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

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

Initial management

Surgical consult and application of pelvic wrap

Intraperitoneal blood?

YES

Laparotomy

NO

Preperitoneal packing

Angiography

Hemorrhage control fixation device
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

<table>
<thead>
<tr>
<th>Clinical Parameters</th>
<th>Laboratory Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP ≥ 100 mmHg</td>
<td>Glucose 80–180 mg/dL</td>
</tr>
<tr>
<td>Temperature 36–38°C</td>
<td>Hemoglobin ≥ 7 g/dl</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monitoring Parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CPP ≥ 60 mm Hg*</td>
<td>INR ≤ 1.4</td>
</tr>
<tr>
<td>ICP 5–15 mm Hg*</td>
<td>Na 135–145 meq/dL</td>
</tr>
<tr>
<td>PbtO₂ ≥ 15 mm Hg*</td>
<td>PaO₂ ≥ 100 mmHg</td>
</tr>
<tr>
<td>Pulse oximetry ≥ 95%</td>
<td>PaCO₂ 35–45 mmHg</td>
</tr>
<tr>
<td></td>
<td>pH 7.35–7.45</td>
</tr>
<tr>
<td></td>
<td>Platelets ≥ 75 X10³/mm³</td>
</tr>
</tbody>
</table>

*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>
<thead>
<tr>
<th>ANTICOAGULANT</th>
<th>TREATMENT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiplatelets (e.g., aspirin, plavix)</td>
<td>Platelets</td>
<td>May need to repeat; consider desmopressin acetate (Deamino-Delta-D-Arginine Vasopressin)</td>
</tr>
<tr>
<td>Coumadin (warfarin)</td>
<td>FFP, Vitamin K, prothrombin complex concentrate (Kcentra), Factor VIIa</td>
<td>Normalize INR; avoid fluid overload in elderly patients and patients who sustained cardiac injury</td>
</tr>
<tr>
<td>Heparin</td>
<td>Protamine sulfate</td>
<td>Monitor PTT</td>
</tr>
<tr>
<td>Low molecular weight heparin, e.g., Lovenox (enoxaparin)</td>
<td>Protamine sulfate</td>
<td>N/A</td>
</tr>
<tr>
<td>Direct thrombin inhibitors dabigatran etexilate (Pradaxa)</td>
<td>idarucizumab (Praxbind)</td>
<td>May benefit from prothrombin complex concentrate (e.g., Kcentra)</td>
</tr>
<tr>
<td>Xarelto (rivaroxaban)</td>
<td>N/A</td>
<td>May benefit from prothrombin complex concentrate (e.g., Kcentra)</td>
</tr>
</tbody>
</table>
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.
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
NT = not testable [i.e., due to immobility, 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 (differentiates between AIS B and C).

Movement

Shoulder: Flexion, extension, abduction, adduction, internal and external rotation
Elbow: Pronation
Wrist: Flexion
Finger: Flexion at proximal joint, extension
Thumbs: Flexion, extension and abduction in plane of thumb
Finger: Flexion at MCP joint
Thumbs: Opposition, adduction and abduction perpendicular to palm
Finger: Abduction of the index finger
Hip: Adduction
Hip: External rotation
Hip: Extension, abduction, internal rotation
Knee: Extension
Ankle: Inversion and eversion
Toe: MP and IP flexion
Hallux and Toe: DIP and PIP flexion and abduction
Hallux: Adduction

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 S4-5 by LT, PP or DAP), and has some sparing of motor function more than three levels below the bilateral 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 NL I have a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (or more) of key muscle functions below the single NL I having a muscle grade ≥ 3.

E = Normal. If sensation and motor function as tested with the ISNCSI 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.

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 (or 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.

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)

Is injury Motor Complete? If YES, AIS=B

Are at least 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:

Any high-risk factor that mandates radiography?
1. Age > 65 years
2. Dangerous mechanism
3. Paresthesias in extremities

NO

Any low-risk factor that allows safe range of motion assessment?
1. Simple rear-end MVC
2. Sitting position in the ED
3. Ambulatory at any time
4. Delayed onset of neck pain
5. No midline cervical tenderness

YES

Able to rotate neck actively (45° left and right)

YES

No Radiography

NO

Radiography

 Dangerous mechanisms:
- Fall from ≥ 1m/5 stairs
- An axial load to the head
- A motor vehicle collision
  - At high speed (> 100 km/hr)
  - Rollover
  - Ejection
- Motorized recreational vehicle collision
- A bicycle collision
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

---

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)

---

YES   NO

No Radiography  Radiography
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

<table>
<thead>
<tr>
<th>Description</th>
<th>First-Generation Cephalosporins (Gram-Positive Coverage)</th>
<th>If Anaphylactic Penicillin Allergy (Instead of First-Generation Cephalosporin) Clindamycin</th>
<th>Aminoglycoside (Gram-Negative Coverage)</th>
<th>Piperacillin/Tazobactam (Broad-Spectrum Gram-Positive and Negative Coverage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound &lt;1 cm; minimal contamination or soft tissue damage</td>
<td>&lt;50 kg: 1 gm Q 8 hr</td>
<td>&lt;80 kg: 600 mg Q 8 hr</td>
<td>Loading dose in ER:</td>
<td>3.375 gm Q 6 hr (&lt;100 kg)</td>
</tr>
<tr>
<td></td>
<td>50–100 kg: 2 gm Q 8 hr</td>
<td>&gt;80 kg: 900 mg Q 8 hr</td>
<td>4.5 gm Q 6 hr (&gt;100 kg)</td>
<td><strong>If anaphylactic penicillin allergy consult Infectious Disease Department or Pharmacy</strong></td>
</tr>
<tr>
<td>Wound 1–10 cm; moderate soft tissue damage; comminution of fracture</td>
<td>&lt;50 kg: 1 gm Q 8 hr</td>
<td>&lt;80 kg: 600 mg Q 8 hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50–100 kg: 2 gm Q 8 hr</td>
<td>&gt;80 kg: 900 mg Q 8 hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe soft-tissue damage and substantial contamination with associated vascular injury</td>
<td>&lt;50 kg: 1 gm Q 8 hr</td>
<td>&lt;80 kg: 600 mg Q 8 hr</td>
<td>2.5 mg/kg for child (or &lt;50 kg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50–100 kg: 2 gm Q 8 hr</td>
<td>&gt;80 kg: 900 mg Q 8 hr</td>
<td>5 mg/kg for adult</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;100 kg: 3 gm Q 8 hr</td>
<td></td>
<td>(i.e., 150-lb pt = 340 mg)</td>
<td></td>
</tr>
<tr>
<td>Farmyard, soil or standing water, irrespective of wound size or severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thermal Injuries
Thermal Injuries

- $2 \text{ ml/kg} \times \text{ weight} \times \% \text{ burn adults}$
- $3 \text{ ml/kg} \times \text{ weight} \times \% \text{ burn children}$
- Fluid titrated to urine output
- Trauma team
<table>
<thead>
<tr>
<th>CATEGORY OF BURN</th>
<th>AGE AND WEIGHT</th>
<th>ADJUSTED FLUID RATES</th>
<th>URINE OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame or Scald</td>
<td>Adults and older children (≥14 years old)</td>
<td>2 ml LR x kg x % TBSA</td>
<td>0.5 ml/kg/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30–50 ml/hr</td>
</tr>
<tr>
<td>Children (&lt;14 years old)</td>
<td></td>
<td>3 ml LR x kg x % TBSA</td>
<td>1 ml/kg/hr</td>
</tr>
<tr>
<td>Infants and young children</td>
<td></td>
<td>3 ml LR x kg x % TBSA</td>
<td>1 ml/kg/hr</td>
</tr>
<tr>
<td></td>
<td>(≤30kg)</td>
<td>Plus a sugar-containing solution at maintenance rate</td>
<td></td>
</tr>
<tr>
<td>Electrical Injury</td>
<td>All ages</td>
<td>4 ml LR x kg x % TBSA until urine clears</td>
<td>1–1.5 ml/kg/hr until urine clears</td>
</tr>
</tbody>
</table>

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.
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
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