Learning Objectives

At the end of the session the rehabilitation nurse will be able to:

• Outline the normal structure and function of the spinal cord

• Describe complete and incomplete spinal cord injury including neurological syndromes

• Be familiar with the ASIA scale

• Describe the significance of spinal shock and autonomic dysfunction in spinal cord injury
Spine

- Vertebral Column
- 26 bones
- 4 major curves
- Weight Bearing
- Protect Spinal Cord

Vertebra

7 Cervical
12 Thoracic
5 Lumbar
5 Sacral
3 Coccygeal
Spinal Cord

- extension of medulla oblongata
- white matter
  - ascending tracts
  - descending tracts
- gray matter
  - motor neurons (ant. horns)
  - sensory neurons (post. horns)
- blood supply - anterior spinal artery & posterior spinal artery
How does your spinal cord work?

- Highway for information between brain and body
- Spinal reflexes

- Central nervous system
  - Brain and Spinal Cord

- Peripheral nervous system
  - Spinal Nerves
  - Somatic and Autonomic
    - Autonomic
      - Sympathetic and Parasympathetic

Spinal Nerves

- 31 pairs
- from spinal cord to peripheral body parts
- dorsal (posterior) ascending, afferent-sensory
- ventral (anterior) descending, efferent-motor
Spinal Reflexes

- don’t require brain involvement
  - muscle stretch
  - cutaneous
  - Pathological

- Above 12th thoracic vertebrae: Upper motor neuron signs - spastic, hyperreflexia

- Below 12th vertebrae: Lower motor neuron-flaccid paralysis

Dorsal Roots (Ascending)

- Posterior part of spinal cord
- Ascending, sensory pathway
- Afferent fibres
  - Sensory input from dermatones
- Two types of fibres:
  - somatic
    - pain, touch, temperature, proprioception
  - visceral
    - from the organs
**Ventral Roots (Descending)**

- Anterior part of spinal cord
- Descending, motor pathway
- efferent impulses
  - motor impulses from spinal cord to body
- Two types of fibres:
  - somatic
    - voluntary striated muscles
  - visceral
    - smooth and cardiac muscle
    - regulate glandular secretion

**Spinal Cord**
Dermatomes and Myotomes

- Dermatomes are innervated by spinal nerves—sensory, afferent pathway
- Myotomes are innervated by spinal nerves—motor, efferent pathway
Autonomic Nervous System

- motor neurons
  - GVE (general visceral efferent fibres)
- regulates activities of the viscera
  - smooth muscles, cardiac muscles, glands
- Purpose:
  - to maintain a stable internal environment
Autonomic Nervous System

- **sympathetic system**
  - stress situations
    - ↑ HR, BP, vasoconstriction
- **parasympathetic system**
  - conservation, restoration of natural functions
    - ↓ HR, ↑ gastrointestinal activity

Sympathetic System

- From T-1 to L2
  - T-1 to T-6 innervate the head
    - T-1 & T-2: pupillary dilation
    - T - to T-6: lungs and heart
  - T-6 to L-2 innervate the abdominal viscera
  - Fibres pass directly to adrenal medulla without synapsing
Parasympathetic System

- from cranial nerves III, VII, IX & X
- to gray matter in S-2 to S-4
  - designed to respond to a specific stimulus in a localized area for a short period of time
    - i.e. bowel or bladder

Spinal Cord Injury
Incidence Canada

- 1,035 Canadians/ year
- Males 4:1 more than females
- 78% 15-34 years
- 50% of spinal cord injuries result in quadriplegia
- Incidents involving brain and spinal cord involve alcohol 1/3 of the time

- Think First Foundation of Canada

Acute Spinal Cord Injury

- 5% of head injured patients also have spinal cord injury
- 11% mortality rate
- 15% of patient’s with vertebral fractures or dislocation present with neurological deficits
- ASCI involves damage to the motor, sensory as well as autonomic nervous system
- Anatomic distribution
  - 55% cervical
  - 15% thoracic
  - 15% thoracolumbar
  - 15% lumbosacral
Mechanism of Injury

Mechanisms of Injury: Closed

- **hyperflexion** MVC, diving
- **hyper-extension**: fall forward, landing head first
Mechanism of Injury: Closed

**Compression:**
fall, landing bottom first

**Subluxation:**
complete or incomplete dislocation

**Acceleration:**
whiplash

Mechanisms of Injury

- **Open**
  - missile
    - high velocity
  - stab
    - low velocity
Classification of Injury

- Concussion (jarring: 24-48 hours)
- Contusion (bruising of the cord)
- Laceration (tear, causing permanent injury)
- Transection (severing of cord)
- Hemorrhage (bleeding into or around cord, damaging delicate tissue)

Vertebral artery injury

- Incidence – 11% after non-penetrating cervical spinal trauma with associated other trauma – head/neck
- Asymptomatic
- Symptomatic
  - Unilateral or bilateral, dissection, ischemia, infarction
  - Posterior stroke symptoms –
  - Stupor, coma, death, transient blurred vision, syncope, vertigo, dysphagia, dysarthria, facial numbness, blurred vision
  - 2 weeks – 3 months
  - IV heparin, anti platelet agents
Complete Cord Injury

Total loss of sensation and movement below the level of injury

Types of SC Injuries - Incomplete

- Central cord syndrome
  - lower cervical spine injury
  - involves central portion of spinal cord, injuring the gray matter and deep aspects of the white matter
  - distal arm and hand weakness with preservation of lower limb and proximal upper limb function;
  - older patients with sig cervical spondylosis & hyperextension injury
Types of SC Injuries

• **Brown-Sequard syndrome**
  - damage to the lateral half of the sc
  - loss of motor on the same side as the injury as well as vibration and proprioception
  - preservation of pain on same side
  - loss of pain and sensory deficits on opposite side of injury
  - penetrating wound or tumors on same side

![Diagram of spinal cord damage](image)

Type 5-13 A cross-section of the spinal cord showing damage that causes a Brown-Sequard syndrome.

Types of SC injuries

• **Anterior cord syndrome**
  - vascular deficit of anterior artery - acute trauma, peripheral vascular disease, and rarely during episodes of systemic hypotension
  - severe motor deficits and loss of pain and temperature below the affected level
  - vibration and proprioception is spared (posterior column)

• **Posterior cord syndrome**
  - very rare; loss of posterior columns - vibration and proprioception
  - sparing of motor function
  - intraspinal tumors; spinal stenosis
Classification of Injury

- **Level** - most caudal segment of the SC with normal motor and sensory function bilaterally

- **Severity** - complete/incomplete, para/quadriplegia, sacral sparing

- **Morphology** - stable/unstable #, dislocation, penetrating injury,
Spinal Cord Testing

• Purpose
  – to assess presence \ absence of injury;
  – determine complete or incomplete injuries;
  – to monitor for other system effects
  – monitor progress following injury\surgery
  – to determine functional outcomes

Classification systems -ASIA

– A - complete - No motor or sensory function is preserved in the sacral segments - S4 - S5
– B - Incomplete - sensory but not motor function is preserved below the neurological level & includes the sacral segments S4-S5
– C - Incomplete: - Motor function is preserved below the lesion and more than half of key muscles below the lesion have a muscle grade less than 3
– D - Incomplete - Motor function is preserved below the lesion and at least half of the key muscles below the level have a muscle grade of 3 or more
– E - Normal - Motor & sensory function is normal
Levels of Injury

- C1
  - Cranial Nerves only
- C2
  - shoulder shrug, head turn
- C3-5
  - move head, some intercostals
  - decreased reserve, flex elbow
- C6
  - sit up, slight roll over, 1\textsuperscript{st} & 2\textsuperscript{nd}
- C7
  - roll over, dress, transfer, toilet, feed self with devices
- C8
Thoracic & Lumbar Injuries

- T1-6: completely independent in wheelchair, able to manage bowel and bladder routines
- T6-12: complete abdominal and upper back control
- L1-3: independent for most activities from wheelchair
- L3-4: walking with braces possible
- L4-S5: relatively independent, may have some bowel or bladder control

Acute SCI - Nervous System

- Flaccid paralysis of all skeletal muscles; loss of spinal reflexes, loss of pain, proprioception and other sensations; bowel & bladder function; loss of thermoregulation
- Complete vs incomplete injury
- No involuntary movements below the injury
- Flaccid bladder
- Flaccid bowel
Acute Injury Spinal Shock

- flaccid paralysis of skeletal muscles
- loss of these, below injury:
  - all spinal reflexes
  - pain, proprioception
  - sensations of touch, temperature, pressure
  - somatic and visceral sensations
  - ability to perspire
  - bowel and bladder control
- caused by sudden and complete cessation of impulses from brain
- lasts hours to weeks
- ends when spinal neurons regain their excitability

Immobilization
Stabilization of Spine

- decompression of cord or spinal nerves
  - skeletal traction or surgery
- realignment of bones
  - skeletal traction or surgery
- long-term stabilization
  - surgery or long term traction and immobilization to promote natural healing

Stabilization

The patient has had spinal fusion of the cervical spine. Screws and pins are stabilizing his cervical vertebrae.
Tongs

Halo Vest
Neuro assessments

- Evaluation of spinal reflexes on admission and weekly
  - bulbocavernous reflex
  - anal reflex
- return of reflexes & initiation of spastic movements signal spinal shock over
- autonomic dysreflexia; bowel & bladder management; transfer techniques

Autonomic Dysreflexia

- A series of S&S including sudden severe headache secondary to an uncontrolled elevation of BP
- occurs when T4-6 or higher is affected
- occurs after spinal shock is over
- exaggerated response of SNS caused by a variety of stimuli:
  - overstretched bladder, rectal stimulation, bowel impaction, urinary infection, pu
Autonomic Dysreflexia

- medical emergency - seizure, stroke, death
- S&S
  - pounding HA
  - elevated BP - variable 140-90
  - profuse sweating, flushed skin, blotchiness of face, goose bumps
  - nasal stuffiness or obstruction
  - apprehension, very frightened
  - bradycardia

Autonomic Dysreflexia

- Treatment
  - prevention
  - recognize onset, remove stimulus, prevent recurring episodes
  - patient education
- Clinical Practice Guidelines
  - elevate head, lower legs, remove TED’s; tight fitting clothing
  - check VS - call stat if BP > 20 mm Hg norm
  - check urine cath for kinks, change cath using anaesthetic gel; bladder spasms
Autonomic Dysreflexia

- assess bowel for impaction; disempact
- Check for other sources of irritation
  - pressure ulcers infection, menses, wrinkle in sheet
- Administer medications

Case Study

21 year old male admitted to ER from Manawaki hospital. Had been at the lake with friends, late night swimming (alcohol involved). T dove into a shallow area of the lake and # his C-spine. Submerged for 10 seconds with a LOC. Pulled out by friends. Unable to feel below nipple line immediately following the injury, flaccid paralysis. Complaining of posterior neck pain.
Case Study ICU Admit

- C collar in place, on back board
- NSR brady cardia 45/min  BP 110/60
- Sat 96 % on 2l NP, but respiratory effort more paradoxical (accessory muscle loss- tiring), SOB
- Elected to intubate in ICU as delay with OR
- Lidocaine 100 mg IV given pre-intubation
- Triple lumen line/ Art line inserted
- Patient asking “will I walk again”
- Shoulder pain- MOS 2 mg given

Case Study

- OR 1330-2030 total of 7 hours anesthetic time
- Anterior C5 C6 decompression and instrumentation, fusion
  - Aiming to salvage cord
  - Very displaced bone fragment and disrupted posterior longitudinal ligament
  - Harvested an iliac bone graft C7 – C4
  - 2 screws and plate
- Posterior Decompression, instrumentation and fusion
  - Lateral mass C2-T1- disorganized ligament
  - Bone graft
  - 6 screws and rods
Case Study

• July 21
  – H flu growing – piptazo and fluconazole
  – Rule out DVT
  – Lines removed and tips sent for culture
  – Ileus- NG placed for decompression – 4L /24 hr
  – Flat plate- stool and gas- Fleet, lactulose and MOM
  – Mag citrate per FT

Case Study

• 8 days post injury
  – Trach hood trial
  – Ileus resolving- tolerating feeds
  – Pysio/OT are involved (getting up in spinal chair- splints and high tops, noted spasticity in legs, resolves with gentle continuation of ROM
  – Consult to rehab
  – Query AD- increased BP and decreased HR on turns?
Lung volume recruitment

- Modified resuscitation bag
- Mechanical in-exsufflator (MI-E)
- Mouth-piece/home ventilator
- Glossopharyngeal breathing (GPB)
+ Assisted cough

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Case Study

Aug 9
- getting ready to leave ICU
- Not sleeping well due to scapular/shoulder pain- affecting trach hood trials also
- Team unsure if neuropathic pain or muscular pain related to increased use of accessory muscles to breath
- Seen by rehab MD – not a burning pain, responds to narcotics, bilateral shoulder pain to neck
- Continue amitriptilyne and ibuprofen and baclofen(has been resolving with increased dosages)
Case Study

• Discharged from ICU Aug 11\textsuperscript{th} to the trauma unit (25 day ICU stay)

• Discharged to spinal cord rehab program from acute care Aug 20\textsuperscript{th}

• Total 34 days in acute care