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Spinal Cord Injury Assessment and Intervention

Activity beats no activity and why more is better.

Rebecca Martin, OTR/L, OTD, CPAM, CKTP

International Center for Spinal Cord Injury

- 17 years in neurorehab, last 11.5 in SCI
- At Kennedy Krieger Institute, Baltimore, MD
- 40 therapists
- Continuum of care for patients with SCI and associated paralysis

www.kennedykrieger.org
Objectives

At the conclusion of the lecture, participants will

- identify anticipated functional deficits by neurological level in patients with SCI.
- select assessments appropriate for functional level and participation domain for patients with SCI.
- discuss interventions designed for compensation, restoration, and recovery of function in SCI.

Etiology

Causes of Spinal Cord Injury

- Motor vehicle accident: 36.5%
- Falls: 28.5%
- Violence: 14.3%
- Other / unknown: 11.4%
- Sports-related accidents: 9.2%
Age and Time Since Injury

<table>
<thead>
<tr>
<th>Severity of Injury</th>
<th>First Year</th>
<th>Each Subsequent Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Tetraplegia (C1-C4)</td>
<td>$1,023,924</td>
<td>$171,808</td>
</tr>
<tr>
<td>Low Tetraplegia (C5-C8)</td>
<td>$739,874</td>
<td>$109,077</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>$499,023</td>
<td>$66,106</td>
</tr>
<tr>
<td>Incomplete motor function at any level</td>
<td>$334,170</td>
<td>$40,589</td>
</tr>
</tbody>
</table>

12 days: length of initial hospitalization following injury in acute care.

37 days: average stay in rehabilitation unit.

89.8: percentage of all spinal cord injured individuals discharged from hospitals to private homes.

6.2: percentage who are discharged to nursing homes.
Introduction and Science

Spinal Cord Cross Section

Levels of Innervation

<table>
<thead>
<tr>
<th>Neuro Level</th>
<th>Key Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1-C4</td>
<td>Diaphragm</td>
</tr>
<tr>
<td>C5</td>
<td>Elbow flexors, deltoid, rotator cuff, clavicular head of pec</td>
</tr>
<tr>
<td>C6</td>
<td>Wrist Extensors, supinator</td>
</tr>
<tr>
<td>C7</td>
<td>Triceps, pronator, wrist flexors</td>
</tr>
<tr>
<td>C8</td>
<td>Finger flexors</td>
</tr>
<tr>
<td>T1</td>
<td>Hand intrinsics</td>
</tr>
<tr>
<td>T2-T12</td>
<td>Segmental innervation of abdominals, intercostals, and paraspinals</td>
</tr>
<tr>
<td>L1-L2</td>
<td>Hip flexor, hip adductors</td>
</tr>
<tr>
<td>L3</td>
<td>Knee extensors</td>
</tr>
<tr>
<td>L4</td>
<td>Ankle dorsiflexors, hip abduction, knee flexion</td>
</tr>
<tr>
<td>L5</td>
<td>Long toe extensors, hip extension</td>
</tr>
<tr>
<td>S1</td>
<td>Ankle plantar flexors, toe flexion</td>
</tr>
<tr>
<td>S2-S4</td>
<td>Bowel and bladder sphincters</td>
</tr>
</tbody>
</table>
THE SCIENCE OF SCI

The Cord Following Injury
Cascades of Secondary Events

Barriers to Recovery
Basic Science Research

• Blocking Inhibitors

• Administration of Exogenous Cells
  – Remyelination
  – Axonal Regeneration

• Bridges and Scaffolding

Enzymatic Treatment To Block Inhibitors
Administration of Exogenous Cells

Clinical Trials: Geron now Asterias

- hESC-derived oligodendrocyte progenitor cells
- 2010 Phase 1: safety and tolerability
  - Acute (<14 days) AIS A thoracic injuries
  - Intramedullary transfer
  - D/c'd due to concerns of undifferentiated cysts
  - Stopped November 2011 due to funding
  - 5/10 patients followed without adverse event
- 2014 Phase 1/2a: dose escalation
  - Acute (<25 days) all AIS C5-C7
  - 2, 10, 20 mill cell via intramedullary injection
Current Clinical Trials

• Neuralstem
  – Phase I enrolled September 2014 – July 2015, 6mo follow-up period
  – 4 chronic SCI patients, T2-T12 AIS A
  – Direct injection of human spinal cord stem cells
  – Follows their work in ALS

• Trials recognized by US
  – Switzerland: HuCNS-SC
  – Texas, Brazil, India, Chile: Auto. bone marrow stem cells
  – Korea: Autologous adipose derived mesenchymal stem cells
  – Russia: Auto. neural stem cells in complete traumatic injury
  – China: Scaffolding + mesenchymal or neural stem cells

Bridges and Scaffolds
Nerve Bridges

reattached spinal nerve

peripherally detached spinal nerve

α-MN

dorsal root

ventral root

MAKING THE DIAGNOSIS
Normal T2 MRI

Imaging: Fracture and Dislocation
Imaging: Infarction with Hyperintensity

[Image of a spinal MRI scan]

http://www.nature.com/sci/journal/v46/n3/fig_tab/3102092f1.html

www.kennedykrieger.org

Imaging: Transverse Myelitis

[Image of spinal MRI scans]

www.kennedykrieger.org
Testing
- Light touch and pin prick sensation in 28 dermatomes
- Motor of 10 key muscles
- Deep anal pressure
- Voluntary anal contraction

Score
- Neurological level (last intact level) C2 to S4
- AIS Classification (completeness of the injury) A to E
SCI Clinical Syndromes

- Central Cord Syndrome
- Anterior Cord Syndrome
- Posterior Cord Syndrome
- Brown-Sequard Syndrome
- Conus Medullaris Syndrome
- Cauda Equina Syndrome

Central Cord Syndrome

- Damaged center of the cord
- Cord compression
- UE > LE weakness
- Sacral tracks preserved
- Possible very rapid, spontaneous recovery
**Anterior Cord Syndrome**

- 2/3 of anterior cord are damaged
- Hyperflexion force
- Lost: motor, light touch, sensitivity to pain and temperature
- Intact: Sensitivity to vibration, pressure, 2-point discrimination and position
- Worst prognosis

---

**Posterior Cord Syndrome**

- Dorsal 1/3 of cord is damaged
- Rare, usually due to vascular incident or tumor
- Lost: 2-point discrimination, proprioception, vibration and pressure
- Intact: Pain, temperature and light touch
- May have motor weakness
Brown-Sequard syndrome

- Hemisection, usually due to penetrating wound
- Ipsilateral
  - Lost: voluntary motor, proprioception, vibration, 2-point discrimination,
  - Intact: pain, temperature, light touch remain intact
- Contralateral:
  - Lost: pain and temperature and light touch,
  - Intact: motor, proprioception, vibration and 2-point discrimination remain intact

Conus Medullaris Syndrome

- Involvement of the terminal end of spinal cord associated with thoracic vertebrae injury
- Combination of a LMN and UMN
- Rapid and bilateral onset of symptoms
  - severe back pain
  - bilateral leg pain
- Symmetrical defects
Cauda Equina Syndrome

- Involvement of peripheral nerves in the canal
- Due to spinal stenosis, disk herniation, trauma, tumor, or could be idiopathic
- Slow progressive, asymmetric
International Classification of Functioning and Disability

- Health condition (disorder or disease)
- Body Functions and Structures
- Activities
- Participation
- Environmental Factors
- Personal Factors

ICF Ex: Teaching Typing to Pt. w/CP

- Body Function/Structure: anatomical parts of the body and their physiological functions of body systems
  - Abnormal tone, joint deformity, decreased strength and coordination, cognitive impairment
- Impairments: problems in body function and structure
  - Decreased strength and coordination
- Activity: execution of a task or action
  - Difficulty learning keyboarding skills
- Participation: involvement in a life situation
  - Difficulty communicating and engaging in school activities

World Health Organization (2007)
Individualized Assessment

- Comprehensive, interdisciplinary assessment
- Goals should be mutually established between the patient and the treatment team
- Injury related skills and conditions
- Contextual factors

Contextual Factors

World Health Organization (2007)
Contextual Factors

- Age
- Body type
- Culture
- Psychological and social resources
- Pre-existing medical conditions and cognitive impairments
- Concomitant injuries
- Secondary complications

Injury Related Skills and Conditions

World Health Organization (2007)
Injury Related Skills and Conditions

- Motor and sensory function
- Respiratory, bowel, and bladder function
- Functional mobility
- Standing and ambulation
- Self care
- IADLs
- Work and leisure

Selecting an outcome measure

- What do I want to measure?
- What are the limits of the patient?
- What are my limits?
- Is the test valid for my patient?
- Do I need more than one?
**Functional Independence Measure (FIM)**

- Measures level of a patient's disability and indicates how much assistance is required for ADLs
- Contains 18 items composed of:
  - 13 motor tasks
  - 5 cognitive tasks (considered basic activities of daily living)
- Tasks are rated on a 7 point ordinal scale that ranges from total assistance (or complete dependence) to complete independence
- Scores are generally rated at admission and discharge
- Basis for Uniform Data Set
FIM Dimensions

- Eating
- Grooming
- Bathing
- Upper body dressing
- Lower body dressing
- Toileting
- Bladder management
- Bowel management
- Bed to chair transfer
- Toilet transfer
- Shower transfer
- Locomotion (ambulatory or wheelchair level)
- Stairs
- Cognitive comprehension
- Expression
- Social interaction
- Problem solving
- Memory

FIM Scoring

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Caregiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Complete Independence</td>
<td>No Caregiver</td>
</tr>
<tr>
<td>6</td>
<td>Modified Independence</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Supervision</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Minimal Assist (&gt;75%)</td>
<td>Caregiver</td>
</tr>
<tr>
<td>3</td>
<td>Moderate Assist (50-74%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Maximal Assist (25-49%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Total Assist (&lt;25%)</td>
<td></td>
</tr>
</tbody>
</table>
**FIM Psychometrics for SCI**

- Excellent correlation between total FIM scores taken by clinician discharge report and self-report at one month
- Excellent correlation between total FIM and LFIM score and WISCI and Berg Balance
- Large effect size for all subjects regardless of AIS classification between initial measurement discharge from rehab
- Small to moderate effect size for subjects at interim assessment


**Spinal Cord Independence Measure III**

- Observational tool to measure functional progress and to be sensitive to clinically modest changes
- Capacity
- Often used by interview
- 19 items in 3 domains
  - Self-care
  - Respiration and sphincter management
  - Mobility
- Weight for clinical relevance

Catz et al., 2001; Itzvoich et al., 2007
SCIM III Psychometrics

- Inter-rater Reliability: Adequate to excellent on individual items and subscales to total score
- Internal consistency: Excellent
- Construct validity: Excellent correlation to FIM scores
- Responsiveness: More sensitive than FIM (26%), better for mid-range injuries

SCIM Dressing

Dressing (clothes, shoes, permanent orthoses: dressing, wearing, undressing).

0. Requires total assistance
1. Requires partial assistance with clothes without buttons, zippers or laces (cwobzl)
2. Independent with cwobzl; requires adaptive devices and/or specific settings (adss)
3. Independent with cwobzl; does not require adss; needs assistance or adss only for bzl
4. Dresses (any cloth) independently; does not require adaptive devices or specific setting
SCIM III-Self Report

- Developed to reduce time, effort, and burden
- Wording of the 19 items was adapted to include personal pronouns and avoid technical terms
- Complex items were broken down

SCIM III: Respiration

0. Requires tracheal tube (TT) and permanent or intermittent assisted ventilation (IAV)
2. Breaths independently with TT; requires oxygen, much assistance in coughing or TT management
4. Breaths independently with TT; requires little assistance in coughing or TT management
6. Breaths independently without TT; requires oxygen, much assistance in coughing, a mask (e.g., peep) or IAV (bipap)
8. Breaths independently without TT; requires little assistance or stimulation for coughing
10. Breaths independently without assistance or device
SCIM-SR: Breathing

- I need a respiratory (tracheal) tube...
  - [0] as well as permanent or from time to time assisted ventilation.
  - [2] as well as extra oxygen and a lot of assistance in coughing or respiratory tube management.
  - [4] as well as little assistance in coughing or respiratory tube management.
- I do not need a respiratory (tracheal) tube...
  - [6] but I need extra oxygen or a lot of assistance in coughing or a mask (e.g., PEEP) or assisted ventilation from time to time (e.g., BIPAP).
  - [8] and only little assistance or stimulation for coughing.
  - [10] and can breathe and cough independently without any assistance or adaptive devices.

SCIM III vs. SCIM-SR

- SCIM-SR correlates with SCIM-III ($r=0.87$; CI=0.82-0.91)
- Mean and median values of SCIM III were lower than SCIM-SR, especially in mobility
- Recommend use of SCIM-SR in outpatient/community setting and SCIM III in hospital
CUE-Q

- Think about reaching out with your arm to touch something directly in front of you that is at shoulder level how difficult is it to do this using your RIGHT ARM?

- Think about raising your arm directly over your head, with your arm straight...

- Think about pushing down with both arms into your chair enough to lift your buttocks (both sides) off the seat (do a push-up weight shift)...

- Think about pinching and holding an object between your thumb and the side of your index finger, such as holding a key, how difficult is it to do this with your RIGHT HAND?

CUE-Q Psychometrics

- Excellent Test-Retest Reliability for total test
- Excellent correlation to Upper Extremity Motor Score (UEMS) & Functional Independence Measure (FIM)
- CUE is a better predictor of the FIM than the UEMS
### Recovery vs Compensation

### NeuroRecovery Scale (NRS)

- Classifies functional performance of mobility tasks according to normal, pre-injury capabilities
- No compensation or assistance
- 7 overground tasks (sit, sit-up, reverse sit-up, trunk extension, sit-to-stand, and walk)
- 4 treadmill tasks (stand retraining, stand adaptability, step retraining, and step adaptability)
- 30-45 minutes to administer

Behman et al., 2012
NRS Psychometrics

- Good interrater reliability, better with more experience
- Discriminant validity demonstrated
  - Able to discriminate categories of patients better than the ISNCSCI

Sit

| 1A: Unable to maintain proper posture of trunk | 1B: Unable to attain. Able to maintain sitting with inappropriate posture of trunk. |
| 2A: Able to both attain sitting appropriate posture of trunk and position of pelvis and maintain this for approximately one minute. |
| 3A: Same as 2C and forward and lateral/reach/lean <5 inches and return to proper sitting posture with inappropriate kinematics of the scapula, shoulder, elbow, wrist and fingers (full UE). |
| 4A: Able to attain and maintain appropriate sitting posture indefinitely. Able to forward and lateral reach/lean >10 inches & return to appropriate sitting posture appropriate kinematics of the elbow, inappropriate kinematics of the scapula, shoulder, wrist and finger flexors. |

| 2B: Able to both attain sitting with appropriate posture of trunk and position of pelvis & maintain this indefinitely. |
| 3B: Same as 2C and forward and lateral reach/lean 5-10 inches and return to proper sitting posture with inappropriate kinematics of the scapula, shoulder, elbow, wrist and fingers (full UE). |
| 4B: Able to attain & maintain appropriate sitting posture indefinitely. Able to forward & lateral with 90 degrees of shoulder flexion & forward & lateral reach/lean >10 inches & return to appropriate sitting posture appropriate kinematics of the scapula, shoulder, and elbow, inappropriate kinematics of the wrist and fingers. |

| 2C: Able to both attain sitting and appropriate posture of trunk and position of pelvis with arms parallel to the legs for 30 seconds with inappropriate kinematics of the full UE. |
| 3C: Same as 2C and able to forward and lateral reach/lean >10 inches and return to proper sitting posture with inappropriate kinematics of the scapula, shoulder, elbow, wrist and fingers (full UE). |
| 3C: Same as 2C and able to forward and lateral reach/lean >10 inches and return to proper sitting posture with inappropriate kinematics of the scapula, shoulder, elbow, wrist and fingers (full UE). |
| 4C: Able to attain and maintain appropriate sitting posture indefinitely. Able to elevate arms out stretched parallel to legs & forward and lateral with 90 degrees of shoulder flexion & forward & lateral reach/lean >10 inches & return to appropriate sitting posture with appropriate kinematics of the scapulae, shoulder, elbows, wrist and fingers. |

NeuroRecovery Network, 2014
Canadian Occupational Performance Measure

- 5-step semi-structured interview
- Focuses on identifying activities within each performance domain that the client wants, needs, or is expected to perform
- Rate the performance and satisfaction for top 5 activities
- The patient and therapist create goals for therapeutic interventions.
- Caregiver/proxy may respond on the patient’s behalf
- Pediatric and multicultural versions available
- Designed for use with any diagnosis
- Available for purchase from CAOT

Lae et al., 2005
COPM Psychometrics

- Validated in Stroke, COPD, Pain, Cerebral Palsy, Traumatic Brain Injury, Parkinson’s Disease, Arthritis, Ankylosing Spondylitis
- Excellent test-retest and interrater reliability
- Score changes of more than 2 are clinically significant

Law et al., 2005

Common Data Elements

- Expert panel convened by NIH/NINDS
- Recommended measures to be used for research based on evidence and clinical experience
  - Core
  - Highly recommended
  - Supplemental
  - Exploratory
- Develop CRF and usage guidelines
### Highly Recommended

- 10 Meter Timed Walk
- 6 Minute Walk Test
- Berg Balance Scale (BBS)
- International SCI Upper Extremity Basic Data Set
- Spinal Cord Independence Measure

### Supplemental

- 2 Minute Walk Test
- Canadian Occupational Performance Measure (COPM)
- Capabilities Upper Extremity Questionnaire
- Five Times to Sit and Stand Test
- Jebsen-Taylor Hand Functioning Test
- Spinal Cord Injury Functional Ambulation Inventory (SCI-FAI)
- Stair Climb
- Stride Analysis and Gait Variability
- Timed Up and Go (TUG)
- Walking Index for Spinal Cord Injury (WISCI II)
- Wheelchair Skills Test
### Exploratory

- Borg Rating of Perceived Exertion (RPE) Scale
- Capabilities Upper Extremity Test (CUE-T)
- Graded Redefined Assessment of Strength, Sensibility and Prehension (GRASSP)
- Grasp and Release Test
- Neuromuscular Recovery Scale
- Nine Hole Peg Test
- Quadriplegia Index Function
- Sollerman Hand Function Test
- Spinal Cord Injury Functional Index (SCI-FI)
- Tetraplegia Hand Activity Questionnaire
- The Activities Based Balance Level Evaluation (ABLE) Scale
- Toronto Rehabilitation Institute Hand Function Test
- Wheelchair Circuit

### Sample Battery for C5 AIS A

- CUE
- SCIM/FIM
- MMT
- ROM
- Functional Reach
- COPM

*What would you add? What if C8 AIS A?*
For More

- rehabmeasures.org
- scireproject.com

EXPECTED OUTCOMES
Prognosis for Ambulation

Level C1-C4

• Relevant Muscles Innervated
  – Upper trapezius
  – Cervical paraspinals
  – Neck accessories
  – Diaphragm at C4
• Probable movements
  – Neck flexion, extension, rotation
  – Scapular elevation, shoulder shrug
• Problems
  – No movement in trunk, LE, UE
  – Ventilator dependent, low respiratory reserve
# C1-C4 Expected Outcomes

<table>
<thead>
<tr>
<th>FIM</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory, bowel, bladder</td>
<td>1</td>
</tr>
<tr>
<td>Functional mobility</td>
<td>1</td>
</tr>
<tr>
<td>Self care</td>
<td>1</td>
</tr>
<tr>
<td>Wheelchair, Management</td>
<td>1-6</td>
</tr>
<tr>
<td>Ambulation</td>
<td>1</td>
</tr>
<tr>
<td>IADL, work, leisure</td>
<td>1-6</td>
</tr>
<tr>
<td>Assist Required</td>
<td>24hrs</td>
</tr>
</tbody>
</table>

---

# Level C5

- **Relevant Muscles Innervated**
  - Deltoid
  - Elbow flexors
  - Rhomboids and serratus anterior

- **Probable movements**
  - Shoulder flexion, abduction, extension
  - Elbow flexion and supination
  - Scapular abduction and adduction

- **Problems**
  - No movement in trunk, LE
  - No elbow extension, pronation, scapular depression, wrist or hand movements

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**www.kennedykrieger.org**
C5 Expected Outcomes

<table>
<thead>
<tr>
<th>FIM</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory, bowel, bladder</td>
<td>1 Low endurance and vital capacity</td>
</tr>
<tr>
<td>Functional mobility</td>
<td>1 Hospital bed with specialty mattress Mechanical lift with sling, transfer board</td>
</tr>
<tr>
<td>Self care</td>
<td>5 Long opponens splint, universal cuff, adapted plates, etc.</td>
</tr>
<tr>
<td>Wheelchair Management</td>
<td>6 Power wheelchair with tilt, joystick control, and pressure relieving cushion. Manual propulsion on smooth flat surfaces</td>
</tr>
<tr>
<td>Ambulation</td>
<td>1 Supported standing frame</td>
</tr>
<tr>
<td>IADL, work, leisure</td>
<td>1-6 Independent after set-up with adaptive equipment</td>
</tr>
<tr>
<td>Assist Required</td>
<td>16hrs Able to instruct care</td>
</tr>
</tbody>
</table>

Level C6-C8

- Relevant Muscles Innervated
  - Pectoralis
  - ECRB and ECRL
  - Latissimus dorsi
  - Triceps, FCR, FDP, FDS, Extensor communis at C7
  - Lumbricals and hypothenar at C8

- Probable movements
  - Shoulder horizontal adduction
  - Wrist extension
  - Wrist and finger flexion, finger extension
  - Finger abduction, adduction, and lateral pinch

- Problems
  - No movement in trunk, LE
  - Limited dexterity
C6-C8 Expected Outcomes

<table>
<thead>
<tr>
<th>FIM</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory, bowel, bladder</td>
<td>Low endurance and vital capacity, Some assist with bowel program, bladder managed with adaptive equipment</td>
</tr>
<tr>
<td>Functional mobility</td>
<td>Hospital bed or regular mattress, Transfer board, (I) on level surfaces</td>
</tr>
<tr>
<td>Self care</td>
<td>Maybe require some set-up</td>
</tr>
<tr>
<td>Wheelchair Management</td>
<td>Lightweight chair, (I) on all terrain</td>
</tr>
<tr>
<td>Ambulation</td>
<td>Supported standing frame</td>
</tr>
<tr>
<td>IADL, work, leisure</td>
<td>Drive an adapted vehicle</td>
</tr>
<tr>
<td>Assist Required</td>
<td>6-8hrs</td>
</tr>
</tbody>
</table>

Level T1-L1

- Relevant Muscles Innervated
  - Hand intrinsics
  - Segmental innervation or abdominals and paraspinals
- Probable movements
  - UE fully intact
  - Segmental trunk function
- Problems
  - No movement in LE
  - Decreased balance
# T1-L1 Expected Outcomes

<table>
<thead>
<tr>
<th>FIM</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory, bowel, bladder</td>
<td>6-7  Adaptive equipment for bowl and bladder program efficiency</td>
</tr>
<tr>
<td>Functional mobility</td>
<td>6-7  Standard bed  (I) Transfer without board</td>
</tr>
<tr>
<td>Self care</td>
<td>7</td>
</tr>
<tr>
<td>Wheelchair Management</td>
<td>6  Lightweight chair, (I) on all terrain</td>
</tr>
<tr>
<td>Ambulation</td>
<td>1-6  Supported standing frame, RGO, HKAFO</td>
</tr>
<tr>
<td>IADL, work, leisure</td>
<td>6-7  Drive an adapted vehicle, load and unload wheelchair</td>
</tr>
<tr>
<td>Assist Required</td>
<td>3hrs</td>
</tr>
</tbody>
</table>

---

# Level L2-S5

- Relevant Muscles Innervated
  - Hip flexors, extensors, abductors, adductors
  - Knee flexors, extensors
  - Ankle dorsiflexors, platar flexors
- Probable movements
  - UE fully intact
  - Good trunk function
  - Partial to full control of LE
- Problems
  - Partial movement in LE
### L2-S5 Expected Outcomes

<table>
<thead>
<tr>
<th>FIM</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory, bowel, bladder</td>
<td>6-7  Adaptive equipment for bowel and bladder program efficiency</td>
</tr>
<tr>
<td>Functional mobility</td>
<td>6-7  Standard bed (I) Transfer without board</td>
</tr>
<tr>
<td>Self care</td>
<td>7    Lightweight chair, (I) on all terrain</td>
</tr>
<tr>
<td>Wheelchair Management</td>
<td>6    Supported standing frame, KAFO, AFO, Adaptive device as indicated</td>
</tr>
<tr>
<td>Ambulation</td>
<td>6-7  Drive an adapted vehicle</td>
</tr>
<tr>
<td>IADL, work, leisure</td>
<td>6-7  Drive an adapted vehicle</td>
</tr>
<tr>
<td>Assist Required</td>
<td>0-1hrs</td>
</tr>
</tbody>
</table>
## Impact of SCI

- Changes in your bladder and bowel functioning
- Disrupts sensation of having to urinate or have a bowel movement
- Disrupt the coordination between the brain and the bowel or bladder
- Voluntary control of sphincters is lost

### Upper Motor Neuron Spastic

### Lower Motor Neuron Flaccid

## Neurogenic Bowel and Bladder

### Upper motor neuron injury T12 and above

- **Spastic Bladder**
  - Bladder is spastic and irritable
  - Urinary sphincter is tight and does not relax voluntarily
    - Difficulty storing and releasing urine
- **Spastic Bowel**
  - Decreased GI motility
  - Rectum holds stool
  - Anal sphincter tight and does not relax voluntarily
    - Difficulty releasing stool

### Lower motor neuron injury T12 and below

- **Flaccid Bladder**
  - Bladder will not contract when it becomes full
  - Urinary sphincter is loose and fails to contract
    - Difficulty storing urine
- **Flaccid Bowel**
  - Rectum holds stool
  - Anal sphincter fails to contract
    - Difficulty storing stool

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**Bladder Management**

**Spastic**
- Frequent and urgent urination
- Medications to relax the bladder
  - Oxybutinin (most common)
- Intermittent Catheterization
  - Every 4 hours (5x/day)

**Flaccid**
- Leaking of urine
- Medications not effective
- Timed voids
- Intermittent catheterization
  - Every 3-4 hours
  - Prior to doing activities that cause valsalva

**Additional Bladder Options**
- Condom catheter
  - Men Only
  - Overflow
- Indwelling Foley catheter
  - Not recommended
- Suprapubic tube
  - Reversible minor surgery
  - Increased UTI and bladder cancer
- Catheterizable stoma placed in belly button
  - Permanent, more major surgery
  - Less UTI and less bladder cancer
- Bladder reconstruction
- Botox
Bowel Management

• Manage stool consistency
  – Diet
    • Fiber (or supplement)
    • Fluid
  – Medications to soften stool
    • Docusate Sodium
    • PEG (lower doses)
• Promote GI motility
  • Senna
  • PEG (higher doses)

Spastic Bowel Program
• Every 1-3 days
• Soft formed stool
• Trigger reflex evacuation
  – Digital stimulation
  – Suppository

Flaccid Bowel Program
• 1-2 x/day
• Firm formed stool
  – Easy to remove but does not leak
• Suppositories generally do not work
• Manual disimpaction
  – 1-2 times per day
  – Prior to activities that cause valsalva
Role of OT

- Problem solve positioning
- Modify task
- Provide adaptive equipment

https://www.coloplast.co.uk/peristeen-ensal-irrigation-system-en-gb.aspx
PVA Clinical Practice Guidelines: UE Preservation

- Ergonomics
- Equipment selection
- Positioning
- Exercise
- Treatment of injury and pain


Prevalence of UE pain

- Overall: 4% to 75%
- Wrist and CTS: 40-66%
  - Ulnar nerve entrapment
  - Tendinitis
  - Wrist Arthritis
- Elbow: 5-16%
  - Cubital Tunnel
  - Lateral epicondilitis
  - Bursitis
- Shoulder: 30-60%
  - Impingement
  - Osteoarthritis
  - Rotator cuff tear
  - Bicipital tendinitis
Ergonomics

- Minimize frequency of tasks
- Minimize force required for tasks
- Minimize extreme positions (overhead reaching)

Equipment Selection and Environmental Adaptations

- Consider power wheelchairs with high risk patients
- Manual w/c users should have a fully custom, light weight chair
- Adjust rear axle as far forward as possible
- Educate patient on propulsion patterns (choo choo train) and transfers (level when possible, vary technique)
- Provide seat elevation/standing to reduce overhead reaching
Positioning

- Avoid direct pressure on shoulder
- Provide support to the limb
- Abduction and external rotation whenever possible
- Avoid pulling on the arm

Exercise

- Incorporate flexibility and resistance training
- Nawoczenski et al., 2006: Pain improved by 20-79% in 8-weeks
  - Stretch: upper trap, pec, long head of biceps
  - Strengthen: middle and low trap, serratus anterior, and shoulder external rotators
- Silvestri & Sadowsky
  - 15 people: 8 tetra, 7 para, ave. 81.5mo post-injury
  - Stretch 5x/week, Strengthen 3x/week
  - Education: transfers, w/c propulsion, gait with AD
  - 6.23/10 at eval, 2.2/10 after 8 weeks
  - Compliance: 4.5/week stretch, 3.7/week strength
Management of UE Injuries

- Manage as in uninjured population
- Intervene early for acute pain
- May need to plan for additional assistance as postsurgical rest is not practical

Treatment of Chronic Pain

- Careful assessment
- Interdisciplinary treatment
- Monitor progress regularly, including psychosocial adjustment
Options for UE Management

- Splints/Orthotics
  - Static
  - Dynamic
  - Therapeutic
  - Functional
- Surgical Reconstruction
  - Tendon Transfer
  - Nerve Graft
  - Muscle Transfer
- Functional Electrical Stimulation
  - Surface Stimulation (Neuro-Prosthesis)
  - Implantable

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QUESTIONS

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