

## Spinal Cord Injury: Observation to Guide Treatment

J.J. Mowder-Tinney PT, PhD, NCS, CSRS, CEEAA  
Jennifer Fay PT, MS

---

---

---

---

---

---

---

## Learning Objectives

- Describe the associated level of injury and appropriate goals for people with SCI.
- Compare and contrast key features of strategies required when treating a patient with a C6 level of injury and a thoracic level injury.

---

---

---

---

---

---

---

## SCI At A Glance

- ✓ Over 17,000 new injuries annually
  - ✓ 290,000 living with SCI in the US
  - ✓ Main causes: Vehicular accidents (38%), Falls (31%), Violence (13%)
  - ✓ Gender: 78% Male      Average age at injury: 43 years
  - ✓ 31% of injuries are classified as complete tetraplegia or paraplegia
- <https://www.nscisc.uab.edu/Public/Facts%20and%20Figures%20-%202018.pdf>

---

---

---

---

---

---

---

### Terminology Check

- ✓ **Tetraplegia:** impairment or loss of motor and/or sensory function in the cervical segments of the spinal cord.
- ✓ **Paraplegia:** impairment or loss of motor and/or sensory function in the thoracic, lumbar or sacral segments of the spinal cord.

Motor Testing: [http://asia-spinalinjury.org/ElearningMotor\\_Exam\\_Guide.pdf](http://asia-spinalinjury.org/ElearningMotor_Exam_Guide.pdf)

---

---

---

---

---

---

---

---

### Classification of Spinal Cord Injury

American Spinal Injury Association (ASIA)

- ✓ Determine Neurological Level of Injury => strength of key muscles and sensation of key points (C6, T12, L3, Left and Right)
- ✓ Determine if Complete/ Incomplete=> sensory or motor function at S4-S5
- ✓ Determine Asia Impairment Scale (AIS)=> response to classification questions (A, B, C, D)

---

---

---

---

---

---

---

---

- ✓ **AIS A = Complete.** No sensory or motor function is preserved in the sacral segments S4-5.
- ✓ **AIS B = Sensory Incomplete.** Sensory function is preserved below the neurological level and includes the sacral segments S4-5
- ✓ **AIS C = Motor Incomplete.** Motor OR sensory function is preserved at the most caudal sacral segments, AND has some sparing of motor function (MMT Grade <3)
- ✓ **AIS D = Motor Incomplete.** As defined above, with at least half of key muscle functions below the single NLI having a muscle grade  $\geq 3$ .
- ✓ **AIS E= Normal**

---

---

---

---

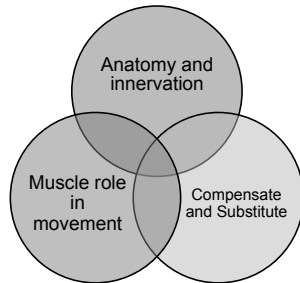
---

---

---

---

## Foundations of SCI Rehab




---

---

---

---

---

---

---

## C6 TETRAPLEGIA

### KEY MUSCLES AND AVAILABLE MOVEMENTS

---

---

---

---

---

---

---

## C6 Key Muscles and Available Movements

KEY MUSCLES	AVAILABLE MOVEMENTS
Face, Neck , Cranial Nerves	Talk, Masticate, Sip, Blow, Elevate Scapulae, Lift Head
Deltoid, Pectoralis Major, Clavicular Head, Infraspinatus, Teres Minor, Latissimus Dorsi	SHOULDER Flexion, Extension, Internal Rotation, External Rotations, Abduction, Adduction
Rhomboids, Serratus Anterior	SCAPULAR Protraction, Retraction, Upward Rotation
Biceps, Brachialis, Brachioradialis, Supinator, Pronator Teres	ELBOW flexion, forearm supination and pronation
Extensor Carpi Radialis Longus and Brevis	WRIST extension for tenodesis grasp

---

---

---

---

---

---

---

## Terminology Check

- ✓ Tenodesis: The use of wrist extension, coupled with the passive flexion of shortened long finger flexors, to create a functional grip.

---

---

---

---

---

---

---

## C6 Key Muscles for Respiration

Sternocleidomastoid  
Trapezius  
Cervical Extensors  
Levator Scapulae  
Scalenes  
Pectoralis Major  
Serratus Anterior  
Rhomboids  
Latissimus Dorsi  
Diaphragm

- ✓ Accessory respiratory muscles- innervated
- ✓ Diaphragm- fully innervated
- ✓ Abdominals – not innervated
- ✓ Decreased expiratory efficiency

---

---

---

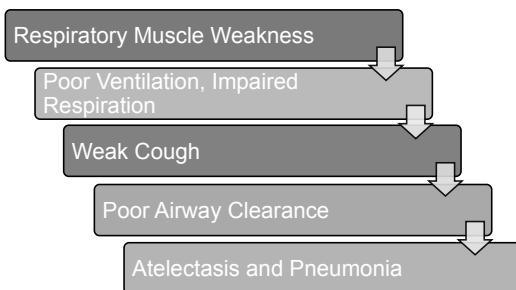
---

---

---

---

## Respiratory Implications




---

---

---

---

---

---

---

## EVALUATE COUGH AND INCLUDE GOAL

- ✓ **Functional**- Clears secretions
- ✓ **Weak Functional**- Clears upper airway secretions in small amounts, assist required for lower airways and mucous
- ✓ **Non Functional**- can't produce force to generate cough

---

---

---

---

---

---

---

C6 LEVEL= NO TRICEPS  
WHAT DO WE DO?

Closed Chain

- ✓ "Dynamic Duo" substitute elbow extension
- ✓ External Rotators and Anterior Deltoid

Open Chain:  
✓ External Rotation

---

---

---

---

---

---

---

## BED MOBILITY GOALS

Bed Mobility: **Minimal Assist- Independent** in a regular bed with adaptive equipment or hospital bed

- ✓ BREAK DOWN BED MOBILITY INTO COMPONENT PARTS WHEN SETTING GOALS!

---

---

---

---

---

---

---

### Rolling: Independent

Utilize strategies and/or equipment, such as a rail or strap.

- ✓ Use of neck flexors, serratus, shoulder flexors (<90) external rotators

---

---

---

---

---

---

---

---

### Independent Supine <-> Long Sit

BE ON THE LOOK OUT FOR:

- ✓ **Elbow flexors** with distal stabilization to lift upper body
- ✓ **Shoulder extensors** to throw arm back, and prep for weight bearing
- ✓ **Dynamic Duo; ER and Ant. Deltoid** to lock elbow
- ✓ **Periscapular muscles** stabilize scapula during weightbearing

---

---

---

---

---

---

---

---

### Independent Long Sit <-> Short Sit

BE ON THE LOOK OUT FOR:

- ✓ **Dynamic Duo** active on the stabilizing arm
- ✓ **Elbow flexors, shoulder flexors, scapular protractors, wrist extensors** active on the arm managing the LE's

---

---

---

---

---

---

---

---

### Independent Transfers Even Surfaces –Sliding Board

#### BE ON THE LOOK OUT FOR:

- ✓ **Dynamic Duo** to allow UE support with extended elbows for sitting balance
- ✓ **Periscapular muscles** to stabilize scapula during WB
- ✓ **Shoulder depressors** generating power for lifts

Why does this level of injury require assist for transfers between uneven surfaces?

---

---

---

---

---

---

---

---

### Independent Wheelchair Mobility and Management

- ✓ Power chair with hand control indoors/ outdoors
- ✓ Manual chair indoors even surfaces
- ✓ Consider ultra light weight chair, plastic rims, power assist

#### BE ON THE LOOKOUT FOR:

- ✓ Shoulder ER, Flexion, wrist extension to propel chair.
- ✓ Elbow, shoulder flexion to manage LE's on/ off leg rests.

---

---

---

---

---

---

---

---

### Independent with pressure relief

Variety of strategies

- ✓ PT and patient determine best options.

---

---

---

---

---

---

---

---

### Thoracic Injury Muscles and Available Movements

KEY MUSCLES	AVAILABLE MOVEMENTS
All muscles active for C6 PLUS	
Sternal Portion of Pectoralis	SHOULDER Adduction and Internal Rotation
Triceps, Pronators	ELBOW extension and FOREARM Pronation
Finger flexors, abductors, lumbricals	Grasp, Pinch, Isolated Control of Fingers
Trunk muscles based on level of injury	TRUNK Flexion, Extension and Rotation

---

---

---

---

---

---

---

### Goal Considerations: Paraplegia

- ✓ Consider respiratory function/ cough due to the role of abdominal muscles
- ✓ Full UE innervation -Independent bed mobility without equipment
- ✓ Even surface transfers without a board and uneven surface transfers
- ✓ Independence with manual wheelchair indoors and outdoors
- ✓ More options for independent pressure relief

---

---

---

---

---

---

---

### Interventions for C6 level Injury

---

---

---

---

---

---

---



**\*\*This level injury needs a lot of rehab  
and has a lot of potential\*\***

- There are many options and strategies  
but need to understand the basic  
foundation

---

---

---

---

---

---

---

### Key Considerations

- Autonomic Dysreflexia
  - 1) Stretching hamstrings – if doing a straight leg raise  
make sure no leg bag or it is empty
- PROM of shoulder/elbow/wrist extension
- Retrain closed chain movement of anterior deltoid  
with arm in external rotation to compensate for  
triceps
- Observe movement and identify compensation.

---

---

---

---

---

---

---

### Pressure Reliefs

- C5 or higher – use  
power tilt/recline for  
regular pressure relief  
or forward with assist
- C5-6 – lean forward or  
side-to side
- C7 or below – lean  
forward or side-to side  
or can perform press –  
up (not preferred)




---

---

---

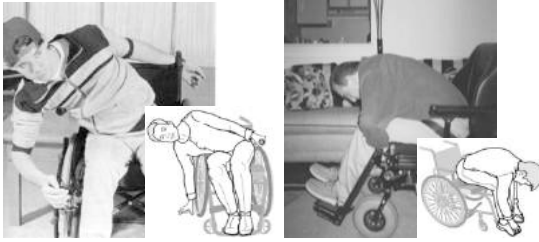
---

---

---

---

## Pressure Reliefs



- Mean duration of pressure relief required to raise tissue oxygen to unloaded levels for most individuals is 1min 51sec

\*Coggrave and Rose. A specialist seating assessment clinic: changing pressure relief practice. Spinal Cord. 2003;41:692-695.

---

---

---

---

---

---

---

---

**95% of all pressure sores are preventable**

---

---

---

---

---

---

---

---

## Functional Activity Techniques

- Strategies for therapists as well as patients
  - 1) Bed mobility
    - Rolling, Short sit ↔ long sit, Supine ↔ long sit, long sit ↔ wheelchair
  - 2) Transfers
    - Even surface

---

---

---

---

---

---

---

---

### THINK Function

- Most of your interventions will be them doing functional activities

---

---

---

---

---

---

---

### Rolling

- Mobility of the spine seems to play a key part in rolling
- The goal is to roll as efficiently as possible and maximize muscle power
- A certain level of flexibility is required in the spine however it cannot be too flexible
  - 1) Trunk ROM for rollers 75° - 100°
  - 2) Trunk ROM for non-rollers is 55° - 115°

Tanaka et al  
2000

---

---

---

---

---

---

---

### Short Sitting to Long Sitting

- When upper extremities are weight bearing externally rotate to lock out elbows
- Move legs toward the base of support
- Lean on left arm and use right wrist extensors to hook under left leg to lift onto mat.
- Move in small increments to be able to maintain balance and reach both legs
- May need momentum for last leg

---

---

---

---

---

---

---

### Supine ⇒ Long Sit

- Can perform initial action by using biceps
- Palms up under buttocks or in pants pocket/waistband
- Use momentum and quick weight shifting to progress to long sit

---

---

---

---

---

---

---

### Even Surface Transfers

- Use head/hips to move hips to start position of UE on seat of chair
- Whenever upper extremities are weight bearing they are externally rotate to lock out elbows
- Position hands with one hand close to hip and the direction of movement hand small distance out – stay by greater tuberosities
- Cue to **lift FIRST** using shoulder depressors
- THEN swing head – opposite direction
- Guard under hips and low

---

---

---

---

---

---

---

### Prone on Elbows

- Excellent transition position and strengthening for shoulder girdle and posterior musculature
- Watch for winging of the scapula
  - 1) Use wedge under chest if it occurs
- Add weightshift and reaching

---

---

---

---

---

---

---

### Supine on Elbows

- Higher level injuries start out very tight in shoulder extensors, external rotators and middle deltoids
- Use elbow pads
- Stretch tightness in sitting and in weight bearing




---

---

---

---

---

---

---

### Long Sitting

- To be able to use this position for transitions excessive ROM is needed in the shoulder
- Especially in the C6 patient
- Maintain tenodesis
- Exercises should include transitions as well as weight shifts, balancing and shoulder stabilization

---

---

---

---

---

---

---

### Takeaways for Strengthening Watch for...

- Prone on elbows
  - 1) Winging scapulas
- Supine on elbows
  - 1) Pain – shoulder extension PROM
- Long Sitting
  - 1) Hamstring length

---

---

---

---

---

---

---

## Interventions for Thoracic level Injury

---

---

---

---

---

---

---

## Functional Activity Strategies

- Strategies for therapists as well as patients
  - 1) Bed mobility
    - Rolling, Short sit ↔ long sit
  - 2) Transfers
    - Uneven, floor to chair
  - 3) Advanced Mobility
    - Wheelies
    - Curbs

---

---

---

---

---

---

---

## Rolling

- Now you can use more upper extremity momentum because of having triceps
- Don't forget to cue to use head

---

---

---

---

---

---

---

### Short Sit ⇒ Long Sit Option 1

- Leaning toward base of support
- One leg up at a time
- Can use head and torso away from leg for extra strength

---

---

---

---

---

---

---

### Long Sitting Transfer

- Can perform transfer board to start and then progress to sit pivot.
- If there is good hamstring PROM and a need for increased stability perform with legs up.




---

---

---

---

---

---

---

### Short Sitting Sit Pivot

- Make sure to practice them getting a full lift to protect the skin
  - 1) Have your hands underneath hips to make sure to get a strong lift
- Guard (pin) the knees and stay low
- Head/hips relationship is key!

---

---

---

---

---

---

---

### Sitting Balance

- Start supported
- Support at shoulders to help find balance point
- Unsupported: Important to find balance using head and arm motions
- Weight shifting side to side
- Take away UE support
- Add hitting the ball
- Use a stick to hit the ball
  - 1) Make sure to guard the legs with a pillow

---

---

---

---

---

---

---

### Sitting Balance Video

---

---

---

---

---

---

---

### Quadruped

- Functional transition from off of floor ⇒ wheelchair
  - 1) Activities to do
  - 2) Side sitting to quad – part task of getting into the position
  - 3) Weight shifting
  - 4) Push ups

---

---

---

---

---

---

---



### Floor ⇒ Wheelchair

- Many different approaches can be used
- Head/Hips is critical here
- Body type will help determine type of transfer
- Front approach
- Side approach
- Back approach

**What would help you determine which transfer to teach?**

---

---

---

---

---

---

---

---

### Floor ⇒ Wheelchair



What would make you choose this option?

---

---

---

---

---

---

---

---

### Advanced Wheelchair Skills

- **Wheelies**
  - 1) Find balance point
  - 2) Maintain balance
  - 3) Pop into wheelie
- **Up a curb**
  - 1) Use momentum and timing
- **Down a curb**
  - 1) Wheelie forwards
  - 2) Backwards

---

---

---

---

---

---

---

---

### Mobility Training

- Make sure to instruct in indoor and outdoor mobility due to incidents of falls.
  - 1) Manual wheelchair falls tend to be forward and backward while power wheelchair falls are sideways.
  - 2) 90% of falls involved riding down a slope and hitting a curb cut at the bottom - practice
- Ability to perform wheelies and negotiate obstacles must be practiced

---

---

---

---

---

---

---

---

### Main Clinical Takeaways

- Head/Hips Relationship is critical for most movements
- Understand level of injury and what compensation is needed to perform each functional activity
- Always address the shoulders
- If in doubt – weight shift!

---

---

---

---

---

---

---

---




---

---

---

---

---

---

---

---