD[b]

Effects of Lumbosacral Spinal Cord Epidural Stimulation for Standing after Chronic Complete Paralysis in Humans

Enrico Rejc[1], Claudia Angeli[1,2], Susan Harkema[1,2]*

1 Kentucky Spinal Cord Injury Research Center, University of Louisville, Louisville, Kentucky, United States of America, 2 Frazier Rehab Institute, Kentucky One Health, Louisville, Kentucky, United States of America

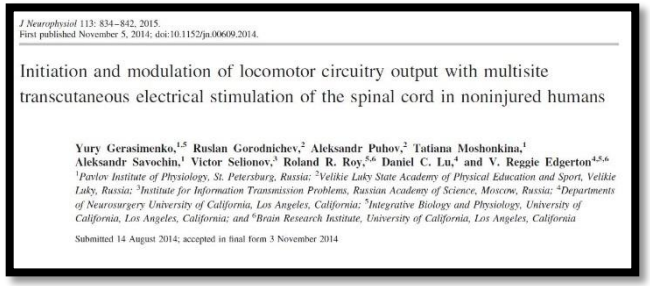
* SusanHarkema@KentuckyOneHealth.org



Non-invasive brain stimulation for the treatment of symptoms following traumatic brain injury

*Simarjot K. Dhaliwal†, Benjamin P. Meek† and Mandana M. Modirrousta **

Department of Psychiatry, University of Manitoba, Winnipeg, MB, Canada



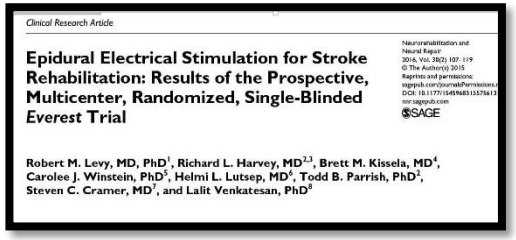
J Neurophysiol 113: 834–842, 2015.
First published November 5, 2014; doi:10.1152/jn.00609.2014.

Initiation and modulation of locomotor circuitry output with multisite transcutaneous electrical stimulation of the spinal cord in noninjured humans

Yury Gerasimenko,[1,5] Ruslan Gorodnichev,[2] Aleksandr Puhov,[2] Tatiana Moshonkina,[1] Aleksandr Savochin,[1] Victor Selionov,[3] Roland R. Roy,[5,6] Daniel C. Lu,[4] and V. Reggie Edgerton[4,5,6]

[1]Pavlov Institute of Physiology, St. Petersburg, Russia; [2]Velikie Luky State Academy of Physical Education and Sport, Velikie Luky, Russia; [3]Institute for Information Transmission Problems, Russian Academy of Science, Moscow, Russia; [4]Departments of Neurosurgery University of California, Los Angeles, California; [5]Integrative Biology and Physiology, University of California, Los Angeles, California; and [6]Brain Research Institute, University of California, Los Angeles, California

Submitted 14 August 2014; accepted in final form 3 November 2014



Clinical Research Article

Epidural Electrical Stimulation for Stroke Rehabilitation: Results of the Prospective, Multicenter, Randomized, Single-Blinded *Everest* Trial

Robert M. Levy, MD, PhD[1], Richard L. Harvey, MD[2,3], Brett M. Kissela, MD[4], Carolee J. Winstein, PhD[5], Helmi L. Lutsep, MD[6], Todd B. Parrish, PhD[7], Steven C. Cramer, MD[1], and Lalit Venkatesan, PhD[8]

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Driving Recovery Forward

The Reeve Foundation's research programs are developing and delivering treatments and cures for spinal cord injury.

Epidural stimulation results in "Unprecedented Breakthrough" for paralysis community

Four young men who have been paralyzed for years achieved groundbreaking progress – moving their legs – as a result of epidural electrical stimulation of the spinal cord. Learn more.

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Epidural Stimulation

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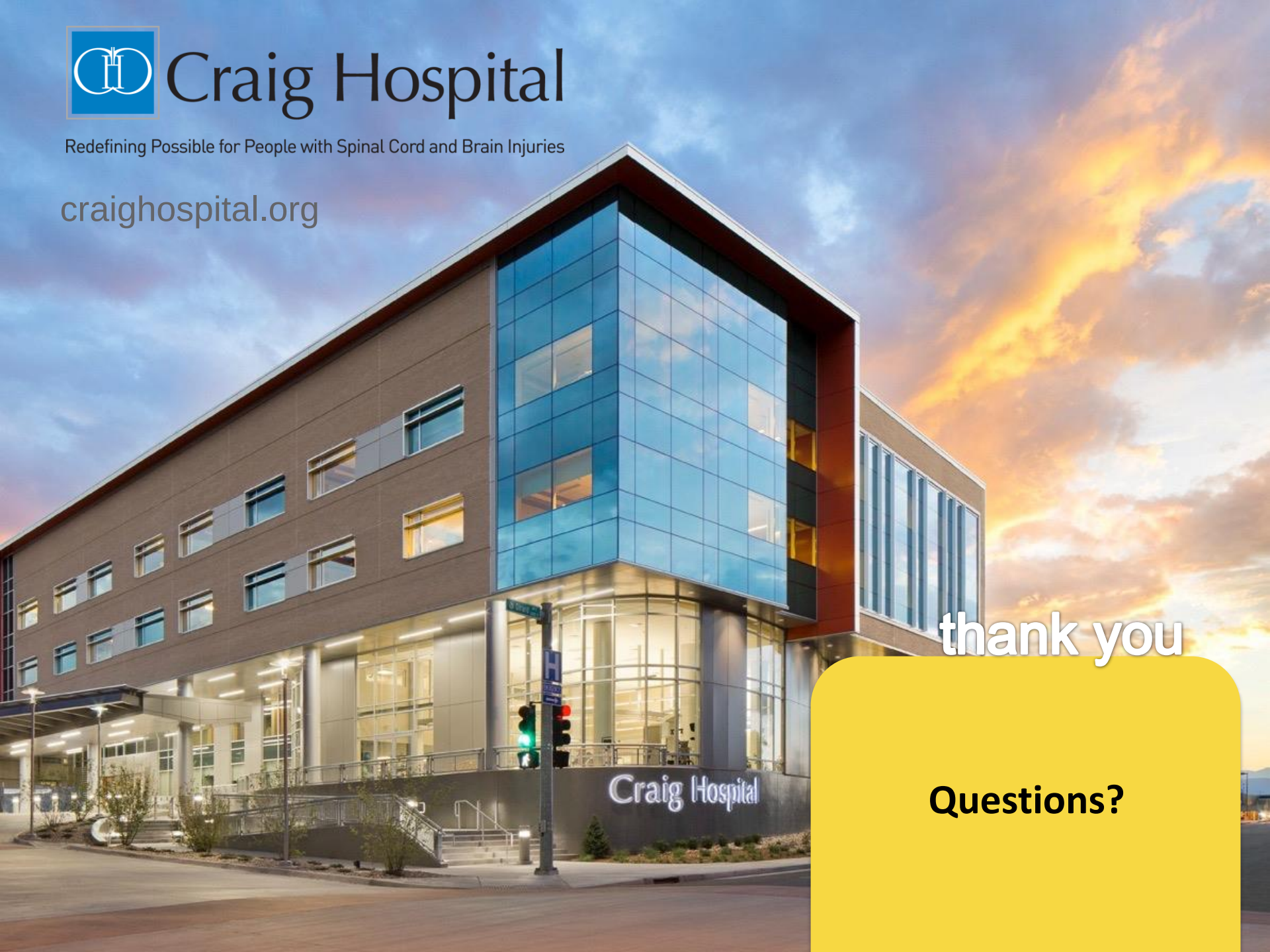
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Redefining Possible for People with Spinal Cord and Brain Injuries
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thank you
Questions?