

INTRODUCTION TO SPINAL CORD INJURIES AND DISORDERS

FSARN REHABILITATION NURSING REVIEW COURSE 2025

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- Anatomy & Physiology of Spinal Cord Injury (SCI)

Pathophysiology/ Mechanisms of Injury

Incidence and Demographics

- Traumatic Injury
- Disease Disorders

Classification Systems/ Evaluation Scales

- Management/ Treatment
- Discharge Planning

**OBJECTIVES
THE
PARTICIPANT
WILL BE
ABLE TO
DESCRIBE:**

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

SCI: INCIDENCE & ETIOLOGY

INCIDENCE (2024)

18,000/Year
54.1 million
worldwide

INCIDENCE (2024)

305,000 in US
Spinal cord injury
54 incidence per million

79% Male
21% Female

The average lengths of stay in the hospital acute care unit have declined from 30 days in the 1970s to 19 days since 2015.

The average rehabilitation lengths of stay have also declined from 110 days in the 1970s to 37 days since 2015.

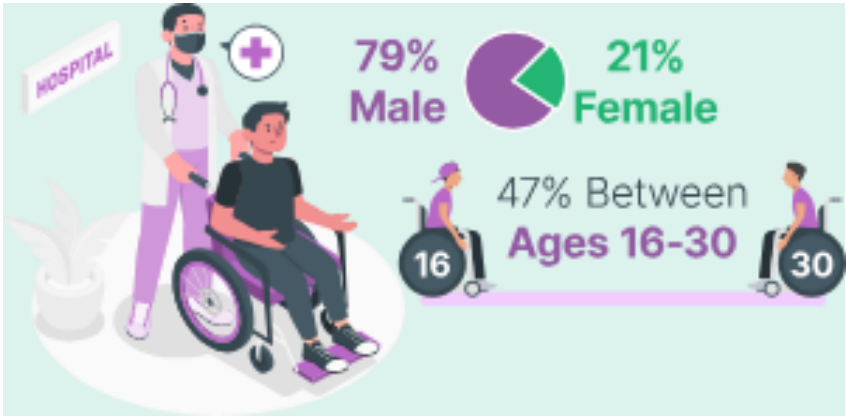
Most Common Causes
of Traumatic Injuries:
Motor Vehicle Accidents
(MVA) 38%
Falls 30%
Violence 13%
Sports/ Recreation 9%

Most Common Ages
Young Adults 16-30 (47%)
Average age 43
Most Common age 19

TRENDS IN SPINAL CORD INJURY

DEMOGRAPHICS 2023

- ▶ **SCI costs yearly \$9.7 billion (CDC, 2008)**
- ▶ **Pressure sores to SCI patients alone cost \$1.4 billion (CDC, 2008)**
- ▶ **Mortality is highest in first year after injury**



Age	43 years old (Average)
Gender	Male 79% - Female 21%
Residence	At Home 88%
Causes Of Death	Pneumonia, Pulmonary Embolism (PE), Septicemia
Classification	47% Tetra; 52% Hemi
Life Expectancy	Slightly Below

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-
 - ▶ Leading causes of death
 - ▶ First year Respiratory/ pneumonia is most common cause of death
 - ▶ First 5 years risk of DVT/PE approx. 20% higher than general pop.
 - ▶ Heart disease- secondary to decreased lean muscle and sedentary lifestyle
 - ▶ Septicemia secondary to HAI
 - ▶ Poorer outcomes for cervical injuries in individuals over 50 y/o.

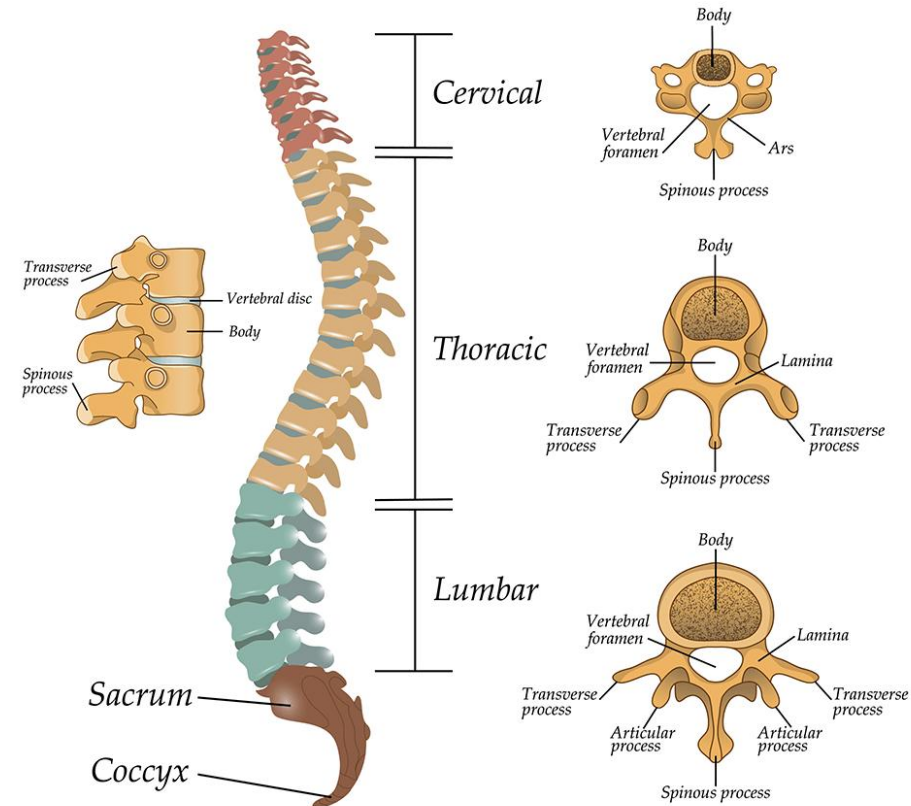
ANATOMY & PHYSIOLOGY

- **Spine**

- Cervical (C 1-7)
- Thoracic (T 1-12)
- Lumbar (L1-5)
- Sacral (S1-5 fused in adults)
- Coccygeal (3)

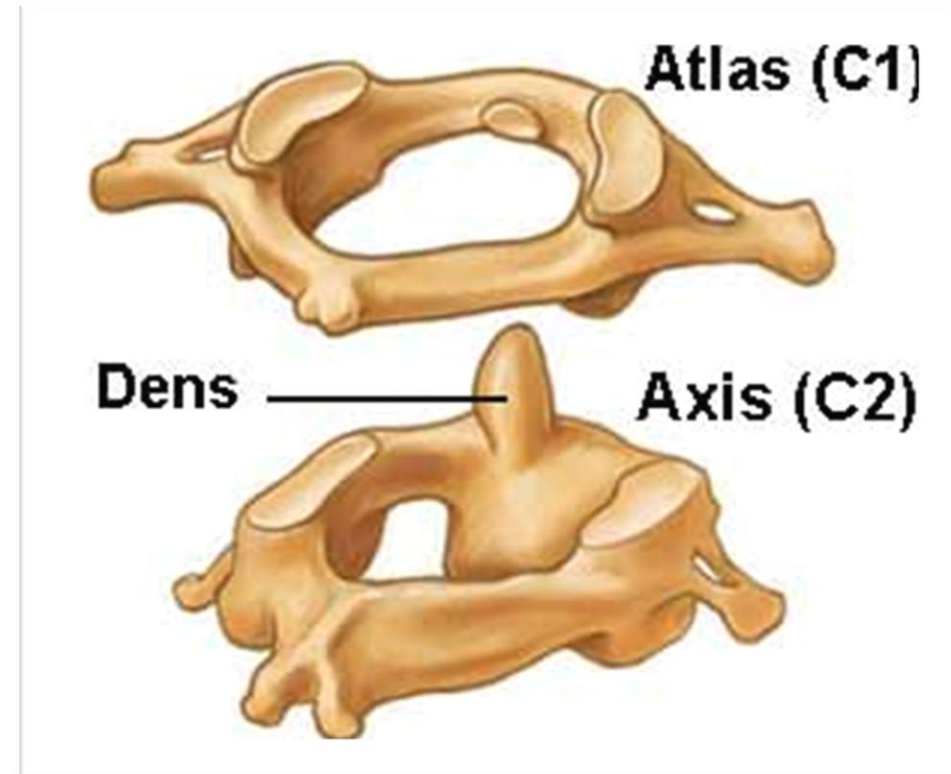
“Landmarks”

The structure of the segments of the spine



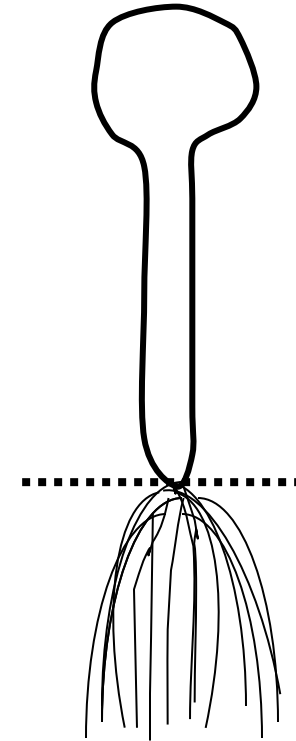
ATLAS & AXIS

- Atlas (C-1)
 - Supports the “globe” (head)
 - Ring-like structure permits rotation of head
- Axis (C-2)
 - Forms pivot C1 rotates on
 - Allows flexion and extension of head
 - Instant death

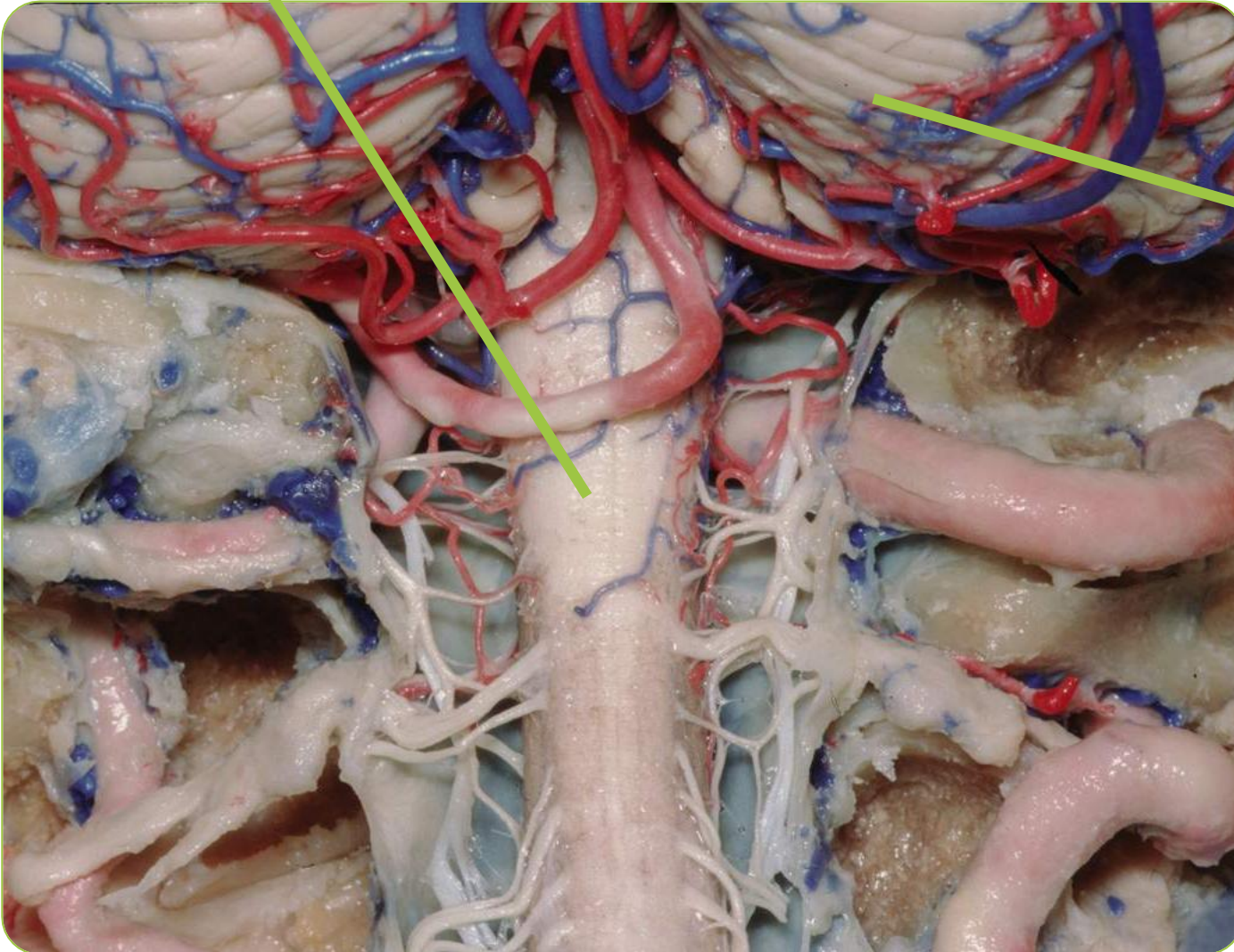


SEGMENTS OF THE SPINAL CORD

- ▶ 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”)



SPINAL CORD



Elongated, cylindrical continuation of the medulla oblongata

Insertion: cranial border of atlas

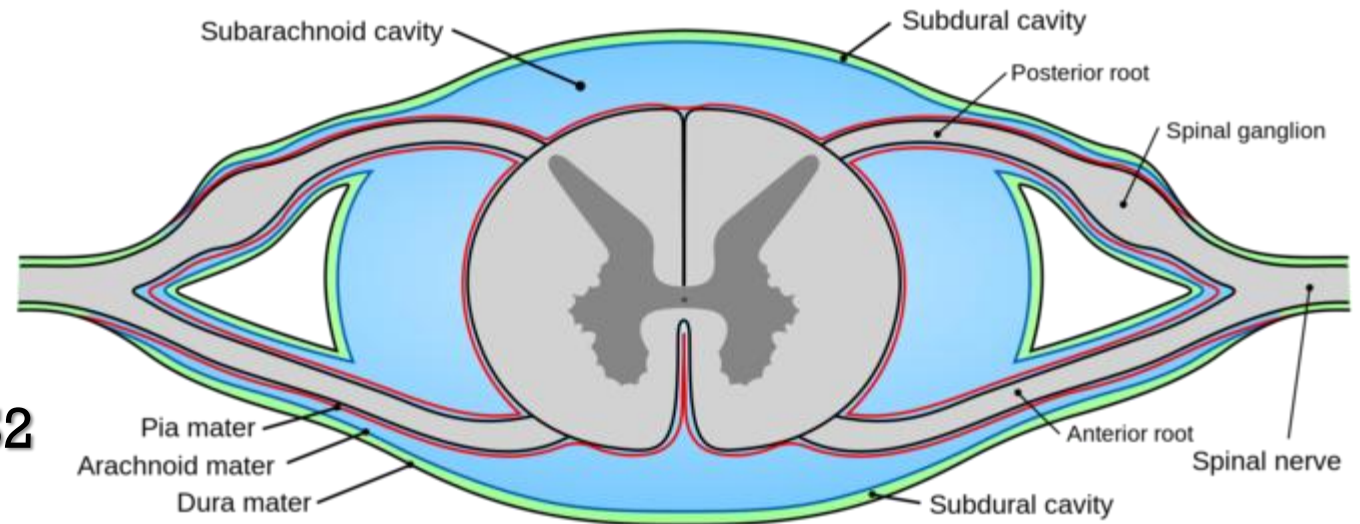
Terminate: lower level of first lumbar vertebra (L1)

Average Length in adult: 45 cm

Average Weight in adult: 30 gm

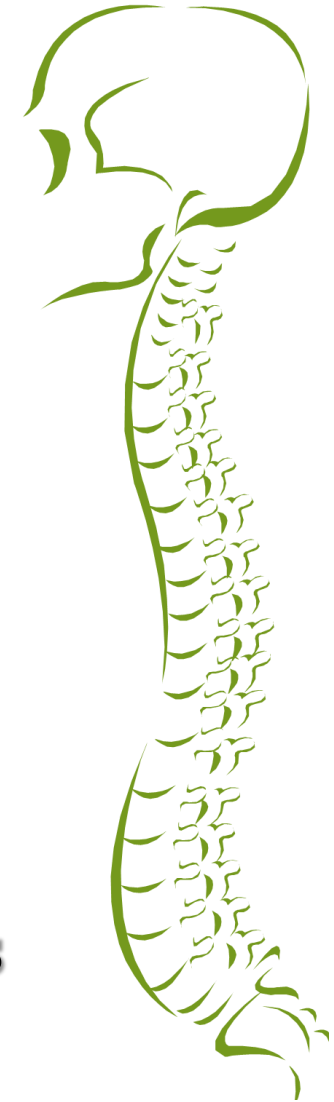
SPINAL CORD

- Surrounded by 3 meninges:
 - **Dura mater** (outer layer) to S2
 - Epidural space
 - Subdural space
 - **Arachnoid mater** to S2
 - Subarachnoid space holds 75ml CSF to protect cord
 - **Pia Mater**
 - Vascular
 - Closely adheres to cord



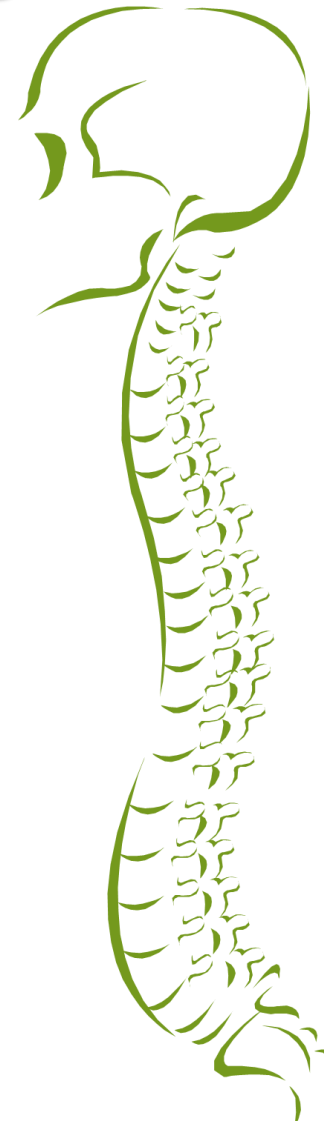
THE SPINAL NERVES

- 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)



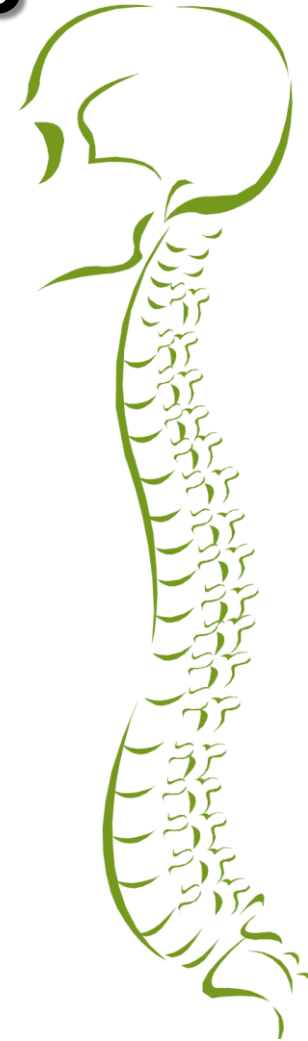
THE SPINAL NERVES

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



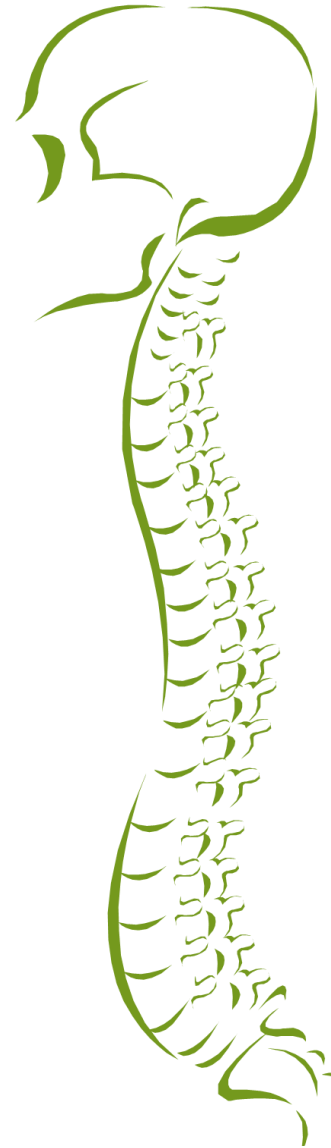
THE SPINAL NERVES

- 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)

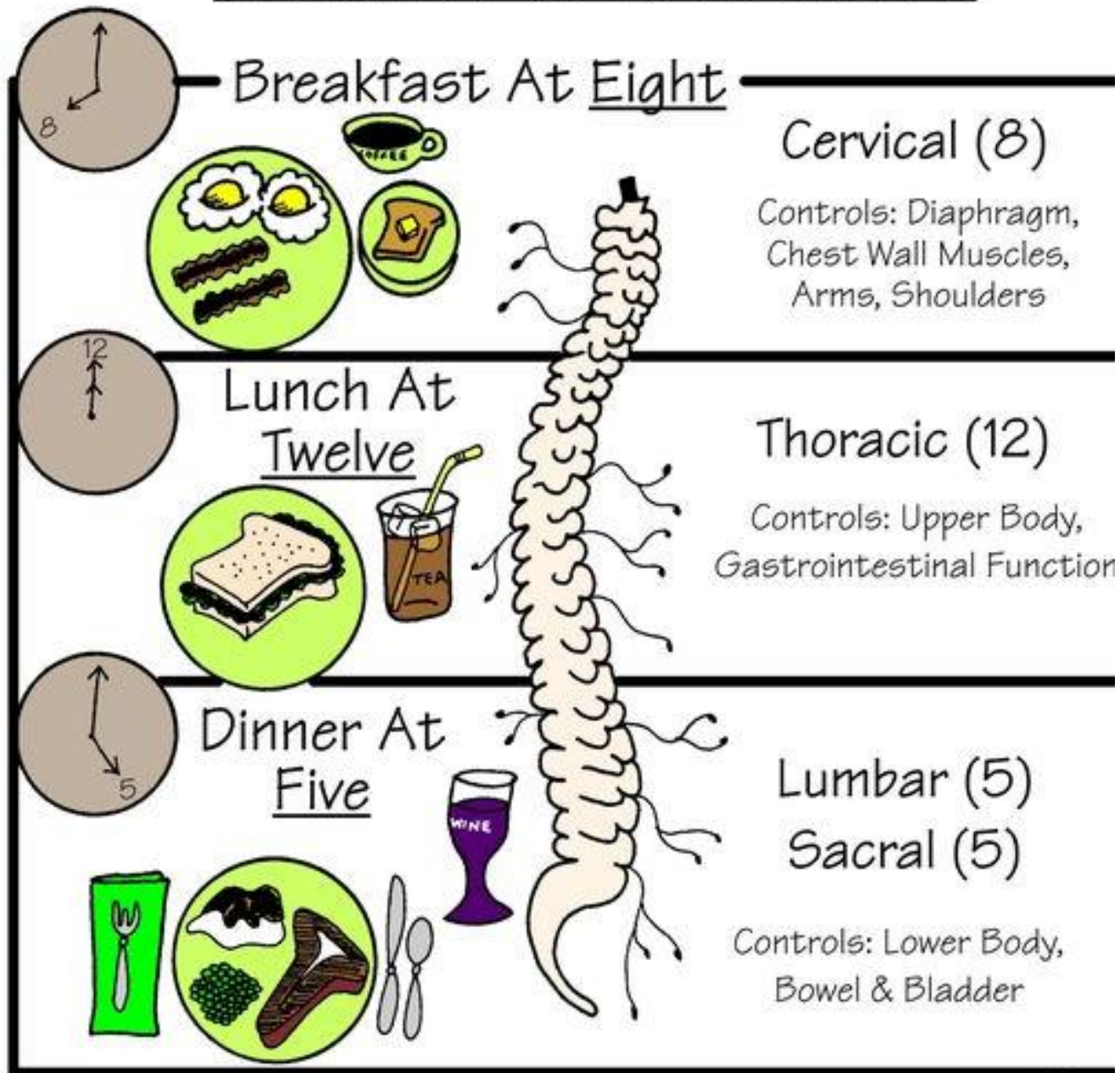


THE SPINAL NERVES

- 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



LEVELS OF SPINAL NERVES



LEVELS OF SPINAL NERVES

Old terminology for injury

- Para – Ionic Greek
"half-stricken".
- Quadri – Latin for
"four"
- Plegia – Greek for
"stroke" or "to strike"



NEW NOMENCLATURE OF SCI

- Hemi – Greek for “Half”
 - Used to describe paralysis of one half of the body
- Para- Greek for “half affected”
 - Used to describe paralysis/paresis of lower limbs
- Tetra – Greek for “Four”
 - Used to describe paralysis /paresis of all 4 limbs

PATHOPHYSIOLOGY: TYPES OF SPINAL CORD INJURY

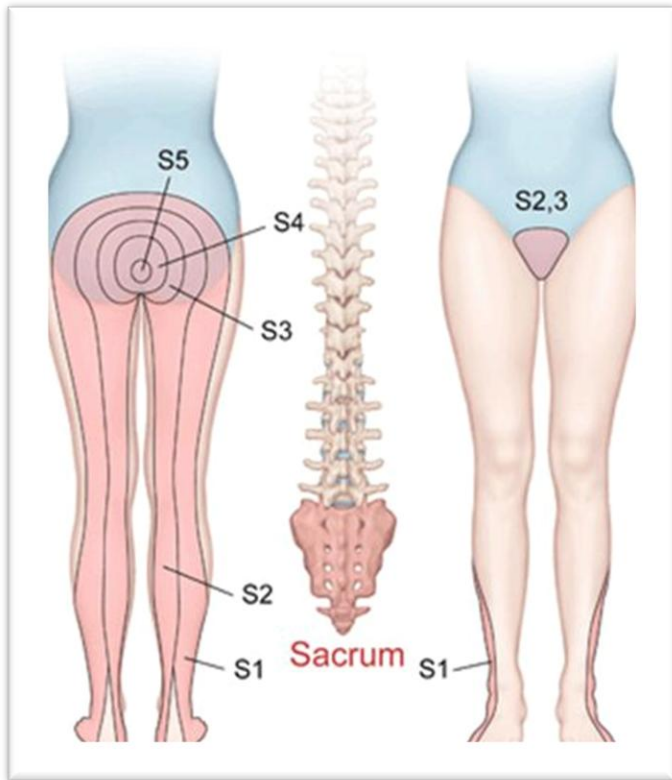
Complete

- Total disruption of the cord
- Complete loss motor & sensory function below level of injury

Incomplete

- Some preservation of motor or sensory functions below level of lesion

SACRAL SPARING



- ▶ Used to help diagnose whether a person's spinal cord injury is complete or incomplete.
- ▶ With complete spinal cord injuries, all sensory and motor functions below the level of injury are affected because signals from the brain cannot travel past the spinal lesion.
- ▶ With an incomplete SCI, some neuronal connections remain, allowing information to be communicated past the level of injury. This results in a greater possibility of functional recovery.

NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

A

Complete
There is no sensory sensation or motor function in S4 or S5.

B

Sensory Incomplete.
There is some sensation at the level below the injury, including S4 and S5.

C

Motor Incomplete
There is voluntary anal sphincter contraction, with some motor function to three levels below the motor level of the injury, but most of the key muscles are weak.

D

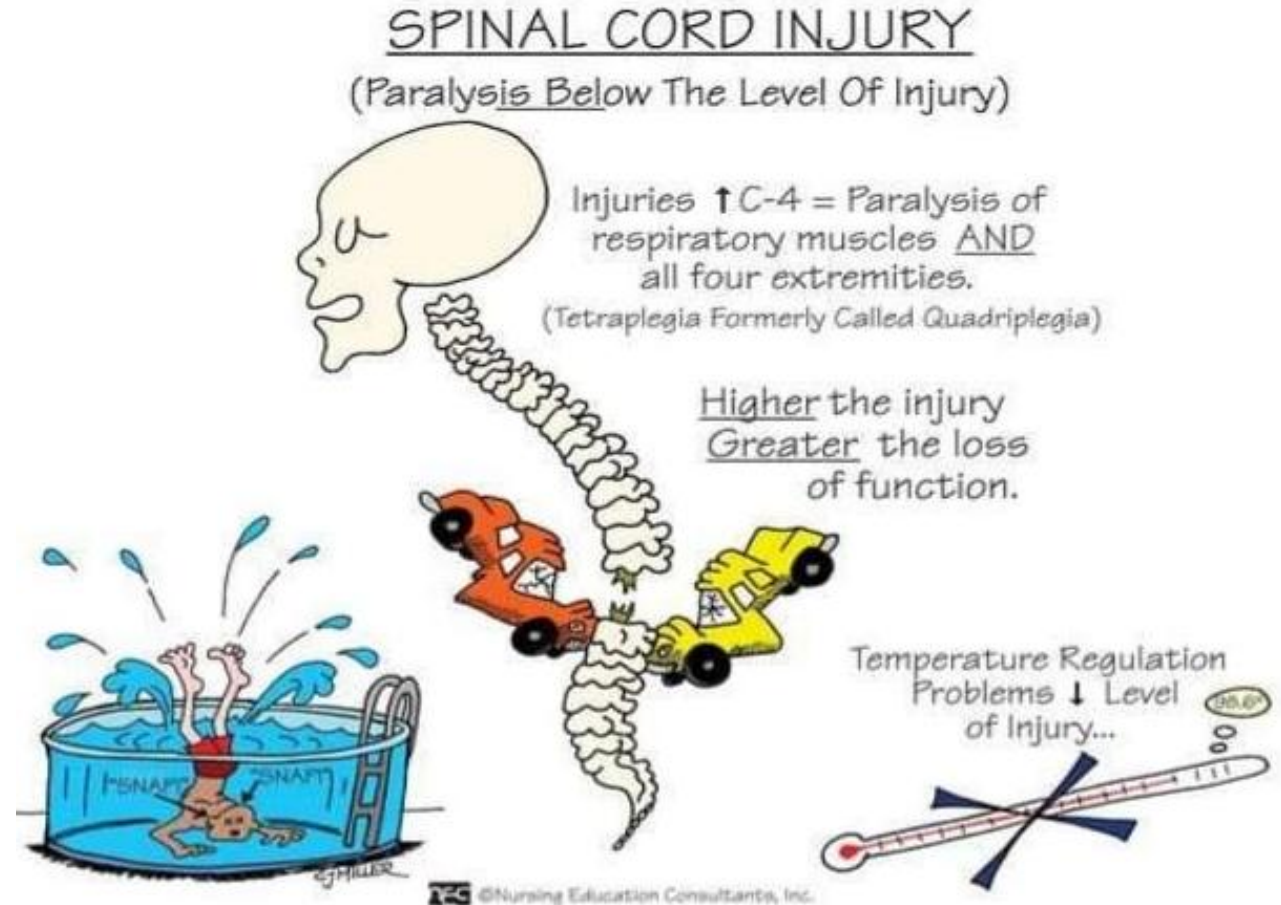
Motor Incomplete
The same as C, with the exception that most of the key muscles are fairly strong.

E

Normal
Although hyperreflexia may be present, normal sensory and motor recovery are exhibited.

SPINAL CORD INJURY BASICS

- Communication is blocked
 - Motor
 - Sensory
 - Reflex
- Higher the Injury, the more loss of function the patient will experience.
- Each person's recovery is different



SOME EFFECTS OF SCI

Loss of movement

Loss of sensation

Loss of bowel
and/or bladder
control

Exaggerated reflex
actions or spasticity

Change in sexual
function, sexual
sensitivity and
fertility

Neuropathic pain
(intense stinging
sensations, shooting
burning pain,
tingling, numbness)

**Autonomic
Dysfunction**

SCI: SYSTEM MANIFESTATIONS

▶ Cardiovascular

- ▶ 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)**

▶ 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**

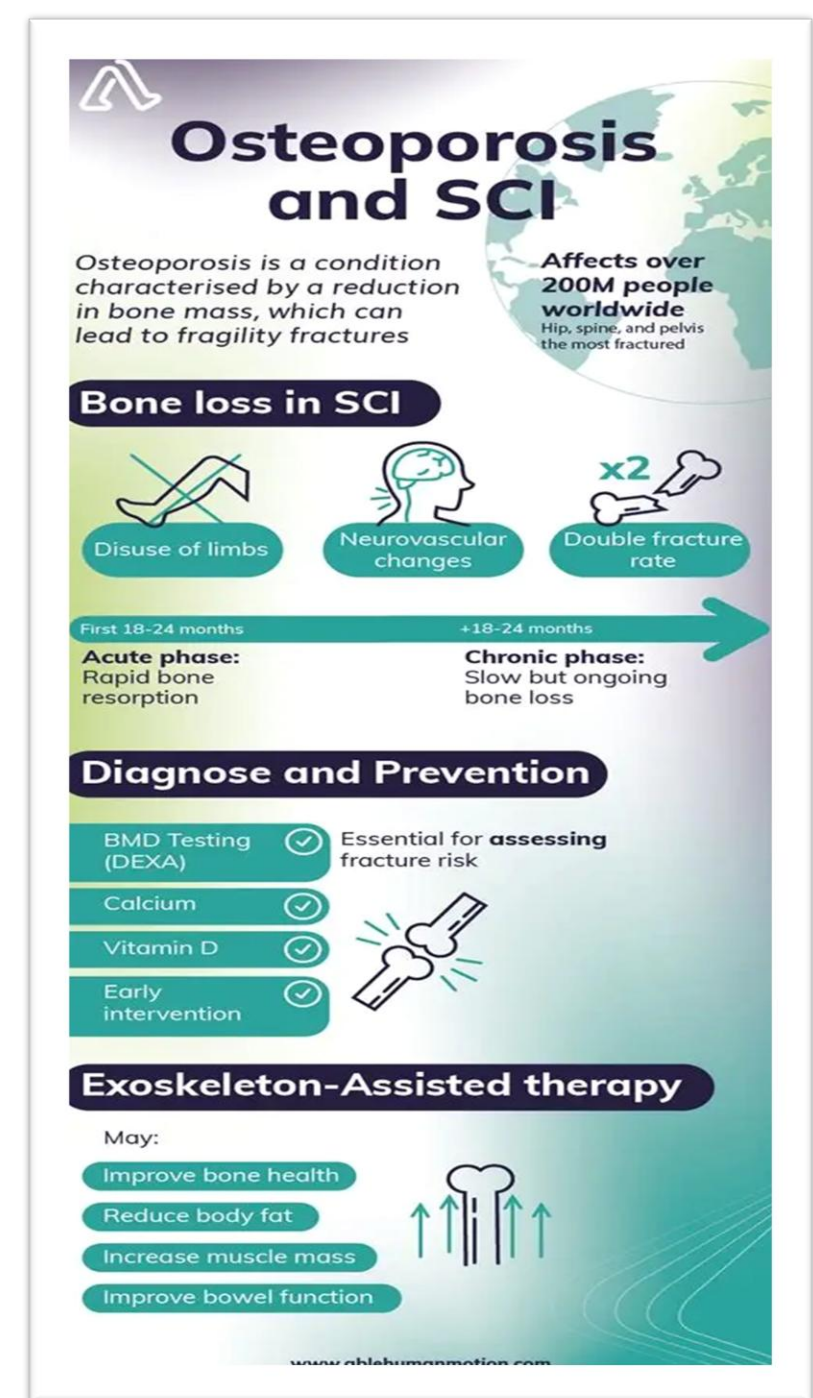
SCI: SYSTEM MANIFESTATIONS

▶ 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

▶ 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

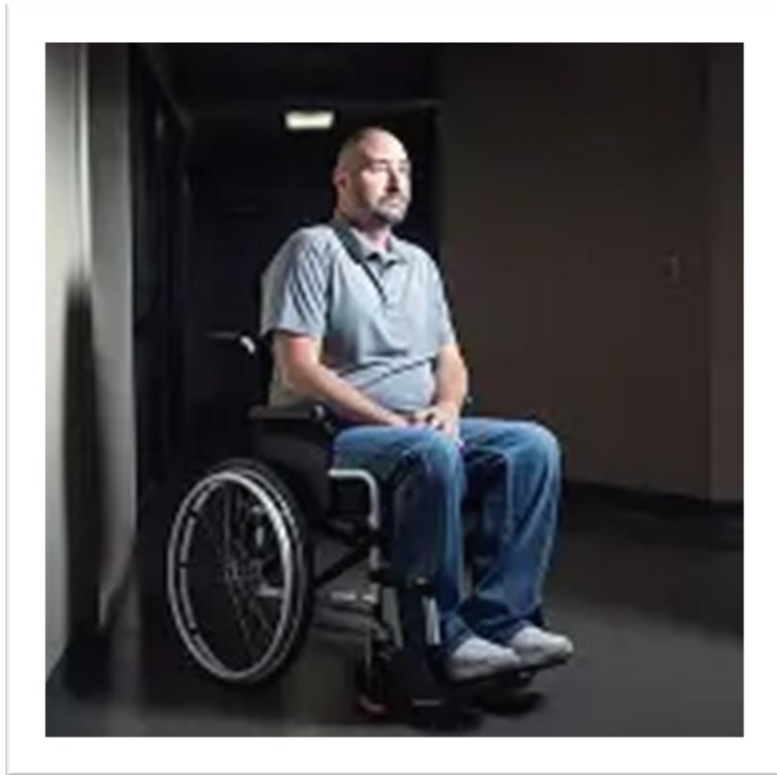
- ▶ *Reflexogenic vs. psychogenic erection*
- ▶ *Change dependent upon level of injury*
 - ▶ *Sperm, fertility, erection, ejaculation*

▶ 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

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 \(va.gov\)](#)

TERMS TO REMEMBER

- Tetraplegia: C 1- 8, most common levels of injury for cervical area are C-5, C-6, C-7
- Paraplegia: T-1 and below, most common levels of injury for thoracic/lumbar areas are L-1, L-2
- Complete - No motor or sensation in lowest sacral segment
- Incomplete - Partial loss of motor or sensation including lowest sacral segment

- Upper Motor Neuron Injury- **Lesions above T12-L1**
 - Injury is to the spinal cord
 - Loss of control over all reflexes below the level of injury
 - Spastic paralysis, Reflexes intact- Spasticity
- Lower Motor Neuron Injury- **Lesions below T12-L1**
 - Injury is to the conus medularis and cauda equina
 - Loss of reflex arc
 - Flaccid paralysis, No reflexes – Flaccid