Objectives

1. Understand the roles of physical and occupational therapy in the acute stages of spinal cord injury (SCI) and other neurological injuries.
2. Review the anatomy and pathophysiology of acute spinal cord injury.
3. Understand key components of acute management of impairments following SCI including respiratory compromise and risk for skin breakdown.
4. Identify signs and symptoms of Autonomic Dysreflexia which is considered a medical emergency.
Objectives

5. Demonstrate knowledge of expected functional outcomes for patients with acute SCI based on level of injury.
6. Identify bracing, splinting, positioning, and adaptive equipment needs of patients with acute SCI and other neurological injuries.
7. Be able to provide basic education to patients and family members on positioning, ROM, pressure relief, and positioning needs for patients with acute SCI and other neurological injuries.

Spinal Cord Injury

• A spinal cord injury occurs a result of damage to any part of the spinal cord or the nerves at the end of the spinal canal.
  – often causes permanent changes in strength, sensation and other body functions below the site of the injury.²
Terminology

- **Tetraplegia** (preferred term to quadriplegia)
  - Impairment or loss of motor and/or sensory function in the cervical segments of the spinal cord.
  - Involves the arms, trunk, legs, and pelvic organs.

- **Paraplegia**
  - Impairment or loss of motor and/or sensory function in the thoracic, lumbar, or sacral segments of the spinal cord.
  - Arm function is spared.
  - Involves trunk, legs, and pelvic organs.

- **Complete Spinal Cord Injury**
  - Absence of sensory and motor function in the lowest sacral segments.

- **Incomplete Spinal Cord Injury**
  - Partial preservation of sensory and/or motor functions below the neurological level, including the lowest sacral segments.

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**Neurological Level and Clinical Presentation**

[Cervical, Thoracic, Lumbar, Sacral, Coccygeal areas with corresponding spinal cord levels marked: C4, C6, T6, L1 injuries]
ASIA Impairment Scale (AIS)

A = **Complete.** No sensory or motor function is preserved in the sacral segments S4-5.

B = **Sensory Incomplete.** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = **Motor Incomplete.** Motor function is preserved below the neurological level, and more than half of key muscle functions below the neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0-2).

D = **Motor Incomplete.** Motor function is preserved below the neurological level, and at least half (half or more) of key muscle functions below the NLI have a muscle grade ≥ 3.

E = **Normal.** If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

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Prevalence of Level of Injury

Since 2010^1^
Spinal Cord Injury Clinical Syndromes

- Brown-Sequard Syndrome\textsuperscript{17}
  - A lesion that produces ipsilateral proprioceptive and motor loss and contra lateral loss of pain and temperature below the level of the lesion.
  - 1-4\% of traumatic SCIs.
  - Syndrome with the best prognosis for ambulation.
    - 75-90\% of patients ambulate independently at discharge from rehab.
  - Knife injuries.

UPMC Centers for Rehab Services
Spinal Cord Injury Clinical Syndromes – Central Cord

- **Central Cord Syndrome**\(^{17}\)
  - Greater motor impairment in upper than lower extremities.
  - Variable sensory loss below the level of the lesion.
  - Associated with bladder dysfunction.
  - Most common SCI syndrome (9% of traumatic SCIs).
  - Classic injury of older individuals (falls, hyperextension injuries).
  - Favorable prognosis for recovery especially in younger patients.

Spinal Cord Injury Clinical Syndromes – Posterior Cord

- **Posterior Cord Syndrome**\(^{17}\)
  - Least common SCI clinical syndrome, < 1%.
  - Omitted by ASIA.
  - Loss of proprioceptive and vibration sense with preservation of muscle strength, temperature, and pain sensation.
Anterior Cord Syndrome

- Lesion affects the anterior two thirds of the spinal cord while preserving the posterior columns.
  - Complete motor paralysis, loss of pain and temperature sensation.
  - Preservation of position and vibration sense.
- 2.7% of all traumatic SCIs.
- Associated with flexion injuries or occlusion of the anterior spinal artery.
- Poor prognosis for functional improvement, 10-20% chance of muscle recovery.

Conus Medullaris Syndrome

- Injury of the sacral cord and lumbar nerve roots.
- Combination of upper and lower motor neuron signs.
- Saddle anesthesia, areflexic bowel and bladder, variable lower extremity weakness.
- Trauma and tumors.

Cauda Equina Syndrome

- Injury to lumbosacral nerve roots.
- Pure lower motor neuron lesion.
- Not a true SCI.
- Saddle anesthesia, bowel and bladder dysfunction, variable, asymmetric lower extremity weakness.
- Acute process or slowly progressive condition.
- Trauma, tumors, spinal stenosis, or disc compression.
- Better prognosis for neurological recovery (nerve roots regenerate).
Etiology

Since 2010¹

- Vehicular: 38%
- Falls: 9%
- Violence: 5%
- Sports: 4%
- Medical/Surgical: 14%
- Other: 30%

Traumatic SCI

- Incidence
  - 12,500 new cases each year in the U.S.¹
- Prevalence
  - 276,000 persons living with SCI¹
- Average Age at Time of Injury
  - 42 years (increased from 29 years in the 1970s)¹
- 80% of new cases are male¹
- 60% have a co-occuring diagnosis of TBI²
  - 57% mild
  - 43% severe

¹ UPMC Centers for Rehab Services
² Incidence and Prevalence data from National Institute on Disability and Rehabilitation Research.
Pathophysiology of Acute SCI

• **Primary SCI**
  - Occurs at the time of injury as a direct result of transection, bruising, ischemia, compression, hemorrhage, etc.

• **Secondary SCI**
  - Occurs over the course of hours to days as a result of a complex inflammatory process resulting in edema and ischemia and causing irreversible damage.

Pathophysiology of Acute SCI

• **Spinal Shock**
  - A combination of diminished or absent reflexes and autonomic dysfunction below the level of injury. Initially presents as a loss of both cutaneous and deep tendon reflexes below the level of injury accompanied by a loss of sympathetic outflow, resulting in hypotension and bradycardia.
  - Autonomic dysfunction is more severe in patients with higher levels of injury.
    • Generally persists for months, some evidence to suggest a permanent level of abnormality.
  - Sympathetic activity can still be present and mediated by the spinal cord distal to the level of injury. Because of this sympathetic/parasympathetic imbalance, patients with complete spinal cord injury can have hypertensive crisis – autonomic dysreflexia.
  - Spinal shock is a continuum of events.
    • Initial hyporeflexia (0-1 days)
    • Reflex return (1-3 days)
    • Early hyperreflexia (1-4 weeks)
    • Late hyperreflexia (1-12 months)
Autonomic dysreflexia – A Medical Emergency

- Autonomic dysreflexia
  - An uninhibited sympathetic nervous system response to noxious stimuli, occurring in people with SCI at T6 level and above.
  - Life-threatening, medical emergency – extremely elevated BP.
  - Symptoms
    - Pounding headache
    - Profuse sweating above the level of the lesion
    - Flushed skin
    - Visual changes
    - Cardiac arrhythmias
    - Elevated blood pressure of 20 to 40 mm Hg above baseline.
  - Immediately place patient in upright position.
  - Identify noxious stimulus – most common cause is bladder distension.
Acute Care Intervention – Cardiovascular/Pulmonary

- Cardiovascular/Pulmonary
  - Lesions above C4 -> paralysis of the diaphragm -> mechanical ventilation.
  - C4-T12 -> respiratory compromise due to paralysis of intercostal and abdominal muscles.
    - The extent of ventilatory impairment is directly proportional to the amount of inspiratory and expiratory muscle involvement.
    - Provide abdominal binder to patients with injuries above T12.
  - Sympathetic outflow to the heart is located T3-5 -> individuals with injuries above T5 will have an altered heart rate response to exercise.
  - Injuries above L1 -> impaired vaso-response to the lower extremities -> exercise hypotension, venous pooling -> decreased stroke volume and cardiac output.
    - Antiembolism stockings, abdominal binder, pre-exercise hydration.
  - Thromboembolism
    - Anticoagulants, pneumatic pumps, anti-embolism stockings out of bed, early mobilization and passive ROM exercises

Acute Care Intervention – Neuromuscular and Musculoskeletal

- Neuromuscular
  - Hypertonicity (spasticity) – the velocity-dependent increase in tonic stretch reflexes.
    - Injuries T12 and above.
  - Hypotonicity –
    - Injuries at L1 and below.
    - Can lead to muscle atrophy.
  - Neurogenic bowel/bladder
  - Thermoregulation
    - Absence of thermoregulatory sweating and vasoconstriction below the lesion results in the patient being influenced by the temperature of the environment.

- Musculoskeletal
  - Joint contractures
  - Heterotopic ossification (HO)
• Pressure Ulcers
  – 2008 – Centers for Medicare and Medicaid Services announced that they will not pay for additional costs incurred for hospital-acquired pressure ulcers.5
  – Incidence of pressure ulcers in the ICU ranges from 10-41%.5
  – Factors associated with increased risk of pressure ulcer:
    • Prolonged ICU stay5
    • Duration of mechanical ventilation5
    • Advanced age5
    • Nutritional deficiency5

Pressure Ulcer Risk Factors

• Several factors contribute to the risk for skin breakdown during the initial 3-7 days.11
  – Reduced pain sensation due to sensory loss, brain injury, medications, immobility due to motor loss, and the use of boards, collars, traction.

• At risk areas:
  – Occiput, scapulae, sacrum/coccyx, trochanters, ankles, heels11
  – Ischial tuberosities (in sitting)11
  – Chin, ears, and occiput in patients wearing hard cervical collars
  – Areas in contact with lines, drains, tubes, braces, etc.
Capillaries close at 30-50 mmHg.

https://www.youtube.com/watch?v=mRiJqtOYegI

Recommendations for Pressure Ulcer Prevention

- **Recommendations for Prevention**\(^{11}\)
  - Reposition or turn at least every 2 hours while maintaining spinal precautions.
  - Pressure reduction mattress.
  - Keep clean, dry, avoid temperature elevation.
  - Assess nutritional status.
  - Inspect under pressure garments and splints.

- An unstable spinal cord patient should be log rolled with caution, just the same as spinal cord patients that have been fused on the standard beds.
  - If patient does not tolerate being turned, then a low air loss or bariatric low air loss bed should be ordered.
**PRAFO – Pressure Relief Ankle Foot Orthosis**

- Appropriate for patients with unilateral or bilateral paresis to prevent plantar flexion contracture and foot drop.
- Preferred over bunny boots for patients with acute neurological injuries – including SCI, CVA, TBI, etc.

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**Bunny Boots**

- Provide heel protection to prevent skin breakdown.
- Not beneficial for positioning.
Acute Care Physical Therapy Intervention

- Physical therapy management begins in the ICU
  - Patient and family education.
  - Prevention of secondary complications.
  - Maintain/improve ROM.
    - Critical ROM requirements for optimal function:
      - Full elbow extension, supination, and wrist extension for UE weight bearing.
      - Ankle dorsiflexion to neutral for proper foot placement on a footplate of a WC.
      - Hip and knee flexion to a minimum of 90 degrees.
      - Full hip and knee extension for functional ambulation.
      - Full external rotation for lower-extremity dressing, transfers, and WC positioning.

Acute Care Physical Therapy Intervention (continued)

- Maintain/improve strength through active exercises.
- Improve the patient's endurance for activities.
- Early mobilization:
  - Incremental increases in head of bed.
    - Monitor vitals.
    - Watch for orthostatic hypotension – abdominal binder is useful.
  - Ability to tolerate sitting at 60 degrees from the horizontal plane is indicative of readiness to transfer to a chair.
    - Stretcher chair
      - Advantages of upright positioning with safety features of stretcher including safe and easy horizontal transfers in and out of hospital bed.
### Expected Functional Outcomes Per Level of Injury

<table>
<thead>
<tr>
<th>Injury Level</th>
<th>Outcome Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1-4</td>
<td>Require ventilator. Modified independent with PWC mobility and pressure relief. Total assist for all ADLs. Able to instruct in all aspects of care.</td>
</tr>
<tr>
<td>C5</td>
<td>Maximum assist with sliding board transfers. Able to use adaptive ADL equipment. Modified Independent with PWC mobility and pressure relief.</td>
</tr>
<tr>
<td>C6</td>
<td>Potential to be independent with level transfers using sliding board. Modified independent with ADL equipment – tenodesis grasp. Modified independent with PWC mobility and pressure relief. Potential for modified independent with MWC on level surfaces.</td>
</tr>
<tr>
<td>C7-8</td>
<td>Independent with transfers and ADLs. Modified independent with MWC. Potential to drive vehicle with hand controls.</td>
</tr>
<tr>
<td>T1-9</td>
<td>Independent with transfers and ADLs. Modified Independent with MWC propulsion. Independent with transportation including loading/unloading wheelchair.</td>
</tr>
<tr>
<td>T10-L1</td>
<td>Potential for functional ambulation with walker/forearm crutches, KAFOs, or AFOs. Good trunk stability. Intact respiratory function. Independent with complex cooking and light housekeeping.</td>
</tr>
<tr>
<td>L2-S5</td>
<td>Potential for functional ambulation with forearm crutches or cane, KAFOs or AFOs.</td>
</tr>
</tbody>
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With Decreased Rehab Length of Stay, Acute Care Management is Crucial

- Hospital Acute Care Unit
  - 11 days (declined from 24 days in the 1970s)
- Rehab
  - 36 days (declined from 98 days in the 1970s)
• We must set our patients up for success in order to achieve the best possible long term functional outcomes.
  – As acute rehab length of stay continues to decline, management in acute care is more important than ever.

• Prevention of secondary complications is essential.

• Optimal care of these patients requires a collaborative, multi-disciplinary approach.

• Improving our knowledge of the pathophysiology, acute management, and expected functional outcomes of SCI will translate to improved patient care and education.

Take Home Points
What is Occupational Therapy (OT)

- As Defined by the American Occupational Therapy Association (AOTA)
- Rehabilitation, habilitation
- Holistic perspective
- Individualized plan of care
  - Patient centered goals
- Interdisciplinary approach
- What this means to us

Activities of Daily Living (ADL)
- Upper body dressing, lower body dressing, simple grooming, eating, toileting

Instrumental Activities of Daily Living (IADL)
- Cooking, cleaning, hobbies, roles, work

Splinting

Adaptive Equipment

Recommendations for the next level of care
SCI and Splinting

- SCI show similarities with brain based lesions
- Prognoses is related to level of injury
- Goal: optimize function of upper extremities
- Static splinting
  - Firm base to immobilize the joints they cross
  - Non articular
  - Used to facilitate dynamic functions
- Dynamic splinting
  - Generate a mobilizing force
  - Results in a passive gain or passive assisted ROM

Static Splinting

- Optimally begins immediately
  - Edema develops below the level of the lesion which must be overcome by movement, elevation and proper hand position.
- Goal is to maintain a functional Hand
- Opponens splint
  - Keeps thumb in opposition to first fingers
  - Pinch motion
  - Long opponens used when there is a flaccid wrist
- Resting Hand splint
  - Long term use
  - C4 and above injury
  - Mild tone
Resting Hand and Opponens Splint

- Custom resting Hand
- Comfortable resting Hand
- Short Opponens Splint
- Long Opponens Splint

Dynamic Splinting

- Wrist extensors present
- Promote functional hand
- Used to generate motion
- Tenodesis splints used to facilitate the Tenodesis Grasp
  - Wrist extends fingers flex wrist flexed fingers extend
  - C6-C7 cord level
Adaptive Equipment

- Universal cuffs
- Tub transfer bench
- Drop arm bedside commode
- Built up eating utensils

Conclusion

- Recapturing “denotes a process of engaging in self care to regain the ability to participate in self care activities.”
- Through the participation in activities of daily living we regain our independence and achieve overall self worth.
Thank you for listening!

References

References


References


