Seating and Positioning for Persons with Spinal Cord Injuries.

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Center Manager : Albertson Site
SCI Facts and Figures From NSCISC

**Incidence:** 17,700 new SCI cases per Year excluding those who die at time of injury.

**Prevalence:** 247,000-358,000

**Average Age of Injury:** 1970’s 29 years old NOW 43 years old

**Race /Ethnicity:** 60.6% White, 22% African Americans, 12.8 Hispanic, 2.7 Asian, 1.3% other

**Cause:** MVA’s 38.3%, Falls 31.6%, Violence 13.8%, Sports 8.2%, Medical/ Surgical 4.6%, Other 3.5%

**Level of Injury:** 47.2% Incomplete Quadriplegia, 20.4% Incomplete Paraplegia, 20.2 % Complete Paraplegia, 11.5 % Complete Quadriplegia
SCI Facts and Figures From NSCISC

Re-Hospitalization: 30% of persons with SCI one or more times per year; LOS about 22 days. Common causes: Genitourinary system, Skin, Respiratory, Circulatory, Digestive, Muscular.

Lifetime Costs: Between: 3- 5 Million depending on age and level of Injury

Life Expectancy: Not improved since 1980’s, significantly lower than persons without SCI. Mortality rates Highest during 1st year especially with most severe Neurological Impairments.

Cause of Death: Greatest Impact of SCI population: Pneumonia and Septicemia no Change in Mortality for Septicemia over past 40 years, slight decrease do to pneumonia.
### Type / Level of Injury ASIA Scale

<table>
<thead>
<tr>
<th>Muscle Grading</th>
<th>Asia Impairment Scale</th>
<th>Steps in Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Total paralysis</td>
<td>□ A = Complete: No motor or sensory function is preserved in the sacral segments S4-S5</td>
<td>The following order is recommended in determining the classification of individuals with SCI:</td>
</tr>
<tr>
<td>1: Palpable or visible</td>
<td>□ B = Incomplete: Sensory but not motor function is preserved below the neurological level</td>
<td>1. Determine sensory levels for right and left sides</td>
</tr>
<tr>
<td>contraction</td>
<td>and includes the sacral segments S4-S5</td>
<td>2. Determine motor levels for right and left sides</td>
</tr>
<tr>
<td>2: Active movement, full</td>
<td>□ C = Incomplete: Motor function is preserved below the neurological level, and more</td>
<td>Note: In regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level</td>
</tr>
<tr>
<td>range of motion, gravity</td>
<td>than half of key muscles below the neurological level have a muscle grade less than 3</td>
<td>3. Determine the single neurological level</td>
</tr>
<tr>
<td>eliminated</td>
<td>□ D = Incomplete: Motor function is preserved below the neurological level, and at least</td>
<td>This is the lowest segment where motor and sensory function is normal on both sides, and is the most cephalad of the sensory and motor levels determined in steps 1 and 2.</td>
</tr>
<tr>
<td>3: Active movement, full</td>
<td>half of key muscles below the neurological level have a muscle grade of 3 or more</td>
<td>Determine whether the injury is Complete or incomplete (sacral sparing)</td>
</tr>
<tr>
<td>range of motion, against</td>
<td>□ E = Normal: Motor and sensory function are normal</td>
<td>If voluntary anal contraction = No AND all S4-5 sensory scores = 0 AND any anal sensation = No, then injury is COMPLETE. Otherwise injury is Incomplete.</td>
</tr>
<tr>
<td>gravity and provides</td>
<td></td>
<td>5. Determine ASIA Impairment Scale (AIS) Grade:</td>
</tr>
<tr>
<td>normal resistance</td>
<td></td>
<td>If Yes, AIS=A Record ZPP</td>
</tr>
<tr>
<td>4: Active movement, full</td>
<td></td>
<td>(For ZPP record lowest dermatome or myotome on each side with some (non-zero score) preservation)</td>
</tr>
<tr>
<td>range of motion, against</td>
<td></td>
<td>If No, AIS=B</td>
</tr>
<tr>
<td>gravity and provides</td>
<td></td>
<td>(Yes=voluntary anal contraction OR motor function more than three levels below the motor level on a given side)</td>
</tr>
<tr>
<td>normal resistance</td>
<td></td>
<td>If sensation and motor function is normal in all segments, AIS=E. Note: AIS E is used in follow up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact, the ASIA Impairment Scale does not apply.</td>
</tr>
<tr>
<td>5: Muscle able to exert,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>in examiner’s judgement,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sufficient resistance to be</td>
<td></td>
<td></td>
</tr>
<tr>
<td>considered normal if</td>
<td></td>
<td></td>
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<tr>
<td>identifiable inhibiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>factors were not present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A not testable, Patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unable to reliably exert</td>
<td></td>
<td></td>
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<tr>
<td>effort or muscle unavailable</td>
<td></td>
<td></td>
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<tr>
<td>for testing due to factors</td>
<td></td>
<td></td>
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<tr>
<td>such as immobilization,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pain on effort or contracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical syndromes (optional)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Central Cord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Brown-Sequard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Anterior Cord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Conus Medullaris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Cauda Equina</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tissue Changes in Persons Following SCI

External and Internal Anatomy and Tissue Structure and Function change considerably in the months and years following loss of mobility and sensation:

- Weight and fat mass gain
- Fat filtration into muscles
- Muscle Atrophy
- Bone loss and Bone shape adaptations at the pelvis
- Vascular Perfusion changes
- Microstructural changes in skin/muscle

➤ These microstructural changes are related to disuse and affect the biomechanical behaviors of these tissues.

➤ Persons with SCI undergo dramatic changes in structural anatomy and tissue physiology following injury and throughout life.

➤ To make matters worse because of these changes they experience more severe ischemic conditions when loaded compared to healthy skin.

➤ History of PU or DTI / scar tissue increase risk
Skin Issues

**Definition of Pressure Ulcer:**
Pressure Ulcer Advisory Panel defines a pressure ulcer as “an area of localized damage to the skin and underlying tissue caused by pressure, shear, friction, or a combination of these” (http://www.epuap.org). This definition encompasses the entire range of severity of the problem, from mild skin irritation to deep tissue necrosis according to the four-stage classification system of Shea [2].

**Visible on inspection**

**Definition of Deep Tissue Injury:**
caused by sustained compression of the tissue, arises at deep vulnerable muscle layers that overlay bony prominences and can rapidly expand unobserved into extensive ulceration. This latter type is considered especially harmful because layers of muscle, fascia, and subcutaneous tissue may suffer substantial necrosis

Not visible on inspection, usually results in Stage III-IV very quickly!!!!
Pressure / Shear/Friction

**Pressure** = Force/Area x Time

**Shear** = Deformation of Tissues over Tissue

**Friction** = Surface of contact and Skin, More superficial

**Pressure Ulcer**: PU

**Deep Tissue Injury**: DTI

Contact Injury

Reperfusion Injury

TIME/Duration

Every surface not just wheelchair!!

Bed, Commode, Car, Airplane, Couch, Floor

Tub, restaurant Chair, Bar Stool

Movement is also an important Consideration
Shear / Friction/ Pressure
Best Practice Advancement in Knowledge

Past Thought Process:

- Lack of Blood Supply
- Pressure

New Info:

- Toxin Build-up / Lymphatic Drainage
- Micro-climate
- Reperfusion Injury
- Nutrients
- Blood Flow & Oxygenation
- Tissue Deformation
- Shear/Friction
- Interface Pressure
- Magnitude and Duration

Deep Pressure/ DTI
Common Issues Affecting Seating SCI

Pressure Ulcers defined according to Stages: **New “Categories” in Process!!**

- **Stage 1**: Skin is unbroken but inflamed
- **Stage 2**: Skin is broken to epidermis or dermis
- **Stage 3**: Ulcer extends to subcutaneous fat layer
- **Stage 4**: Ulcer extends to muscle or bone
DTI Progression  Phase 1-2  72 hours  Phase 3  7-10 Days

Sub Classification of DTI

Phase 1  Phase 2  Phase 3

Acknowledgements

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Suspected Deep Tissue Injury

- Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear
- The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue
Heterotopic Ossification

**Definition:**
- Abnormal growth of bone in the non-skeletal tissues including muscle, tendons or other soft tissue.
- New bone growth 3 x the normal rate resulting in jagged, painful joints.
- Usually occurs 3-12 months post SCI, greater in men than women.
- More prevalent in people in their 20’s and 30’s.
- 90% in Hips, but also knees, shoulders and elbows

**How is it diagnosed:**
- X-rays
- CT-Scan
- U.S. Blood Tests
- Three Phase Bone scan
- Cause unknown
- Complicate to manage
- Has significant ramifications for seating
Hip Flexion Measurement

- Degree of hip flexion:
  - Trunk to thigh angle
  - 90° - 180°

- Anterior Pelvis:
  - Seat to back support angle
  - 85° - 100°
  - COG

- Posterior Pelvis:
  - Seat to back support angle
  - 100°
  - COG

- Accompanied by increased kyphosis
- Ischial travel forwards
- New pressure points at sacrum and spine
What Information is Important?

**Diagnosis, Prognosis, Clinical Considerations:**

- **PMH**
- Past Equipment History
- Activities: Sports, Hobbies, How time is spent
- Level of Function/ MRADL’s
- Environmental Considerations: Immediate, Community, Natural
- Transportation
- Goals and Objectives
Specific to Each Person’s MRADL’s

- Home set-up: accessible?, Ramp?, Elevator?, Ranch, Limited access?
- Toileting, dressing, grooming, bathing, Transfers,
- What Type of Tie-Down System?
- Child-Care Role?
- OTHER
THE ASSESSMENT PROCESS

Identify Goals

Funding Information

Profile

Best Recommended Equipment

Simulation Support and Mobility

Functional Assessment

Physical Assessment
Assessment Information/Mat Evaluation

What are we evaluating?
- Level of Injury  Muscle Strength, Sensation, Co-Morbidities, Cardiac, Surgeries?
- Age, Body Weight, Body Proportions
- Abnormal Tone: Spasticity, Hypotonic, Atrophy, Postural Deformities Reducible/ Non- Reducible
- ROM all joints, Contractures, H.O.
- PAIN: Where, Intensity/ Constant/ Inconsistent/ Acute /Chronic?
- Skin: Pressure Ulcers? History/current/stage/chronic problem/Location/ Flap Surgies?
- Continence: Leg bag/ Cath /Supra-Pubic/ Diapers
- Balance sitting: Static, Dynamic, Posture
- Functional Status/ Home Environment: Bed Mobility, Transfers, Propulsion, MRADL’s, Driving Status
- Safety: Judgement/Vision/Cognition/Psycho-Social /Medications
- Work / School / Volunteer/ Child –Care
Assessment Info/Mat Eval Continued

- **Support**: Family/ S.O./Care-Takers/ HHA how many hours a week/Patient Reliability.
- **Current Equipment**: How old/ is it working/ has it been Successful/ if not what issues.
- **Financial Issues/Funding**: Insurance/ financial status/ family assistance.
- **Community**: Where do they live/ City/Suburb/Rural/environment/ Pavement/Grass/Dirt?
Pelvis in Seated Position
Definitions of Postural Positions

- Anterior Pelvic Tilt
- Pelvic Obliquity
- Pelvic Rotation
- Posterior Pelvic Tilt
- Windswept Deformity
Anterior Pelvic Tilt

- A lordosis is identified by an increased lumbar curve.
- Anterior pelvic tilt
- Increased tone in hip flexors
- Weakened abdominals relative to extensors
- Not Common in SCI
Pelvic Obliquity

- Uneven weight and Pressure Distribution.
- Rib cage/Organ Issues

1) Possible Causes Intrinsic:
   - Structural Changes
   - Surgery Spinal Fixation
   - Asymmetrical Strength or Muscle Tone / Muscle Bulk
   - H.O. of Hip

2) Possible Causes Extrinsic:
   - No Solid Base of Support
   - Person Leans to one side to gain contact with chair
   - Wheelchair to Wide
   - Back Rest Does Not Support Posterior Pelvis
   - Trunk Not Supported
Pelvic Rotation

**Intrinsic Causes**
- Leg length Discrepancy
- Hip Dislocation or Subluxation
- Girdlestone Arthroplasty
- Structural
- Asymmetrical Hip Flexion/ Muscular or H.O.
- Asymmetrical Hip Adduction

**Extrinsic Causes**
- Trunk not supported
- Back rest does not support the Posterior Pelvis
- Seat too wide
Posterior Pelvic Tilt

- Very Common in People with SCI, especially with higher injuries with compromised trunk strength and stability.
- Commonly referred to as “sacral sitting”, PSIS lower than the ASIS. May cause difficulty in swallowing, communicating and breathing.
- Kyphotic posture and sliding from the chair.
- Increased loading on the sacrum and less thru I.T. s - often lead to sacral pressure ulcers.
- Ulcers can occur on spinus processes and scapulars due to kyphosis and on the heels as a result of the person ‘anchoring’ themselves to reduce sliding.

1) Intrinsic Factors:
- Trunk muscles unable to hold spine upright against gravity
- Sliding forward in seat
- Limited hip flexion
- Abnormal tone
- Obesity
- Tight hamstrings
Posterior Pelvic Tilt

**Extrinsic Factors:**
- Seat depth too long
- Inadequate foot loading: Leg-rest wrong size
- Footplates too low
- Back too vertical
- Arm rest too low
- Tight Hamstrings/ Angle of Hangers too great
- Inadequate Femoral thigh loading
Windswept Deformity

Abduction and E.R. of one Hip and Adduction and I.R. of the other.

May be associated with Hip dislocation, Scoliosis and pelvic rotation.

Not Very Common in individuals with SCI but it does occur.
APT/PPT/ Obliquity
Mat Evaluation “The Details“

Supine:
- ASIS: Obliquity/ Fixed /Flexible
- Trunk/ scoliosis/ Kyphosis
- ROM: Hips/knees/Ankles
- I.T. Palpation
- Tone Assessment
- Shoulder ROM
- MMT
- Measurements
Mat Evaluation “ The Details “

Seated:
- Head / Neck Alignment: Reducible/Non-Reducible
- ASIS/ PSIS: Obliquity/ Reducible/Non-Reducible
- Trunk/ Scoliosis/ Kyphosis/ ‘C’ curve/ Rotational/ Rib Humps ( Apex )
- ROM: Hips/Knees/Ankles
- Balance: Static/Dynamic/Functional reaching
- Tone Assessment
- Shoulder ROM
- MMT
- Measurements
More Pictures
Measurements Required
We Have the Info! , Now What ???

- **Accommodate or Correct:** How do we decide.....? Head, Trunk, arms, pelvis, femurs, lower legs feet?
- **What Type of:** Back? Cushion? Options ? What is required ?
- **First Time User or many years using a wheelchair?** Very different issues!!
- **As a clinician** LISTEN!!!! Don’t just plow thru process.
- **Have a discussion about Pro’s and Con’s of each possibility.”**
Accommodate or Correct?

Fixed or Flexible - New Terms: Reducible or Non-Reducible

Reducible: Can correct to an extent

Non-Reducible: Accommodate
Accommodate Must Support
Cushion Properties

**Immersion** (cushion height)

**Envelopment** (self-contouring)

Images show typical soft tissue wasting following spinal cord injury.

OFFLOADING

OFFLOADING
Cushion Selection What to Consider?

- Postural Deformities: Reducible /Non-Reducible /Contractures
- Sensation/Pain Issues
- Pressure Ulcer History? Current skin status? Flap surgeries? Orthopedic interventions?
- Balance /Ability to pressure relieve/Weight shift/Return from
- Muscle strength/Tone/Vision
- Transfers
- Bowel/Bladder
- Weight consistent /fluctuations
- Patient and care-giver reliability and follow thru
Cushion Materials

Foam: Open cell /Closed cell
Gel: Viscous Fluid
Air Floatation
Honeycomb/Floam
Aqueous Gel
Combinations
Custom Molded

Advantages and Disadvantages to all Selections:
Indentation Force: Stiffness vs Squishiness
Pressure Distribution/Immersion vs stability/Positioning
Stability
Weight
Friction/Shear
Temperature /Heat insulator
Modifications/ Maintenance
Thickness of Cushion – How it Effects Fit
Jay 2 Cushion Example

Optional accessories
- Fluid supplement pad
- 1-inch adduction wedges
- Firm foam base
- Deep well
- Velcro anchors top layers

Stretch fabric cover
- Pleats at rear
- Handle at front
- Protective gel layer
- Bunching gel pockets

Slight pommel built in
Soft foam encased in plastic
Foam Cushions

Cushion (shown without cover)
Air Floatation  ROHO and STAR
Custom Molded Ride Design: Off-Load
Back Rests Varying levels of Control
Custom Backs Ride Designs / Bio Dynamics Etc
This is what we need to avoid!!
Interface Pressure Mapping

Limitations

- Not to be utilized in Isolation.
- Must consider all information from eval and palpation.
- Careful calibration-Relative not Absolute values.
- Must allow adequate settling time/duration on surface.
- Solid Base of support
- No creases of folded / overlapping sensors

Pro’s

- Relative Pressure Comparisons
- Visual Feedback for Patients and care-takers during pressure relief techniques/ different body positions
- Can demonstrate Symmetry or lack there of
- Can Compare Cushions and save Info
- Helps confirm clinical suspicions
MWC Wheelchair Definitions
MWC’s K1-K5  Focus on K5
CoG : Point at which an object is Balanced
Center of Gravity
Why is adjustable Axle Important?
Flexible Axle And Adjustable STF heights

Flexible Posterior Pelvic Tilt

- Fixed tilt in space
  - Reduce the effects of gravity

Before

After
Considerations when Deciding Back and “Dump” Angles

Fixed Posterior Pelvic Tilt

- Fixed tilt in space
- Upright seating does not accommodate deformity
- Poor visual field
- Fixed tilt prevents further deformity
- Improves visual field
Full-Time W/C user K5 Flexibility
Configuration Of MWC
How TO Know When It’s Time for a Change?
Power Assist on a MWC Options
Videos Of Power Assist
Smart Drive
Time For Re-evaluation and Some Support System Changes
Power Wheelchairs
How to Decide

- Level Of Injury
- Co-Morbidities
- Age/ Weight
- Functional Impairments
- Postural Deformities
- Skin /Pressure Ulcer History
- Spasticity
- Contractures
- Edema

- Home Environment
- Community
- Transportation
- Work Environment
- School Environment
- Hobbies
- Vision
- Cognition
- Safety Awareness
Types of Power Wheelchairs

Group 1-4

Focus on Group 3-4

Specifis Beyond Scope of this presentation However Group 3-4:

❖ **Programmable:** Acceleration/Deceleration/Torque/Joystick throw/Sensitivity/Neutral zone/Reassign directions/Latch/Cruise

❖ **Can Use Alternative Drives:** Head Array/Sip/Puff/Chin Control/Single Switch Drive/Infra-red allows Tracking with Alt Drives.

❖ **Power Seat Functions/Actuators/Attendant Controls**

❖ **Can Accommodate Ventilator and Third Battery**
PWC Drive Definitions

**RWD: Rear Wheel Drive:**

**MWD: Mid Wheel Drive:**

**FWD: Front wheel Drive:**
**RWD - Rear Wheel Drive**

**PRO’s:**
- Like a car – Familiar
- Most Stable – performs well at high speeds
- Excellent Traction Uphill/Ramps/Lifts
- Can Be Bumped Up Curb/Step with Help
- In-line stability when using Alternative Drives
- Force Behind User

**CON’s:**
- Largest Turning Radius/ footprint
- Decreased Traction when going Downhill
- Front End can slip Downhill
- Increased Hanger Angles will Create interference issues cannot accommodate casters will “crash” into footplates
- Difficult for that reason to accommodate Center Mount Footplates
MWD – Mid Wheel Drive

**PROs:**
- Tightest Turning radius for 360°
- Very Intuitive for Most users
- Good Traction on Level Surfaces

**CON’s:**
- Can Give Person sense of instability /Rocking back and forth
- Can be troublesome on Steep Ramps/Lifts
- Not as Stable at higher Speeds
- Can have issues on Grass/Dirt
FWD – Front Wheel Drive

**PRO’s:**
- Maneuvers Well
- Leading Drive
- Best for 90° Turns (hallways into room)
- Climbs well – Ramps/Lifts
- Can “GO UP “ Curbs 2”+
- Best For L.E. Positioning when Hamstring Issues. NO Caster Interference
- Excellent Downhill Traction

**CON’s:**
- Larger Turning Radius Then MWD
- CAN ‘Fishtail” at Higher Speeds
- Less Intuitive
- Less Control for some with Alternative Drives
- Can Slip Upward when driving on Slope
Power Seat Functions
Tilt/Recline/Power Legs/Seat Elevation
Putting Them Together
Why Power Seat Functions
Tilt /Recline /Power

- Postural Stability/ Alignment  Ability to Change COG
- Limited Joint Mobility: Hip Flexion ROM can “Open Seat to Back Angle”
- Pressure Relief
- Management of Pain Issues: Neck/ Shoulders/Back/Hips
- Edema Issues
- Visual Field Improvement/Respiration/ Respiratory Hygiene Alertness/speech/Swallowing
- Bowel / Bladder Management/ Positioning for Cauterization
- Sitting Tolerance
- Just Movement Thru Different ROM’s of Joints
Seat Elevator
Transfers/Reach/Eye Contact/Neck Pain
Alternative Drives
Take Home Message

• Wheelchair Prescription is a very complex time consuming process and should not be rushed and should be done only by qualified clinicians that work alongside wheelchair company professional.

• All Equipment must be trialed prior to ordering: This means Cushions /Backs/Wheelchairs/Drive Systems/Joystick Handles and all accessories that may be appropriate.

• Make Sure Patients/Client goals are heard. If this goals are inappropriate, take the time to educate the person and explain what the issues may be and the potential harm.

• If unsure about patients ability to utilize a specific piece of Equipment may have to set up training appointments prior to ordering equipment.

• Every person requires a fitting and delivery appointment! Sometimes multiple appointments may need an “interim fit” to make sure you get it right.

• Patient and care-takers should be present during evaluation and fitting for education about the chair /seating system /positioning/safety/maintenance/transportation/etc

• Every patient Should leave with a patient education sheet to refer to whenever needed. They will not remember everything.

• Regular intervals of follow-up required
Bibliography


