Rehabilitation Medicine Issues & Interventions in Trauma Patients

2024 Fall Trauma Nursing Conference

OCTOBER 19TH, 2024 IAN LOGAN, MD

Learning Objectives

1. Identify key differences between the settings for post-acute care rehabilitation of trauma patients
2. Understand the terminology of classification systems and apply clinical assessments used for spinal cord injury (SCI) and traumatic brain injury (TBI)
3. Identify common rehab-related issues in trauma patients including those specific to SCI and TBI
4. Describe management strategies for common rehab issues

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Settings for Rehabilitation

- Inpatient Rehabilitation Facility (IRF, ARU, IPR)
- Long Term Acute Care Hospital (LTACH)
- Skilled Nursing Facility (SNF)
- Home Health Therapies
- Outpatient Therapies

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Continuum of Rehabilitation Services

Patients will often progress through a variety of settings during the course of their rehabilitation

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Settings for Rehabilitation

Why is this important?

- What happens on acute care can have a lasting impact on patients after they discharge
  - Improve health outcomes
  - Decrease readmission rates due to complications
  - Patient education and self-advocacy

IRF vs. SNF

Inpatient Rehab Facility

- CMS 13
- Daily physician oversight of rehab plan of care
- Rehab nursing
- Can tolerate 3 hours of therapy five out of seven days
- Requires two out of three therapy disciplines (PT, OT, and SLP)

Skilled Nursing Facility

- Physician visit at least once every 30 days for the first 90 days after admission, and at least once every 60 days thereafter
- Primarily staffed by nursing assistants
- Daily therapy hours is patient-dependent

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LTACH

- Ventilator weaning
- Complex wound care needs
- End Stage Renal Disease on Dialysis

- Daily provider rounding
- Nursing care
- Daily therapy hours is patient-dependent

Outpatient options

Outpatient Clinic

- Hospital based clinics often more equipped to treat complex neurotrauma patients
- Some community clinics have therapists with neuro expertise

Home Health

- Need to meet CMS homebound criteria
- Requires provider certification
- Geographic/Staffing limitations

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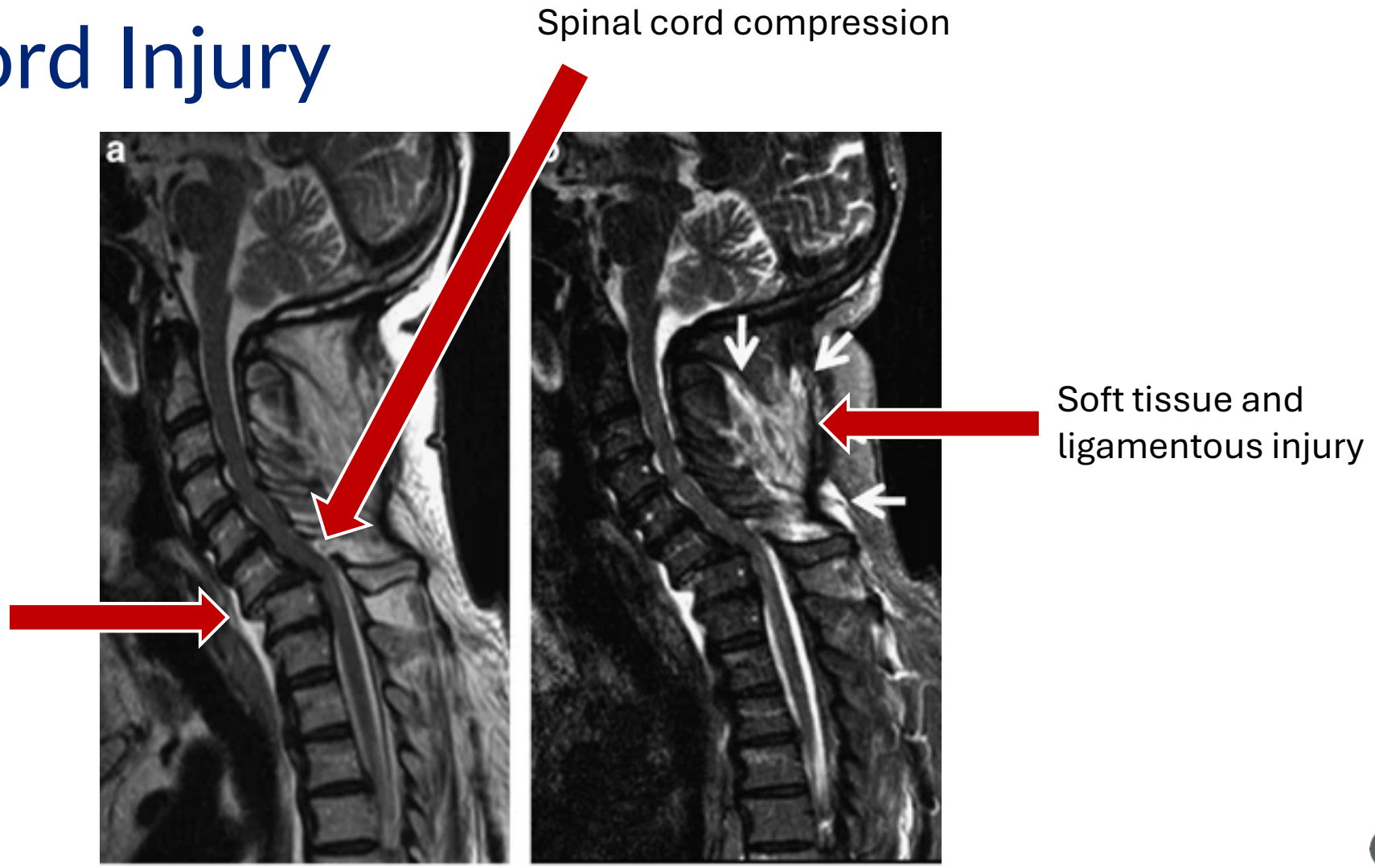
Spinal Cord Injury



Chandra, J., Sheerin, F., Lopez de Heredia, L. *et al*. MRI in acute and subacute post-traumatic spinal cord injury: pictorial review. *Spinal Cord* **50**, 2–7 (2012). https://doi.org/10.1038/sc.2011.107

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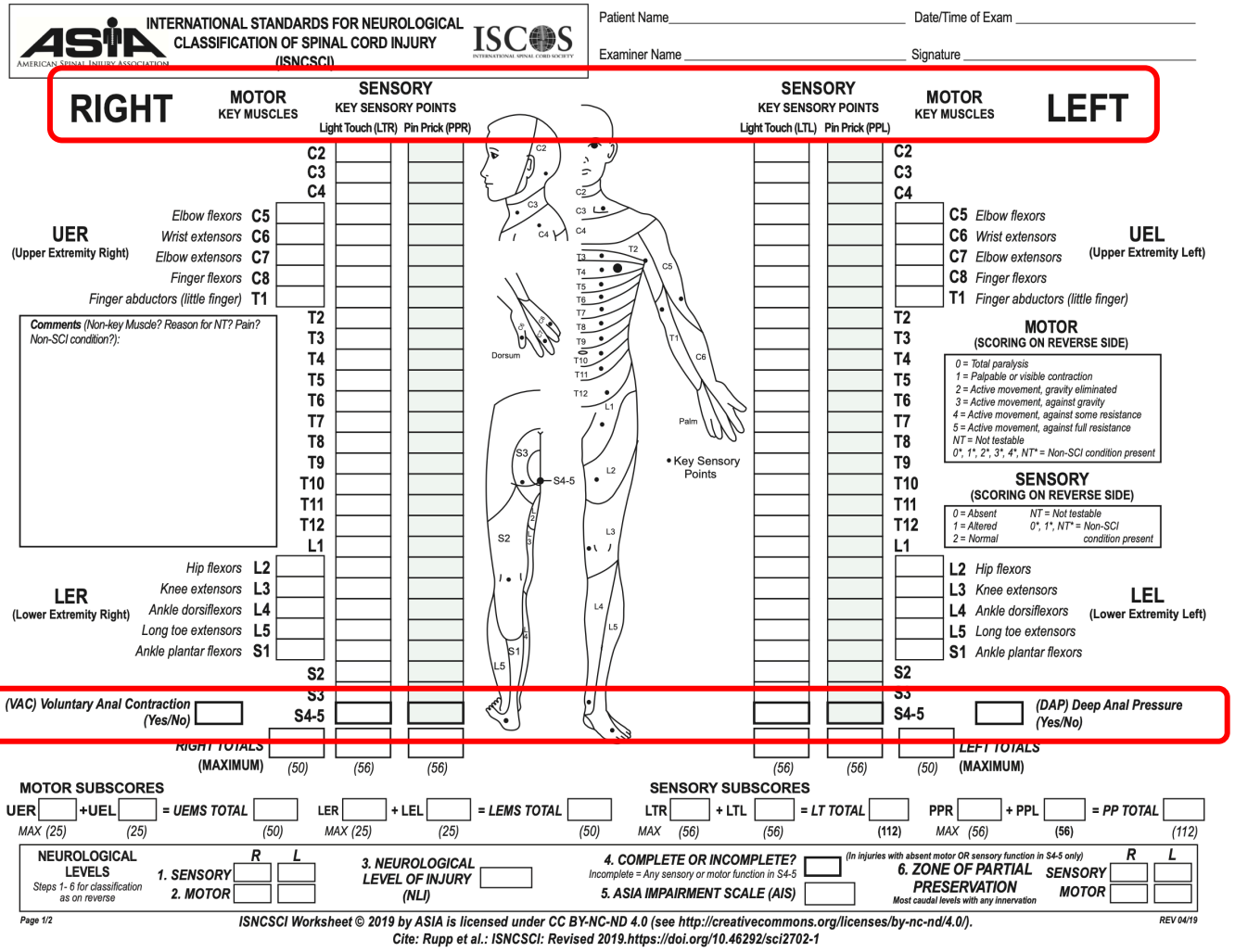
ISNCSCI (ASIA) exam



INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

Patient Name _____ Date/Time of Exam _____

Examiner Name _____ Signature _____

RIGHT — MOTOR KEY MUSCLES — SENSORY KEY SENSORY POINTS Light Touch (LTR) Pin Prick (PPR) — SENSORY KEY SENSORY POINTS Light Touch (LTL) Pin Prick (PPL) — MOTOR KEY MUSCLES — LEFT

UER (Upper Extremity Right): Elbow flexors C5; Wrist extensors C6; Elbow extensors C7; Finger flexors C8; Finger abductors (little finger) T1

UEL (Upper Extremity Left): C5 Elbow flexors; C6 Wrist extensors; C7 Elbow extensors; C8 Finger flexors; T1 Finger abductors (little finger)

Comments (Non-key Muscle? Reason for NT? Pain? Non-SCI condition?):

LER (Lower Extremity Right): Hip flexors L2; Knee extensors L3; Ankle dorsiflexors L4; Long toe extensors L5; Ankle plantar flexors S1

LEL (Lower Extremity Left): L2 Hip flexors; L3 Knee extensors; L4 Ankle dorsiflexors; L5 Long toe extensors; S1 Ankle plantar flexors

C2 C3 C4 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1 S2 S3 S4-5

• Key Sensory Points

MOTOR (SCORING ON REVERSE SIDE)

0 = Total paralysis
1 = Palpable or visible contraction
2 = Active movement, gravity eliminated
3 = Active movement, against gravity
4 = Active movement, against some resistance
5 = Active movement, against full resistance
NT = Not testable
0*, 1*, 2*, 3*, 4*, NT* = Non-SCI condition present

SENSORY (SCORING ON REVERSE SIDE)

0 = Absent
1 = Altered
2 = Normal
NT = Not testable
0*, 1*, NT* = Non-SCI condition present

(VAC) Voluntary Anal Contraction (Yes/No) _____ (DAP) Deep Anal Pressure (Yes/No) _____

RIGHT TOTALS (MAXIMUM) (50) (56) (56) — (56) (56) (50) LEFT TOTALS (MAXIMUM)

MOTOR SUBSCORES

UER _____ +UEL _____ = UEMS TOTAL _____ MAX (25) (25) (50)

LER _____ + LEL _____ = LEMS TOTAL _____ MAX (25) (25) (50)

SENSORY SUBSCORES

LTR _____ + LTL _____ = LT TOTAL _____ MAX (56) (56) (112)

PPR _____ + PPL _____ = PP TOTAL _____ MAX (56) (56) (112)

NEUROLOGICAL LEVELS (Steps 1- 6 for classification as on reverse)

1. SENSORY R _____ L _____
2. MOTOR R _____ L _____

3. NEUROLOGICAL LEVEL OF INJURY (NLI) _____

4. COMPLETE OR INCOMPLETE? _____ (In injuries with absent motor OR sensory function in S4-5 only)
Incomplete = Any sensory or motor function in S4-5

5. ASIA IMPAIRMENT SCALE (AIS) _____

6. ZONE OF PARTIAL PRESERVATION (Most caudal levels with any innervation) SENSORY R _____ L _____ MOTOR R _____ L _____

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Cite: Rupp et al.: ISNCSCI: Revised 2019.https://doi.org/10.46292/sci2702-1

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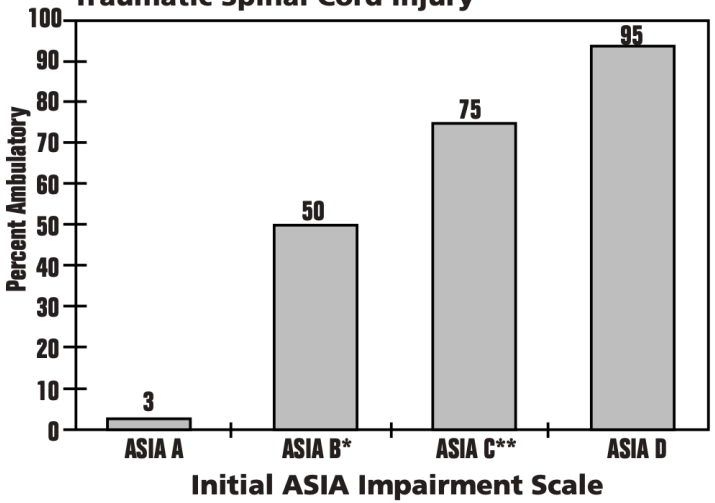
ISNCSCI (ASIA) exam

- SCI classification informs prognosis and functional abilities of the patient

FIGURE 1
Prognosis for Ambulation after Traumatic Spinal Cord Injury



*Prognosis influenced by presence or absence of pin sensation (see text)
**Prognosis influenced by age (see text)

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 at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments S4-5 by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body. (This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having 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.

Using ND: To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

https://pva.org/wp-content/uploads/2021/09/cpg_outcomes-following-traumatic-sci.pdf

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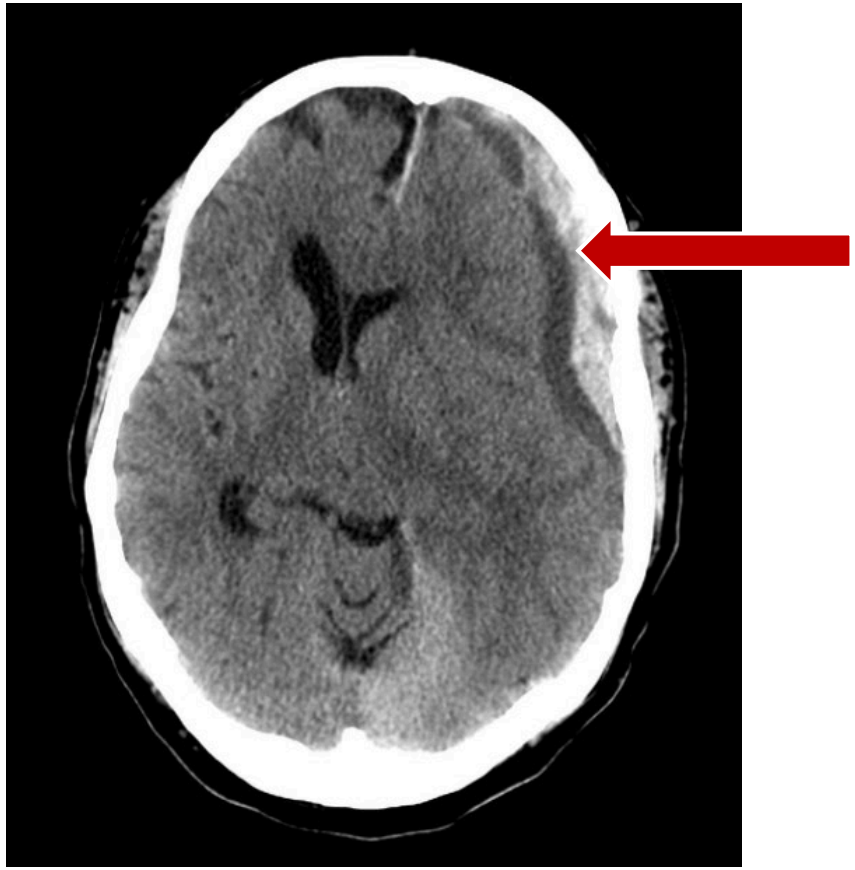
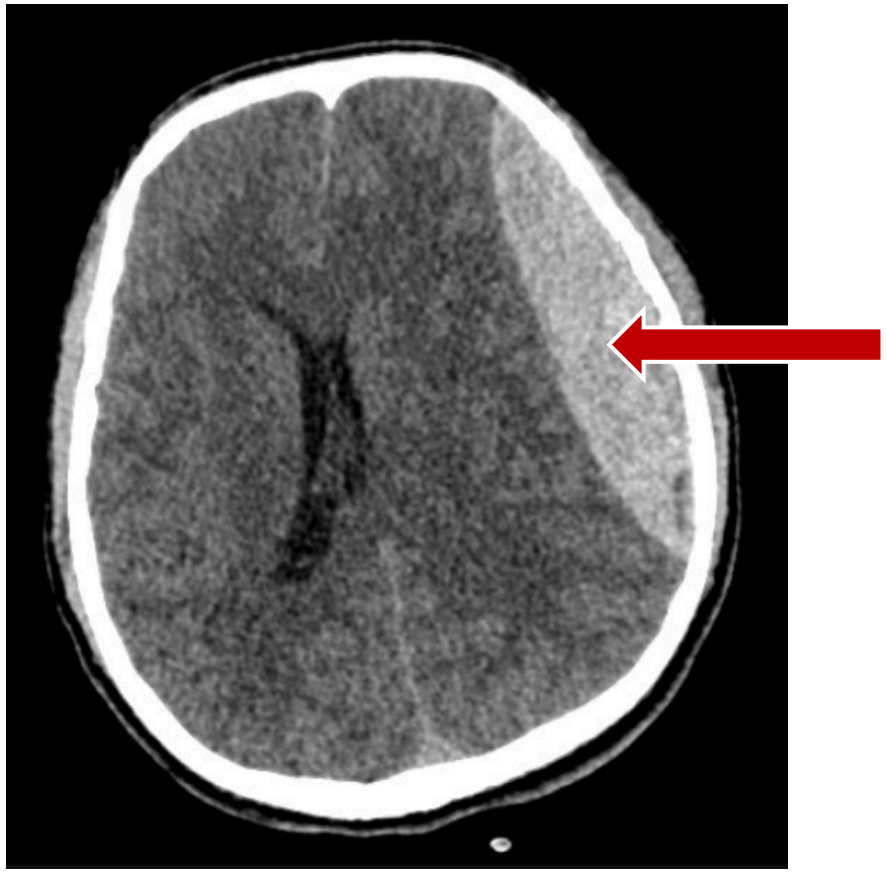
Traumatic Brain Injury



Subdural hemorrhage



Epidural hemorrhage

https://radiopaedia.org/articles/extradural-haematoma-vs-subdural-haematoma?lang=us

TBI Classification - Traditional Model

Sidebar 2: Classification of TBI Severity[a]			
Criteria	**Mild**	**Moderate**	**Severe**
Structural imaging (see Recommendation 4)	Normal[b]	Normal or abnormal	Normal or abnormal
Loss of consciousness	0 – 30 min	>30 min and <24 hours	>24 hours
Alteration of consciousness/mental state[c]	up to 24 hours	>24 hours; severity based on other criteria	
Post-traumatic amnesia	0 – 1 day	>1 and <7 days	>7 days
Glasgow Coma Scale (best available score in first 24 hours)[d]	13 – 15	9 – 12	<9

[a] If patient meets criteria in more than one category of severity, the higher severity level is assigned.

[b] No clinically relevant findings.

[c] Alteration of mental status must be immediately related to the trauma to the head. Typical symptoms would be: looking and feeling dazed and uncertain of what is happening, confusion, difficulty thinking clearly or responding appropriately to mental status questions, and/or being unable to describe events immediately before or after the injury event.

[d] In April 2015, the DoD released a memorandum recommending against the use of Glasgow Coma Scale scores to diagnose TBI. See the memorandum for additional information(3)

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VA/DoD TBI clinical practice guidelines 2021

TBI Terminology

Glasgow Coma Scale

Eye Opening	
Spontaneous	4
Open to verbal command	3
Open to pain	2
No eye opening	1
Verbal Response	
Oriented	5
Confused	4
Inappropriate words	3
Incomprehensible sounds	2
No verbal response	1
Motor Response	
Follows commands	6
Localizes to pain	5
Withdrawals from pain	4
Flexes to pain	3
Extends to pain	2
No Movement	1
Total score	3-15

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TBI Terminology

Post-Traumatic Amnesia

- Transient state of altered brain function (confusion, loss of memory, inability to form new memories) that may follow a TBI

Clinical Assessments

- GOAT (score >75 on consecutive tests)
- O-Log (score >25 on consecutive tests)

The Orientation Log (O-Log)

Patient Name:

Key: 3=spontaneous/free recall
2=logical cuing
1=multiple choice, phonemic cuing
0=unable, incorrect, inappropriate

Date																		
Time																		
City																		
Kind of Place																		
Name of Hospital																		
Month																		
Date																		
Year																		
Day of Week																		
Clock Time																		
Etiology/ Event																		
Pathology Deficits																		

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TBI and Functional Outcomes

TBI classification informs prognosis and functional abilities of the patients

Severe Disability = "conscious but dependent"

- Unable to live alone, requires a 24 hour caregiver

Good Recovery = "mild to no residual deficits"

- Capacity to resume normal occupational and social activities

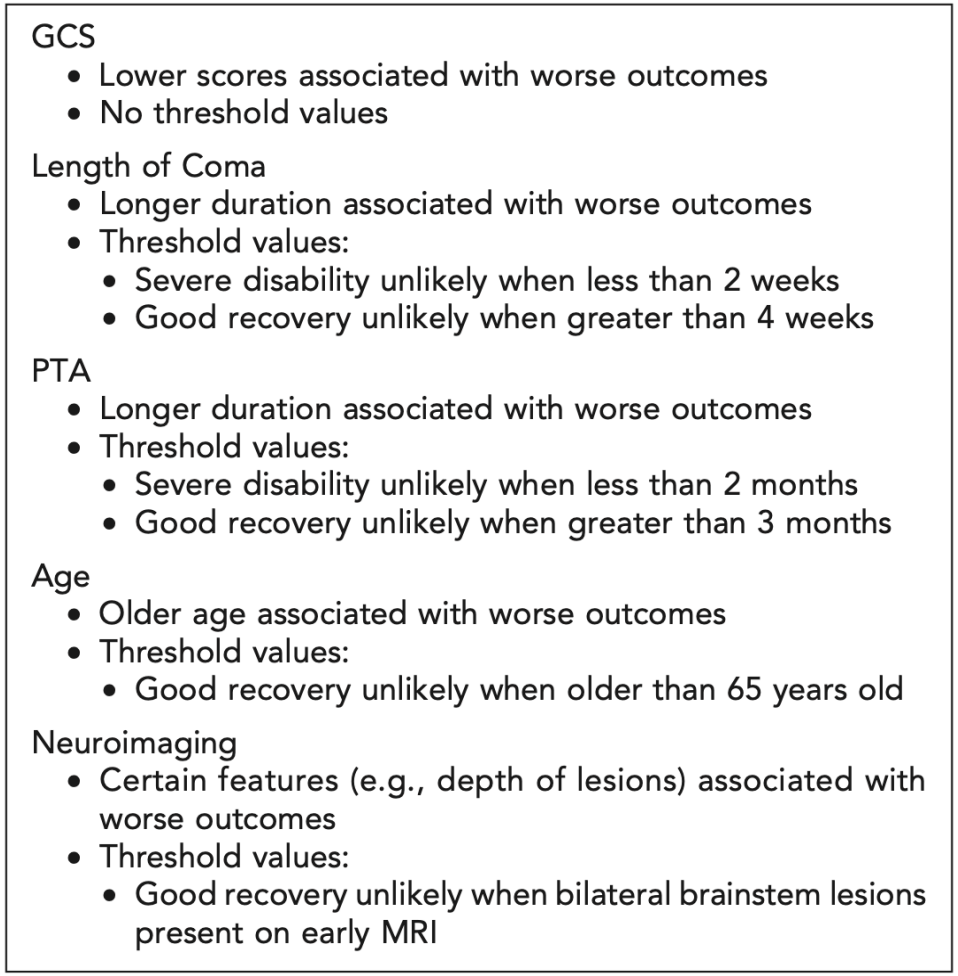

FIGURE 18–6 Summary of studies of nonpenetrating TBI.

1. Glasgow Outcome Scale
2. Text: Brain Injury Medicine Principles and Practice

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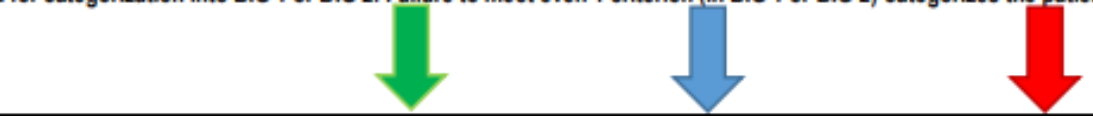
TBI Classification – Brain Injury Guidelines (BIG)

	BIG 1	BIG 2	BIG 3
Neuro Exam (Abnormal = Best GCS <15 at time of classification, or focal deficit)	Normal	Normal	Abnormal
Intoxication (EtOH > 80 mg/dl, Suspicion of any non-EtOH substance abuse)	No	No/Yes	No/Yes
Coagulopathy [Pharmacological (anticoagulation, antiplatelets), Non-pharmacological (Abnormal TEG, cirrhosis, INR>1.4, thrombocytopenia <100)]	No	No	Yes
Skull fracture	No	Non-displaced	Displaced
Subdural Hematoma	≤4mm	5-7mm	≥8mm
Epidural Hematoma	≤4mm	5-7mm	≥8mm
Intraparenchymal Hemorrhage	≤4mm and 1 location	5-7mm and/or 2 locations	≥8mm and/or multiple locations
Subarachnoid Hemorrhage	"Trace" = ≤3 sulci	"Localized" =Single hemisphere	"Scattered" Bi-hemispheric
Intraventricular Hemorrhage	No	No	Yes
Midline Shift	No	No	Yes

All measurements/exact verbiage according to FINAL HCT

Patients must meet all criteria for categorization into BIG 1 or BIG 2. Failure to meet even 1 criterion (in BIG 1 or BIG 2) categorizes the patient into the BIG 3 category



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Management Plan

	BIG 1	BIG 2	BIG 3
Repeat HCT	No	No	Yes @6 Hours
Neurosurgical Consultation	No	No	Yes
Hospitalization	6 hour observation	Yes, 24 hour observation	Yes
Neurocheck Frequency	Q2	Q4	Q1 (until otherwise specified by NSG)
Discharge Criteria	GCS 15 (or baseline), Neuro Intact	GCS 15 (or baseline), Neuro Intact	NA

Disorders of Consciousness

- Coma
- Vegetative state
- Minimally conscious (MCS- and MCS+)

- Eye Opening
- Sleep Wake Cycle
- Command Following
- Language Function

https://msktc.org/tbi/factsheets/facts-about-vegetative-and-minimally-conscious-states-after-severe-brain-injury

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Disorders of Consciousness

Disorder of Consciousness	Eye Opening	Sleep-wake cycle	Command Following	Language Function
Coma	No	No	No	
Vegetative State	Intermittent	Yes	No	
Minimally Conscious State				
MCS -	Yes	Yes	Automatic motor behaviors (i.e. scratching nose, visual pursuit)	Not preserved
MCS +	Yes	Yes	Yes	Intelligible verbalization/intentional communication

Cognitive Motor Dissociation or "functional locked-in syndrome" is not a DOC, but often misdiagnosed as VS or MCS due to paralysis.

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Rancho Los Amigos Scale - Revised

Total Assistance	Max -> Mod	Min -> SBA	SBA -> Mod-I
Level I No response	Level IV Confused/Agitated	Level VII Automatic/Appropriate	Level IX Purposeful/Appropriate (SBA on request)
Level II Generalized response	Level V Confused/Inappropriate	Level VIII Purposeful/Appropriate	Level X Purposeful/Appropriate
Level III Localized response	Level VI Confused/Appropriate		

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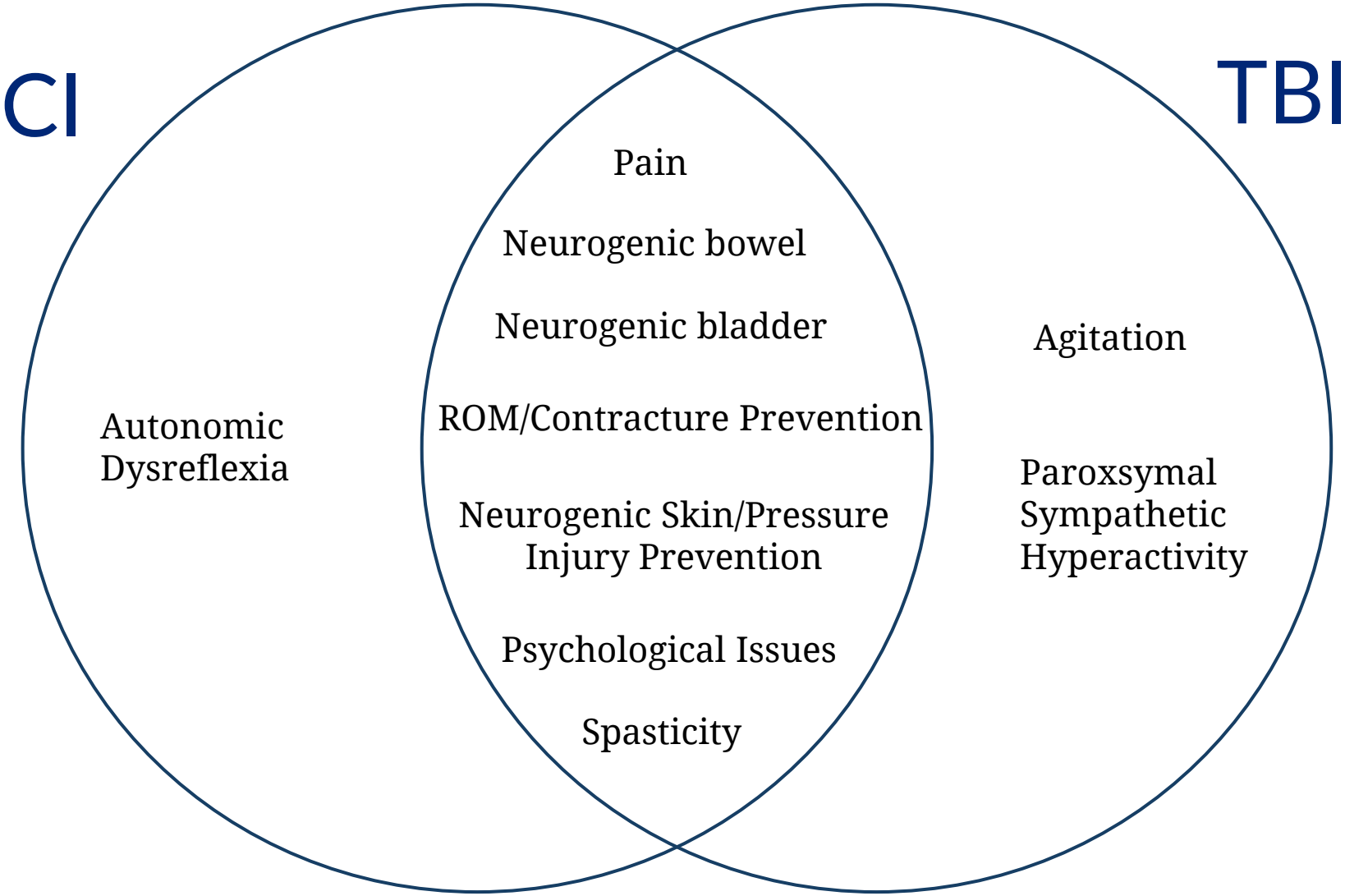
Common Clinical Issues



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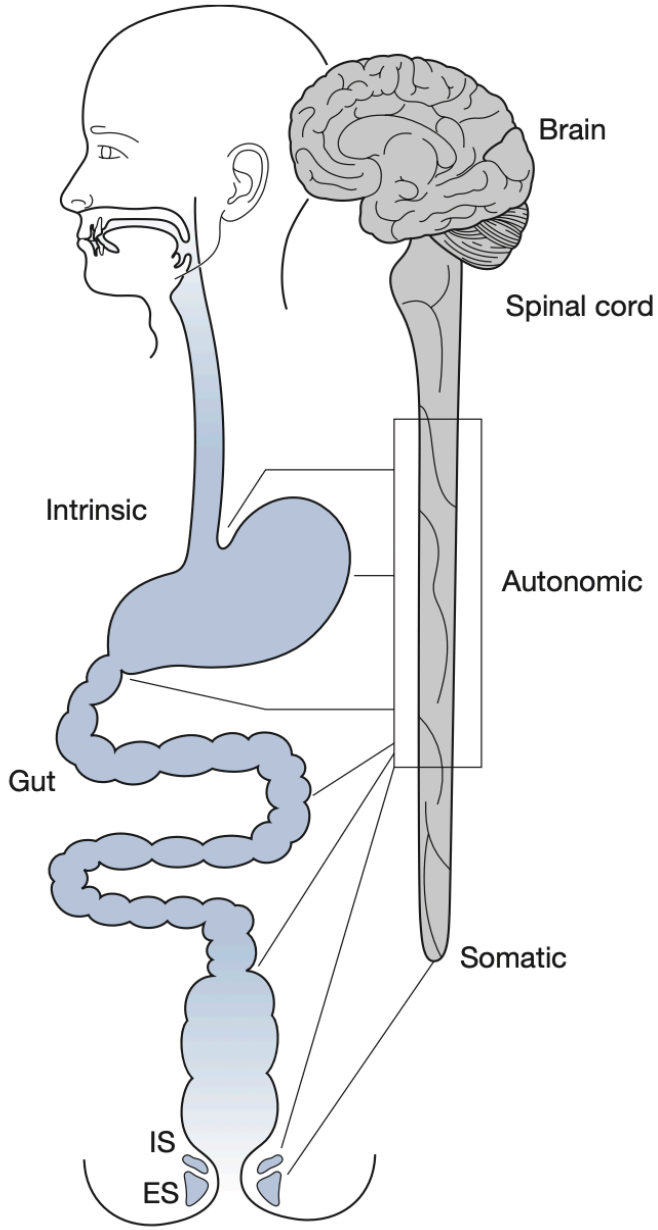
Neurogenic Bowel

Gastrointestinal function

- Coordinated by the somatic, autonomic, and enteric nervous systems

Goals of bowel program

- Regular
- Consistent
- Complete
- Timely



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Neurogenic Bowel – UMN vs. LMN

Upper Motor Neuron

- Brain disease and spinal cord disorders usually T12 and above
- Spastic/increased muscle tone
- Defecatory reflex intact

Lower Motor Neuron

- Spinal cord disorders usually T12 and below (conus, cauda equina) and polyneuropathy
- Flaccid muscle tone
- Diminished or areflexic spinal arc

- Damage to the conus medullaris (terminal portion of the spinal cord) often presents with mixed UMN and LMN due to damage to the anterior horn cells of the sacral segments and exiting peripheral sacral nerves.

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Neurogenic Bowel Management

Upper Motor Neuron

- Keep stool soft and formed
- Suppository or enema + digital rectal stimulation
- Stimulants and stool softeners PRN

Lower Motor Neuron

- Keep stool firm, but not hard
- Fiber for bulking
- Manual removal or large volume enemas

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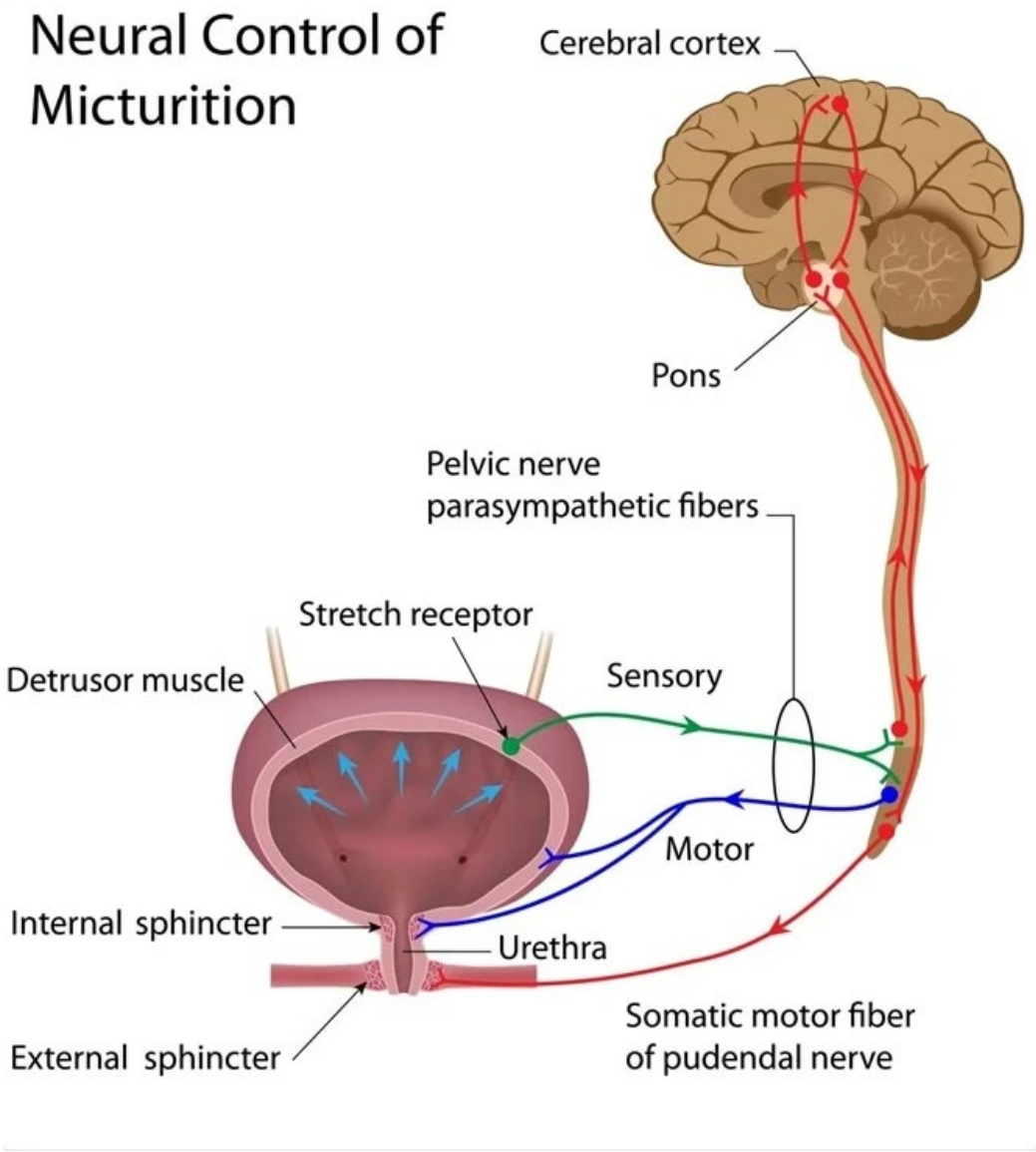
Neurogenic Bladder

Control of voiding

- Coordinated by the pontine micturition center, parasympathetic and somatic nervous systems

Goals of bladder management

- Empty no more than q4h
- Continence
- Reduce risk of UTI and other complications



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Neurogenic Bladder

SCI

- Flaccid vs. Spastic bladder
- Urinary retention and/or incontinences

TBI

- Loss of cortical control and frequently see incontinences due to hyperactive bladder with uninhibited detrusor reflex
- Less commonly urinary retention

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Neurogenic Bladder Management

SCI

- Foley vs. Intermittent straight catheterization
  - Intermittent catheterization generally feasible only if daily UOP <2L
  - Post void residual/bladder scans <500ml
  - CAUTION with TOV... might see "voiding" which is actually urinary retention with overflow incontinence
- Bladder spasms
  - Oral Medications
  - Botox injections

TBI

- Timed voiding schedule
- Bladder spasms
  - Oral Medications
  - Botox injections

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Hypertonia (increased muscle tone)

Spasticity

- Velocity-dependent increase in muscle tone

Rigidity

- Resistance to passive stretch throughout range of motion

When to treat

- Pain
- Interference with sleep
- Hygiene considerations
- Transfers/care issues
- Concern for contracture development

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Spasticity Treatments

Centrally Acting

- Baclofen (GABA-B agonist)
- Diazepam (GABA-A agonist)
- Tizanidine (Alpha-2 agonist)

Peripherally Acting

- Dantrolene (inhibits release of calcium in sarcoplasmic reticulum)

Injections/Interventional

- Botox (inhibits release of presynaptic acetylcholine)
- Phenol (denatures nerves)
- Intrathecal Baclofen Pump

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4349402/

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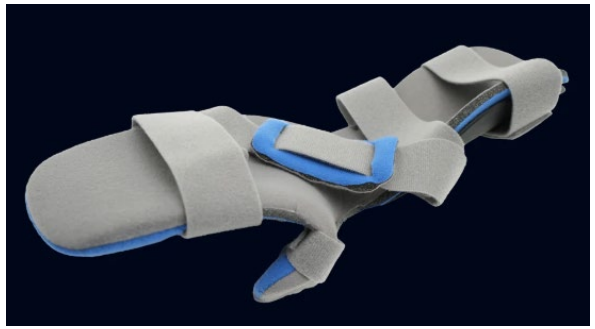
Contracture Prevention

First line

- ROM and stretching



Additional considerations

- Lower extremity weakness – recommend posterior resting foot orthosis (PRAFO)
- Upper extremity weakness – recommend hand and wrist splint

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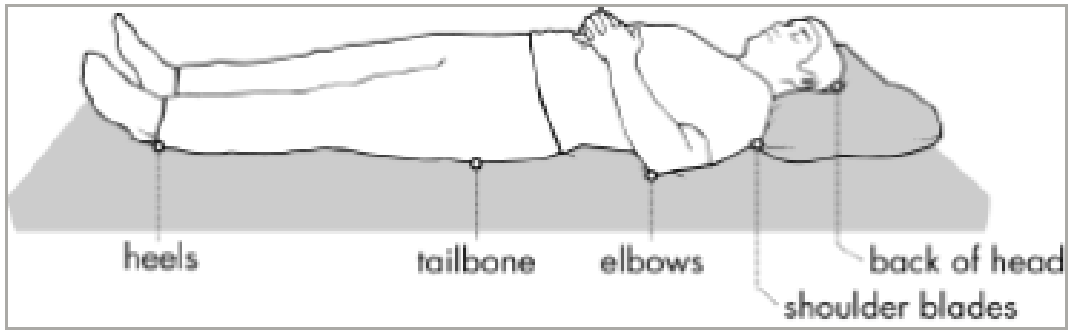
Pressure Injury Prevention

- q2h turns in bed
- When in wheelchair, q15-30 minute pressure reliefs
- Alternating pressure air mattress if appropriate
- Frequent skin checks at bony prominences and under splints/braces or lines/drains/airway



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Orthostatic Hypotension

First line

- TEDs
- Abdominal binder
- Hydration

Medications

- Midodrine
- Fludrocortisone

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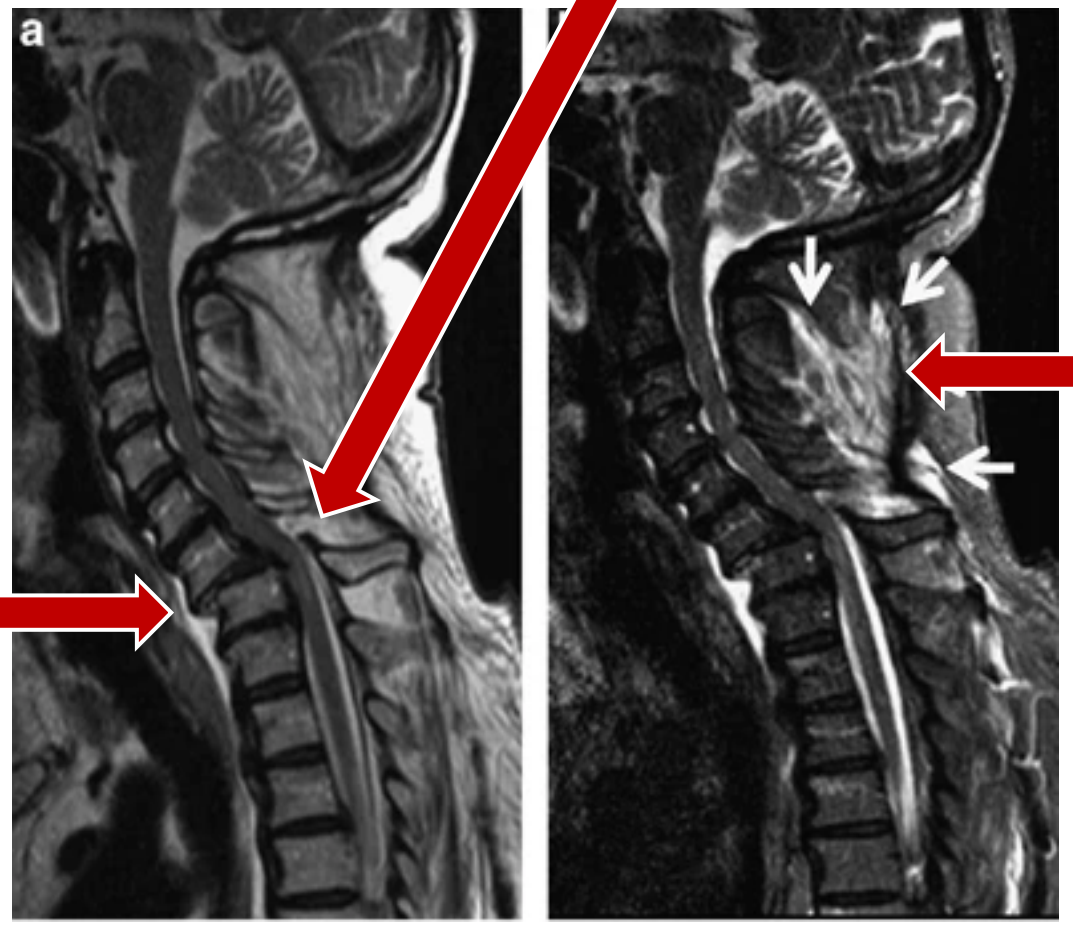
Psychological Issues

- PTSD
- Anxiety
- Depression

- Medications take time for effectiveness
- Untreated can impede recovery and functional outcomes

SCI Specific Considerations

Spinal cord compression



Soft tissue and ligamentous injury

Bilateral facet dislocation

Chandra, J., Sheerin, F., Lopez de Heredia, L. *et al*. MRI in acute and subacute post-traumatic spinal cord injury: pictorial review. *Spinal Cord* **50**, 2–7 (2012). https://doi.org/10.1038/sc.2011.107

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Autonomic Dysreflexia

Definition

Dysregulation of the autonomic nervous system leads to unopposed sympathetic response due to a noxious stimulus below the level of the spinal cord injury.

- NLI T6 or above (some reports as caudal at T10)

Symptoms/signs may include:

- Flushing/sweating/goosebumps above NLI, pale/cool skin below NLI, nasal congestion, headache, bradycardia
- May have none of these except…

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Autonomic Dysreflexia

- Hypertension (sudden onset)
  - Defining feature SBP>150 or 20-40mmHg above baseline (NOTE that typically after SCI resting blood pressure is lower)
  - Can lead to stroke, cardiac arrest, seizure, death

Management

- Most common causes include bladder >>> bowel > skin
- Sit patient up, remove tight clothing, check bladder, bowels, skin
- If persistent HTN, then Nitro paste above NLI
- IV antihypertensives if unable to control blood pressure

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VTE Prophylaxis

DVT and PE in the acute phase (within 3 months of injury)

- Numbers vary widely based on study
  - DVT incidence 10-100%
  - PE incidence 5-10%

- Recommendations:
  - Duration of prophylaxis of at least 8 weeks for all SCI, consider 12 weeks for polytrauma, comorbidities
  - LMWH (Lovenox), DOACs may be considered
  - No evidence for routine use of IVC filter

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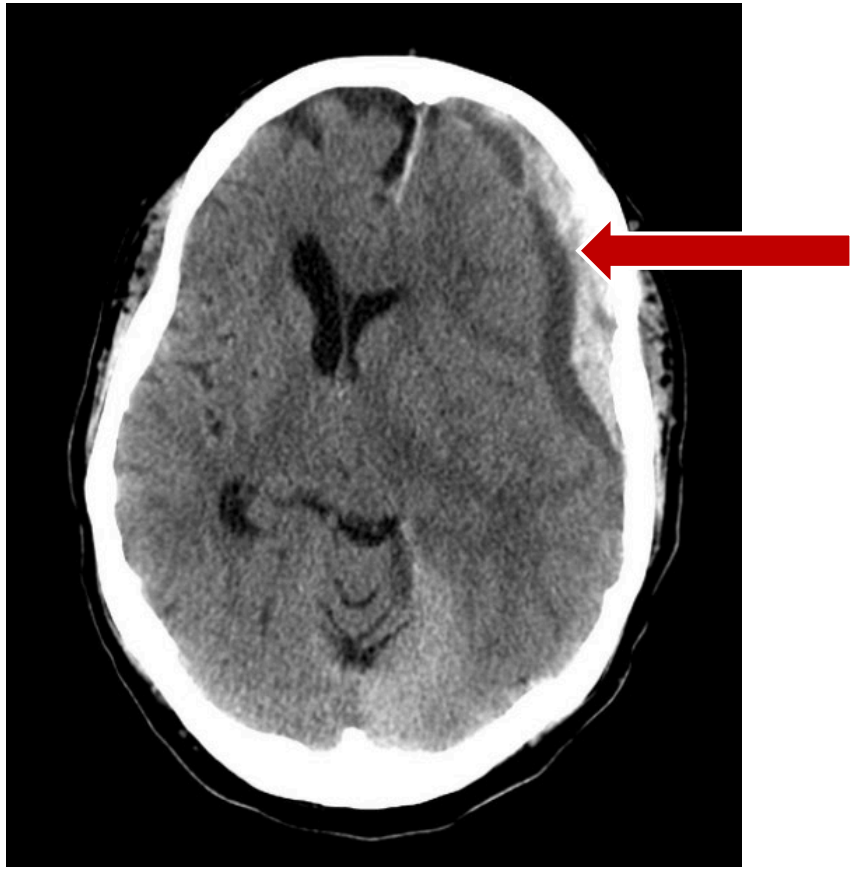
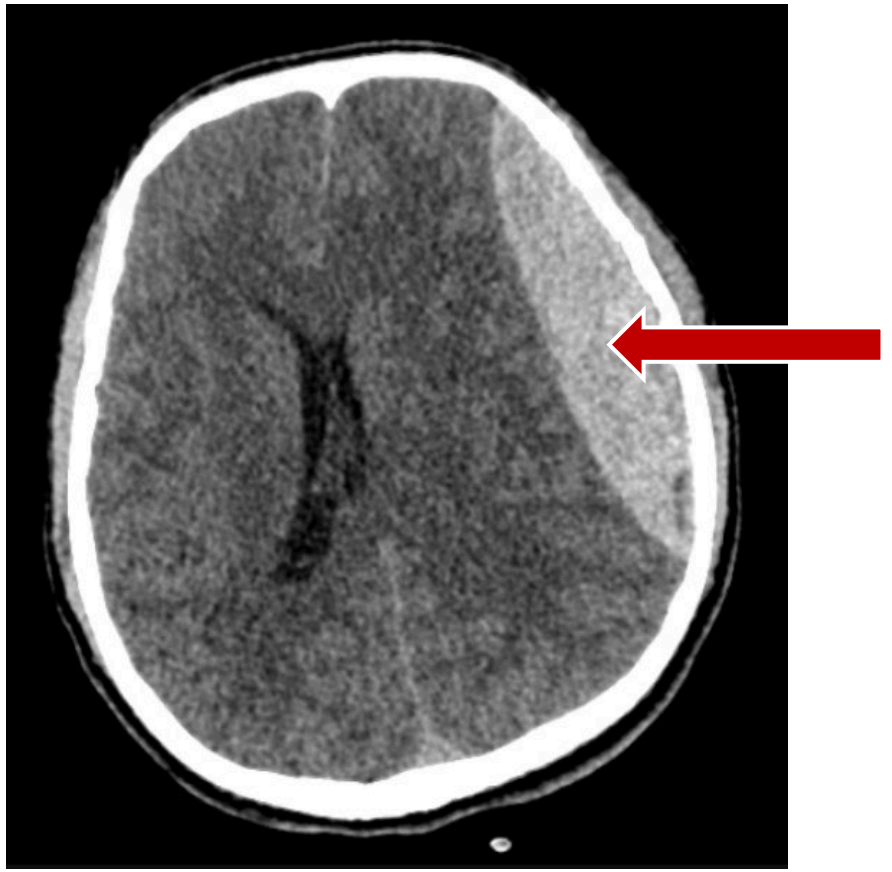
TBI Specific Considerations



Subdural hemorrhage



Epidural hemorrhage

https://radiopaedia.org/articles/extradural-haematoma-vs-subdural-haematoma?lang=us

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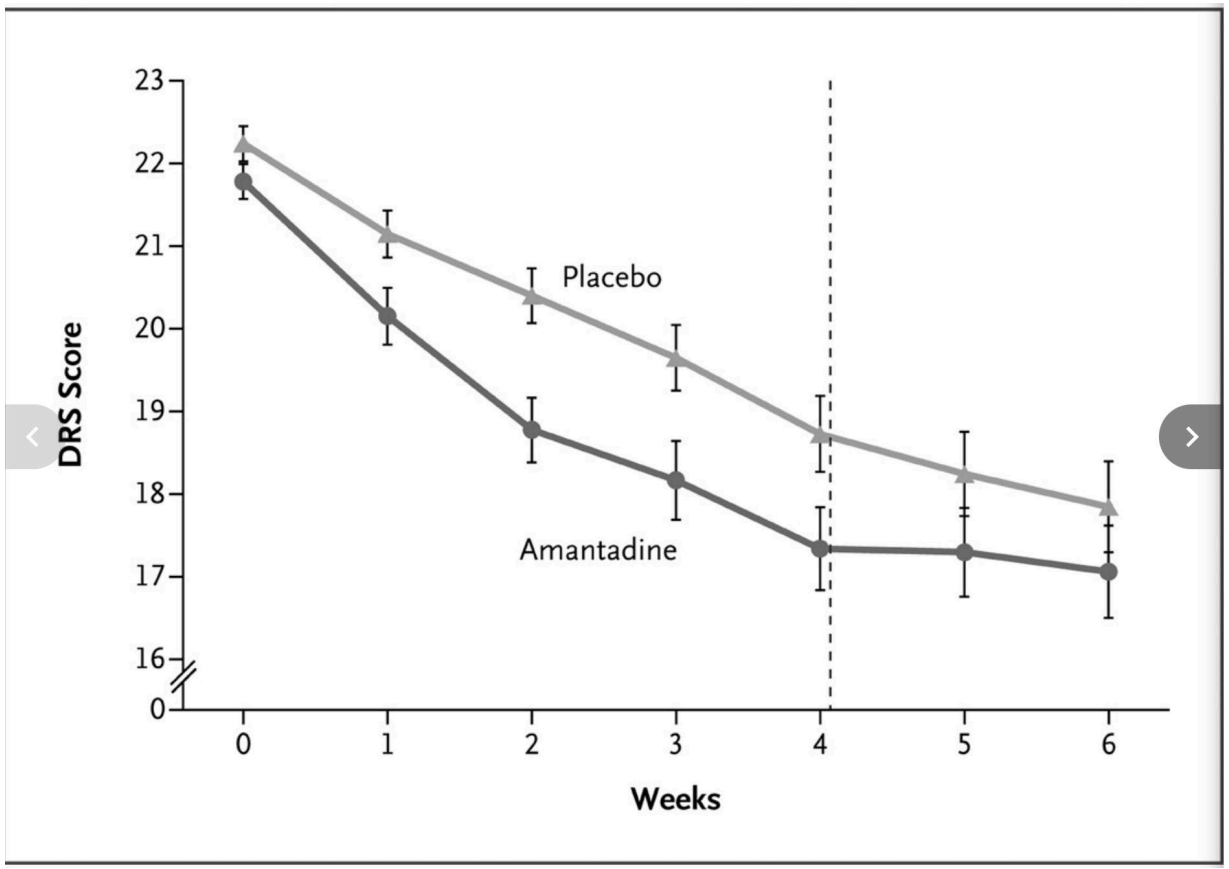
Disorders of Consciousness

Neurostimulation for emerging consciousness

- Amantadine
- Ritalin
- Modafinil

- Dose BID at ~8am and 12pm
- Can interfere with sleep if given later in the day… they are stimulants!



Placebo-Controlled Trial of Amantadine for Severe Traumatic Brain Injury. **Authors**: Joseph T. Giacino, Ph.D., et al. **Published March 1, 2012. N Engl J Med 2012;366:819-826. DOI: 10.1056/NEJMoa1102609. VOL. 366 NO.**

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Agitation

Avoid if possible… as they may impair neurocognitive recovery

- Haldol (and other typical antipsychotics)
- Benzodiazepines

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Agitated Behavior Scale

1 = absent: the behavior is not present.
2 = present to a slight degree: the behavior is present but does not prevent the conduct of other, contextually appropriate behavior. (The individual may redirect spontaneously, or the continuation of the agitated behavior does not disrupt appropriate behavior.)
3 = present to a moderate degree: the individual needs to be redirected from an agitated to an appropriate behavior, but benefits from such cueing.
4 = present to an extreme degree: the individual is not able to engage in appropriate behavior due to the interference of the agitated behavior, even when external cueing or redirection is provided.

DO NOT LEAVE BLANKS.

_____ 1. Short attention span, easy distractibility, inability to concentrate.
_____ 2. Impulsive, impatient, low tolerance for pain or frustration.
_____ 3. Uncooperative, resistant to care, demanding.
_____ 4. Violent and or threatening violence toward people or property.
_____ 5. Explosive and/or unpredictable anger.
_____ 6. Rocking, rubbing, moaning or other self-stimulating behavior.
_____ 7. Pulling at tubes, restraints, etc.
_____ 8. Wandering from treatment areas.
_____ 9. Restlessness, pacing, excessive movement.
_____ 10. Repetitive behaviors, motor and/or verbal.
_____ 11. Rapid, loud or excessive talking.
_____ 12. Sudden changes of mood.
_____ 13. Easily initiated or excessive crying and/or laughter.
_____ 14. Self-abusiveness, physical and/or verbal.

_____ **Total Score**

Scoring

21 or below: Normal behavior
22–28: Mild agitation
29–35: Moderate agitation
36–56: Severe agitation

https://www.sralab.org/rehabilitation-measures/agitated-behavior-scale

Agitation Management

Identify Triggers

- LDA, pain, bowel/bladder incontinences, overstimulation

First Line

- Environmental

Medication management

- Propranolol (lipophilic beta-blocker)
- Seroquel, Zyprexa (Atypical antipsychotics)
- Depakote

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Paroxysmal Sympathetic Hyperactivity
(Storming, dysautonomia)

Definition

- Hypertension, Tachycardia, Hyperthermia, Spasticity, Perspiration
  - Resulting from a surge in catecholamines
  - Typically seen during first two weeks of injury
  - Triggers?
- Need to rule out infection, DVT/PE, etc.

Management depends on manifestations and triggers

  - Lipophilic beta blockers, Dantrolene, cooling blankets, Benzodiazepines, Opiates, Amantadine, Gabapentin, Clonidine

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Questions?

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Thank You