



INTRODUCTION TO Spinal Cord Injury

FSARN: REHABILITATION NURSING
CORE REVIEW COURSE (CRRN)

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Disclosure

No conflict of interest and/or financial disclosure to report.

Objectives

- ▶ Define, describe, or identify the following regarding spinal cord injury:
 - ▶ Tetraplegia (Quadriplegia) and Paraplegia
 - ▶ Segments of the spinal column and spinal cord
 - ▶ Epidemiology
 - ▶ Mechanisms of injury
 - ▶ Pathophysiology
 - ▶ Levels and syndromes
 - ▶ Classifications
 - ▶ Physical assessment
 - ▶ Interventions
 - ▶ System manifestations
 - ▶ Discharge planning

Definitions

- ▶ SCI is an injury to spinal cord resulting in changes to motor, sensory, and autonomic function
 - ▶ Tetraplegia (Quadriplegia)
 - ▶ damage to spinal cord (between C₁ to T₁) affecting all 4 extremities
 - ▶ Paraplegia
 - ▶ damage to spinal cord (between T₂ to S₅) affecting trunk, lower extremities, and pelvic organs

Segments of the Spinal Column



▶ Cervical (1-7)

▶ Thoracic (1-12)

▶ Lumbar (1-5)

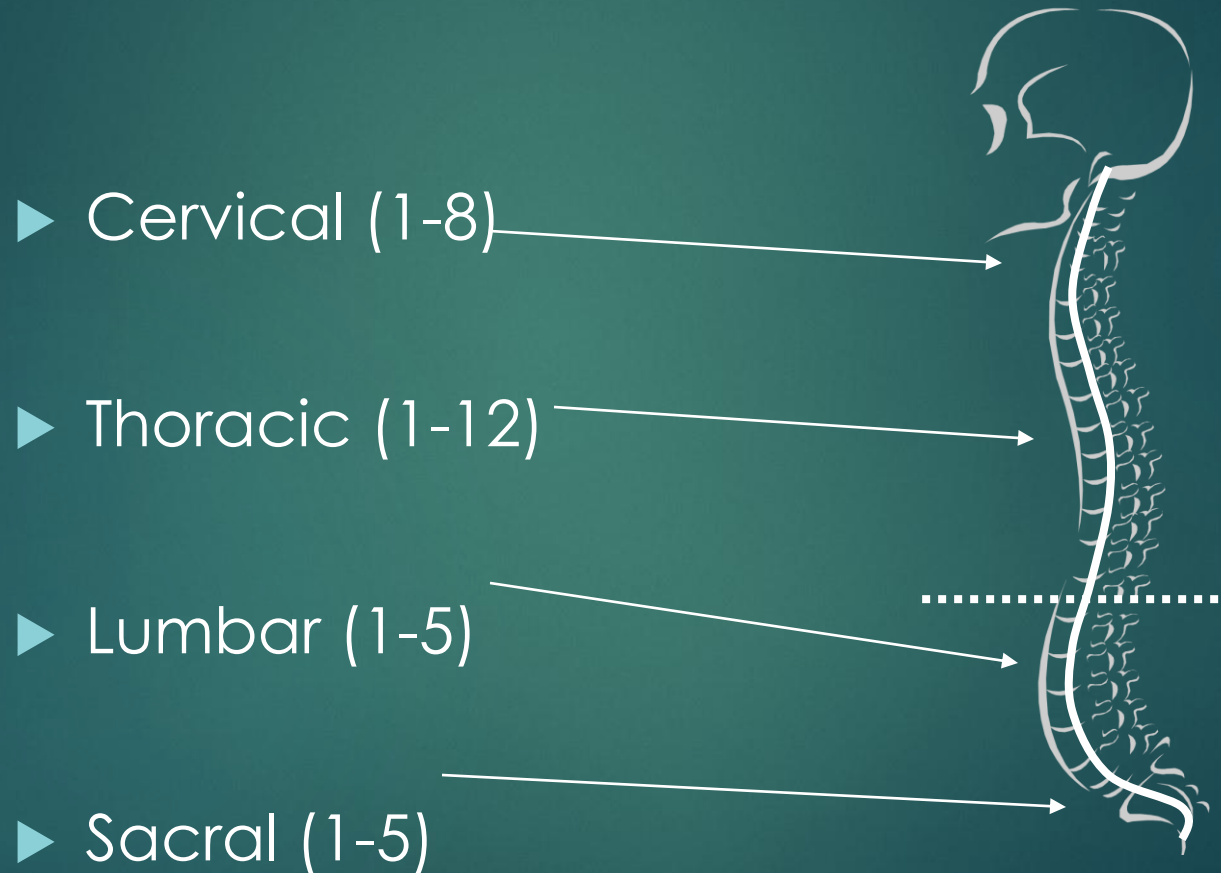
▶ Sacral (1-5)

Segments of the Spinal Cord

- ▶ The Spinal Cord terminates around T12-L1
- ▶ Below that level, nerves exit to the legs/feet, bowels, bladder, and genitals
 - ▶ End of cord is called conus medularis
 - ▶ Nerves exiting cord are called cauda equina (“horse’s tail”)



Sements of the Spinal Cord



The Spinal Nerves

- ▶ Cervical (1-8)
 - ▶ C1-C3 = neck
 - ▶ C3-C5 = diaphragm
 - ▶ C4 = shoulders, deltoids (shrug shoulders)
 - ▶ C5 = shoulders, biceps (bend elbows)
 - ▶ C6 = outer forearms (bend wrist back), thumbs, 1st and 2nd fingers
 - ▶ C7 triceps (straighten elbow), 3rd and 4th fingers
 - ▶ C8 = 5th fingers (bend fingers)



The Spinal Nerves

- ▶ Thoracic (-12)
 - ▶ T1 = inner forearms (spread fingers)
 - ▶ T2-12 = chest, intercostals, upper back, abdomen
 - ▶ T4 at nipple line
 - ▶ T10 at umbilicus line



The Spinal Nerves

- ▶ Lumbar (1-5)
 - ▶ L1 = suprapubic
 - ▶ L2 = upper thighs (bend hips)
 - ▶ L3 = mid thighs, inner thighs, knees, upper calves (straighten knees)
 - ▶ L4 = lower thighs, inner calves, 1st toes (pull foot up, dorsi flexion)
 - ▶ L5 = outer thighs, outer calves, dorsal ankles, 2nd to 4th toes (wiggle toes)

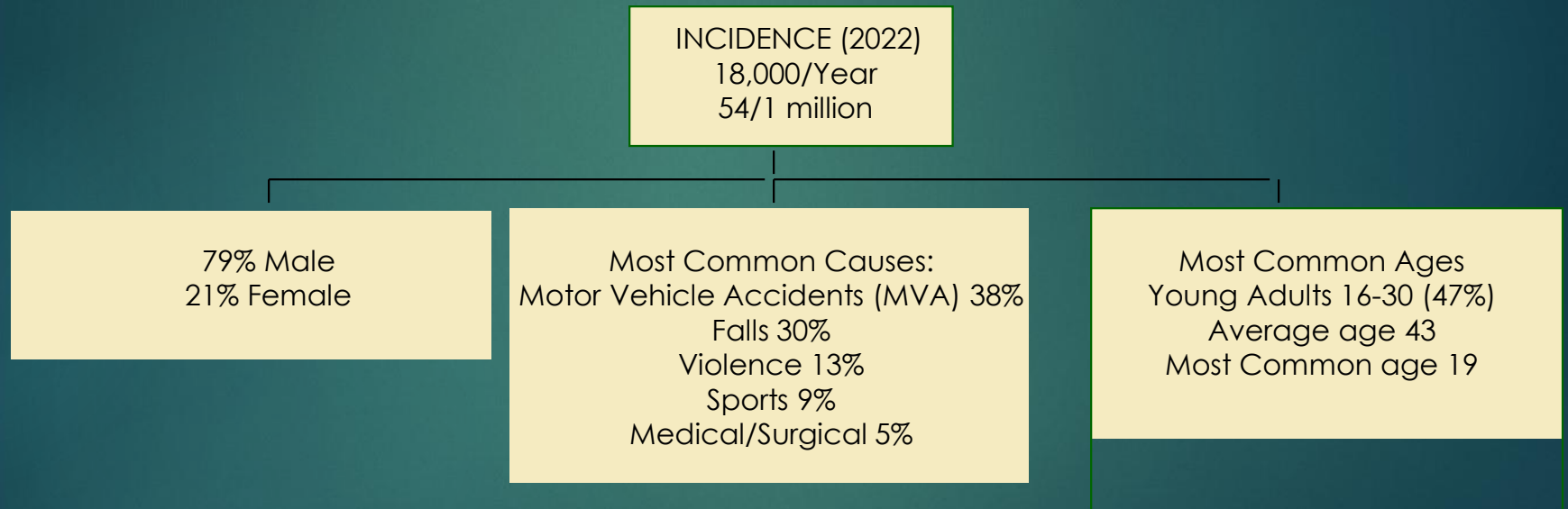


The Spinal Nerves

- ▶ Sacral (1-5)
 - ▶ S1 = back of legs, outer ankles, outer feet, 5th toes (push foot down, plantar flexion)
 - ▶ S2 = back of legs
 - ▶ S3-S5 = bladder, genitals, bowels, sacrum, inner buttocks, anal and pelvic muscles



SCI: INCIDENCE & ETIOLOGY



SCI: PROGNOSIS/Life Span Post Injury

- ▶ **Paraplegia:** slightly less than normal
- ▶ **Tetraplegia:** slightly less than paraplegia
 - ▶ The higher the level of injury the more negative effect on life expectancy
- ▶ Mortality highest in first year and among older individuals
 - ▶ 10-20% do not survive
 - ▶ Pneumonia, PE, heart disease, septicemia leading causes of death
 - ▶ Poorer outcomes for cervical injuries in individuals over 50 y/o.

SCI: MECHANISMS OF INJURY

▶ **Direct trauma**

- ▶ Flexion injuries (commonly in MVA and backward falls: head thrown forward, hit on back of head)
- ▶ Flexion with rotation (combination of forces, ruptures ligaments, results in dislocation)
- ▶ Hyperextension (forward falls, face and chin struck)
- ▶ Penetration (piercing of cord: knife wound, gsw)

Mechanisms of Injury

▶ **Compression**

- ▶ flexion, axial wedging and compressing of thoracic and lumbar vertebra (falling on buttocks)
- ▶ vertical shattering and bursting of cervical vertebra (high velocity on head such as diving)
- ▶ **Ischemia** (damage to or blockage of spinal arteries such as clots)

SCI: PATHOPHYSIOLOGY

- ▶ Severity of bony injury does not always correlate with neurological impairment
- ▶ Common sites are most mobile parts: cervical and thoracic
 - ▶ Most common are C4-C5
- ▶ Spinal cord can be contused without fractures or dislocations

Pathophysiology

- ▶ Progressive cord tissue damage occurs within hours of injury
 - ▶ Decreased microperfusion at site
 - ▶ Hemorrhage in gray matter
 - ▶ Hematoma and edema
 - ▶ Release of biochemicals at site
 - ▶ Ischemia and necrosis resulting in neurological damage

PATHOPHYSIOLOGY

- ▶ Clinical presentation of edema and tissue damage
 - ▶ Spinal shock (reflex depression of cord, initial hypertension, flaccid paralysis including bowel and bladder) – last several hours to days
 - ▶ Differentiate between spinal and hypovolemic shock

PATHOPHYSIOLOGY

- ▶ Neurogenic shock (hypotension, bradycardia, hypothermia) – most common above T6
- ▶ Autonomic dysreflexia (medical emergency, C1-T6, noxious stimuli below injury)

Autonomic Dysreflexia

- ▶ **Causes:** distended bladder, distended bowel, pressure ulcers, urological procedures or infection/stones, ingrown nails, fractures, Deep Vein Thrombosis (DVT), gynecological procedures/pregnancy/delivery, restrictive clothing/shoes

Autonomic Dysreflexia

- ▶ **Signs/symptoms:** hypertension with bradycardia; flushing, perspiration, piloerection (goosebumps) above injury level, nasal congestion, blurred vision/dots in vision

Autonomic Dysreflexia

- ▶ Blood pressure 20-40 mmHg above baseline
- ▶ **Treatment:** remove noxious stimuli
 - ▶ Bladder and bowel most common
- ▶ Untreated can result in stroke or coma or death
- ▶ Preventable with proper bladder and bowel management

SCI: LEVELS

- ▶ **Upper motor neuron (UMN) injury**
 - ▶ Lesions above T12-L1
 - ▶ Injury is to the spinal cord
 - ▶ Loss of control over all reflexes below the level of injury
 - ▶ Spastic paralysis

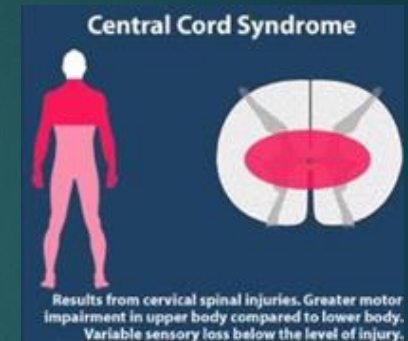
Levels

- ▶ **Lower motor neuron (LMN) injury**
 - ▶ Lesions below T12-L1
 - ▶ Injury is to the conus medularis and cauda equina
 - ▶ Loss of reflex arc
 - ▶ Flaccid paralysis

SCI: SYNDROMES

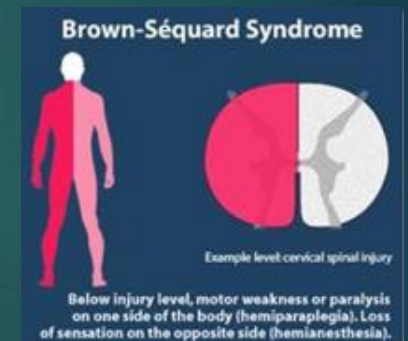
▶ Central cord syndrome (CCS)

- ▶ Damage to central cord (usually cervical)
- ▶ Loss of motor/sensory limbs (arms > legs)



▶ Brown-Sequard syndrome (BSS)

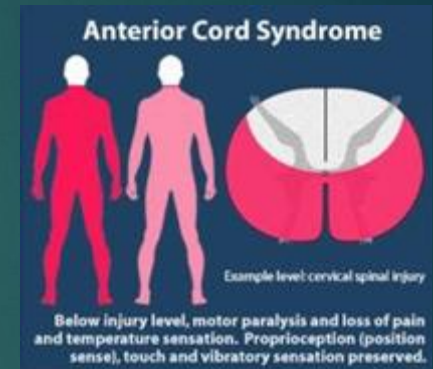
- ▶ Hemi-section of cord
- ▶ Loss of motor function/position sense on same side as damaged side of cord
- ▶ Loss of pain/temperature sensation/light touch on opposite side



SCI: SYNDROMES

▶ Anterior cord syndrome (ACS)

- ▶ Damage to anterior spinal artery (anterior 2/3 of cord)
- ▶ Paralysis and loss of pain/temperature sensation below injury, preservation of position sense



▶ Conus medularis syndrome (CMS)

- ▶ Damage to the conus and lumbar nerve roots
- ▶ May result in flaccid bowel, bladder, and lower extremities

Syndromes

- ▶ **Cauda equina syndrome (CES)**
 - ▶ Damage below conus to lumbar/sacral nerve roots
 - ▶ May result in flaccid bowel, bladder and lower extremities

FUNCTIONAL POTENTIAL

Independent:

- ▶ C6-7 (may or may not need adaptive devices)
- ▶ T1 and below
 - ▶ T2-T10 may be able to ambulate with braces and crutches or walker indoors (nonfunctional)
 - ▶ T11-L2 may be able to ambulate functionally
 - ▶ L2-S3 may be able to ambulate with braces and crutches or walker indoors and outdoors (functional)

Dependent:

- ▶ C1-C3 (also ventilator dependent)
- ▶ C4 (may not need ventilator)
- ▶ C5 (may be able to do light grooming & feeding with set-up & adaptive devices)

(based on complete injuries)

SCI: PHYSICAL ASSESSMENT

▶ **Neurological**

- ▶ Cognitive, motor, sensory status, reflexes, cranial nerves, signs/symptoms of changes in function, pain and abnormal sensations

▶ **Respiratory**

- ▶ Breath sounds, airway patency, O₂ sat, diaphragm function, sputum and aspiration, pulmonary emboli

▶ **Cardiovascular**

- ▶ Blood pressure, pulse, HR, rhythm, edema, DVT, orthostatic hypotension

SCI: PHYSICAL ASSESSMENT

▶ **Nutritional**

- ▶ Weight, hydration, dietary intake, CBC, electrolytes, albumin and prealbumin

▶ **Elimination**

- ▶ Abdominal tenderness/distention/masses, bowel sounds, premorbid/current bowel patterns, urine characteristics and amount

▶ **Musculoskeletal**

- ▶ Swelling, spasticity, ROM, tone, contractures, orthopedic injuries, HO

SCI: PHYSICAL ASSESSMENT

- ▶ **Integumentary**

- ▶ Skin breakdown: assessment, prevention

- ▶ **Psychosocial**

- ▶ Family support, coping, adjustment, potential responses to fear/anxiety, suicidal ideation, emotional state, behaviors of denial/anger/depression

- ▶ **Sexual**

- ▶ Physical capabilities, significant other/spouse, birth control practices, sexually transmitted diseases

SCI: INTERVENTIONS

- ▶ **Planning:** setting goals should focus on
 - ▶ Ability not disability
 - ▶ Should be directed toward helping the individual attain and maintain maximum independence
 - ▶ Should include the patient and family

SCI: INTERVENTIONS

▶ **Interventions:**

- ▶ Spinal stability, preservation of life
 - ▶ Log rolling, no twisting
 - ▶ Surgery
 - ▶ Orthotics
 - ▶ Collars, TLSO, LSO
 - ▶ Usually worn for 3 months post surgery or post injury
- ▶ Prevention of complications
 - ▶ Infections, psychiatric disorders, pressure sores, cardiovascular problems

SCI: INTERVENTIONS

- ▶ Interventions determined by team including patient and family
- ▶ Teaching patient and family
 - ▶ Problem solving, adaptive devices, safe and effective performance of skills
 - ▶ Learning new skills while maintaining newly learned skills

SCI: INTERVENTIONS

- ▶ Therapeutic relationship: rapport, trust
- ▶ Provide safe environment for verbalizing feelings without judgment
- ▶ Answer questions, find answers, don't take away hope
- ▶ Meet physical as well as emotional and psychosocial needs
- ▶ Promote a good self concept and body image
- ▶ Involve the team including the patient and family

SCI: INTERVENTIONS

- ▶ **Common concerns of individuals with SCI:**
 - ▶ Walking
 - ▶ Sexual function
 - ▶ Pain
 - ▶ Bowel and bladder
 - ▶ Finances
 - ▶ Loss of independence
 - ▶ anxiety

SCI: INTERVENTIONS

- ▶ **Common concerns of family caregivers:**
 - ▶ Negative attitudes toward SCI
 - ▶ Feelings of guilt
 - ▶ Frustration over lack of appreciation
 - ▶ Loss of alone time
 - ▶ Feeling overwhelmed
 - ▶ Setting boundaries in the relationship of caregiving

SCI: SYSTEM MANIFESTATIONS

▶ **Cardiovascular**

- ▶ Hypotension and vasodilation decreases cardiac output
 - ▶ Orthostatic hypotension – problem getting blood from lower extremities back to heart
 - ▶ Vasodilation – loss of sympathetically induced vasoconstriction, pulling blood in abdomen and lower extremities
- ▶ Bradycardia caused by unopposed vagal tone
- ▶ Impaired temperature regulation (poikilothermia) due to inability to sweat or shiver below injury
- ▶ Cardiac dysrhythmias (in first few weeks especially severe injuries)
- ▶ Blood clots (3x higher)

SCI: SYSTEM MANIFESTATIONS

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SCI: SYSTEM MANIFESTATIONS

▶ **Respiratory**

- ▶ C1-4 paralysis of diaphragm, C4-T6 paralysis of intercostals and abdominals, T6-T12 paralysis of some abdominals
- ▶ Pneumonia common complication (trach increases risk)
- ▶ Wean from vent if possible – home vent management is difficult

SCI: SYSTEM MANIFESTATIONS

▶ **Metabolic and musculoskeletal**

- ▶ Negative nitrogen balance
- ▶ Decreased metabolic rate and expenditure of energy
- ▶ Hypercalcemia or hypercalciuria
- ▶ Altered secretion of pituitary derived hormones
- ▶ Heterotopic ossification
- ▶ Contractures
- ▶ Muscle spasms

SCI: SYSTEM MANIFESTATIONS

▶ **Gastrointestinal**

- ▶ Slowed peristalsis → paralytic ileus
- ▶ Increased acidity → GI bleeding
- ▶ Pancreatitis (initial injury)
- ▶ Abnormal liver function (trauma)
- ▶ Neurogenic bowel

SCI: SYSTEM MANIFESTATIONS

▶ **Genitourinary**

- ▶ Neurogenic bladder
- ▶ Urinary outlet sphincter dysfunction
- ▶ Autonomic dysreflexia

▶ **Sexuality**

- ▶ Males
 - ▶ Reflexogenic vs. psychogenic erection
 - ▶ Change dependent upon level of injury
 - ▶ Sperm, fertility, erection, ejaculation

SCI: SYSTEM MANIFESTATIONS

▶ Females

- ▶ Menses stops then resumes in 6 -12 months
- ▶ Fertility unchanged
 - ▶ Should be under care of OB/GYN Specialist
 - ▶ Autonomic Dysreflexia (AD) may be problem during pregnancy and delivery

SCI: SYSTEM MANIFESTATIONS

▶ **Psychosocial**

- ▶ Stressors: quality of life, lifestyle changes, employment changes, relationships, etc.
- ▶ Losses: sensation, mobility, bowel and bladder, sexual function, independence, roles, self-esteem
- ▶ Emotions and behaviors: anxiety, frustration, anger, fear, denial, depression, sensory overload

SCI: DISCHARGE PLANNING

- ▶ It's never too early
 - ▶ Preadmission through rehabilitation
 - ▶ Collaborative process
 - ▶ Identify caregivers
 - ▶ Return demonstration
 - ▶ Prevention of secondary complications
 - ▶ Discharge destination
 - ▶ Home evaluation
 - ▶ Durable Medical Equipment (DME)
 - ▶ Funding/Transportation

Resources/Links:

- ▶ [Atlanta Brain and Spinal Cord Injury Rehabilitation | Shepherd Center](#)
- ▶ [The Christopher & Dana Reeve Foundation | Paralysis Foundation \(christopherreeve.org\)](#)
- ▶ [Home \(pva.org\)](#)
- ▶ [Spinal Cord Injury Rehabilitation | SCI Physical Therapy Center \(craighospital.org\)](#)
- ▶ [Spinal Cord Injuries and Disorders System of Care Home \(va.gov\)](#)

Thank you/Contact Information

▶ Thank you to VA Palo Alto Health Care System,
Spinal Cord Injury/Disorders Center Staff

▶ Contact:

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