Standing Up
to Complications of SCI/D

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Disclosure

- Ginger Walls, PT, MS, NCS, ATP/SMS
- Full-time employee with Permobil

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Learning Objectives

At the conclusion of this activity, the participant will be able to:

1. Participants will be able to identify 3 common secondary health conditions associated with SCI/D.
2. Participants will be able to identify 3 benefits of standing for persons with SCI/D as evidenced by the research.
3. Utilizing the ICF model, participants will be able to discuss 3 evidence-based benefits for body structure/function, functional activities, and/or participation offered by a wheelchair-based standing device.

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Common Secondary Conditions with SCI

Skin breakdown
↑ obesity & adipose tissue
↑ Cardiovascular disease risk
Bone density complications
Musculoskeletal wear & tear
Bowel dysmotility
Bladder infections
Pulmonary Insufficiency
Depression
↓ function
↓ participation

Are these complications of SCI or of chronic sitting?

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Accelerated Aging:

Trajectory where the rate and the effects of aging are accelerated
Health conditions occur *earlier and/or more frequently* than would otherwise be observed, leading to a narrow margin of health.

- Due to physiologic changes due to SCI and impairments that lead to immediate and long term effects on the body
- Susceptibility of those with SCI to numerous medical conditions that impart a health hazard
- Disproportionate % of deaths as a result of preventable causes, including septicemia

Groah, et al. *Am. J. Phys. Med. Rehabil.* Vol 91, No 1, Jan 2012

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Interactions Relevant to Aging with SCI

1. Current chronologic age
2. Age at injury
3. Duration of injury
4. Age cohort –social, economic, and medical context around an individual's SCI
   - Medical advances
   - Access to care and equipment
   - ADA 25 year anniversary

Groah, et al. *Am. J. Phys. Med. Rehabil.* Vol 91, No 1, Jan 2012

Spinal Cord Injury and Aging
Challenges and Recommendations for Future Research

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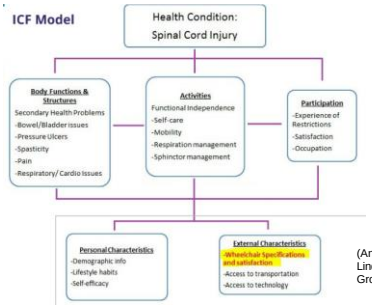


(Andriaasen, Asbeck, Lindeman, vand der Woude, de Groot, & Post, 2013)

Why Stand? Examining the Evidence

Why NOT?

Potential Complications of Immobility- After 6 weeks of bed rest

- Decreased Bone Mineral Density (BMD)
- Risk of Pressure Ulcers
- Development of Joint Contractures
- Impaired bowel and bladder functioning
- Impaired respiratory functioning
- Gastro-Intestinal problems

Deitrick J, Whedon G, Shorr E. Effects of immobilization upon various metabolic and physiologic functions of normal men. American Journal of Medicine, 1948; 4: 3.

Options for Standing

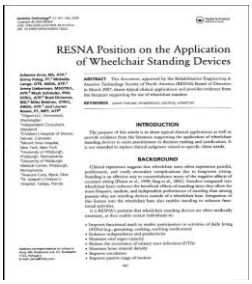
BWS/Ambulatory Aids
- Bionic Exoskelton

Separate Standing Devices
- Static or Dynamic

Wheelchair Standing Devices
- Manual/Manual
- Manual/Power
- Power/Power

RESNA Position on Wheelchair Standing Devices

- Best comprehensive overall summary of research examining wheelchair standers.
- Recently updated - 2013 (Current State of Literature)
- Benefits, Indications, Contraindications, Case Studies (CP, MS, SCI)
- Available online for download www.resna.org


RESNA Position on the Application of Wheelchair Standing Devices

WHAT IS EVIDENCE BASED PRACTICE? (EBP)

➢ Body Structure/Function Issues: *Increased Cardiovascular Risk with SCI*

Increased obesity and adipose tissue

Lack of standing, ambulation, and w/b result in changes in body composition, including decreased muscle mass and increased adipose tissue.

- Up to 75% of those with chronic SCI are overweight or obese
- Need for prudent diet, physical activity and equipment considerations.
- Increased adiposity in the abdominal region in SCI, positively correlates with increased risk for cardiovascular disease.
- Ischemic heart disease and other heart disease were the 3rd and 4th leading causes of death in people with SCI.

Groah, et al. *Am. J. Phys. Med. Rehabil*. Vol 91, No 1, Jan 2012

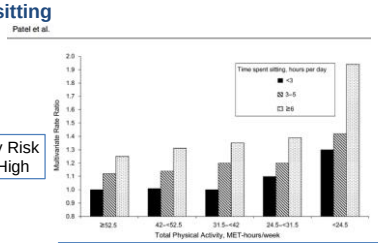
Metabolic effects of sitting

Study of 123,216 men and women over a 14 year period.

Mortality Risk
Low → High

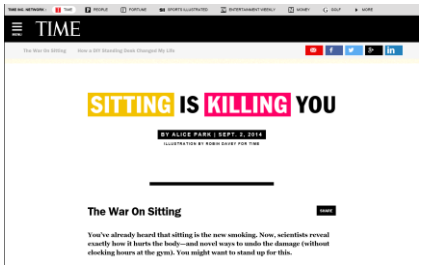
Results were independent of physical activity level.

(Patel, et al., 2010)



Activity Levels (METs)
High activity – Low Activity

STAND FOR HEALTH



Why wouldn't wheelchair users benefit from standing?

Cardiovascular Output (SCI)

4 subjects with SCI (T6, T5-6, C2-5, C5) completed 12-wk exercise with dynamic weight bearing (DWB)

- Surface EMG, HR, BP measured throughout DWB

Conclusion: Exercise during DWB can induce positive physiologic and neuromuscular responses and may serve as preparation for more advanced rehabilitation.

- Also, improved functional skills due to decreased spasticity

Edwards, L., & Layne, C. (2007). Effect of dynamic weight bearing on neuromuscular activation after spinal cord injury. American journal of physical medicine and rehabilitation, 499-506.

➢ Body Structure/Function Issues: *Bowel & Bladder*

Repeated UTI due to need for catheterization.

- Septicemia is a significant cause of death in SCI, compared with general population.

Dysmotility of bowel

UTI Risk / Hypercalciuria (SCI)

8 men; 2 women (Range: 19-56 y/o); n=10. Incomplete C5-C7 SCI

- 6 - Early Group (within 6 months post SCI)
- 5 - Late Group (12-18 months post SCI)

Compared tilt table (at least 20 min) with strengthening exercises

- Both groups – Tilt table had greater impact on Calcium balance in urine than strengthening
  – Early group with more significant results

(Kaplan, Roden, Gilbert, Richards, & Goldschmidt, 1981)

Evidence: Standing to Assist with Constipation Management (SCI)

- Single case study - 62 y/o male with T12-L1 ASIA B paraplegia
- Injured in 1965 - chronic constipation
- Standing table 5x/week - 1 hour duration
- Significant increase in frequency of BM's
- Significant decrease in bowel care time

(Hoenig, Murphy, Galbraith, Zolkewitz, 2001)

Survey of Standing Benefits

Dunn et al. (1998): Respondents reported improved bladder emptying, bowel regularity, decreased UTIs, leg spasticity, and less "bed sores". 78% "highly recommend" the use of the standing device

Survey by Eng et al. (2001) perceived benefits included improved well-being, circulation, skin integrity, bowel/bladder function, digestion, sleep, pain, and fatigue.

A survey of 99 individuals with spinal cord injuries also revealed fewer UTIs and improved bowel regularity attributed to standing (Walter et al., 1999).

STANDING – THERE'S NOTHING LIKE IT!

➢ Body Structure/Function Issues: *Respiration*

Pulmonary Insufficiency –

People with tetraplegia and high paraplegia have ineffective cough leading to increased mucous retention and infection risk

Evidence about Standing & Respiration (Critical Care)

Patients in ICU who had been intubated and mechanically ventilated more than 5 days (n=15)

- Tilt table to 70 degrees x 5 minutes
- Significant improvement in respiratory parameters during and immediately after tilt table.
  - Minute ventilation, tidal volume, respiratory rate, and arterial partial pressure of oxygen and carbon dioxide
- Not present 20 minutes later.

Chang, A., Boots, R., Hodges, P., Thomas, P., & Paratz, J. (2004). Standing with the assistance of a tilt table improves minute ventilation in chronic critically ill patients. Archives of physical medicine and rehabilitation, 1972-1976.

Orthostatic Hypotension (SCI)

Survey to determine the impact OH has on restricting the use of standing devices or standing wheelchairs for people with SCI. (n=293)

- 38% suffered from OH
- Majority complete injuries; T5 or above (except 1– T12)

52% were using standing wheelchairs/frames

- 59 people (20% of total), OH limited stander use
- 16 people (5.5% of total) not standing due to fear of worsening OH

Chelvarajah, R. (2009). Orthostatic hypotension following spinal cord injury: Impact of the use of standing apparatus. NeuroRehabilitation, 237-242.

➢ Body Structure/Function Issues: *Skin Breakdown*

Skin breakdown is very prevalent in people with SCI both during acute and rehab stays, as well as afterwards

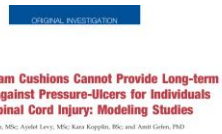
In Europe and US, 1 in 4 persons with SCI is affected by PU with the most common site being under the ITs

Complications: septicemia, osteomyelitis, renal failure, hinder functional recovery, pain, infection, loss of quality of life

Costly: Managing full thickness PU in US can cost up to $70,000

Annual PU costs in US estimated to be $11 billion

PREVENTION IS KEY

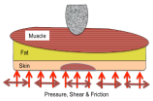

ORIGINAL INVESTIGATION

Contoured Foam Cushions Cannot Provide Long-term Protection Against Pressure-Ulcers for Individuals with a Spinal Cord Injury: Modeling Studies

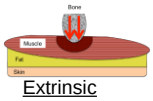
Naama Shoham, MSc; Ayelet Levy, MSc; Kara Kopplin, BSc; and Amit Gefen, PhD

Shoham, N; Levy, A; Kopplin, K; Geffen, A. "Contoured Foam Cushions Cannot Provide Long-term Protection Against Pressure Ulcers for Individuals with SCI: Modeling Studies". *Advances in Skin and Wound Care*. July 2015, p 303-316. www.woundcarejournal.com

Superficial

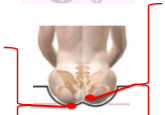


Deep



Extrinsic Risks

- Friction
- Temperature
- Moisture



Extrinsic Risks

- Pressure
- Shear
- Posture
- Stiffness of support
- Time

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Sustained Cellular Deformation with Chronic Sitting

Sustained compression can cause cell deformation, leading to tissue breakdown

Stekelenburg in 2007 concluded:

- "2 hours of compressive loading lead to irreversible damage; whereas, ischemic loading results in reversible tissue changes"
- "Large deformation, in conjunction with ischemia, provides the main trigger for irreversible muscle damage."

(Ryan, 1990, Bouten, 2003, Stekelenburg, 2007)

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Ischemia

Occlusion of blood

Reduce oxygen

Change

Accumulation of waste products

Decrease in pH

Cell death

Up to 6 – 8 hours

Deformation

Deformation of cells

Cell membrane failure

Cell

Disruption of the cytoskeleton

Decrease in pH

Cell death

Minutes to hours

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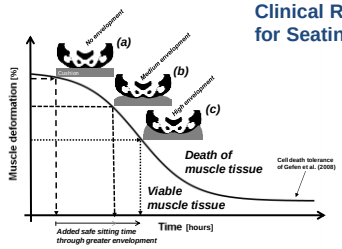
Clinical Relevance for Seating



Greater Immersion & Envelopment = Less Risk for Deformation

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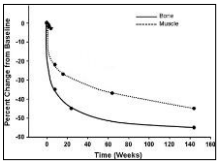
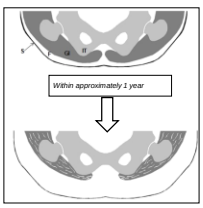
Patho-anatomical Changes in Individuals with SCI

- Gaining bodyweight and fat (F) mass
- Lose gluteal muscle (Gl) mass
- Intramuscular fat infiltration
- Ischial tuberosity (IT) bone adaptation
- Skin (S) thinning



Scott et al. Spinal Cord 2011



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Characteristics of a Good Cushion

Sufficient immersion and envelopment

Adjustability to the uniqueness of the individual at initial fitting

Adaptability to movement and activities

Adjustability to the individual throughout subsequent weeks, months and years

Durability over time

(2015) Ayelet Levy, Naama Shoham, Kara Kopplin, Amit Gefen

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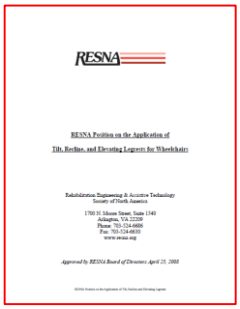
RESNA Position on the Application of Power Tilt/Recline and ELRs for W/Cs – considerations for clinical practice

Best comprehensive overall summary of research examining multiple seat functions.

Dicianno, B.E., Arva, J.A., Lieberman, J., Schmeler, M., Souza, A., Phillips, K., Lange, M., Cooper, R., Davis, K., & Betz, K. (2009) RESNA Position on the Application of Tilt, Recline, and Elevating Legrests for Wheelchairs. *Assistive Technology, 21: 13-22.*


RESNA

RESNA Position on the Application of Tilt, Recline, and Elevating Legrests for Wheelchairs

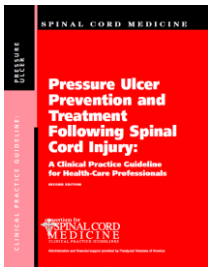
Rehabilitation Engineering & Assistive Technology Society of North America

1700 N. Moore Street, Suite 1540
Arlington, VA 22209
Phone: 703-524-6686
Fax: 703-524-6630
www.resna.org

Approved by RESNA Board of Directors April 25, 2008

Prevention – Pressure Reliefs

- Avoid prolonged immobilization
- Establish and initiate a specific pressure relief regimen within the individual's capability.
  - Frequency/Duration: 1-3 minutes for every for every 15-30 in seated in w/c
- Prescribe a power weight-shifting wheelchair system for individuals who are unable to independently perform an effective weight shift.
- Education on effective strategies for the prevention and treatment of pressure ulcers.



Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals. Consortium for Spinal Cord Medicine. Administrative and financial support provided by Paralyzed Veterans of America. © Copyright 2000, Paralyzed Veterans of America. Updated 2014. www.pva.org

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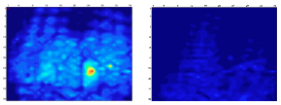
Power Tilt & Recline

- 45°tilt/120°recline: 40.5% weight shift (Aissaoui et al, 2001)
- **The combination of tilt and back recline reduces the seat mean pressure and peak pressure more than does each system separately.**

Pressure mapping Tilt & Recline:
Upright vs. 30 tilt/150 recline ↓



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Why would someone need tilt/recline compared to a tilt only system?

Maximum Pressure Relief with shear reduction
Improved Sitting Tolerance/Pain Management
Functional Activities (toileting/lower body clothing mgmt., getting knees under a table)
Respiration (respiratory care)
Tone Management
Position of Rest
Medical Management (orthostatic hypotension)
Accommodation of hip flexor and hamstring muscle length

Power Tilt AND Recline

How much do clients actually use?

Sonenblum & Sprigle, 2011- Distinct Tilting Behaviors…

- n=45; 1-2 week period
- Monitoring power tilting behaviors
- **Results:** On average, participants spend **12.1 hours** in a wheelchair daily.
  - Median position was 8° tilt. Median user tilted every [redacted]
  - However pressure relieving tilts (defined as a tilt greater than 30° for longer than 1 min) were performed on average once every [redacted]
  - Majority of users were tilting for comfort, but not performing tilts for pressure relief.

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Pressure Relief Methods

Walter, et al showed that individuals with spinal cord injuries who stood 30 minutes or more per day reported fewer pressure ulcers than those who stood less than 30 minutes per day.

Walter, JS, Sola, PG, Sacks, J., Lucero, Y., Langbein, E., & Weaver, F. (1999). Indications for a home standing program for individuals with spinal cord injury. *Journal of Spinal Cord Medicine, 22*(3), 152-158.

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Pressure Relief (SCI)

Compared tilt, recline, and standing - looking at seat and backrest pressure
- 6 Able-Bodied (AB) and 10 Subjects with SCI

Maximum decreases in seat pressure in full standing and full recline. Standing reduced both seat and backrest pressure.

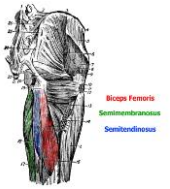
(Sprigle, Mauer, & Sorenblum, 2010)

Edlich et al. (2004) recommends power wheelchair standing for those who are able to tolerate weight bearing for prevention and treatment of pressure ulcers.

Body Structure/Function Issues
Contracture Risk & Spasticity Management

Chart review (n=482) for patients with acute SCI admitted between 1990-1995.

44 patients (9%) developed contractures during initial hospitalization.
- 30 Tetraplegic; 14 Paraplegic
- Pressure Ulcer – more likely (14.1%)
- Spasticity – more likely (12.7%)
- Co-existent or suspected head injury (15%)



Dalyan, Sherman, Cardenas, 1998)

Body Structure/Function Issues
Spasticity Management (SCI)

Single Case - T12 SCI

Tilt table used 5 non-consecutive days

Immediate and significant effect on spasticity lasting until the following morning

Particularly useful to improve car transfers

Indication for wheelchair stander allowing management of spasticity when needed

(Bohannon, 1993)

Spasticity Management (SCI)

Standing wheelchair users experienced significant reduction in spasticity

- This helps with transfers, can aid in better sleep, reduces fatigue and pain, and improves positioning in the wheelchair.

(Dunn, et al, 1988; Eng et al, 2001)

Body Structure/Function Issues
Bone density complications

Decreased muscle activity, standing, & ambulation, also contribute to decreased bone mineral density with SCI

Results in increased risk for fractures and accompanying reductions in function and independence

www.medscape.com

Bone Mineral Density (SCI)

SCI triggers rapid loss of BMD in both the trabecular bone and cortical cross sectional area (shaft of the bone).
- 15%-35% BMD in the LEs was lost during the first year post injury.
- Steady state reached at 4 years post SCI at ~50% BMD of healthy controls.

Dudley-Javorski, S., & Shields, R. (2012). Regional cortial and trabecular bone loss after spinal cord injury. Journal of Rehabil Res Dev., 49(9), 1365-1376.

Bone Mineral Density (SCI)

Bone loss after SCI is associated with increased fracture risk; 10-20% fractures occur at proximal femur. (n=13)

- Compared Femoral BMD (DXA Scan) and Femoral Strength (CT Scan w/ Finite Element Modeling in a sideways fall configuration)
- Reductions in femoral strength were some 3 times greater than BMD (~2% vs 6% loss per month.)

Edwards, B., Schnitzer, T., & Troy, K. (2014). Reduction in proximal femoral strength in patients with acute spinal cord injury. Journal of Bone and Mineral Research, 29(9), 2074-2079.

Bone Mineral Density (SCI)

54 subjects divided into 2 groups:

- Standing
- Non-Standing

After 1st year: LE BMD decreased 19.62% (standing); 24% (non-standing)

After 2 years: Standing group had significantly higher BMD than non-standing group

Conclusion: SCI patients who stood at least 1 h/day; at least 5 days/week, had significantly higher BMD in the lower extremities after 2 years compared to patients who did not perform standing.

Alekna, V., Tamulaitiene, M., Sinevicius, T., & Juocevicius, A. (2008). Effect of weight-bearing activities on bone mineral density in spinal cord injured patients during the period for the first two years. Spinal Cord, 727-732.

Bone Mineral Density (SCI)

3 Groups:

- SCI Standing (n=38)
- SCI Non-Standing (n=15)
- Healthy controls

- BMD in lumbar spine and femur decreased in all individuals with SCI as compared to healthy controls
- Standing vs. Non-standing: Standing group had improved BMD in the lumbar spine
- Standing in long leg braces also showed improved BMD at proximal femur.

Goemaere, S, Van Laere, M, et al. (1994). Bone mineral status in paraplegic patients who do or do not perform standing. Osteoporosis International, 4: 138-143.

Bone Mineral Density (Animal Models)

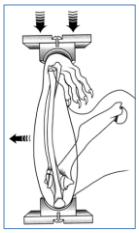
Right forelimbs of adult rats loaded 360 cycles, 3 days/week, 4 months duration (16 weeks)

- Group 1 - 360 cycles at one time
- Group 2 - 90x4 cycles (3 hours rest between)

Loaded limbs (Right) - significantly greater bone density

Group 2 - significantly greater bone density

Conclusion: Shorter duration with periods of rest may be better for bone density



Robling, A; Hinant, F; et al. (2001). Shorter, more frequent mechanical loading sessions enhance bone mass. Medicine and Science in Sports and Exercise, 34(2), 196-202.

Standing Dosage: Compliance and Recommendations

"Loading delivered in a manner that subjects could administer themselves was useful in alleviating the normally occurring decline in BMD."

"Frequent low-intensity strains build BMD"

(Dudley-Javorski & Shields, 2008)

- High frequency and low level mechanical stimuli were capable of augmenting bone mass and morphology.

(Rubin, Sommerfeldt, Judex, & Qin, 2001)

Safety, Program Progression & Compliance

It is suggested that having power wheelchair features, such as power tilt/recline/standing, is not enough to facilitate use to prevent pressure ulcers.

Consumers must be specifically educated on how to best utilize these features in order that they be used in the optimal manner.

One study indicated that even though 97.5% of individuals had power tilt and/or recline on their wheelchairs and used these functions daily, less than 35% used them for the purpose of pressure redistribution rather using them to reduce pain and increase comfort

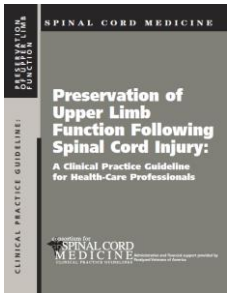
(Lacoste et al., 2003).

Options:

- Client and Caregiver Education
- Timers – phone or watch
- Virtual Seat Coach

➢ **Body Structure Function Issues:**
Increased UE RSI Risk with SCI

- Manual w/c and other UE over-use can contribute to UE RSI injuries, including biceps and rotator cuff tendinitis, CTS, and other syndromes
- PVA CPGs on UE Preservation includes regular assessment of function, ergonomics, equipment, and pain



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Ergonomics 101

Minimize the frequency of repetitive upper limb tasks.

Minimize the force required to complete upper limb tasks.

Minimize extreme/injurious positions at all joints.

- Avoid extreme positions of the wrist.
- *Avoid positioning the hand above the shoulder.*
- Avoid extreme shoulder internal rotation and abduction.

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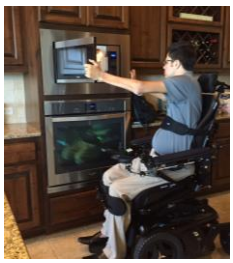
Equipment Selection for UE Preservation

High Risk Pts May Need Power

- those who have a prior injury
- obese, elderly or live alone
- live in a challenging environment

Promote optimal postural alignment and support

Provide seat elevation or a standing position to individuals with SCI.



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STAND FOR PSYCHO-SOCIAL BENEFITS

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➢ **Body Structure/Function Issues:**
Increased Risk for Depression with SCI

Depression rates for SCI are higher than general population, but they vary with age and time since injury.

6 paralyzed men from VA used standing frame (Kunkel et al., 1993)

Positive psychological impact noted and men continued to use standing because it made them "feel" healthier.

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STAND FOR FUNCTION

Perform functional activities in standing position

Improves performance of MRADLs (ADLs/IADLs)

- Toileting, Feeding (cooking), Dressing (access to closets/drawers), Grooming (access to mirrors/sinks), Bathing (access to supplies). Improves FIM scores!

Improves vertical range of reach & protects shoulders; supported, stable standing position

- Kitchen counters/cabinets, medicine cabinets, refrigerator, sinks, drawers, closets, thermostat, light switches, window shades/blinds, etc.)

Functional Pressure Relief

Reduce amount of caregiver assistance and home modifications required

Improved compliance with standing program

Provide energy conservation

- Fewer transfers required

Improves productivity at work or school

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STAND FOR HEALTH - SUMMARY OF EVIDENCE

Bone Mineral Density
- Dynamic Weight Bearing – Shorter, More Frequent
  - Higher Frequency (Robling 2001; Eng 2001)
  - Dynamic Loading (Thompson et al 2000; Ward et al 2004)

GI/Respiratory/Circulatory
- Higher Frequency of Standing – Greater Impact

Bowel/Bladder
- Reducing UTI/Kidney Stones/Constipation/Bowel Accidents

Spasticity
- Immediate and Significant Effect - Beneficial for Function

Contractures
- Providing Prolonged Stretch

Pressure Management
- Reduced Frequency PU when Using Stander
- Best Pressure Relief Overall (Sprigle 2010)

Improved **compliance** with standing program (Shields 2005)

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How do we make this happen?

Talk about it as an option!

Get Fired Up!

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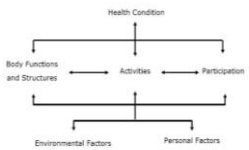
The Ultimate Goal of Any Medical Recommendation

Improve quality of life!



Archer Hadley

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Thank You for Coming!

QUESTIONS?

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