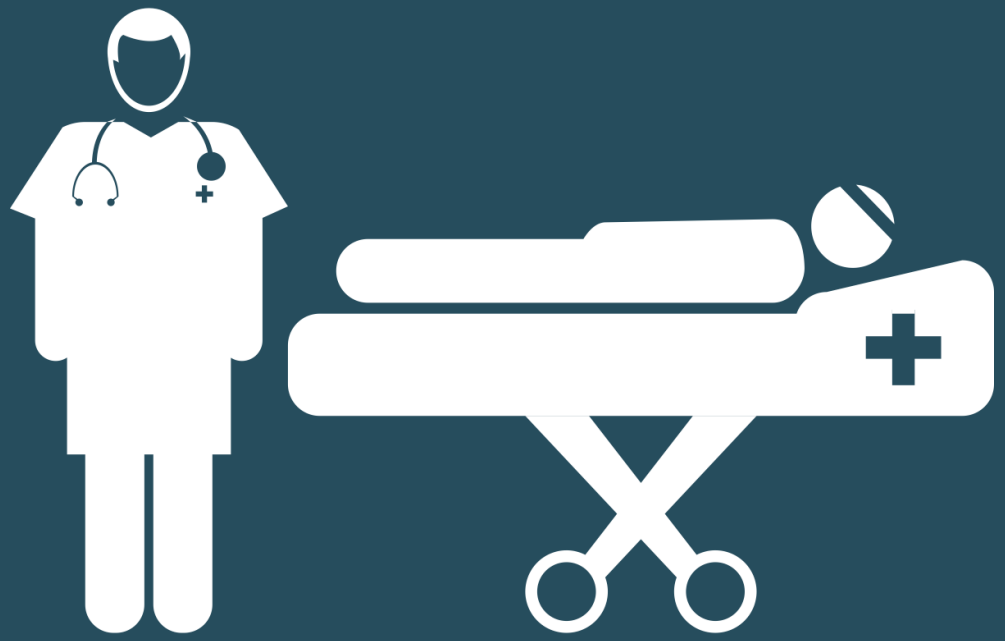
10th Edition Update

ATLS®

Advanced Trauma Life Support



Initial Assessment

Initial Assessment

- 1 litre of fluid, judicious approach
- Focus on massive transfusion protocols
- Tranexamic acid
- Coagulopathy
- Canadian C Spine Rule
- Trauma team

One liter of fluid, judicious approach

A bolus of isotonic solution **1 L for adults** and **20 mL/kg for pediatric < 40 kg** may be administered judiciously, as aggressive resuscitation before control of bleeding has been demonstrated to increase mortality and morbidity.

If a patient is unresponsive to initial crystalloid therapy, he should receive a blood transfusion.

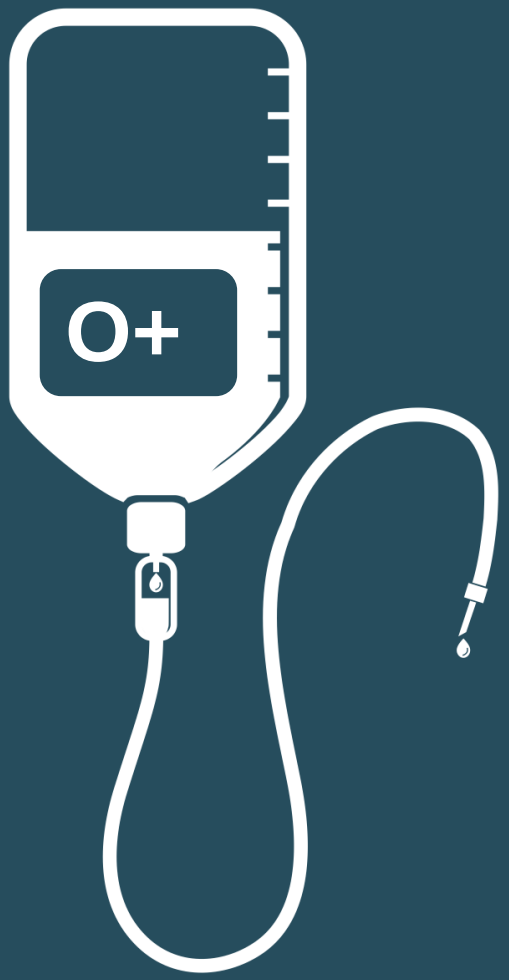
Aggressive and continued volume resuscitation is not a substitute for definitive control of hemorrhage.

Airway and Ventilation

Airway and Ventilation

- **RSI changed to Drug Assisted Intubation**
- **Video-laryngoscopy**
- **Trauma team**

Shock



Shock

- Class of haemorrhage table amended: Base excess
- Early use of blood and blood products
- Management of coagulopathy
- Tranexamic acid
- Trauma team

ATLS classification of hypovolemic shock

TABLE 3-1 SIGNS AND SYMPTOMS OF HEMORRHAGE BY CLASS

PARAMETER	CLASS I	CLASS II (MILD)	CLASS III (MODERATE)	CLASS IV (SEVERE)
Approximate blood loss	<15%	15–30%	31–40%	>40%
Heart rate	↔	↔/↑	↑	↑/↑↑
Blood pressure	↔	↔	↔/↓	↓
Pulse pressure	↔	↓	↓	↓
Respiratory rate	↔	↔	↔/↑	↑
Urine output	↔	↔	↓	↓↓
Glasgow Coma Scale score	↔	↔	↓	↓
Base deficit*	0 to –2 mEq/L	–2 to –6 mEq/L	–6 to –10 mEq/L	–10 mEq/L or less
Need for blood products	Monitor	Possible	Yes	Massive Transfusion

Early use of blood and blood products

Early resuscitation with blood and blood products must be considered in patients with evidence of class III and IV hemorrhage.

Early administration of blood products at a low ratio of packed red blood cells to plasma and platelets can prevent the development of coagulopathy and thrombocytopenia.

Management of coagulopathy

Uncontrolled blood loss can occur in patients taking antiplatelet or anticoagulant medications.

Prevention

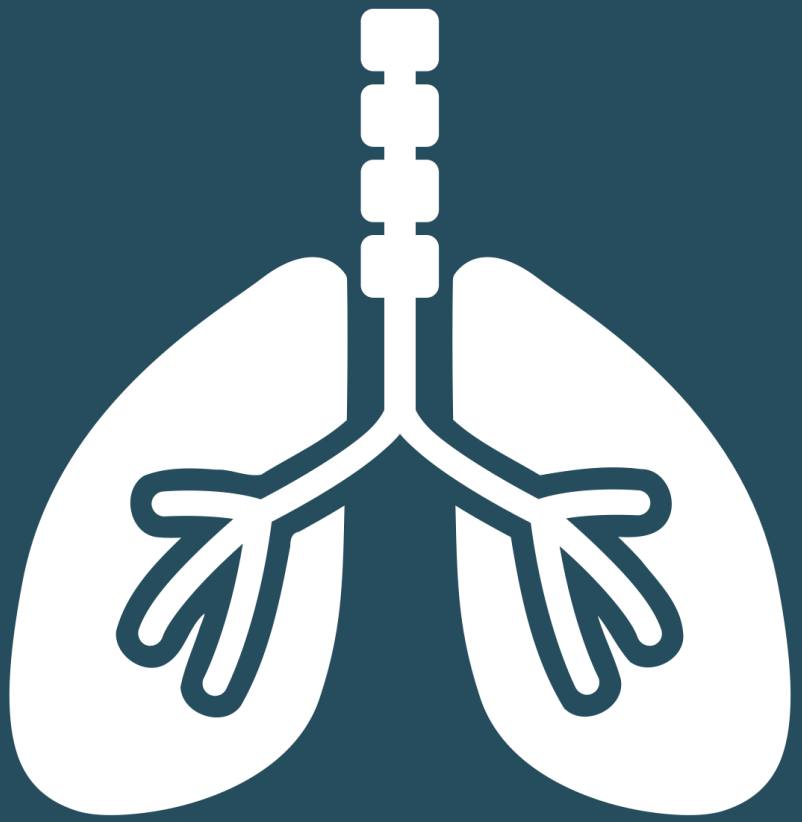
- Obtain medication list as soon as possible.
- Administer reversal agents as soon as possible.
- Where available, monitor coagulation with thromboelastography (TEG) or rotational thromboelastometry (ROTEM).
- Consider administering platelet transfusion, even with normal platelet count.

Tranexamic acid (TXA)

European and American military studies demonstrate improved survival when **TXA** is administered **over 10 minutes within 3 hours of injury**.

When bolused in the field, follow up **infusion TAX 1 gram over 8 hours** in the hospital.

Thoracic Trauma



Thoracic Trauma

- **Life Threatening Injuries**
  - Flail chest out
  - Tracheobronchial injury now in
- **Tension pneumothorax**
  - Needle thoracocentesis
    - 5th ICS MAL for adult
    - UNCHANGED 2nd ICS for child
  - 28-32 Fr chest drain for hemothorax (not 36-40 Fr)
- **Algorithm for circulatory arrest approach**
- **Aortic rupture management with Beta Blocker**
- **Trauma team**

Life-threatening injuries during primary survey

Airway

- Airway Obstruction
- Tracheobronchial Tree Injury

Breathing

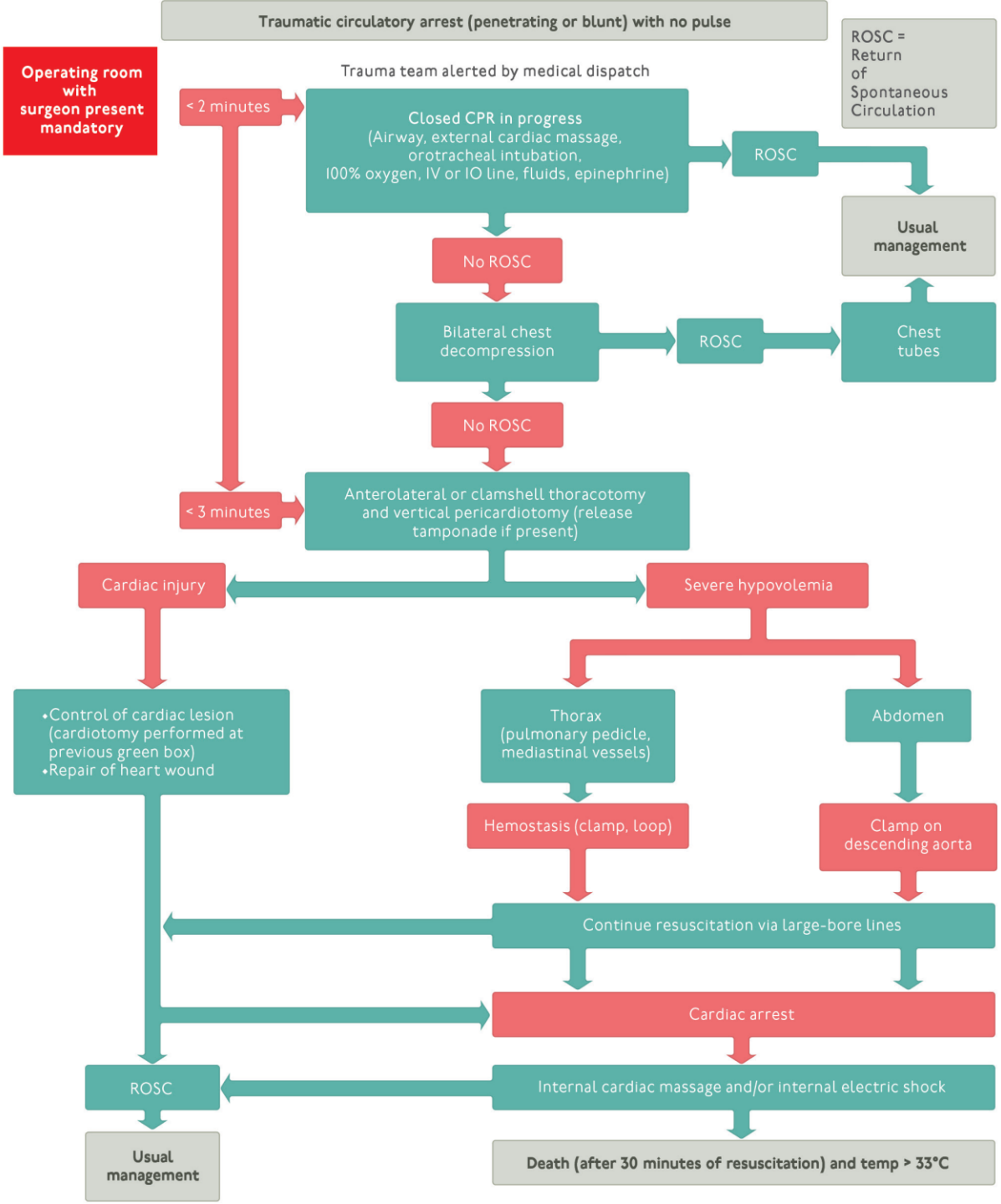
- Tension Pneumothorax
- Open Pneumothorax

Circulation

- Massive Hemothorax
- Cardiac Tamponade
- Traumatic Circulatory Arrest

Tension pneumothorax

- When ultrasound is available, tension pneumothorax can be diagnosed using an **extended FAST (eFAST):** seashore, bar code, or stratosphere sign in M mode.
- **Needle decompression**:
  Recent evidence supports placing the large, over-the-needle catheter at the fifth interspace, slightly anterior to the midaxillary line
- 28-32 Fr chest tube for hemothorax (not 36-40Fr)



Algorithm for management of traumatic circulatory arrest.

ECM = external cardiac massage;
OTI = orotracheal intubation;
IVL = intravenous line;
IOL = intraosseous line.

Aortic rupture management with beta blocker

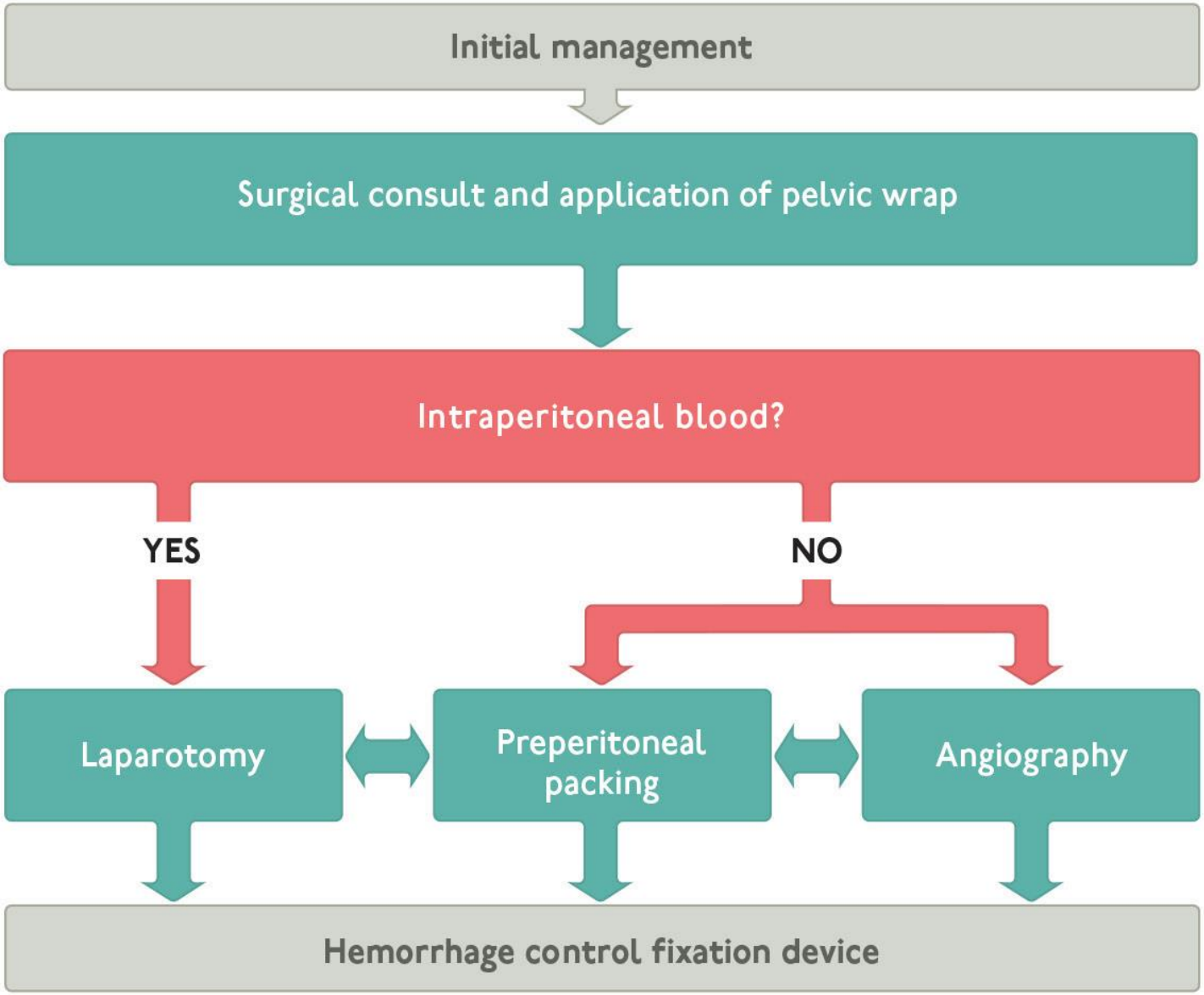
If no contraindications exist, heart rate control with a short-acting beta blocker (esmolol) to a **goal heart rate < 80 bpm** and blood pressure control with a **goal MAP 60-70 mmHg** is recommended.

Abdominal and Pelvic Trauma

Abdominal and Pelvic Trauma

- Palpation of prostate gland no longer recommended for urethral injury
- Flow chart for pelvic fracture with hemorrhage amended
- Trauma team

Pelvic fractures and hemorrhagic shock management algorithm



Head Trauma

Head Trauma

- Detailed guidance on SBP management
- Classification – ‘mild’ head trauma
- Anticoagulation reversal guidance
- Seizure prophylaxis
- Trauma team

Detailed guidance on SBP management

Maintain **SBP at ≥ 100 mmHg** for patients 50-69 years or at ≥ 110 mmHg for patients 15-49 years or older than 70 years; this may decrease mortality and improve outcomes (III).

Goals of treatment of brain injury

Clinical Parameters

- Systolic BP ≥ 100 mmHg
- Temperature 36–38°C

Monitoring Parameters

- CPP ≥ 60 mm Hg*
- ICP 5–15 mm Hg*
- $PbtO_2$ ≥ 15 mm Hg*
- Pulse oximetry ≥ 95%

Laboratory Parameters

- Glucose 80–180 mg/dL
- Hemoglobin ≥ 7 g/dl
- INR ≤ 1.4
- Na 135–145 meq/dL
- PaO_2 ≥ 100 mmHg
- $PaCO_2$ 35–45 mmHg
- pH 7.35–7.45
- Platelets ≥ 75 $X10^3/mm^3$

*Unlikely to be available in the ED or in low-resource settings

Data from ACS TQIP Best Practices in the Management of Traumatic Brain Injury. ACS Committee on Trauma, January 2015.

Anticoagulation reversal guidance

TABLE 6-6 ANTICOAGULATION REVERSAL

ANTICOAGULANT	TREATMENT	COMMENTS
Antiplatelets (e.g., aspirin, plavix)	Platelets	May need to repeat; consider desmopressin acetate (Deamino-Delta-D-Arginine Vasopressin)
Coumadin (warfarin)	FFP, Vitamin K, prothrombin complex concentrate (Kcentra), Factor VIIa	Normalize INR; avoid fluid overload in elderly patients and patients who sustained cardiac injury
Heparin	Protamine sulfate	Monitor PTT
Low molecular weight heparin, e.g., Lovenox (enoxaparin)	Protamine sulfate	N/A
Direct thrombin inhibitors dabigatran etexilate (Pradaxa)	idarucizumab (Praxbind)	May benefit from prothrombin complex concentrate (e.g., Kcentra)
Xarelto (rivaroxaban)	N/A	May benefit from prothrombin complex concentrate (e.g., Kcentra)

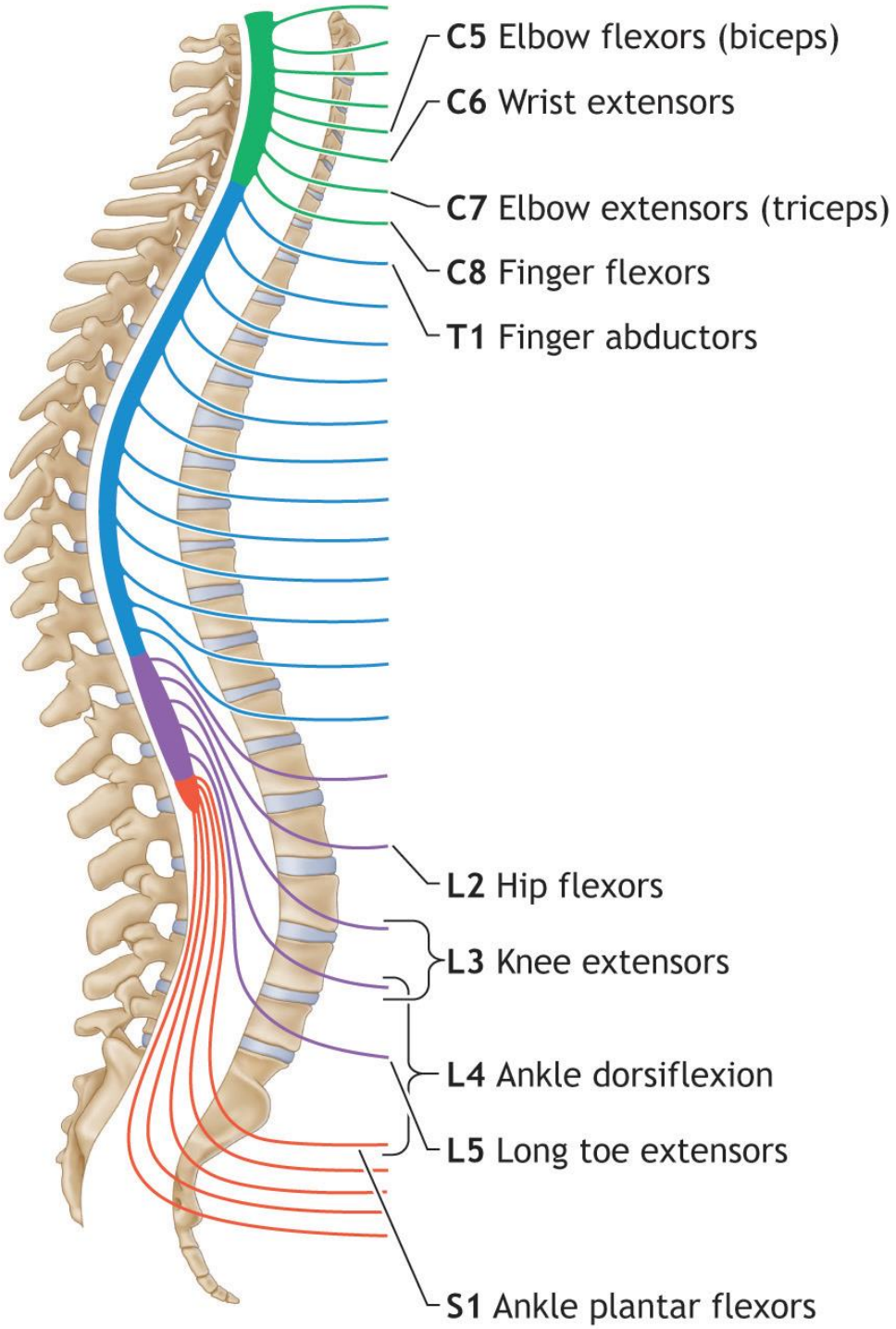
Seizure prophylaxis

Prophylactic use of phenytoin (Dilantin) or valproate (Depakote) is not recommended for preventing late posttraumatic seizures (PTS). Phenytoin is recommended to decrease the incidence of early PTS (within 7 days of injury), when the overall benefit is felt to outweigh the complications associated with such treatment. However, early PTS has not been associated with worse outcomes (IIA).

Spine and Spinal Cord Trauma

Spine and Spinal Cord Trauma

- C-spine protection changed to ‘Restriction of spinal motion’
- New myotome diagram
- Canadian C-Spine Rule (CCR) and NEXUS Criteria
- Trauma team



Key Myotomes. Myotomes are used to evaluate the level of motor function

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

ASIA American Spinal Injury Association — ISCOS International Spinal Cord Society

Patient Name _____ Date/Time of Exam _____

Examiner Name _____ Signature _____

RIGHT

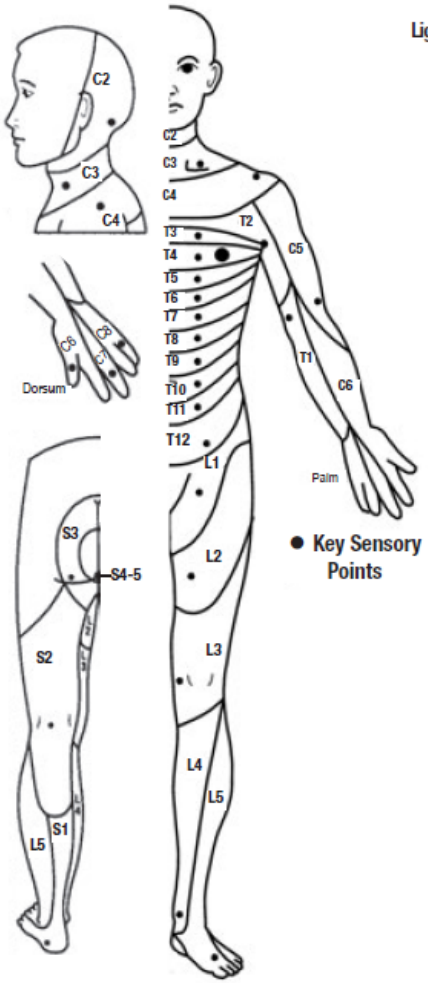
MOTOR KEY MUSCLES		SENSORY KEY SENSORY POINTS Light Touch (LTR)	Pin Prick (PPR)
	C2		
	C3		
	C4		
Elbow flexors	C5		
Wrist extensors	C6		
Elbow extensors	C7		
Finger flexors	C8		
Finger abductors (little finger)	T1		
	T2		
	T3		
	T4		
	T5		
	T6		
	T7		
	T8		
	T9		
	T10		
	T11		
	T12		
	L1		
Hip flexors	L2		
Knee extensors	L3		
Ankle dorsiflexors	L4		
Long toe extensors	L5		
Ankle plantar flexors	S1		
	S2		
	S3		
	S4-5		
RIGHT TOTALS (MAXIMUM)		(50)	(56) (56)

UER (Upper Extremity Right)

LER (Lower Extremity Right)

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

(VAC) Voluntary Anal Contraction (Yes/No) ☐



● Key Sensory Points

LEFT

SENSORY KEY SENSORY POINTS Light Touch (LTL)	Pin Prick (PPL)	MOTOR KEY MUSCLES	
			C2
			C3
			C4
		C5	Elbow flexors
		C6	Wrist extensors
		C7	Elbow extensors
		C8	Finger flexors
		T1	Finger abductors (little finger)
			T2
			T3
			T4
			T5
			T6
			T7
			T8
			T9
			T10
			T11
			T12
			L1
		L2	Hip flexors
		L3	Knee extensors
		L4	Ankle dorsiflexors
		L5	Long toe extensors
		S1	Ankle plantar flexors
			S2
			S3
			S4-5
(56)	(56)	(50)	LEFT TOTALS (MAXIMUM)

UEL (Upper Extremity Left)

LEL (Lower Extremity Left)

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
5* = normal corrected for pain/disuse
NT = not testable

SENSORY *(SCORING ON REVERSE SIDE)*

0 = absent
1 = altered
2 = normal
NT = not testable

(DAP) Deep Anal Pressure (Yes/No) ☐

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 1-5 for classification as on reverse

	R	L
1. SENSORY	☐	☐
2. MOTOR	☐	☐

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

	R	L
SENSORY	☐	☐
MOTOR	☐	☐

REV 11/15

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 ROM)

Sensory Grading

0 = Absent

1 = Altered, either decreased/impaired sensation or hypersensitivity

2 = Normal

NT = Not testable

When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
Shoulder: Flexion, extension, abduction, adduction, internal and external rotation **Elbow:** Supination	C5
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 **Knee:** Flexion **Ankle:** Inversion and eversion **Toe:** MP and IP extension	L4
Hallux and Toe: DIP and PIP 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 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-S5) 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.

ASIA
AMERICAN SPINAL INJURY ASSOCIATION

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCOS
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?

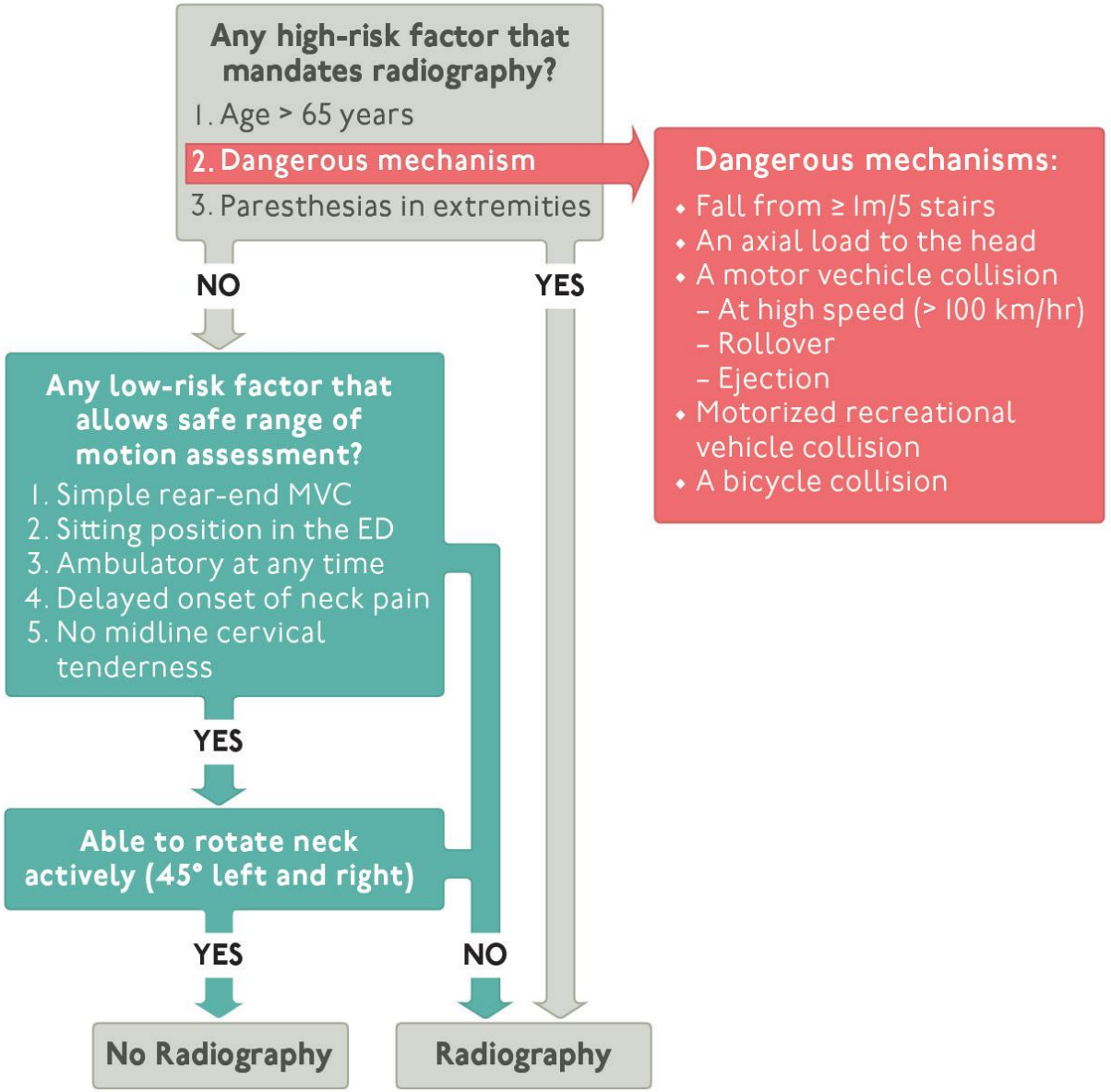
NO ↓ **AIS=C**

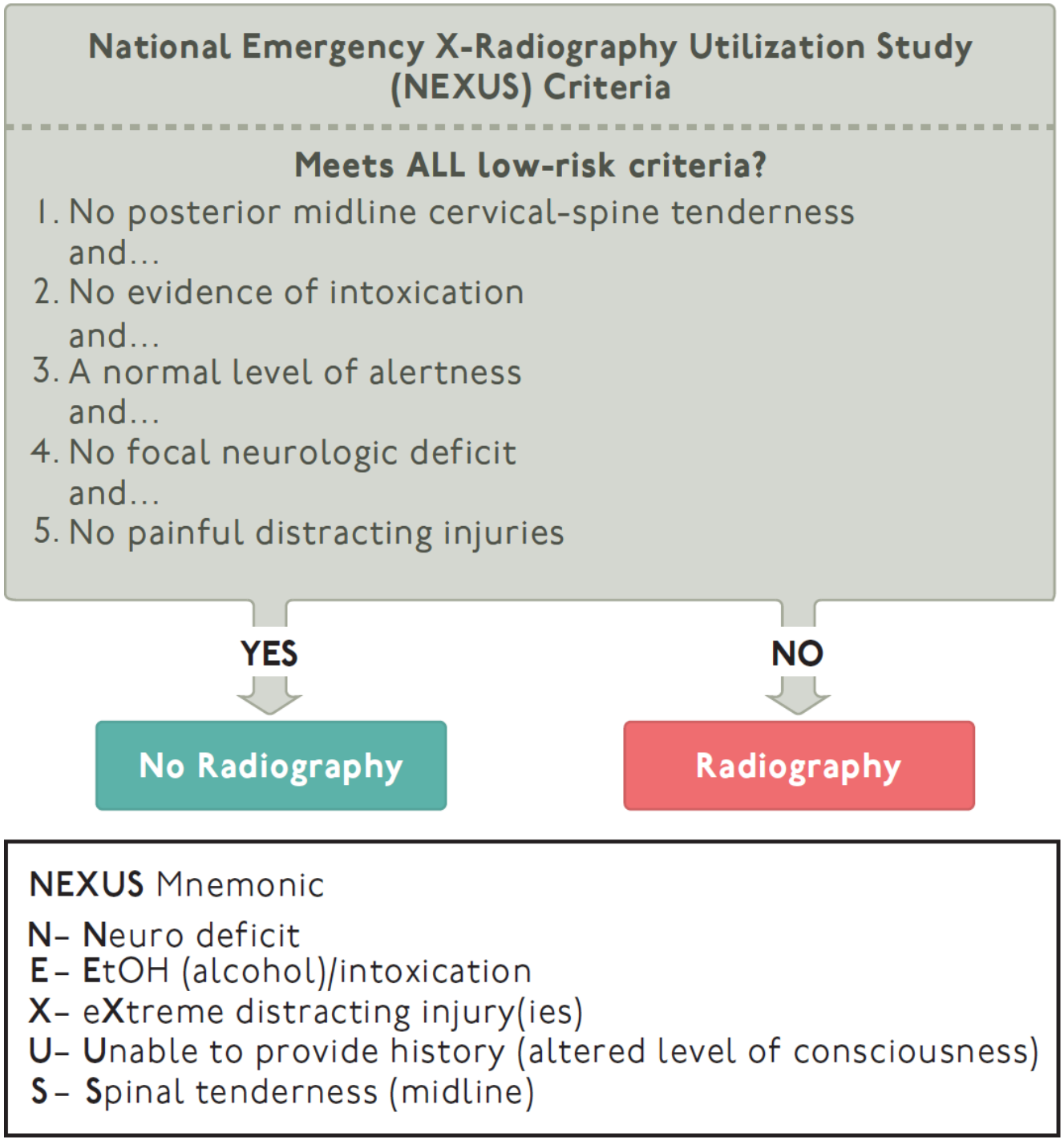
YES ↓ **AIS=D**

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.

Canadian C-spine Rule (CCR)

For alert (GCS score =15) and stable trauma patients in whom cervical spine injury is a concern:




National Emergency X-Radiography Utilization Study (NEXUS) Criteria
Meets ALL low-risk criteria?
1. No posterior midline cervical-spine tenderness
and...
2. No evidence of intoxication
and...
3. A normal level of alertness
and...
4. No focal neurologic deficit
and...
5. No painful distracting injuries
YES
NO
No Radiography
Radiography
NEXUS Mnemonic
N– Neuro deficit
E– EtOH (alcohol)/intoxication
X– eXtreme distracting injury(ies)
U– Unable to provide history (altered level of consciousness)
S– Spinal tenderness (midline)

Musculo-Skeletal Trauma

Musculoskeletal Trauma

- Weight based IV antibiotic regime
- Highlighting risk factor of bilateral femur fractures
- Trauma team

Highlighting risk factor of bilateral femur fractures

Compared with patients with unilateral femur fractures, patients with bilateral femur fractures are at higher risk for significant blood loss, severe associated injuries, pulmonary complications, multiple organ failure, and death.

TABLE 8-2 INTRAVENOUS ANTIBIOTIC WEIGHT-BASED DOSING GUIDELINES

OPEN FRACTURES	FIRST-GENERATION CEPHALOSPORINS (GRAM-POSITIVE COVERAGE) CEFAZOLIN	IF ANAPHYLACTIC PENICILLIN ALLERGY (INSTEAD OF FIRST-GENERATION CEPHALOSPORIN) CLINDAMYCIN	AMINOGLYCOCIDE (GRAM-NEGATIVE COVERAGE) GENTAMICIN	PIPERACILLIN/ TAZOBACTAM (BROAD-SPECTRUM GRAM-POSITIVE AND NEGATIVE COVERAGE)
Wound <1 cm; minimal contamination or soft tissue damage	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr		
Wound 1–10 cm; moderate soft tissue damage; comminution of fracture	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr		
Severe soft-tissue damage and substantial contamination with associated vascular injury	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr	Loading dose in ER: 2.5 mg/kg for child (or <50 kg) 5 mg/kg for adult (i.e., 150-lb pt = 340 mg)	
Farmyard, soil or standing water, irrespective of wound size or severity				3.375 gm Q 6 hr (<100 kg) 4.5 gm Q 6 hr (>100 kg) **If anaphylactic penicillin allergy consult Infectious Disease Department or Pharmacy

Thermal Injuries

Thermal Injuries

- 2 ml/kg × weight × % burn adults
- 3 ml/kg × weight × % burn children
- Fluid titrated to urine output
- Trauma team

TABLE 9-1 BURN RESUSCITATION FLUID RATES AND TARGET URINE OUTPUT BY BURN TYPE AND AGE

CATEGORY OF BURN	AGE AND WEIGHT	ADJUSTED FLUID RATES	URINE OUTPUT
Flame or Scald	Adults and older children (≥14 years old)	2 ml LR x kg x % TBSA	0.5 ml/kg/hr 30–50 ml/hr
	Children (<14 years old)	3 ml LR x kg x % TBSA	1 ml/kg/hr
	Infants and young children (≤30kg)	3 ml LR x kg x % TBSA Plus a sugar-containing solution at maintenance rate	1 ml/kg/hr
Electrical Injury	All ages	4 ml LR x kg x % TBSA until urine clears	1-1.5 ml/kg/hr until urine clears

LR, lactated Ringer's solution; TBSA, total body surface area

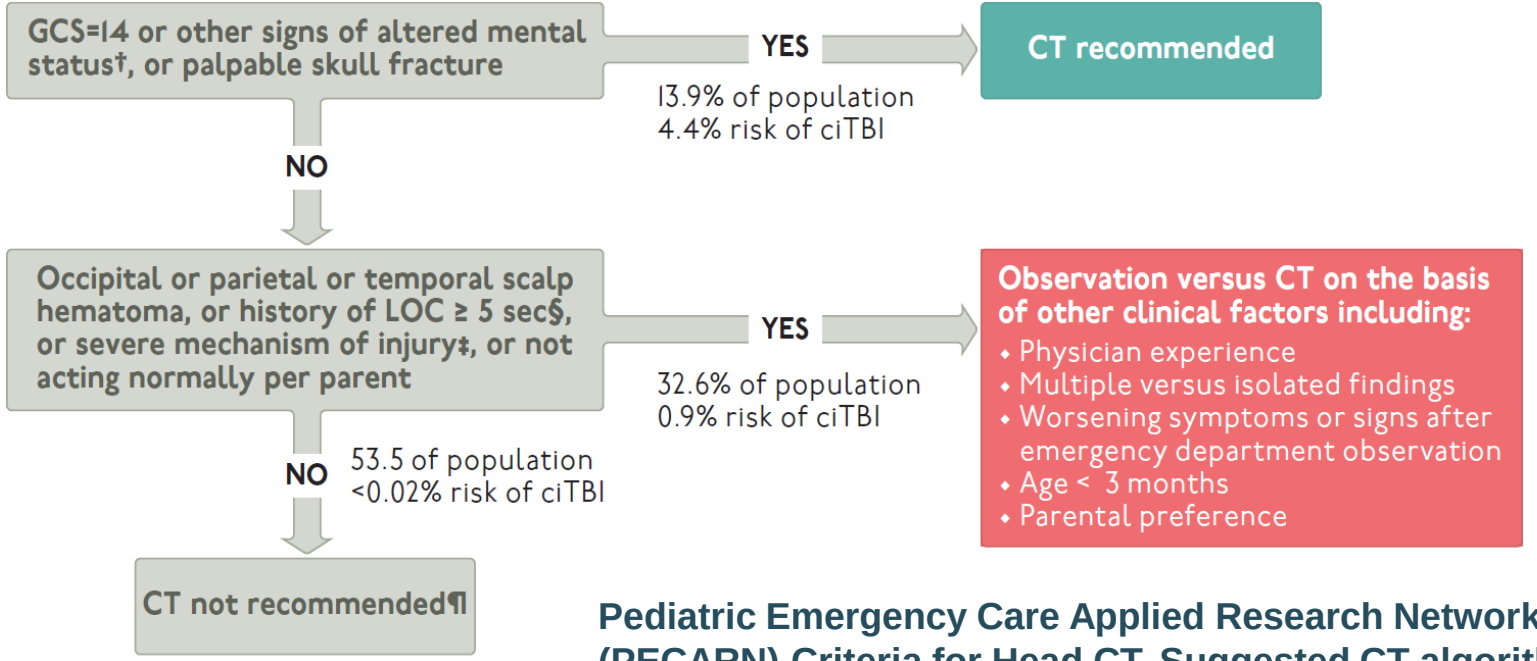
Paediatric Trauma

Paediatric Trauma

- **Needle thoracocentesis UNCHANGED 2nd ICS**
- **Limiting crystalloid resuscitation**
- **Pediatric Emergency Care Applied Research Network (PECARN) Criteria for Head CT**
- **Trauma team**

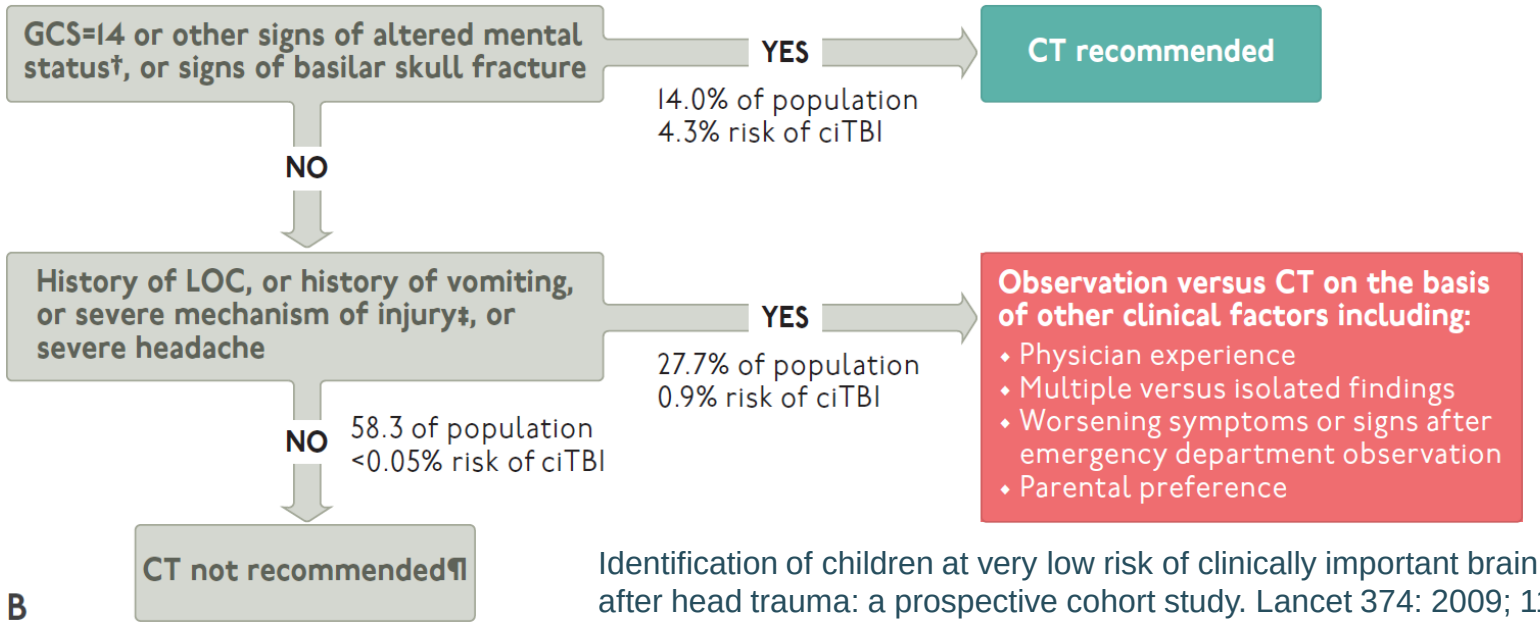
Pediatric Mass Transfusion Protocol

Initial 20 mL/kg bolus of isotonic crystalloid followed by weight-based blood product resuscitation with 10-20 mL/kg of RBC and 10-20 mL/kg of FFP and platelets.



A

Pediatric Emergency Care Applied Research Network (PECARN) Criteria for Head CT. Suggested CT algorithm for children younger than 2 years (A) and for those aged 2 years and older (B) with GCS scores of 14-15 after head trauma.*



B

Identification of children at very low risk of clinically important brain injuries after head trauma: a prospective cohort study. Lancet 374: 2009; 1160–1170.)

Transfer to Definitive Care

Transfer to Definitive Care

- **Specific mention of avoiding CT in primary hospital**
- **SBAR template for communication**
- **Trauma Team**

Avoiding CT in primary hospital

Do not perform diagnostic procedures (e.g., DPL or CT) that do not change the plan of care.

However, procedures that treat or stabilize an immediately life-threatening condition should be rapidly performed.

ABC-SBAR template for transfer of trauma patients

- **Airway**, **Breathing**, and **Circulation** problems identified and interventions performed
- **Situation**: patient name, age, referring facility, referring physician name, reporting nurse name, indication for transfer, IV access site, IV fluid and rate, other interventions completed
- **Background**: event history, AMPLE assessment, blood products, medications given (date and time), imaging performed, splinting
- **Assessment**: vital signs, pertinent physical exam findings, patient response to treatment
- **Recommendation**: transport mode, level of transport care, medication intervention during transport, needed assessments and interventions

Mobile eLearning

TENTH EDITION

1 INITIAL ASSESSMENT AND MANAGEMENT

ATLS®

Advanced Trauma Life Support®

American College of Surgeons

Inspiring Quality:
Highest Standards, Better Outcomes

100+years

ACS Committee on Trauma®

Other Monitoring Includes:

- Pulse rate
- Blood pressure
- Pulse pressure
- Ventilatory rate
- Oxygen saturation
- Arterial blood gas levels
- Body temperature
- Urinary output

Obtain actual values for these parameters as soon as possible during the primary survey, and then periodically reevaluate them.

Focused Assessment with Sonography for Trauma

Duration 1:56