

Secondary Complications In Trauma Patients: Acute Care to Rehabilitation

Physiatrist?

- Physical Medicine and Rehabilitation (PM&R) physicians, aka physiatrists:
 - treat a wide variety of medical conditions affecting the brain, spinal cord, nerves, bones, joints, ligaments, muscles, and tendons with a focus on restoring function
- Typical diagnoses managed:
 - Stroke
 - Brain injury
 - Spinal Cord Injury
 - Multiple Sclerosis
 - Amputations

Objectives

- Be able to recognize traumatic brain injury in trauma patients

Types of Injury

- Concussion
- Contusion
- Hemorrhagic injury
- Open head injury- penetrating trauma
- Closed head injury
- Can be focal or diffuse

Traumatic Brain Injury (TBI)

- An outside force that impacts the head hard enough to cause the brain to move within the skull which creates damage to the brain
 - Examples: motor vehicle collisions, falls, gun-shot wounds, sports, physical violence, etc.
 - Closed Head Injury vs. Open Head Injury.
-
- TBI cited to co-exist with traumatic SCI in 25% – 55%*

*Macciocchi S, Seel RT, Thompson N, Byams R, Bowman B. Spinal cord injury and co-occurring traumatic brain injury: assessment and incidence. Arch Phys Med Rehabil. 2008;89(7):1350-7.

Mechanism of Injury

- Acceleration
- Deceleration
- Rotation
- Shearing
- Penetrating
- Coup and Contrecoup
 - **Coup:** Laceration or contusion at sight of impact
 - **Contrecoup:** Injury occurs at the opposite side due to movement of the brain

Secondary Injury

Occurs after the primary trauma and can result in further damage

- Cerebral Edema
- Hemorrhage
- Increased ICP
- Hypoxia
- Hypotension
- Hyperthermia
- Electrolyte Disturbance
- Seizures
- Infections
- Vasospasms

Characteristics of Concussion

- Immediate temporary altered or loss of consciousness resulting from a violent blow or motion to the head lasting less than 30 minutes
- May or may not report this LOC
- Headache*
- Confusion
- Dizziness
- Visual, gait disturbances
- Memory issues* - around the time of injury

Post concussion Syndrome

- Can last 1 week to 1 year after initial injury, but typically improves/resolved by 3 months
- Headache – myofascial vs vascular/nerve injury
- Dizziness – vestibular changes, N/V
- Confusion/disorientation
- Hearing loss, tinnitus, photophobia and other visual changes
- Speech and cognitive deficits
- Irritability and poor attention
- Sleep disorders

Contusion

- Bruising of cerebral tissue without disruption of brain architecture
- Usually associated with a LOC, stupor, and confusion

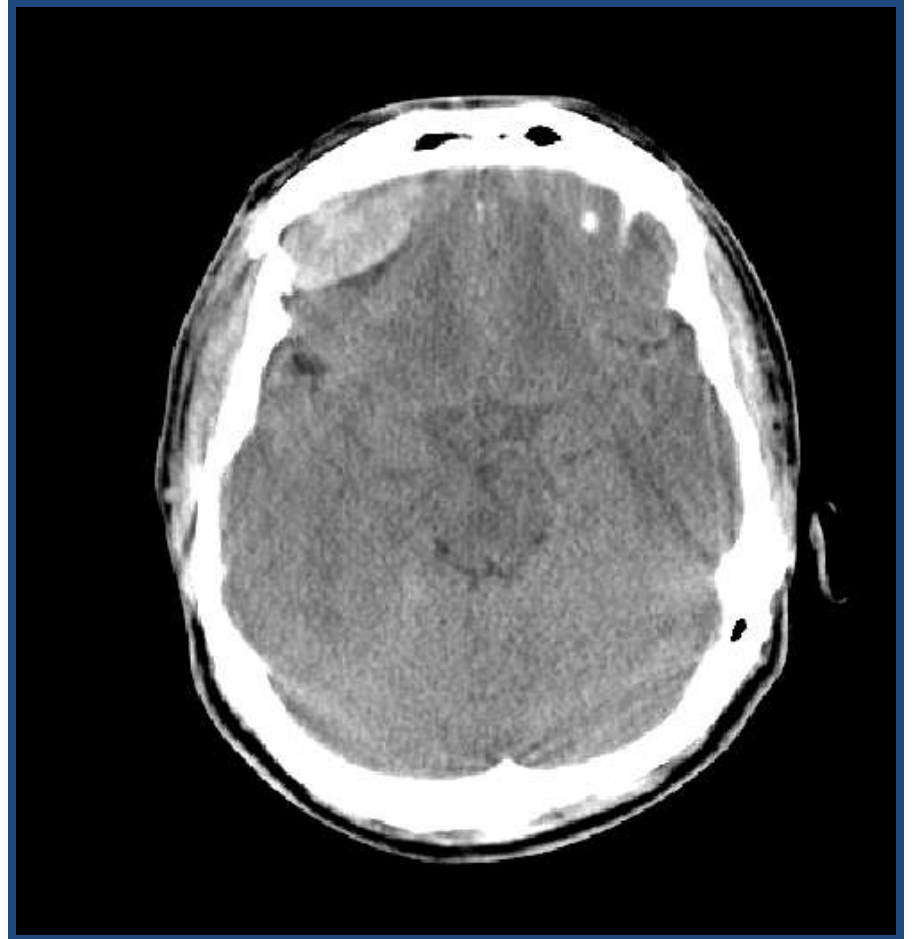


Hemorrhagic Injury

- Any injury causing bleeding into the central nervous system
- Subdural hematoma
- Epidural hematoma
- Intra-cerebral hemorrhage
- Subarachnoid hemorrhage

Epidural Hematoma

- Arterial bleed
- Initially lucid then rapidly declines
- Rapid onset of symptoms
- Risk of uncal herniation
- Symptoms: LOC; dilated, nonreactive ipsilateral (same side) pupil



Subdural Hematoma



- Bleeding between dura & arachnoid layer
- > common in older adults, +/- EtOH

Intracerebral Hemorrhage



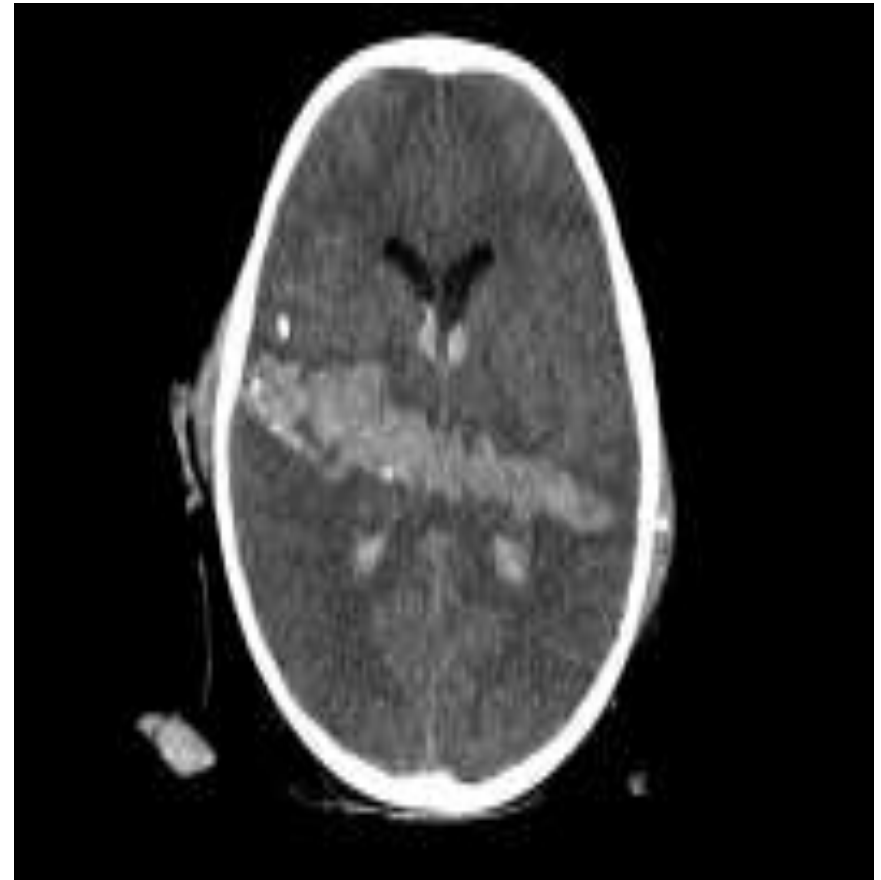
Intracerebral Hematoma

- Note the midline shift



Open Head/Trajectory Injury – Penetrating Trauma

- Penetrating brain trauma caused by any missile that penetrates skull and brain
- GSW
- Knives, ice picks
- Nail guns
- High risk for infection
- Very high seizure risk



Closed head Injury – Diffuse Axonal Injury

- Rotation mechanism (e.g. cracked helmet, rollover vehicle)
- Shearing of the axons
- Prognosis: Poor clinical status with relatively normal CT scan
- CT scan: Small hyperdense areas



Closed head Injury – Diffuse Axonal Injury

- Complications
 - Hypertension
 - Dysautonomia
 - Post-traumatic agitation
 - Hydrocephalus
 - Dysfunction of hypothalamus
 - Endocrine dysfunction



Characteristics of Mild TBI

- LOC < 30 minutes = Concussion
- GCS 13-15
- No CT results
- 75% of TBIs are classified as mild
- Residual symptoms
 - Memory loss
 - Headache
 - Vestibular symptoms
 - Sleep disorders

Characteristics of Moderate TBI

- GCS 9-12
- LOC > 30 minutes
- Abnormal CT scans
- Physical, cognitive, behavioral symptoms several months or permanent
- May have good recovery or long term deficits
- Post concussive symptoms may be extensive

Characteristics of Severe TBI

- Injuries are combination of focal and diffuse spread throughout the cortex and brainstem
- LOC hours, days, months, years
- GCS < 8
- Deficits are widespread, severe and long duration
- Most will have permanent residual deficits involving cognition, swallow, speech, mobility and/or bladder/bowel function

Disorders of Consciousness

- The severity and length of the disorder is related to the degree of disruption of the RAS

- 3 Types

Coma

- **Lack of Sleep Wake Cycle on EEG**
- Eyes remain Closed
- No spontaneous or purposeful movements

Vegetative State

- **Resumption of sleep wake cycle on EEG**
- No awareness of environment
- No purposeful behavior

Minimally Consciousness State

- Evidence of inconsistent but reproducible and purposeful behaviors
- **Increased awareness of environment, eyes tracking**

Treatment

- Neuromedical Stabilization and Manage medical issues
- Pharmacologic Intervention

Remove Medications that can sedate or can delay neurological and cognitive recovery

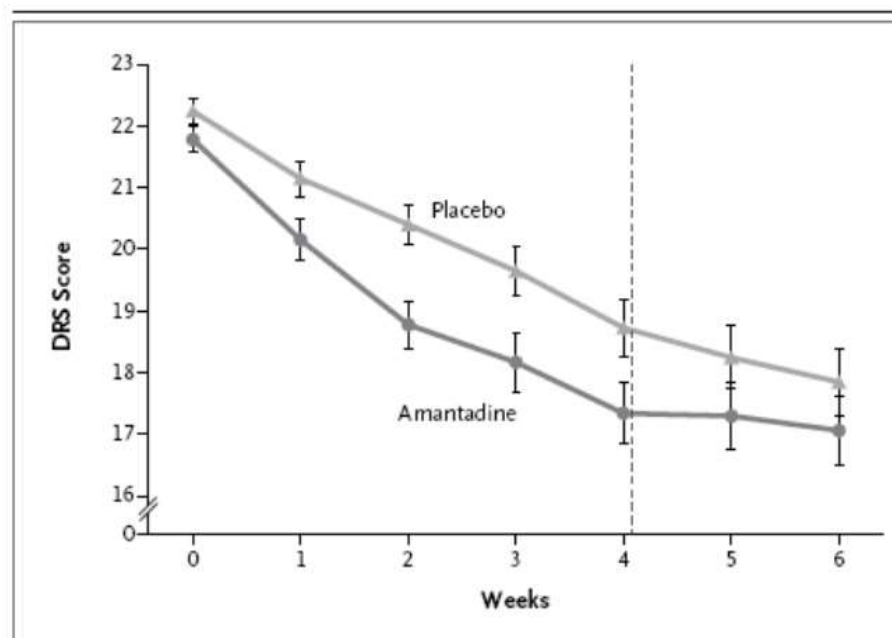
- Benzos
- H-2 Blockers
- Reglan
- Narcotics

Agents the may hasten Neurorecovery

- Methylphenidate
- Dextroamphetamine
- Dopamine agonist
- Amantadine
 - Giacino and Whyte 2012

Amantadine in DOC

- Whyte, Giacino et al 2012
- Multicenter International Study
160 patients
- Double Blind RCT with Amantadine
and Placebo
- 6 week study of patients
 - 4 to to 16 weeks post TBI
 - Were either VS or MCS at time
of study
 - Given either amantadine or
placebo for 4 week and given
washout the last two weeks
 - DRS
 - The amantadine group showed
a steeper recovery than the
control group, but after washout
the DRS in both groups came
together.
 - Both groups were recovering
but the amantadine group was
faster.



Sympathetic Storming – Autonomic Dysregulation

- Fever of unknown origin
- Tachycardia +/- hypertension
- Diaphoresis
- Hyper-metabolic state

Storming Treatment

- Rule-out infection
- Identify cause/remove
- Betablockers – Propranolol
- Goal is to prevent the secondary complications of prolonged stress
- Venous Thromboembolism
- DVT PE

Post Traumatic Agitation

- A subtype of delirium during Post Traumatic Amnesia
- Typically involves Frontal and Temporal Lobes in TBI
 - Responsible for Inhibition and Perseveration
 - Excess of one or more behaviors
 - Aggression
 - Disinhibition
 - Lability
 - Low arousal/hyperarousal
 - Confusion
 - Restlessness
 - Irritability/Outbursts of anger
 - Sensory Hyper stimulation (light/sound)
 - Distractibility/Poor Sustained attention
 - Compulsive Behaviors
 - Egocentricity

Post Traumatic Agitation

- Treatment First Line
- Rule out an infectious process, a DVT/PE, or an Intracranial process
 - Non-pharmacological
 - Reduce stimulation
 - sound, light, people, objects in room, noxious stimuli like lines tubes restraints that are not necessary.
 - Protect patient from harm
 - 1:1 sitter, Posey Bed, lock ward (not every place has one)
 - Reduce confusion
 - Minimize staff to those familiar
 - One person speaking at a time
 - Tolerate Restlessness when possible
 - Easier said than done
 - Allow a patient to be verbally inappropriate



Communication Techniques

- Respectful and with patience
- Speak slowly and clearly – give them time to respond – response time can vary from patient to patient
- Many times, “less is more” – keep conversation simple
- Emphasize abilities and not deficits
- Speak naturally
- Keep calm, avoid yelling or raise your voice
- Provide choices rather than asking them “What do you want?”

Interaction Recommendations

Behavioral or Agitated Patients

- Remain calm
- Keep yourself safe
- Don't draw attention to their behavior or argue with them
- Don't try to reason with them
- Re-direct them to the task that they are doing
– or re-direct them to a new task or subject

Post Traumatic Agitation

- Second line: Pharmacological
 - Propranolol:
 - Beta-Blockers - Cochrane Review: best evidence for efficacy in treating agitation
 - Helpful in autonomic dysregulation
 - Side effects - Hypotension, Bradycardia
 - Anticonvulsants
 - Valproate - Requires LFT, CBC monitoring
 - Avoid in pregnant pts-neural tube defects
 - Others
 - Gabapentin, Lamictal

Post Traumatic Agitation

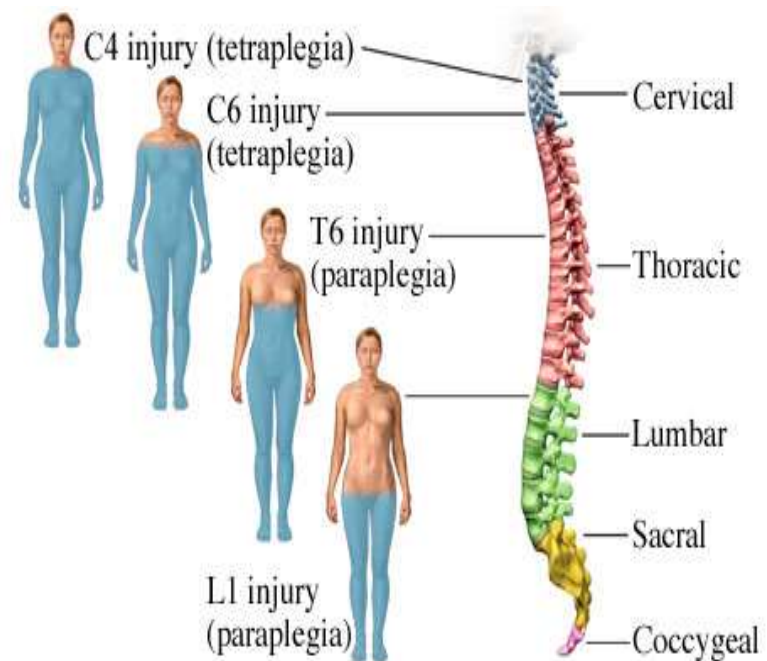
Anti-Psychotics

Typical and Atypical

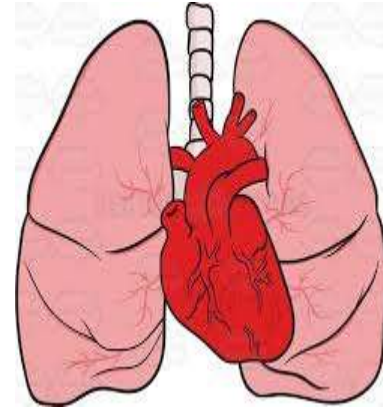
- Atypical - Better
 - Seroquel, Zyprexa, and Risperidone are typically used
 - Seroquel has an additive affect of sedation
- Typical : Haldol
 - More adverse affects
 - Neuroleptic Malignant Syndrome, Tarditive dyskinesia
 - Feeney et al 1982 - Showed that Hadol can slow motor recovery in animal models
- Benzo's
 - Not favorable
 - Can delay cognitive and motor recovery

Spinal cord injury

- Spinal Cord is an extension of the brain.
- Composed of neurons and its varying components.
- The cord is as sensitive to injury as the brain.
- Injury results in lesion to the CNS
- Symptoms of SCI depends on the level and type of injury.



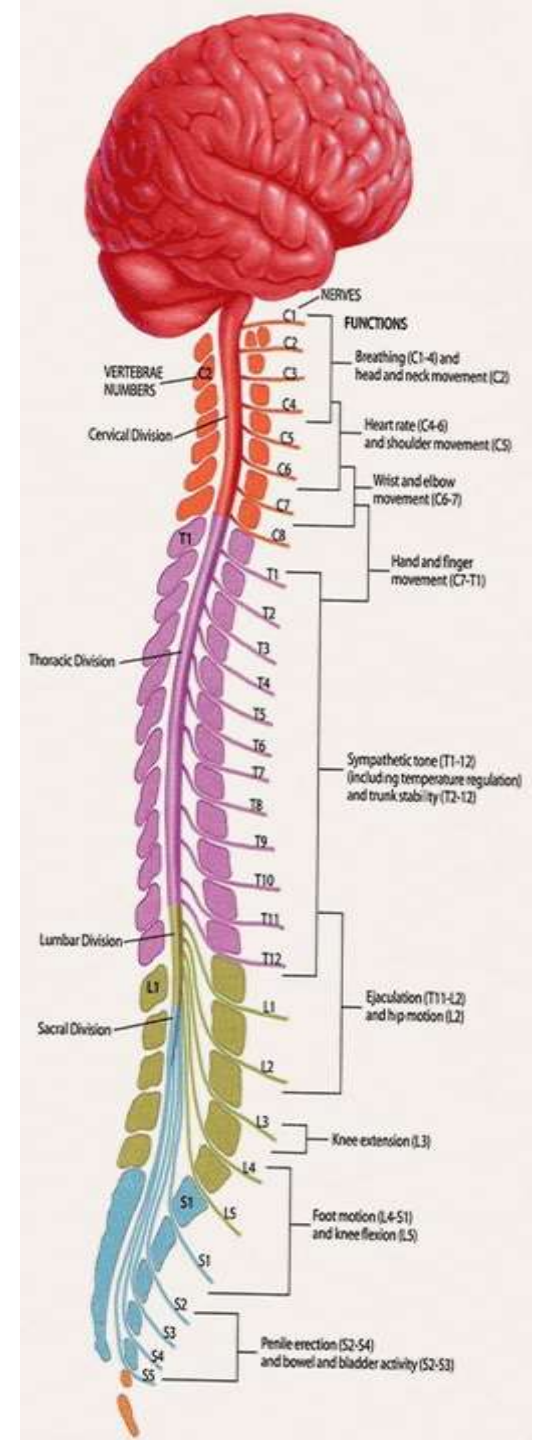
Mortality



- Predictors
 - Male gender
 - Advanced age
 - Ventilator dependent
 - Level of injury
 - Complete vs. incomplete
 - Poor economic status
 - Poor community integration
- Causes of death in chronic SCI
 - #1 Respiratory disorders → pneumonia
 - #2 Heart Disease → CHF, MI, CAD
 - #3 Septicemia → UTI, Pressure ulcers
- Suicide is the #1 cause of death in patients younger than 25 years old.

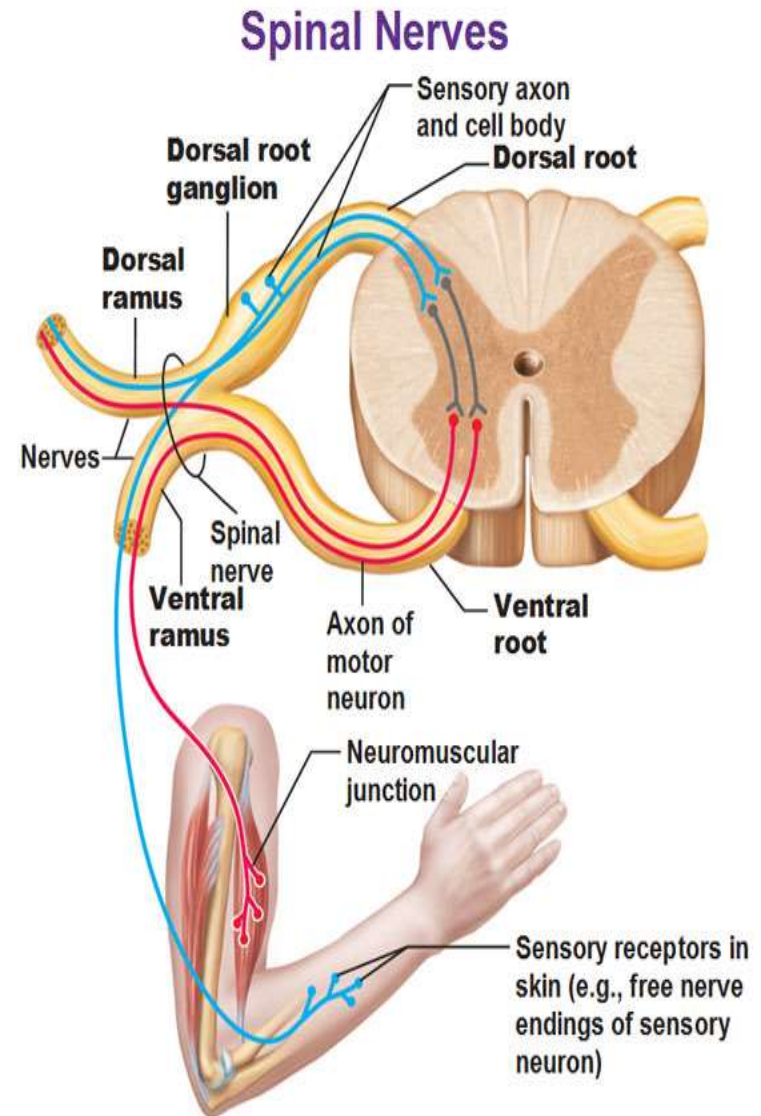
Spinal cord anatomy

- **Spinal Cord carries motor and sensory information to and from brain via efferent and afferent fibers.**
- **31 Spinal Segments**
 - **8 Cervical**
 - **12 Thoracic**
 - **5 Lumbar**
 - **5 Sacral**



Spinal cord anatomy

- Each spinal segments have a dorsal and ventral root and a spinal nerve except for the 1st segment which only has a ventral root.
- Dorsal root contains afferent sensory fibers. These carry information from your skin and organs back to the spinal cord.
- The Dorsal root ganglion contains the cell bodies to the sensory nerves. There are no synapses in the ganglion.



Motor and descending (efferent) pathways (red)

Pyramidal tracts

- Lateral corticospinal tract
- Anterior corticospinal tract

Extrapyramidal Tracts

- Rubrospinal tract
- Reticulospinal tracts
- Olivospinal tract
- Vestibulospinal tract

Sensory and ascending (afferent) pathways (blue)

Dorsal Column Medial Lemniscus System

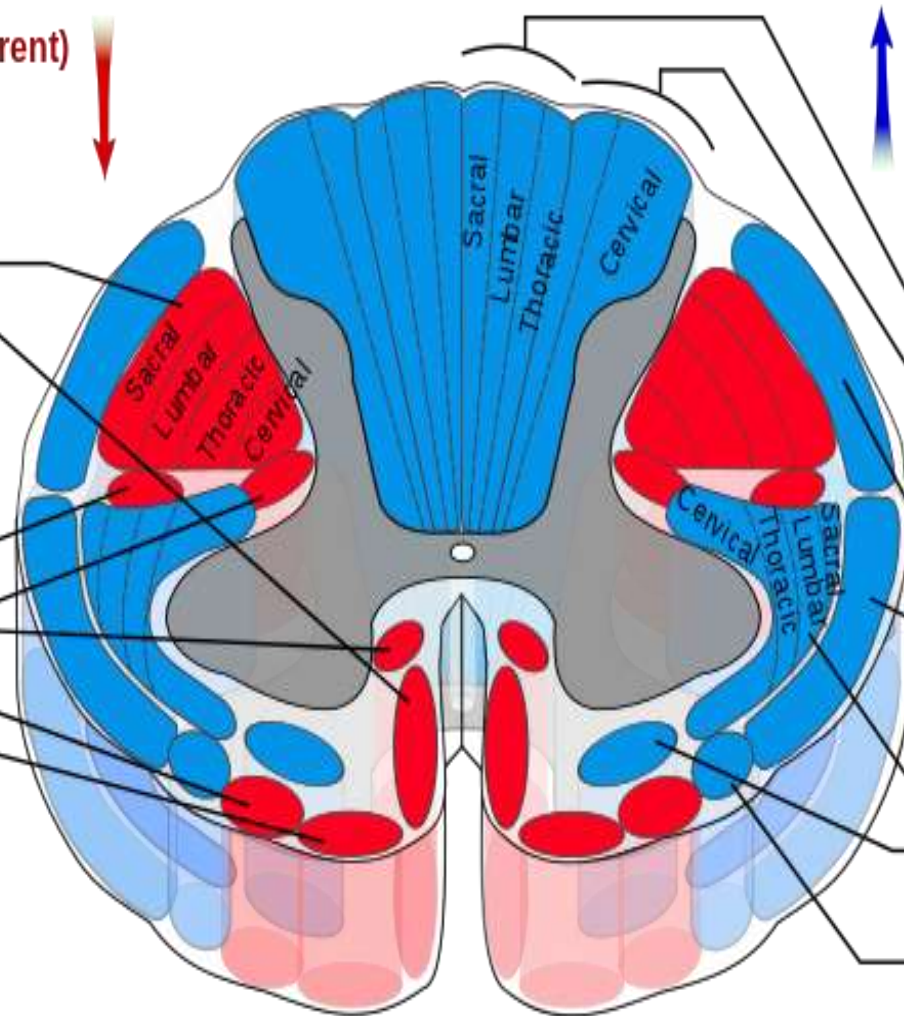
- Gracile fasciculus
- Cuneate fasciculus

Spinocerebellar Tracts

- Posterior spinocerebellar tract
- Anterior spinocerebellar tract

Anterolateral System

- Lateral spinothalamic tract
- Anterior spinothalamic tract
- Spino-olivary fibers



AIS Grading

- **ASIA Impairment Scale – AIS**
- **International Standards for Neurological Classification of Spinal Cord Injury – ISNCSCI**
- **American Spinal Injury Association – ASIA**
- **International Spinal Cord Society - ISCOS**
- **<http://www.asia-spinalinjury.org/index.php>**

RIGHT		MOTOR KEY MUSCLES	SENSORY KEY SENSORY POINTS Light Touch (LTR) Pin Prick (PPL)		SENSORY KEY SENSORY POINTS Light Touch (LTR) Pin Prick (PPL)		MOTOR KEY MUSCLES	LEFT					
UER (Upper Extremity Right)	Elbow flexors	C5							UEL (Upper Extremity Left)				
	Wrist extensors	C6											
	Elbow extensors	C7											
	Finger flexors	C8											
	Finger abductors (little finger)	T1											
Comments (Non-key Muscle? Reason for NT? Pain?): 					T2								
					T3								
					T4								
					T5								
					T6								
					T7								
					T8								
					T9								
					T10								
					T11								
					T12								
					L1								
LER (Lower Extremity Right)	Hip flexors	L2							LEL (Lower Extremity Left)				
	Knee extensors	L3											
	Ankle dorsiflexors	L4											
	Long toe extensors	L5											
	Ankle plantar flexors	S1											
(VAC) Voluntary anal contraction (Yes/No) ☐					S2								
					S3								
					S4-5								
					RIGHT TOTALS								
		(MAXIMUM)	(50)	(56)	(56)								
MOTOR SUBSCORES					SENSORY SUBSCORES								
UER ☐ + UEL ☐ = UEMS TOTAL ☐		LER ☐ + LEL ☐ = LEMS TOTAL ☐		LTR ☐ + LTL ☐ = LT TOTAL ☐		PPR ☐ + PPL ☐ = PP TOTAL ☐							
MAX (25) (25) (50)		MAX (25) (25) (50)		MAX (56) (56) (112)		MAX (56) (56) (112)							

NEUROLOGICAL LEVELS Steps 1-5 for classification as on reverse	1. SENSORY	R ☐	L ☐	3. NEUROLOGICAL LEVEL OF INJURY (NLI) ☐	4. COMPLETE OR INCOMPLETE? Incomplete = Any sensory or motor function in S4-5 ☐	5. ASIA IMPAIRMENT SCALE (AIS) ☐	(In complete injuries only) ZONE OF PARTIAL PRESERVATION Most caudal level with any innervation	SENSORY	R ☐	L ☐
	2. MOTOR	R ☐	L ☐					MOTOR	R ☐	L ☐

Muscle Function Grading

- 0 = total paralysis
- 1 = palpable or visible contraction
- 2 = active movement, full range of motion (ROM) with gravity eliminated
- 3 = active movement, full ROM against gravity
- 4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
- 5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
- 5* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present
- NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal range of motion)

Sensory Grading

- 0 = Absent
- 1 = Altered, either decreased/impaired sensation or hypersensitivity
- 2 = Normal
- NT = Not testable

Non Key Muscle Functions (optional)

May be used to assign a motor level to differentiate AIS B vs. C

Movement	Root level
Shoulder: Flexion, extension, abduction, adduction, internal and external rotation	C5
Elbow: Supination	
Elbow: Pronation	
Wrist: Flexion	C6
Finger: Flexion at proximal joint, extension	
Thumb: Flexion, extension and abduction in plane of thumb	C7
Finger: Flexion at MCP joint	
Thumb: Opposition, adduction and abduction perpendicular to palm	C8
Finger: Abduction of the index finger	T1
Hip: Adduction	L2
Hip: External rotation	L3
Hip: Extension, abduction, internal rotation	L4
Knee: Flexion	
Ankle: Inversion and eversion	
Toe: MP and IP extension	
Hallux and Toe: DIP and PP flexion and abduction	L5
Hallux: Adduction	S1

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.

** For an individual to receive a grade of C or D, i.e. motor incomplete status, they must have either (1) voluntary and sphincter contraction or (2) sacral sensory sparing with sparing of motor function more than three levels below the motor level for that side of the body. The International Standards at this time allows even non-key muscle function more than 3 levels below the motor level to be used in determining motor incomplete status (AIS B versus C).

NOTE: When assessing the extent of motor sparing below the level for distinguishing between AIS B and C, the **motor level** on each side is used, whereas to differentiate between AIS C and D (based on proportion of key muscle functions with strength grade 3 or greater) the **neurological level of injury** is used.

ASIA
AMERICAN SPINAL INJURY ASSOCIATION
INTERNATIONAL STANDARDS FOR NEUROLOGICAL
CLASSIFICATION OF SPINAL CORD INJURY

ISCS
INTERNATIONAL SPINAL CORD SOCIETY

Steps in Classification

The following order is recommended for determining the classification of individuals with SCI.

1. Determine sensory levels for right and left sides.

The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.

Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).

Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

3. Determine the neurological level of injury (NLI)

This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.

The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.

(i.e. absence or presence of sacral sparing)

If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0**

AND deep anal pressure = **No**, then injury is **Complete**.

Otherwise, injury is **Incomplete**.

5. Determine ASIA Impairment Scale (AIS) Grade:

Is Injury Complete? If YES, AIS=A and can record ZPP (lowest dermatome or myotome on each side with some preservation)

NO ↓

Is Injury Motor Complete? If YES, AIS=B

NO ↓

(No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?

NO ↓

AIS=C

YES ↓

AIS=D

If sensation and motor function is normal in all segments, AIS=E

Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.

AIS Grading Terms

- **Dermatome** – area of skin innervated by the sensory axons within each segmental nerve.
- **Myotome** – collection of muscle fibers innervated by the motor axons within each segmental nerve.
- **Sensory Level** – Determined after performing a full AIS exam. It is the lowest level at which a patient retains normal sensation, with all the dermatomes below being abnormal or absent sensation. The levels may differ left to right.
- **Motor Level** – Determined after performing a full AIS exam. It is the lowest level at which a patient retains a muscle strength of 3 or greater. The levels may differ left to right.

AIS Grading Terms

- **Neurological Level of Injury** – the most caudal neurological segment with **NORMAL** sensory and motor on **BOTH** sides. The single Neurological Level is the level assigned to the patient after the AIS exam.
- **Skeletal Level** – Level of greatest vertebral damage is noted on radiographic exam. **NOT** included on current AIS exam, as the level of vertebral damage **DOES NOT** correlate with the neurological injury.
- **Sensory Scores** – the total numerical summary score of sensory function. There is a total of 56 for both pin prick and light touch each for a max total of 112 per side. Can reflect the degree of neurological impairment.
- **Motor Scores** – numerical summary score of motor function. Max score of 25 for each extremity, totaling 50 for BUE and 50 for BLE. Score reflects the degree of neurological impairment.

AIS Grading

Complete

- Results in complete loss of motor and sensory function below the level of injury.
- No Sacral Sparing
- Has zone of partial preservation
- Worst prognosis

Incomplete

- Results in varying levels of loss of motor and sensory function.
- Sacral sparing – Sensation preserved at S4-S5 dermatome in one or both sides for light touch or pin prick or presence of Deep Anal Pressure
- Some continuity of white matter long tracts.
- Better prognosis for return of motor and sensory function below the level of injury.

AIS grading

- **A – Complete: no sensory or motor function is preserved in sacral segments S4-S5.**
- **B – Sensory Incomplete: Sensory but no motor function is preserved below the neurological level and includes the sacral segments S4-S5, AND no motor function preserved more than three levels below the motor level on either side of the body**

AIS grading

- **C – Motor Incomplete:** Motor function is preserved below the neurological level*, and more than half of key muscle functions below the single NLI have a muscle grade ≤ 3 (grades 0-2)
- **D – Motor Incomplete:** Motor function is preserved below the neurological level*, and at least half or more of key muscle functions below the NLI have a muscle grade ≥ 3 .

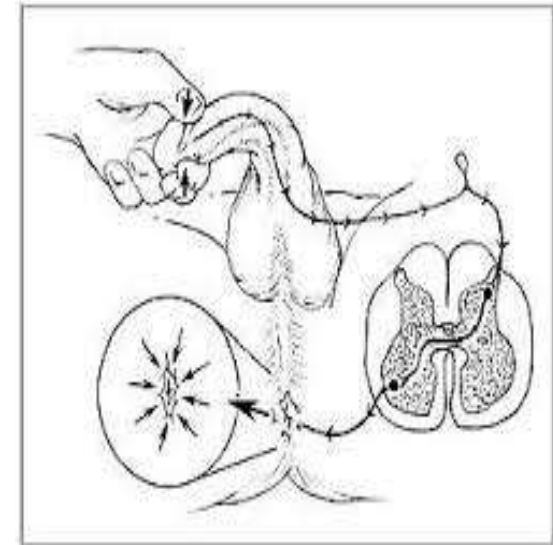
***For a patient to receive a grade of C or D, they must have:**

Voluntary anal sphincter contraction or
Sacral sensory sparing at S4-S5 or DAP

- **E – Normal:** Normal exam on AIS exam with deficits noted on prior exam. Someone without a SCI does not receive an AIS grade.

Immediately after injury → Spinal shock

- Loss of all spinal reflexes below the level of lesion temporarily.
- Flaccid paralysis and hyporeflexia below the level of injury.
- Usually resolves after 24 hours but can last longer.
- Bulbocavernosus Reflex is the first reflex to return
 - Indicates UMN lesion
 - Reflex innervation of bowel and bladder are intact
 - Squeezing the glans of the penis causes anal sphincter contraction
- Perianal Sphincter Reflex
 - Similar to bulbocavernosus reflex
 - Perianal stimulation causes anal sphincter contraction



Rehabilitation of

- Patients have survived the
- They survived the acute hospital stay
- New normal
- Needs and goals vary depending on the level of injury

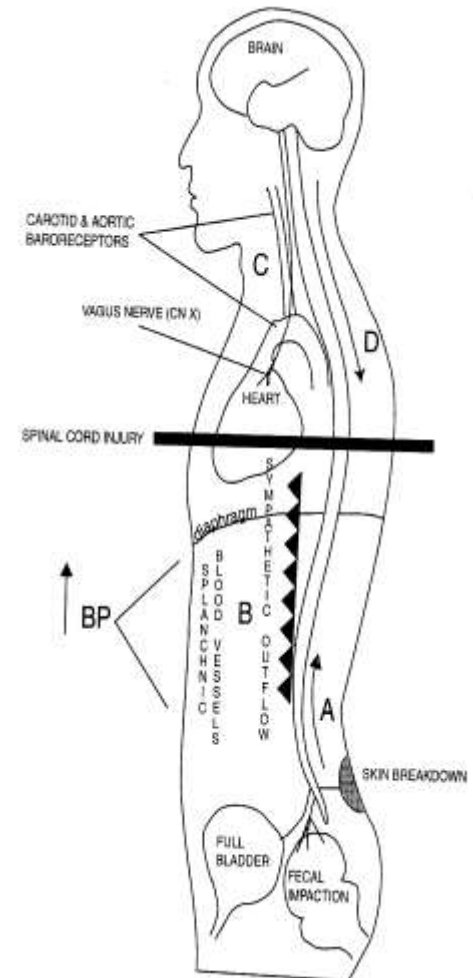


Medical complications

- Autonomic Dysreflexia
- Orthostatic Hypotension
- Neurogenic Bladder
- Neurogenic Bowel
- Pulmonary complications
- Heterotopic Ossification
- Depression/Psych
- Spasticity
- Musculoskeletal – Overuse injury
- Endocrine Abnormalities
- Neuropathic Pain
- Pressure Ulcer
- Sexual Dysfunction and Infertility

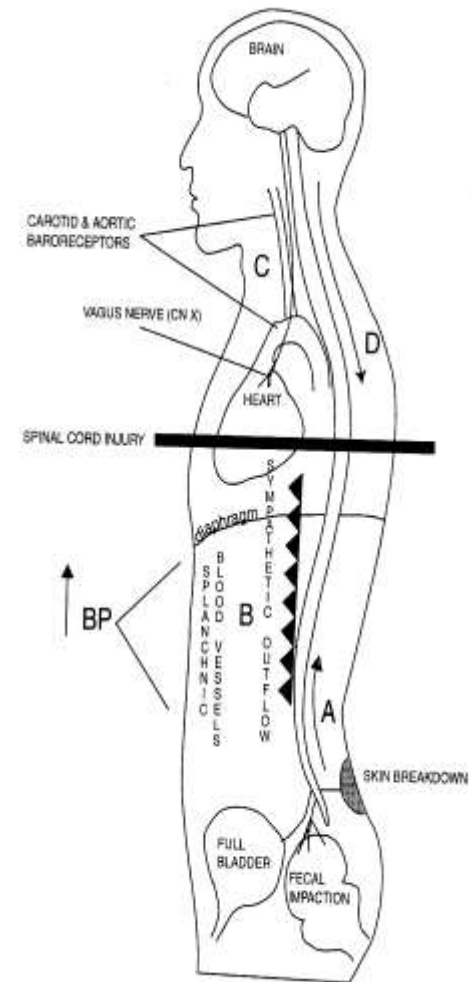
Autonomic dysreflexia (AD)

- **PM&R Emergency!**
- **Increased sympathetic outflow to a noxious stimuli.**
- **In patients with lesions above T6.**
- **Secondary to loss of descending central sympathetic control and hypersensitivity of receptors below the level of the lesion.**
- **Occurs after spinal shock**
- **90% of SCI patients will experience AD within the first year.**
- **Classically seen in complete injuries, although it can occur in incomplete injuries as well.**



Autonomic dysreflexia

- Noxious stimuli causes regional vasoconstriction causing hypertension.
 - Hypertension: Increased arterial BP, increased PVR, increased cardiac output.
- Aortic and Carotid baroreceptors detect the elevated BP and send signal to brainstem.
- Parasympathetic system via vagus nerve causes bradycardia as a response to the elevated BP
- The brainstem is unable to send sympathetic signals to vasodilate the splanchnic blood vessels to decrease BP.



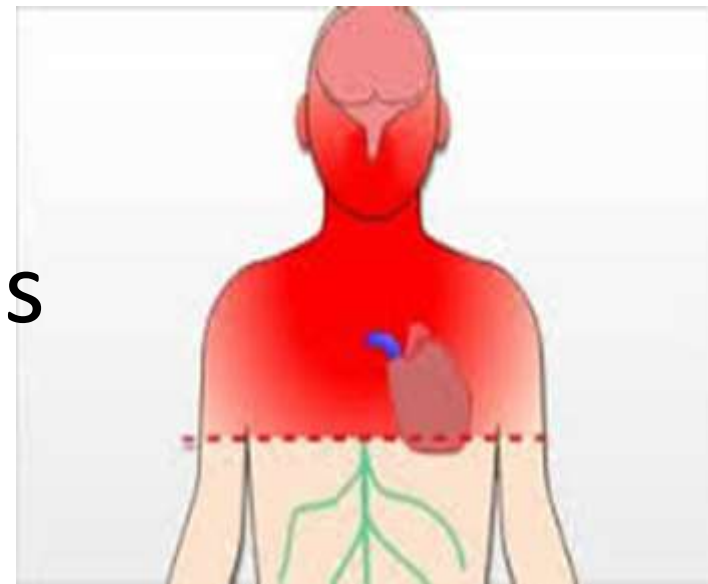
AD complications

- **CVA/SAH**
- **Seizure**
- **Confusion**
- **Loss of Consciousness**
- **Encephalopathy**
- **Retinal hemorrhage**
- **Arrhythmias**
- **Myocardial Infraction**
- **Pulmonary edema**
- **Death**

AD presenting symptoms

- **Elevated blood pressure**
- **Headache**
- **Reflex bradycardia (occ tachycardia)**
- **Piloerection**
- **Sweating above the level of SCI**
- **Flushing above the level of SCI**
- **Pupillary congestion**
- **Sinus congestion**

Appropriate sympathetic response to the elevated blood pressure above the lesion resulting in vasodilation



AD management

- 1. Sit patient up and loosen all tight/fitting clothing**
- 2. Identify and remove noxious stimulus**
 - ✓ Bladder – flush indwelling catheter, or catheterize the bladder to empty completely - do not just check PVR.
 - ✓ Use lidocaine jelly if catheterizing
 - ✓ Bowel – do manual fecal impaction, using lidocaine jelly
 - ✓ Is patient sitting on wrinkled sheet
- 3. Monitor BP every 2-5 minutes during episode and monitor for recurrent episodes for at least 2 hours to ensure complete resolution.**
- 4. Medications (should be initiated before checking for fecal impaction)**

AD management - medications

- **Acutely:**
 - **Nitropaste:** ½ - 2 inches, can be removed once noxious stimulus identified and corrected
 - **Clonidine:** 0.3 – 0.4mg
 - **Procardia;** 10mg chew and Swallow
- **ICU Management:**
 - **Diazoxide**
 - **Sodium Nitroprusside**
 - **Hydralazine**
 - **Labetalol**

Common causes of AD

- Bladder – urinary retention
- Bowel – fecal impaction
- Abdominal emergency (appendicitis, cholecystitis, pancreatitis)
- Labor
- Pressure ulcers
- Fractures
- Ingrown toenails
- Orgasm
- Urinary tract infections
- Epididymitis
- Bladder stones
- Gastric ulcers

CV - Orthostatic hypotension

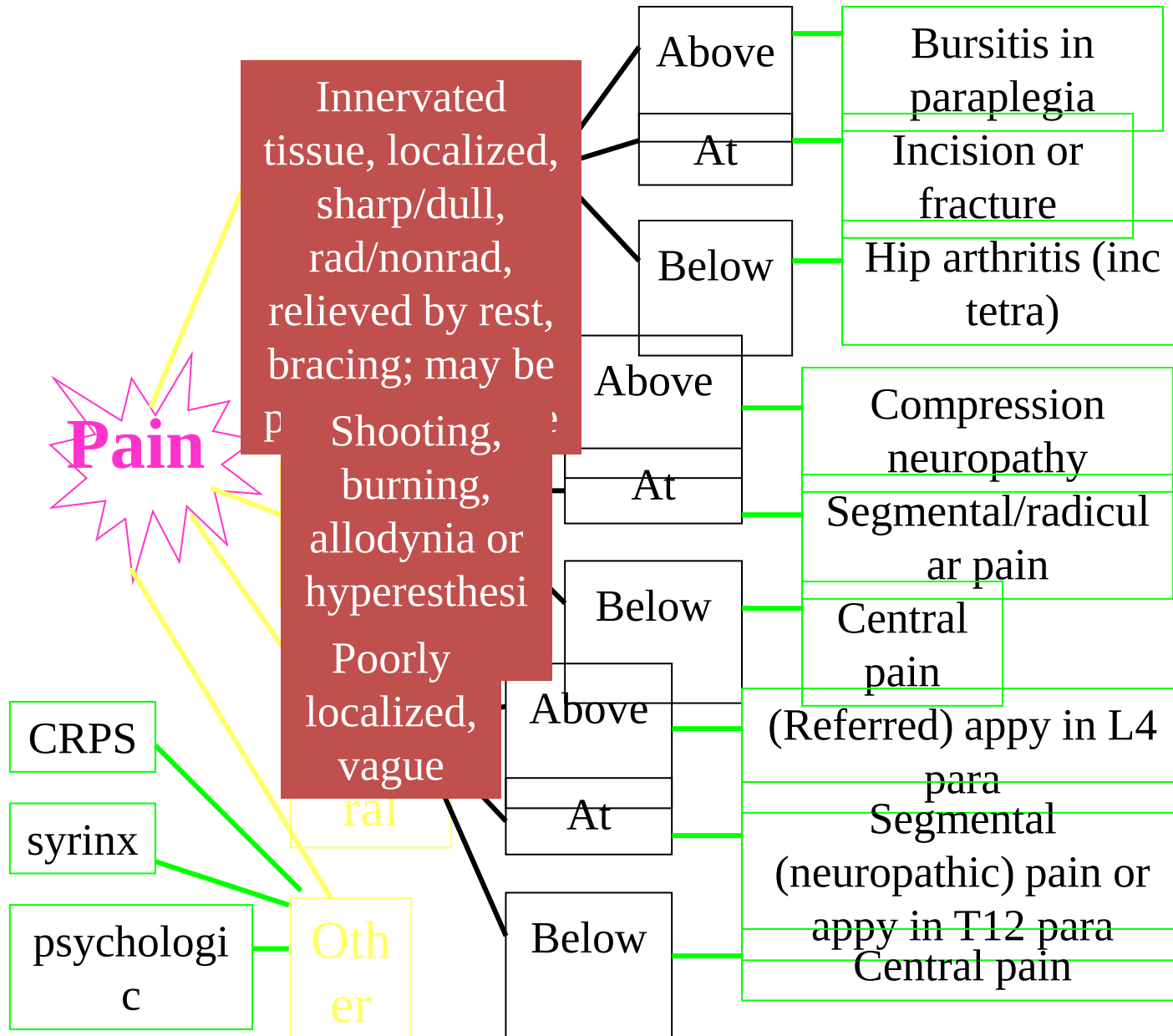
- Occurs due to lack of sympathetic signals reaching the target end organ from lesion in pathway.
- Deconditioned - Patients have been bed ridden for weeks.
- Therapist sits patient up in the experiences:
 - Dizziness
 - Presyncope
 - Nausea
 - Pallor
 - Hypotension
 - Tachycardia
- Use abdominal binders
- Compression stockings
- Therapy as tolerated
- Medications: Midodrine, flornidol



Spasticity

- **Loss of communication (inhibitory signals) from UMNs, results in hyperactivity of the LMNs → Spasms**
 - Motor disorder characterized by **velocity-dependent** increase in tonic stretch reflexes (**muscle tone**) with **exaggerated tendon jerks**, resulting from hyperexcitability of the stretch reflex
- **Affects joint ROM, movement, gait, ADLs, can lead to contractures**
- **Treat when tone interferes with function: hygiene, ambulation, movement, or causes pain/discomfort and insomnia**
- **Rule out any inciting causes such as UTI or ingrown toe nails that can cause increased spasticity**
- **Treatment:**
 - Oral Medications: baclofen, zanaflex, diazepam, dantrolene
 - Botulinum toxin injection
 - Phenol injections
 - Intrathecal baclofen pump

Pain



Musculoskeletal – overuse injury

- Rotator cuff impingement
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- Rotator cuff tear
- Biceps tendonitis
- Medial/lateral epicondylitis
- Carpal tunnel syndrome
- Osteoarthritis
- Fractures

Psychosocial

- A person with SCI may have:
 - Depression
 - Post-traumatic stress disorder
 - Anxiety
 - Social phobia (may be related to bowel/bladder)
- Psychiatry, psychology, social work and religious workers
- Medications - be aware of side effects (e.g., urinary retention, constipation, muscle weakness)

Rehabilitation of SCI

- **Mobility**
 - Wheelchair
 - Manual
 - Power
 - Joy stick
 - Sip and puff
 - Head control
 - Eye control
 - **Orthosis**
 - Reciprocal gait orthosis
 - Craig Scott orthosis
 - C-brace



Prognosis

- AIS exam after 72 hours from injury is the most reliable for prognostic purposes, assuming spinal shock has resolved.
- Presence of pin prick is a better predictor for ambulation than preservation of light touch.
- Complete injuries have a poor prognosis for improvement
- Preservation of sensation alone carries an intermediate prognosis for improvement in neurological level.
- Patients with incomplete injury recover faster at the zone of injury than those with complete injury, but their degree of recovery is not necessarily greater.



Prognosis

- **Patients with lesions below L3 or AIS D injuries have a favorable prognosis for long term community ambulation.**
- **Nearly all muscles with a MS of 1 or 2/5 at 1 month out will recover up to MS 3/5 strength by one year.**
- **Muscles with a MS 0/5 at the first neurological level below the most caudal segment having motor function will typically recover up to 3/5 by one year.**

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Take Home Message

Through an understanding of basic anatomy, physiology and pathophysiology, augmented by the use of medical advances in diagnostics and treatment, we have been able to manage the patient with a spinal cord injury better than we ever did in the past - leading to longer life expectancy and better quality of life.