TRAUMA POCKET GUIDE

MULAGO HOSPITAL

WE BUILD FOR THE FUTURE

Table of Contents

Primary Survey - ABCDE

A - Airway maintenance with cervical spine protection

- ☐ Check for patency, airway obstruction

- ☐ Establish patent airway while maintaining cervical spine in neutral position

B - Breathing and ventilation

- ☐ Expose neck and chest, ensure immobilization of head and neck
- ☐ Determine rate and depth of respirations
- ☐ Inspect and palpate neck and chest for tracheal deviation, unilateral and bilateral chest movement, use of accessory muscles, signs of injury
- ☐ Percuss chest for presence of dullness or hyper resonance
- ☐ Auscultate chest bilaterally

- ☐ Administer high-concentration oxygen
- ☐ Ventilate with bag-mask device
- ☐ Alleviate tension pneumothorax, seal open pneumothorax
- ☐ Attach CO_2 monitoring device to endotracheal tube
- ☐ Attach pulse oximeter to patient

C - Circulation with hemorrhage control

- ☐ Identify source of external, exsanguinating hemorrhage
- ☐ Identify potential source of internal hemorrhage
- ☐ Assess pulse: quality, rate, regularity, paradox
- ☐ Evaluate skin color
- ☐ Measure blood pressure if time permits

- ☐ Apply direct pressure to external bleeding sites
- ☐ Consider presence of internal hemorrhage and potential need for operative intervention
- ☐ Insert two large-caliber IV catheters
- ☐ Simultaneously obtain blood for hematologic and chemical analyses
- ☐ Initiate IV fluid therapy with warmed crystalloid solution and blood replacement
- ☐ Prevent hypothermia

D - Disability: neurologic status

- ☐ Determine level of consciousness using the GCS
- ☐ Check pupils for size and reaction
- ☐ Assess for lateralizing signs and spinal cord injury

E - Exposure/environmental control

- ☐ Completely undress the patient, but prevent hypothermia

Adjuncts to primary survey and resuscitation

Obtain ABG analysis and ventilatory rate
Monitor the patient's exhaled CO2 with an appropriate monitoring device
Attach and ECG monitor to the patient
Insert urinary and gastric catheters unless contraindicated, monitor patient's hourly output of urine
Consider the need for and obtain AP chest and AP pelvic x-rays
Consider the need for and perform FAST or DPL

Glasgow Coma Score

	Infant < 1 yr	Child 1-4 yrs	Child 4 yrs - Adult
		Eyes	
4	Open	Open	Open
3	To voice	To voice	To voice
2	To pain	To pain	To pain
1	No response	No response	No response
		Verbal	
5	Coos, babbles	Oriented, speaks, interacts, social	Oriented and alert
4	Irritable cry, consolable	Confused speech, disoriented, consolable	Disoriented
3	Cries persistently to pain	Inappropriate words, inconsolable	Nonsensical speech
2	Moans in pain	Incomprehensible, agitated	Moans, unintelligible
1	No response	No response	No response
		Motor	
6	Normal, spontaneous movement	Normal, spontaneous movement	Follows commands
5	Withdraws to touch	Withdraws to touch	Withdraws to touch
4	Withdraws to pain	Withdraws to pain	Withdraws to pain
3	Decorticate flexion	Decorticate flexion	Decorticate flexion
2	Decerebrate extension	Decerebrate extension	Decerebrate extension
1	No response	No response	No response

Secondary Survey

Obtain AMPLE history and mechanism of injury

A - allergies

M - medications currently used

P - past illnesses/pregnancy

L - last meal

E - events/environment related to the injury

Head and maxillofacial

- ☐ Inspect and palpate entire head and face for lacerations, contusions, fractures, thermal injury
- ☐ Reevaluate pupils
- ☐ Reevaluate level of consciousness and GCS score
- ☐ Assess eye for hemorrhage, penetrating injury, visual acuity, dislocation of lens, presence of contact lens
- ☐ Evaluate cranial-nerve function
- ☐ Inspect ears and nose for cerebrospinal fluid leakage
- ☐ Inspect mouth for evidence of bleeding and CSF, soft-tissue lacerations, loose teeth

- ☐ Maintain airway, continue ventilation and oxygenation as indicated
- ☐ Control hemorrhage
- ☐ Prevent secondary brain injury
- ☐ Remove contact lenses

Cervical spine and neck

- ☐ Inspect for signs of blunt and penetrating injury, tracheal deviation, use of accessory respiratory muscles
- ☐ Palpate for tenderness, deformity, swelling, subcutaneous emphysema, tracheal deviation, symmetry of pulses
- ☐ Auscultate the carotid arteries for bruits
- ☐ Obtain a CT of the cervical spine or a lateral, cross-table cervical spine x-ray
- ☐ Maintain adequate in-line immobilization and protection of the cervical spine

Chest

- ☐ Inspect the anterior, lateral, posterior chest wall for signs of blunt and penetrating injury, use of accessory breathing muscles, bilateral respiratory excursions
- ☐ Auscultate the anterior chest wall and posterior bases for bilateral breath sounds and heart sounds
- ☐ Palpate the entire chest wall for evidence of blunt and penetrating injury, subcutaneous emphysema, tenderness, crepitation
- ☐ Percuss for evidence of hyperresonance or dullness

- ☐ Perform needle decompression of pleural space or tube thoracostomy, as indicated
- ☐ Attach the chest tube to an underwater seal-drainage device
- ☐ Correctly dress an open chest wound
- ☐ Perform pericardiocentesis, as indicated
- ☐ Transfer the patient to the operating room, if indicated

Abdomen

- ☐ Inspect the anterior and posterior abdomen for signs of blunt and penetrating injury and internal bleeding
- ☐ Auscultate for presence of bowel sounds
- ☐ Percuss the abdomen to elicit subtle rebound tenderness
- ☐ Palpate the abdomen for tenderness, involuntary muscle guarding, unequivocal rebound tenderness, gravid uterus
- ☐ Obtain a pelvic x-ray film
- ☐ Perform DPL/abdominal ultrasound, if warranted
- ☐ Obtain CT of the abdomen if the patient is hemodynamically abnormal

- ☐ Transfer the patient to the operating room if indicated
- ☐ Wrap a sheet around the pelvis or apply a pelvic compression binder as indicated to reduce pelvic volume and control hemorrhage from a pelvic fracture

Perineum/rectum/vagina

- ☐ Assess perineum for contusions and hematomas, lacerations, urethral bleeding
- ☐ Assess rectum for rectal blood, anal sphincter tone, bowel wall integrity, bony fragments, prostate position

- ☐ Assess vagina for presence of blood in vaginal vault, vaginal lacerations

Musculoskeletal

- ☐ Inspect upper and lower extremities for evidence of blunt and penetrating injury, including contusions, lacerations, deformity
- ☐ Palpate upper and lower extremities for tenderness, crepitation, abnormal movement, sensation
- ☐ Palpate all peripheral pulses for presence, absence, and equality
- ☐ Assess the pelvis for evidence of fracture and associated hemorrhage
- ☐ Inspect and palpate the thoracic and lumbar spines for evidence of blunt and penetrating injury, including contusions, lacerations, tenderness, deformity, and sensation
- ☐ Evaluate the pelvic x-ray film for evidence of a fracture
- ☐ Obtain x-ray films of suspected fracture sites as indicated

- ☐ Apply and/or readjust appropriate splinting devices for extremity fractures, as indicated
- ☐ Maintain immobilization of the patient's thoracic and lumbar spines
- ☐ Wrap a sheet around the pelvis or apply a pelvic compression binder as indicated to reduce pelvic volume and control hemorrhage associated with a pelvic fracture
- ☐ Apply a splint to immobilize and extremity injury
- ☐ Administer tetanus immunization
- ☐ Consider the possibility of compartment syndrome
- ☐ Perform a complete neurovascular examination of the extremities

Neurologic

- ☐ Reevaluate the pupils and level of consciousness
- ☐ Determine the GCS score
- ☐ Evaluate the upper and lower extremities for motor and sensory functions
- ☐ Observe for lateralizing signs

- ☐ Continue ventilation and oxygenation
- ☐ Maintain adequate immobilization of the entire patient

Adjuncts to secondary survey

Consider the need for and obtain these diagnostic tests as the patient's condition permits and warrants:

- Spinal x-rays
- CT of head, chest, abdomen, and/or spine
- Contrast urography
- Angiography
- Extremity x-rays
- Transesophageal ultrasound
- Bronchoscopy
- Esophagoscopy

Resource Limited Settings:

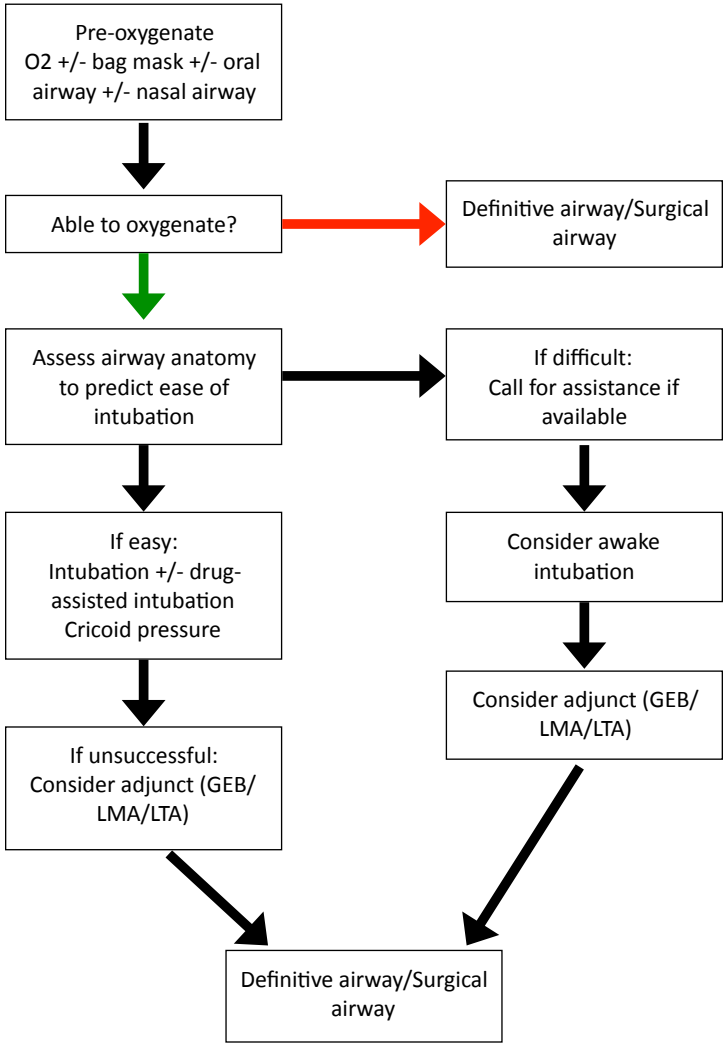
- In the absence of CT scanner
  - Use clinical acumen to identify pathology
- In the absence of blood products
  - Give IV fluids
  - Identify and control hemorrhage
- If IV fluids are limited
  - Warm lactated ringers is preferred fluid of choice, but can use normal saline if available
- In the absence of an ICU or ventilators
  - Consider early tracheostomy

Airway Management

Airway Maintenance

Maneuver	Technique
Chin-lift	Place fingers of one hand under mandible, gently lift upward to bring chin anterior
Jaw-thrust	Grasp the angles of the lower jaw, one hand on each side, and displace mandible anteriorly
Oropharyngeal airway	Insert oral airway upside down so concavity is directed upward until the soft palate is encountered, then rotate device 180 degrees so the concavity is directed inferiorly and the device is slipped into place over the tongue *Do not use this technique in children
Nasopharyngeal airway	Lubricate airway and insert into nostril that appears to be unobstructed *Do not use this procedure in patients with suspected or potential cribriform plate fracture
Laryngeal mask airway	Direct assistant to manually immobilize the head and neck. Do not hyperextend or hyperflex the neck. Lubricate the device. Use tongue depressor to secure tongue. Place pointed end of device toward hard palate, then spin 180 degrees when entering posterior oropharynx. Inflate cuff (can add or subtract air to improve seal) *Not a “protected airway”

Airway decision scheme



Standardized Labs and Imaging for Trauma Activations

Labs

- CBC
- Chemistries (Na, K, Cl, bicarbonate, BUN, creatinine, glucose)
- Blood alcohol level
- Urine "drugs of abuse"
- Coagulation studies (PT, INR, PTT) if head injury, spine injury, or liver disease)
- Urine pregnancy if female and of childbearing age
- Liver tests (AST, ALT, alk phos, total bili, direct bili)
- Amylase
- Lactic acid
- Type and screen in stable patients, type and cross for SBP<90

Indications for Chest X-ray in trauma

- Age >60
- Rapid deceleration (fall >20 ft, MVC >40 mph or 65 kph)
- Chest pain
- Intoxication
- Abnormal alertness/mental status
- Distracting injury
- Tenderness on chest wall palpation
- Auscultation abnormalities
- Hypoxia
- Respiratory distress

Indications for Pelvis X-ray in trauma

- Hemodynamic instability
- Mechanical instability of the pelvis
- Physical exam findings consistent with pelvic trauma

Adult Pan-Scan Protocol

Pan-scan: CT scan of head, chest, abdomen, pelvis, with cervical, thoracic, and lumbar spine reconstructions (including axial, sagittal, coronal reconstructions)

Indications for whole body CT scanning in adult blunt trauma:

- High energy mechanisms
  - MVC >20 mph or 32 kph
  - Fall from >1 story
  - Frame intrusion into passenger compartment
  - Ejection
  - Rollover
  - Death of another passenger in the vehicle
  - Pedestrian struck
  - Prolonged extrication
  - Windshield spidering
  - Bicyclist or motorcycle crash with separation from cycle

- Clinical findings
  - Altered mental status (GCS<13)
  - AIS of 2 or more in 2 body areas based on physical exam
  - 2 or more long bone fractures
  - Unstable pelvis
  - Flail chest
  - Sternal, scapula, clavicle, and/or upper rib fractures

No patient should be transported to CT unless medically stable, with a protected airway and stable hemodynamic parameters

Shock

	Hypovolemic	Cardiogenic	Obstructive	Distributive
Etiology	Hemorrhagic		Flow obstructive	Septic
	Non-hemorrhagic		Increased intrathoracic pressure	Anaphylactic
				Neurogenic
				Endocrine
Physiology	CO: decreased CVP: decreased SVR: increased	CO: decreased CVP: increased SVR: increased	CO: decreased CVP: increased SVR: increased	CO: increased (early), decreased (late) CVP: decreased SVR: decreased

Estimated Blood Loss (For a 70-kg Man) Based on Patient's Initial Presentation				
	Class I	**Class II**	**Class III**	**Class IV**
Blood loss (mL)	Up to 750	750-1500	1500-2000	>2000
Blood loss (% blood volume)	Up to 15%	15%-30%	30%-40%	>40%
Pulse rate (bpm)	<100	100-120	120-140	>140
Systolic blood pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mmHg)	Normal or increased	Decreased	Decreased	Decreased
Respiratory rate	14-20	20-30	30-40	>35
Urine output (mL/hr)	>30	20-30	5-15	Negligible
CNS/mental status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic
Initial fluid replacement	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood

Responses to Initial Fluid Resuscitation (Isotonic Crystalloid Solution, 2000 mL in Adults, 20 mL/kg in Children)			
	Rapid Response	**Transient Response**	**Minimal or No Response**
Vital signs	Return to normal	Transient improvement, recurrence of decreased blood pressure and increased heart rate	Remain abnormal
Estimated blood loss	Minimal (10-20%)	Moderate and ongoing (20-40%)	Severe (>40%)
Need for more crystalloid	Low	Low to moderate	Moderate as a bridge to transfusion
Need for blood	Low	Moderate to high	Immediate
Blood preparation	Type and crossmatch	Type-specific	Emergency blood release
Need for operative intervention	Possibly	Likely	Highly likely
Early presence of surgeon	Yes	Yes	Yes

Head Injury: Blunt

Obtain CT scan in all patients with:

- ➡ Suspected brain injury
- ➡ Suspected skull fracture
- ➡ >2 episodes of vomiting
- ➡ >65 years of age
- ➡ Loss of consciousness >5 minutes
- ➡ Severe headaches
- ➡ Dangerous mechanism of injury
- ➡ Focal neurological deficit

Management of minor brain injury (GCS 13-15): patient has history of disorientation, amnesia, transient loss of consciousness, but is conscious and talking

1. ABCDE per ATLS protocol
2. Secondary survey
3. Serial examinations with repeat GCS to monitor for change and obtain CT scan
4. Surgical consult early if abnormalities on CT scan
5. If asymptomatic and fully awake and alert with no neurologic abnormalities:
    - Observe for several hours
    - Re-examine: if stable, can be discharged with instructions regarding warning signs to seek further care

Management of minor brain injury (GCS 9-12): patient is able to follow simple commands but is usually confused or somnolent, can have focal deficits such as hemiparesis

1. ABCDE per ATLS protocol
2. Secondary survey
3. Perform serial neurologic examinations and obtain CT scan
4. All patients with moderate brain injury should be admitted to an ICU or unit capable of close monitoring and frequent reassessment
5. Follow up CT scan if initial CT is abnormal or if change in neurologic status

Initial management of severe head injury (GCS<8)

1. ABCDE per ATLS protocol
2. Elevate head to 30 degrees (if spine not cleared, use reverse Trendelenberg)
3. Check pupils q5minutes x3, then q15 minutes
4. Foley catheter to drainage
5. Orogastric tube (first assess for base of skull fracture or CSF leak)
6. Sedation and pain control
7. Glasgow Coma Score less than or equal to 8 AND/OR signs of intracranial hypertension (dilated pupil, bradycardia with hypertension)
   - 3% hypertonic saline: bolus 500 ml x1 through peripheral IV
   - Mannitol 25 gm IV x1 through peripheral IV (avoid with any systolic blood pressure <90)
   - Post-traumatic brain injury seizure prophylaxis

Intensive care unit management of severe head injury (GCS<8)

1. Maintain systolic blood pressure >100 mmHg
2. Maintain oxygenation SpO2>90%
3. PaCO2: 35 mmHg
4. Maintain normothermia (97.0-100.9 F)
5. Maintain euglycemia (80-180 mg/dL)
6. INR <1.4
7. Elevate head to 30 degrees (reverse Trendelenberg if spine not cleared)
8. Sedation/pain control (paralytic agents if refractory ICP)
9. Early enteral access and feeding when safe
10. Anticonvulsant therapy for a minimum of 7 days
11. Stress ulcer prophylaxis
12. Intracranial pressure monitor guidelines
    - Maintain ICP <20 mmHg (hyperosmolar therapy, sedation)
    - Maintain CPP >70 mmHg (fluids, pressors)
    - Hyperosmolar therapy (3% saline 250 ml, mannitol 0.5-1.0 gm/kg)
    - Maintain serum osmolarity <320, serum sodium <155
    - Discuss with neurosurgery for individualization for specific patient situations
    - Refractory intracranial hypertension: consider craniotomy

Managing Head Trauma in Resource Limited Settings:

- In the absence of CT scanner

Skull x-rays can be useful sources of information that help with diagnosis and deciding on surgical vs non-operative management

Any skull fracture can have underlying brain injury or intracranial bleed

Diagnosis from skull x-ray:

1. Classification of head injury:
    - Open head injury
        - Base of skull fracture
        - Pneumocephalus
    - Closed head injury
        - Linear fracture
        - Depressed skull fracture
        - Comminuted fracture
2. Midline shift
    - In the anteroposterior view, pineal body will have shift either right or left to varying degrees
3. Penetrating injury with retained foreign body
4. Scalp hematoma without underlying fracture

Findings on skull x-ray that should prompt urgent intervention:

➡ Skull fracture with any new neurological deficit
➡ Any fracture involving a sensitive area (Broca's area, Wernicke's area, occipital region)
➡ Any fracture with materializing signs (anisocoria, unilateral weakness of any limb)
➡ A fall in GCS of greater than 2
➡ Focal convulsions

<u>With the above findings, perform urgent decompression with burr holes to evacuate any underlying clot. Localize burr holes near fracture sites.</u>

Managing Head Trauma in Resource Limited Settings continued:

- Falling GCS in the absence of ventilator

  The patient with head injury and a GCS of 8 or less, or a falling GCS to below 8 will need airway protection

  If there is no access to a ventilator and the patient has respiratory effort, a tracheostomy should be performed immediately to secure the airway

- Management of skull fractures

  Any skull fracture should be considered as having an underlying bleed until proven otherwise. Patient should be closely monitored.

  A simple linear fracture in a neurologically intact patient can be managed conservatively.

  A depressed skull fracture in a neurologically intact patient can be managed conservatively.

Cervical Spine Evaluation and Clearance

Clinical Clearance

Cervical collar may be removed if patient:

- ❑ Is awake and alert
- ❑ Is not intoxicated
- ❑ Does not have distracting injuries
- ❑ Does not complain of neck pain
- ❑ Has no tenderness on physical examination

Radiologic Clearance

- ➡ If the patient has neck pain or tenderness on exam, is intoxicated, has distracting injuries, or has impairment of mental status, a CT of the cervical spine should be performed.
- ➡ If the CT cervical spine is normal (no fractures or evidence of traumatic injury), and the patient has no neck pain or tenderness, the cervical collar may be removed.
- ➡ If the patient has moderate to severe neck pain or tenderness with no neurologic symptoms or sings, obtain cervical flexion and extension x-rays. If the flexion and extension x-rays reveal normal alignment, the cervical collar may be removed.
- ➡ If the patient has altered mental status and has movement of all extremities, and the CT cervical spine is normal, the cervical collar may be removed.
- ➡ If the patient has a cervical spine fracture or subluxation on flexion-extension views, the cervical collar should be maintained with an Aspen collar, and a consultation to the spine surgeon should be made.
- ➡ If the patient has a cervical spine fracture, the thoracic and lumbar spine should also be imaged.

Evidence of neurologic symptoms or signs

If the patient has evidence of neurologic signs or symptoms (numbness or paresthesia in the hands, weakness of the extremities), a CT cervical spine should be performed followed by an MRI of the cervical spine. A consultation to the spine surgeon should be made and the patient should be placed in an Aspen collar.

Thoracic/Lumbar/Sacral Spine Evaluation and Clearance

Clinical Clearance

TLS spine may be considered to be cleared from acute traumatic injury if patient:

- ❑ Is awake and alert
- ❑ Is not intoxicated
- ❑ Does not have distracting injuries
- ❑ Does not complain of back pain
- ❑ Has no tenderness on physical examination

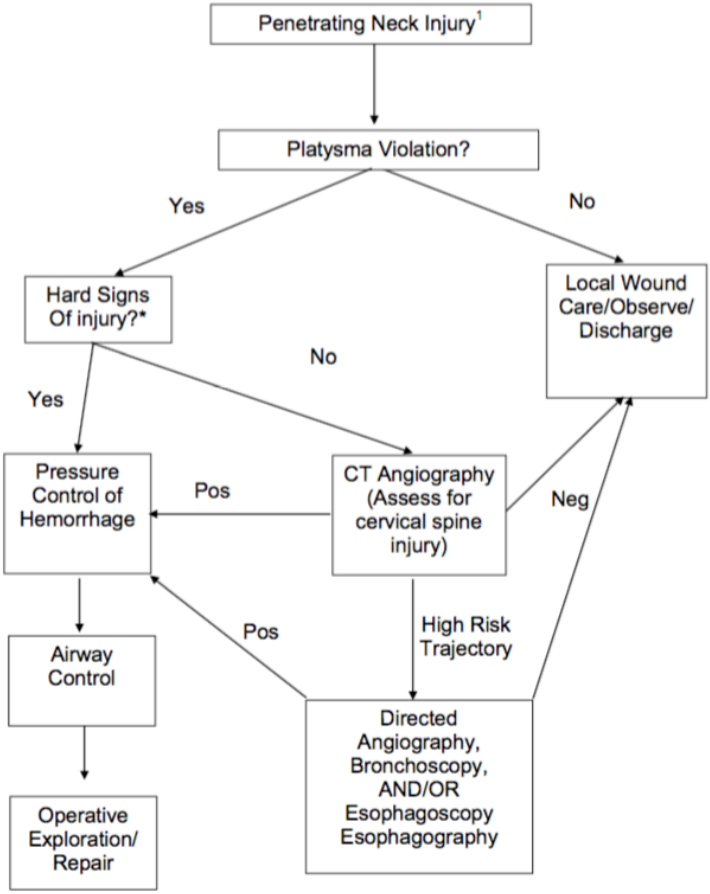
Radiologic Clearance

- ➡ If the patient has back pain or tenderness on exam, or is intoxicated, has distracting injuries, or has impairment of mental status, a CT of the thoracolumbar spine should be performed.
- ➡ If the patient has a thoracolumbar spine fracture, the patient should be maintained at flat bed rest with spine injury precautions, and a consultation to the spine surgeon should be made.

Evidence of neurologic symptoms or signs

If the patient has evidence of neurologic symptoms, a CT cervical, thoracic, and lumbar spine should be performed. A consultation to the spine surgeon should be made, and the patient should be placed in an Aspen collar. An MRI of the affected area of the spine may be necessary in the evaluation of the spine injury.

Neck Trauma: Penetrating



*Hard signs of injury:
Airway compromise, shock, pulsatile bleeding, expanding hematoma, unilateral pulse deficit, bruit or thrill, subcutaneous emphysema, stridor/hoarseness, signs of stroke

Neck Trauma: Blunt Cerebrovascular Injury

Blunt cerebrovascular injury (BCVI) occurs in 1-2% of blunt trauma patients. Given the morbidity of stroke associated with BCVI, risk factors should be identified to ensure proper screening is performed in high-risk patients. CT angiography of the neck is the diagnostic modality of choice for screening trauma patients.

Screening guidelines for BCVI:

- GCS < 8
- Petrous bone fracture
- Diffuse axonal injury
- Lefort II or III facial fractures
- Cervical spine fracture including:
  - C1 to C3
  - Fracture through the foramen transversarium
  - Subluxational or rotational injury

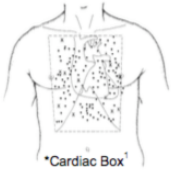
Grades of Injury:

- Grade I: intimal irregularity with <25% narrowing
- Grade II: dissection or intramural hematoma with >25% narrowing
- Grade III: pseudoaneurysm
- Grade IV: occlusion
- Grade V: transection with extravasation

Treatment

Treatment using antiplatelet vs. anticoagulation therapy AND/OR further procedural interventions will be based on other injuries and patient stability. Vascular consultation should be considered in higher-grade injuries. Repeat imaging should be considered in 7-10 days and again at 3 months depending on increasing grade of injury. In the event of synchronous spine and/or head injury, neurosurgery should participate in the decisions regarding anticoagulant and/or antiplatelet therapy.

Thoracic Trauma: Penetrating

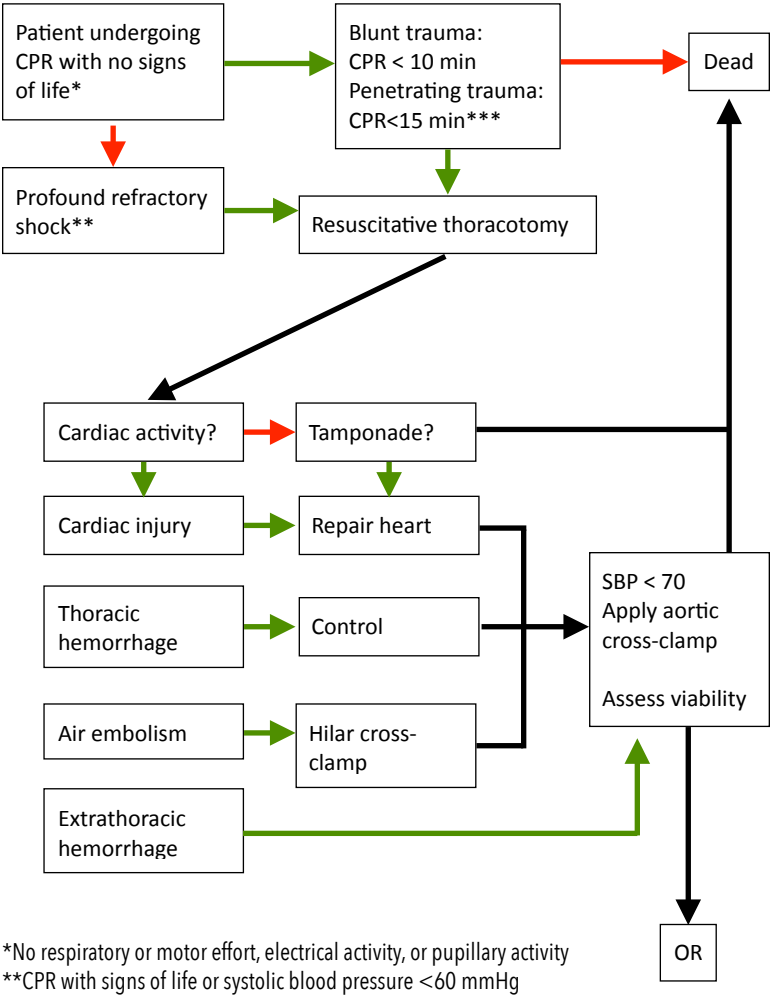


The majority of penetrating trauma to the thorax can be managed by tube thoracostomy (Up to 85%). In addition to the above algorithm, there are some special considerations when managing these injuries:

Trans-mediastinal Gunshot Wounds: After completing the above workup, additional imaging including **IV contrast enhanced CT of the chest** may define the tract of the bullet more definitively. Further work-up may include angiography, fluoroscopic swallow studies, esophagoscopy, and/or bronchoscopy.

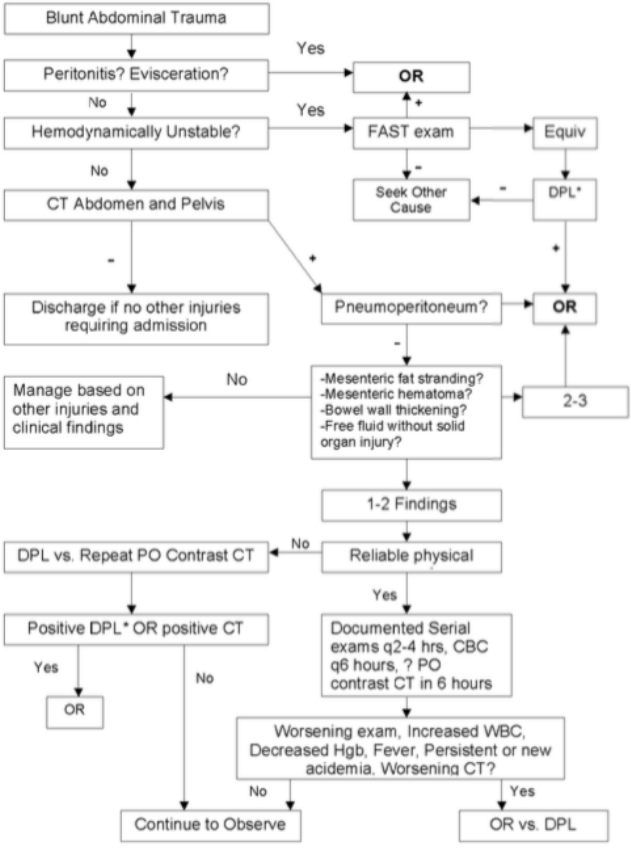
Autotransfusion in Isolated Massive Hemothorax: All chest tubes inserted in the ED are connected to a thoracic drainage unit with autotransfusion capability. A micro pore filter should always be used to transfuse the blood. Indications include isolated massive hemothorax especially in hemodynamically unstable patients that have been injured within four hours of injury.

Thoracic Trauma: Resuscitative Thoracotomy



*No respiratory or motor effort, electrical activity, or pupillary activity
**CPR with signs of life or systolic blood pressure <60 mmHg
***Penetrating trauma to the neck or extremities with >5 min of CPR heralds non-salvageability

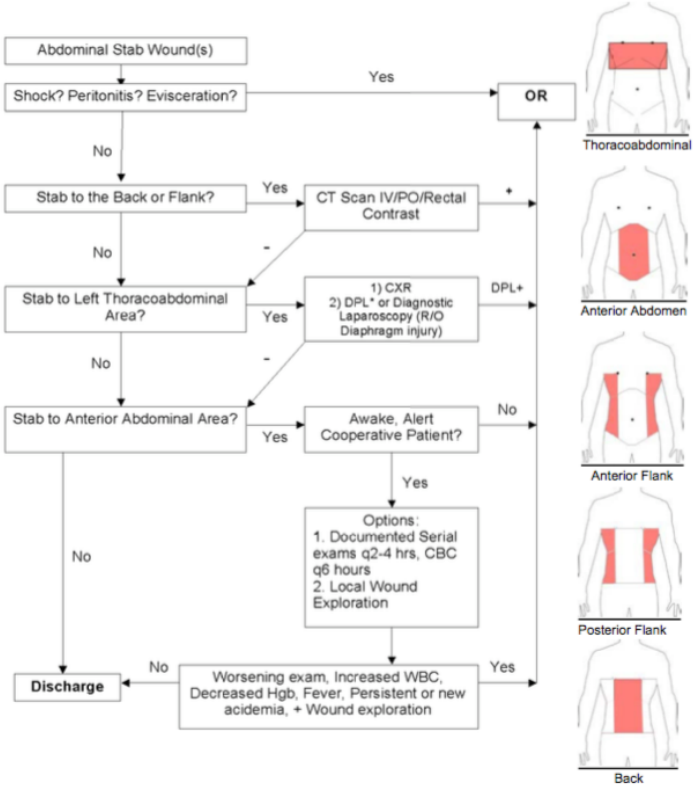
Abdominal Trauma: Blunt



DPL*: Diagnostic peritoneal lavage: Positive findings include: Gross blood on aspiration, >100,000 RBC, >500 WBC, Gram stain: Bacteria/particulate matter, Bilirubin>Serum, Creatinine>serum, Amylase>serum

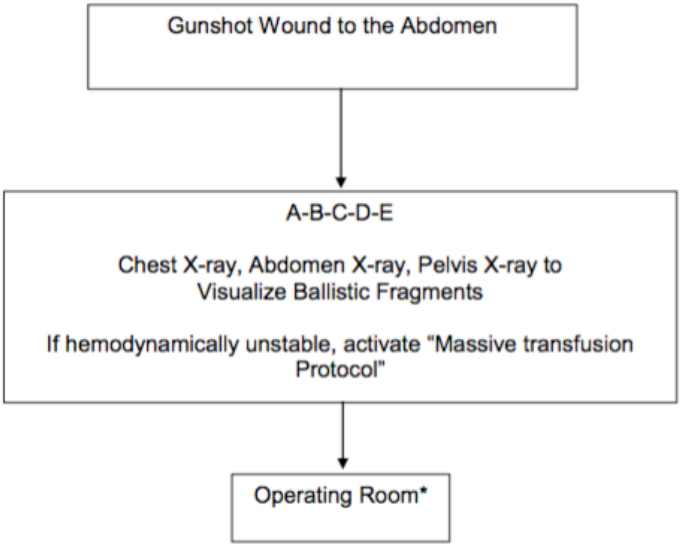
NOTE: ALTHOUGH THE FAST EXAM IS PERFORMED ON ALL TRAUMA PATIENTS FOR EDUCATIONAL PURPOSES, ITS RESULT SHOULD NOT GUIDE THE NEED FOR ADDITIONAL IMAGING IN HEMODYNAMICALLY STABLE PATIENTS!

Abdominal Trauma: Stab



DPL*: Diagnostic peritoneal lavage: Positive findings to assess for diaphragm injury includes >5,000 RBC or Gross blood on aspiration. Additional hollow viscus injury + criteria include >500 WBC, Gram stain: Bacteria or particulate matter, Bilirubin>Serum, Creatinine>serum, Amylase>serum

Abdominal Trauma: Gunshot



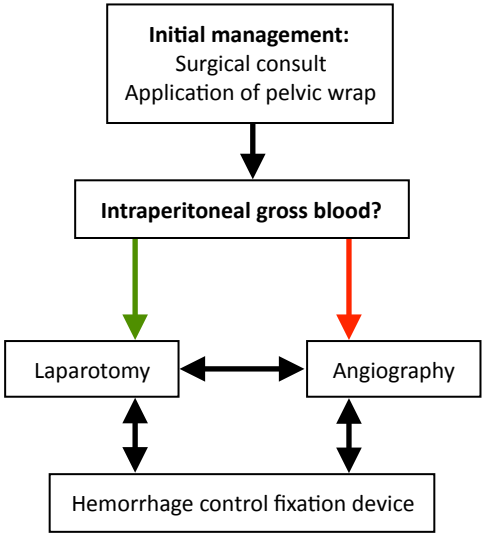
Managing Abdominal Trauma in Resource Limited Settings:

- In the absence of CT scanner

  If FAST exam shows peritoneal fluid and patient is hemodynamically unstable, get a surgical consult and prepare for likely laparotomy (intubate, prepare OR)

  If not ultrasound is available, can consider laparotomy without imaging if patient is hemodynamically unstable or has signs of hollow viscus rupture

Pelvis Trauma: Hemodynamically Unstable



Management of unstable pelvic fracture:

➡ Hemorrhage control, fluid resuscitation (large bore central venous catheter), and pain control

➡ Surgical consult and possible transfer for definitive care

➡ Mechanical stabilization of pelvic ring and application of external counter pressure

- Wrap pelvis with commercial stabilizer or sheet over greater trochanters of femur, tape knees and ankles
- External fixation

➡ May require laparotomy or angiography

Extremity Trauma: Penetrating

Hard signs: mandate immediate operative intervention
Pulsatile bleeding
Expanding hematoma
Absent distal pulses
Thrill/bruit
Focal neurologic dysfunction

Soft signs: lower probability of vascular trauma, warrant further investigation
Small, stable hematomas
Diminished pulses
Unexplained hypotension
History of hemorrhage that has since ceased

Ankle/brachial indices (ABIs) should be obtained on these patients, and an abnormal value (0.9 or less) should prompt evaluation with CT angiography. Proximity of injury to a vessel alone is not an indication for routine angiography EXCEPT for shotgun injuries.

A vascular surgery consultation should be obtained as well. Repercussion should take place within 6 hours in order to optimize results.

2012 EAST guidelines suggest that reliable patients with normal physical findings and normal ABIs may be safely discharged to home.

Extremity Trauma: Blunt

Compartment Syndrome

6 P's of limb ischemia

Pallor

Pain

Paresthesias

Paralysis

Poikilothermy

Pulselessness - LATE FINDING, DON'T WAIT FOR THIS TO MANIFEST

Immediate fasciotomy is required if:

- Compartment pressure is 30-35 mmHg
- The difference between diastolic and compartment pressures is 30 mmHg

Managing Compartment Syndrome in Resource Limited Settings:

- If unable to measure pressures
  Palpate the affected limb compartments and feel for tension in the tissues; if compartments are tense, this should raise concern and fasciotomy should be considered

Urologic Trauma

Urethral Trauma

Retrograde urethrograms are indicated in patients with any one of the following:

- Blood at the urethral meatus
- High riding or "boggy" prostate on rectal exam
- A scrotal hematoma
- Major pelvic disruption

The study may be performed in males by inserting the tip of a Foley catheter about 1-2 cm inside the penis, insufflating the balloon with <1 ml of sterile water to hold in place, and injection of about 3-5 ml undiluted radio contrast media. Two images should be taken: one with patient tilted at 45 degrees to the right in log roll positioning, and a second 45 degrees to the left in log roll positioning. With the penis laying laterally, this positioning will maximize visualization of the membranous portion of the urethra. Evidence of extravasation contraindicates insertion of a Foley catheter and a urology consultation should be obtained. Failure of dye to reach the bladder is frequent. In the absence of visualized injury on urethrogram, an attempt at gentle insertion of Foley may be performed.

Renal Trauma

Findings on physical exam may include:

- Hematuria
- Flank pain
- Flank abrasions and ecchymosis
- Fractured ribs
- Abdominal tenderness, distension or mass

Guidelines on radiographic assessment:

➡ Blunt trauma patients with visible (gross) or non-visible hematuria and hemodynamic instability should undergo radiographic evaluation

➡ Immediate imaging is recommended for all patients with a history of rapid deceleration injury and/or significant associated injuries

➡ All patients with or without hematuria after penetrating abdominal or lower thoracic injury require urgent renal imaging

➡ Ultrasound alone should not be used to set the diagnosis of renal injury since it cannot provide sufficient information

➡ A CT scan with enhancement of intravenous contrast material and delayed images is the gold standard for the diagnosis of renal injuries in hemodynamically stable patients

Guidelines on management of renal trauma:

➡ Following blunt renal trauma, stable patients should be managed conservatively and closely monitored for vital signs until gross hematuria resolves

➡ Isolated grade 1-3 stab and low-velocity gunshot wounds in stable patients, after complete staging, should be managed expectantly

➡ Indications for renal exploration include

- Hemodynamic instability
- Exploration for associated injuries
- Expanding or pulsatile peri-renal hematoma identified during laparotomy
- Grade 5 vascular injury

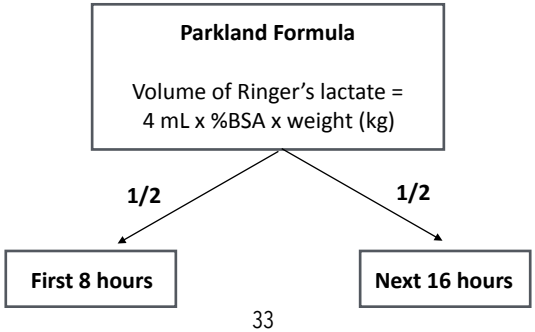
➡ Radiological embolization is indicated in patients with active bleeding from renal injury but without other indications for immediate abdominal operation

➡ Intra-operatively, renal reconstruction should be attempted once hemorrhage is controlled and there is sufficient viable renal parenchyma

Burns

Management of burns:

1. ABCDE as per ATLS protocol
    - ➡ Special considerations
        - Airway: higher risk of threatened airway due to inhalation burns
            - Signs of airway injury: face/neck burns, singed nasal hair, carbonaceous sputum, hoarse voice, airway swelling
            - Evaluate for possible airway burns with optic bronchoscopy
            - Early intubation if airway burn is suspected as progressive swelling will make intubation more difficult
            - High dose steroids may be useful with airway compromise especially if unable to intubate patient
        - Breathing: provide supplemental oxygen
            - Consider escharotomy in circumferential chest burns
        - Circulation
            - Control external bleeding
            - Establish IV access
            - Fluid resuscitation with crystalloid via Parkland formula (use normal saline if Lactated Ringers is not available)
        - Disability
        - Exposure: make sure to fully expose the patient and stop the burning process
            - Estimate total body surface area burned
            - Keep environment/patient warm (burned skin is unable to preserve internal body heat)



2. Secondary survey
    - ➡ Special considerations
        - Determine the size of the burn (% total body surface area burned)
        - Determine the severity of the burn
        - Ensure pain control
        - Ensure IV access
3. Consider transfer options
    - ➡ Adults with 15% TBSA or children with 10% TBSA are best treated initially in the burn unit if one exists or in the OR
4. Interventions
    - ➡ Vascular access including central line placement
    - ➡ Foley insertion to aid in monitoring urine output and resuscitation
    - ➡ Burn wound assessment and debridement
    - ➡ Escharotomy if necessary (can bleed significantly)
    - ➡ Topical antibiotics and dressings
5. Nutrition: critical due to hypermetabolic state of burn patients
    - ➡ Feeding tube is indicated for >20% burn
    - ➡ If not, aim for 7g/kg carbohydrates, 2 g/kg protein

Managing Burns in Resource Limited Settings:

- Resuscitation

  Lactated Ringers is fluid of choice but can use normal saline if no LR available
  Albumin is usually indicated after initial resuscitation but is expensive
  Burns >20% can be resuscitated with oral rehydration solution
  - Homemade: 1L clean water, 1 tsp salt, 2 tbsp sugar
  - Drink 1L/hr sipping q5minutes
  - Can give via nasogastric tube if patient is unable to take PO or if unable to obtain IV access due to shock and collapsed vessels. Can then switch to IV fluids after IV access is obtained
- Antibiotics

  Patients often present late and after local remedies are tried. It is acceptable to start antibiotics on presentation even after signs of infection are present
  - Start with penicillins or cephalosporins and broaden to stronger antibiotics after culture results

Managing Burns in Resource Limited Settings continued:

- Wound care and dressings

  Closed, layered dressing is recommended
  - Silver sulfadiazine cream
  - Vaseline gauze (can use locally prepared one from plain petroleum jelly and sterilize it)
  - Iodine soaked gauze (2-3 layers, dilute iodine with normal saline in a 1:1 ratio)
  - Saline soaked gauze (2-3 layers)
  - Gauze pad (can make by wrapping cotton to 3-5 cm thickness)
  - Crepe bandages to hold layers in place

  Dress fingers and toes individually

  Provide adequate analgesia

- Airway burns with no resources to ventilate patient

  Elevate head of bed

  Give high dose steroids: dexamethasone and hydrocortisone

  Give oxygen

  Pain control

  Resuscitate patient

  Nasotracheal tube or non-cuffed endotracheal tube through nose

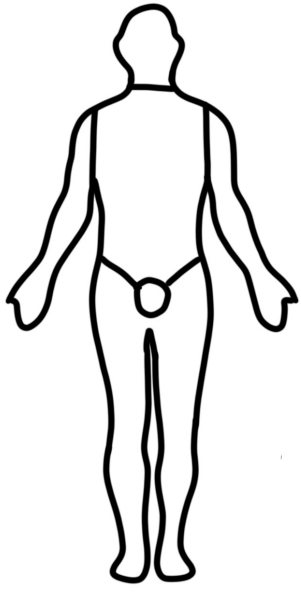
  Consider early tracheostomy

- Mass casualties

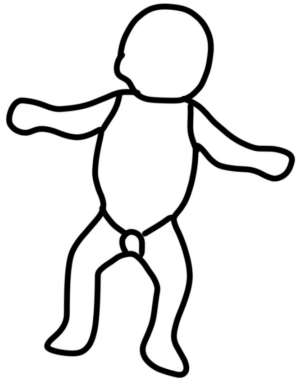
  Triage and palliative care may be indicated for higher total body surface area burns

Estimating % Total Body Surface Area Burned

Body part	% Total surface area
Head	9%
Each arm	9%
Each leg	18%
Genitals	1%
Front	18%
Back	18%



Body part	% Total surface area
Head	18%
Each arm	9%
Each leg	14%
Genitals	1%
Front	18%
Back	18%



Pediatric Trauma

Pediatric Vital Signs

	Pulse (beats/min)	Systolic blood pressure (mmHg)	Respiratory rate (breaths/min)
Neonate	95-145	60-90	30-60
Infant (1-12 mo)	125-170	75-100	30-60
Toddler (1-3 yrs)	100-160	80-100	24-40
Preschool (3-5 yrs)	70-110	80-100	22-34
School age (6-12 yrs)	70-110	85-120	18-30
Adolescent (13+ years)	55-100	95-120	12-16

Management of pediatric trauma:

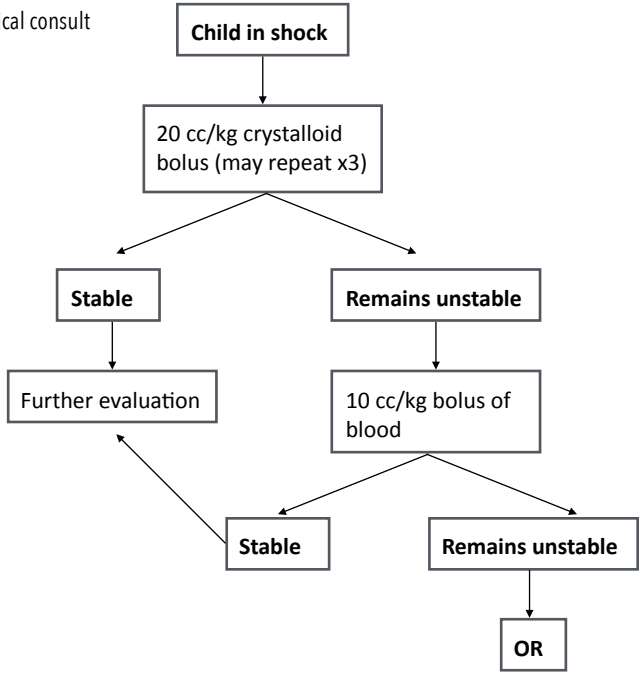
Special considerations for initial assessment

- ➡ Airway:
  - Anatomic differences: larger head and tongues, smaller nasal passages, shorter trachea (5 cm in infants, 7 cm at 18 mo)
  - Place 1 in thick padding beneath torso to preserve alignment of spinal column in infants and toddlers
  - Approximate diameter of endotracheal tube by matching to diameter of external nares, matching to diameter of tip of child's small finger, or using the formula [(age+16)/4 = diameter]
- ➡ Breathing:
  - Use pediatric bag-mask for children under 30 kg to avoid barotrauma
- ➡ Circulation
  - Fluid resuscitation
    - 20 mL/kg bolus x3 if necessary
    - 10 mL/kg packed RBCs if necessary
    - Maintenance fluids: 4-2-1 rule
      - 4 mL/kg for first 10 kg
      - 2 mL/kg for second 10 kg
      - 1 mL/kg for every kg after 20 kg
- ➡ Disability
- ➡ Exposure

Systemic Response to Blood Loss in Children			
System	**Mild blood volume loss (<29%)**	**Moderate blood volume loss (30%-45%)**	**Severe blood volume loss (>45%)**
Cardiovascular	Increased heart rate Weak, thready peripheral pulses Normal systolic blood pressure Normal pulse pressure	Markedly increased heart rate Weak, thready central pulses Absent peripheral pulses Low systolic blood pressure Narrowed pulse pressure (<20 mmHg)	Tachycardia followed by bradycardia Very weak or absent central pulses Absent peripheral pulses Hypotension Narrowed pulse pressure (<20 mmHg) or undetectable diastolic blood pressure
Central nervous system	Anxious, irritable, confused	Lethargic, dulled response to pain	Comatose
Skin	Cool, mottled Prolonged capillary refill	Cyanotic Markedly prolonged capillary refill	Pale and cold
Urine output	Low to very low	Minimal	

Resuscitation algorithm

*Get early surgical consult



Signs of adequate resuscitation	
Urinary output of 1-2 ml/kg/hr	Return of normal skin color
Urine specific gravity return to normal	Increased warmth of extremities
Slowing of heart rate to normal	Normalization of blood pressure
Clearing of sensorium	Return of peripheral pulses

Managing Pediatric Trauma in Resource Limited Settings:

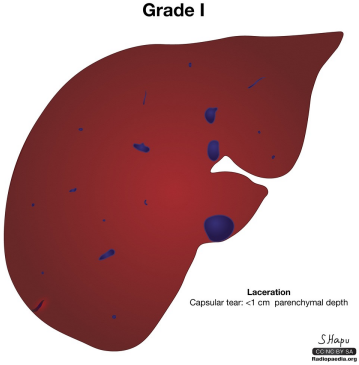
- Abdominal trauma in settings with limited monitoring and intensive care, lack of imaging beyond ultrasound
  - Reasonable to attempt non-operative approach in hemodynamically normal patient with known solid organ injury
  - Requires close monitoring and true serial exams
  - If transfusion of 40% or more of blood volte is needed, may require laparotomy
  - Must be prepared to mobilize the OR quickly
  - Majority of patients who require laparotomy will do so within 6 hrs of injury

- Lack of fluid pumps or pediatric sized fluid bottles
  - Give fluid boluses every 2 hrs rather than letting drip run unattended
  - Can use syringe to give boluses

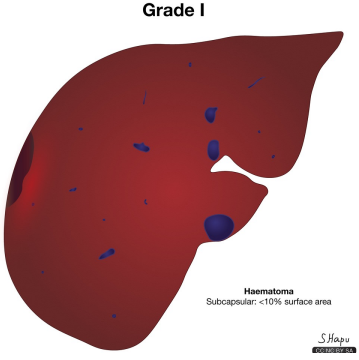
- Hypothermia
  - Large sheets of polyethylene paper can be placed between sheets to encourage heat retention
  - Put warm water in plastic gloves and pack around child's body

APPENDIX

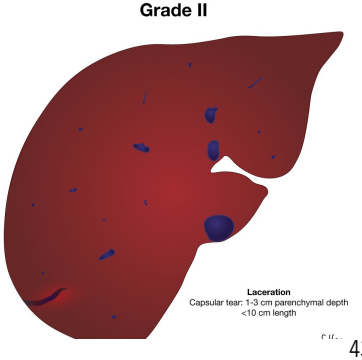
AAST Organ Injury Scale - Liver



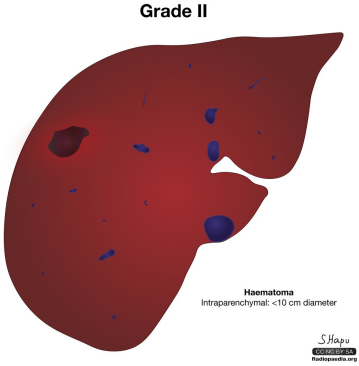
Grade I:
Laceration: capsular tear, <1 cm parenchymal depth



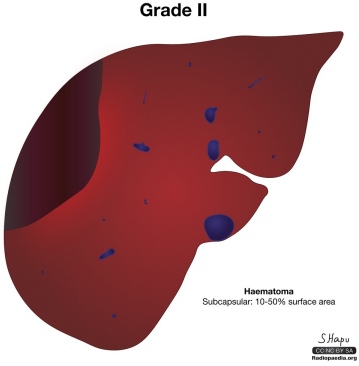
Grade I:
Hematoma: subcapsular, <10% surface area



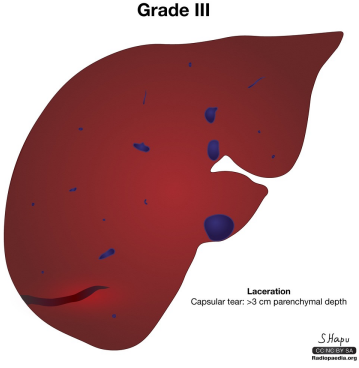
Grade II:
Laceration: capsular tear, 1-3 cm parenchymal depth, <10 cm length



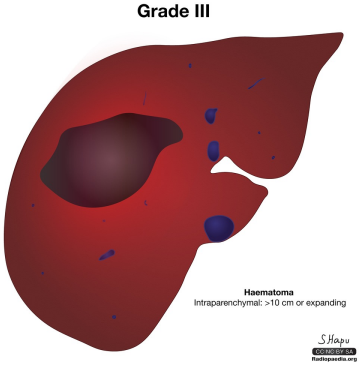
Grade II:
Hematoma: intraparenchymal, <10 cm diameter



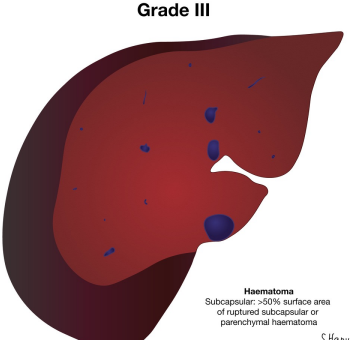
Grade II:
Hematoma: subcapsular, 10-50% surface area



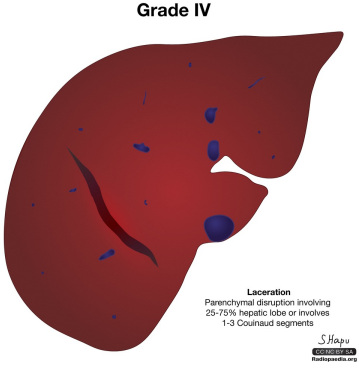
Grade III:
Laceration: capsular tear, >3 cm parenchymal depth



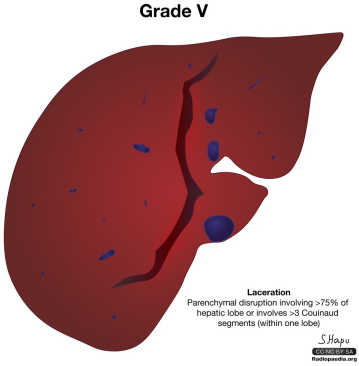
Grade III:
Hematoma: intraparenchymal, >10 cm or expanding



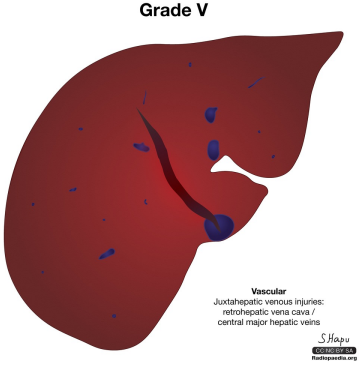
Grade III:
Hematoma: subcapsular, >50% of surface area or expanding, or ruptured subcapsular or parenchymal hematoma



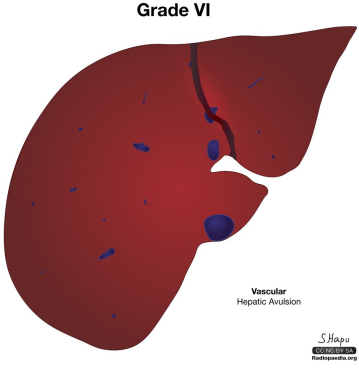
Grade IV:
Laceration: parenchymal distribution involving 25-75% of hepatic lobe, or involves 1-3 Coinaud's segments in a single lobe



Grade V:
Laceration: parenchymal distribution involving >75% of hepatic lobe or >3 Coinaud's segments within a single lobe

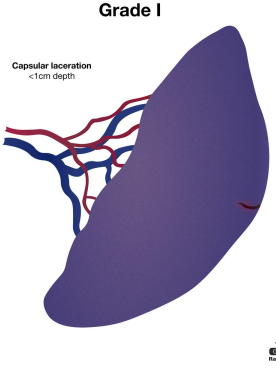


Grade V:
Vascular: juxtahepatic venous injuries i.e. retrohepatic vena cava/central major hepatic veins

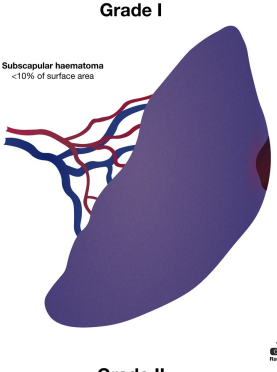


Grade VI:
Vascular: hepatic avulsion

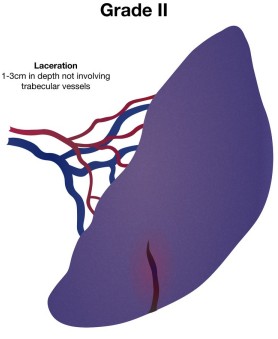
AAST Organ Injury Scale - Spleen



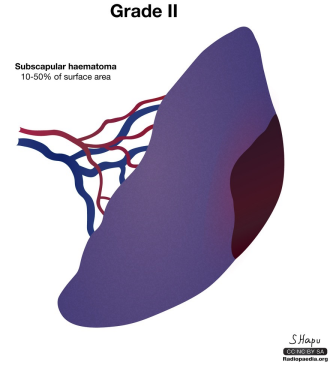
Grade I:
Laceration: capsular tear, <1 cm parenchymal depth



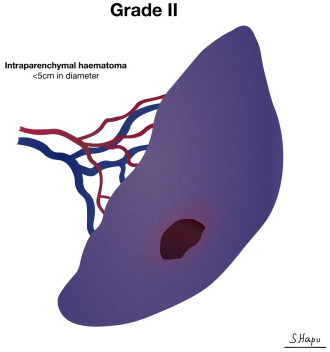
Grade I:
Hematoma: subcapsular, <10% surface area



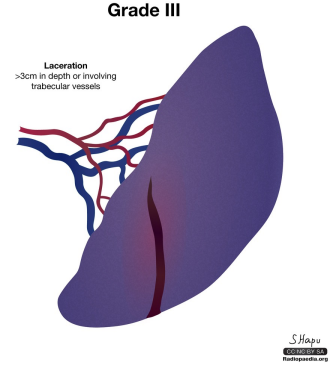
Grade II:
Laceration: 1-3 cm parenchymal depth not involving a parenchymal vessel



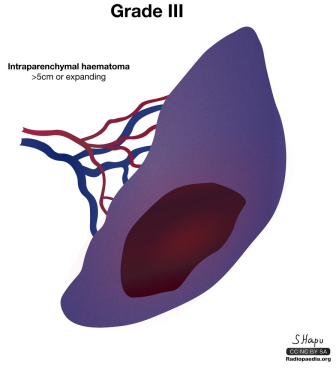
Grade II:
Hematoma: subcapsular, 10-50% surface area



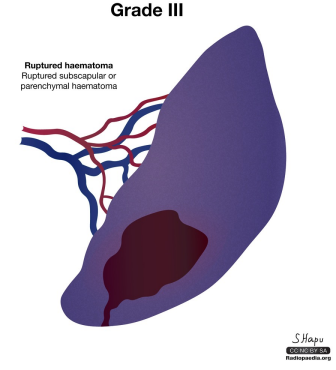
Grade II:
Hematoma: intraparenchymal, <5 cm diameter



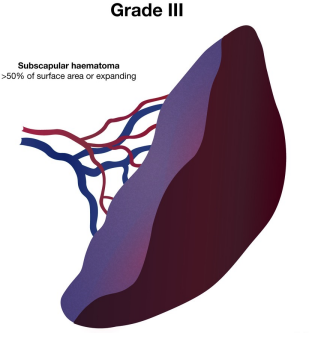
Grade III:
Laceration: >3 cm parenchymal depth or involving trabecular vessels



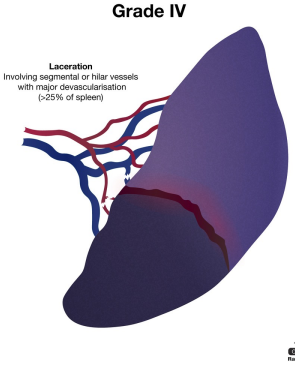
Grade III:
Hematoma: intraparenchymal hematoma >5 cm



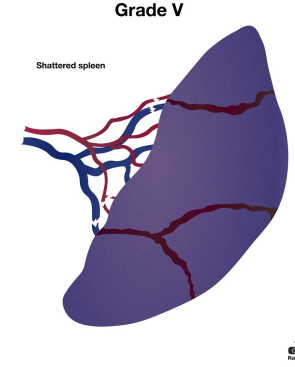
Grade III:
Hematoma: ruptured subcapsular or parenchymal hematoma



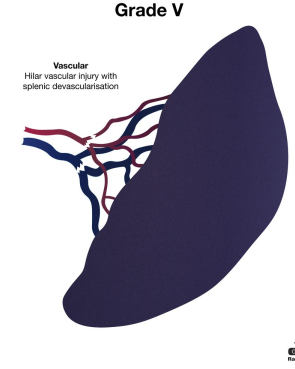
Grade III:
Hematoma: subcapsular, >50% surface area or expanding



Grade IV:
Laceration: laceration of segmental or hilar vessels producing major devascularization (>25% of spleen)



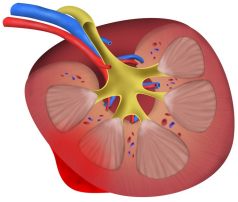
Grade V:
Laceration: completely shattered spleen



Grade V:
Vascular: hilar vascular injury which devascularizes spleen

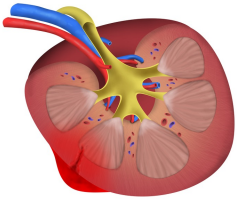
AAST Organ Injury Scale - Kidney

Grade 1



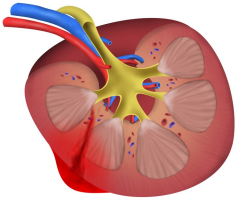
Grade I:
Contusion: microscopic or gross hematuria, urological studies normal
Hematoma: subcapsular, non-expanding without parenchymal laceration

Grade 2



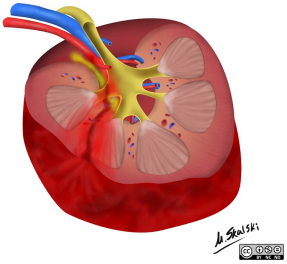
Grade II:
Contusion: non expanding perirenal hematoma confined to renal retroperitoneum
Laceration: <1 cm parenchymal depth of renal cortex without urinary extravasation

Grade 3



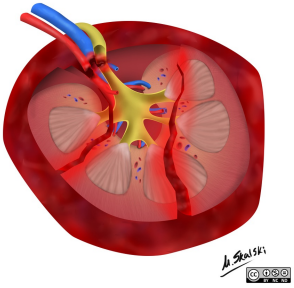
Grade III:
Laceration: >1 cm parenchymal depth of renal cortex, without collecting system rupture or urinary extravasation

Grade 4



Grade IV:
Laceration: parenchymal laceration extending through renal cortex, medulla, and collecting system
Vascular: main renal artery or vein injury with contained hemorrhage

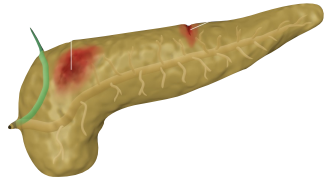
Grade 5



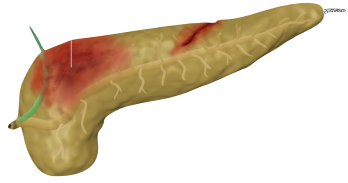
Grade V:
Laceration: completely shattered kidney
Vascular: avulsion of renal hilum which devascularizes kidney

AAST Organ Injury Scale - Pancreas

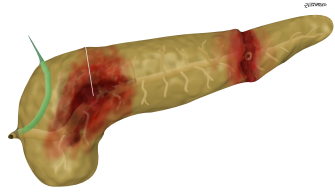
Grade I:
Superficial contusion or laceration, no ductal injury



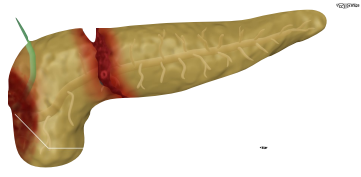
Grade II:
Parenchymal contusion or laceration, no ductal injury



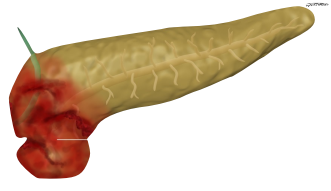
Grade III:
Parenchymal and ductal injury involving the body or tail of the pancreas



Grade IV:
Ductal injury in the head of the pancreas



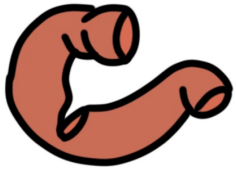
Grade V:
Massive disruption of the head of the pancreas or ampullary injury



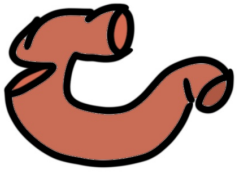
AAST Organ Injury Scale - Duodenum

Grade I:
Contusion: intramural hematoma
<50% length
Laceration: partial thickness

Grade II:
Contusion: intramural hematoma
>50% length
Laceration: <50% circumference



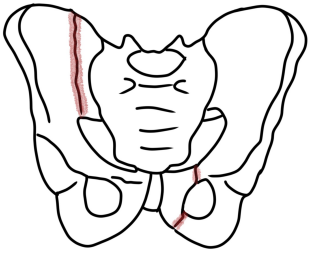
Grade III:
Laceration: >50% circumference, any segment
Transcection of D1, D3, D4



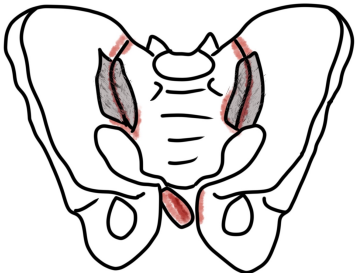
Grade IV:
Laceration: >75% circumference of D2
Transection of Ampulla of Vater
Trisection of intrapancreatic bile duct

Grade V:
Laceration: duodenal devascularization
Combined duodena-pancreatic injury

Young and Burgess Pelvic Fracture Classification



Lateral compression:
I - sacral crush injury on ipsilateral side
II - sacral crush injury with disruption of posterior SI ligaments, iliac wing fracture may be present (crescent fracture), rotationally unstable
III - severe internal rotation of ipsilateral hemipelvis with external rotation of contralateral side ("windswept" pelvis), rotationally unstable



Anteroposterior compression:
I - Symphysis diastasis <2.5 cm
II - Symphysis diastasic >2.5 cm, sacrospinous and anterior sacroiliac ligament disruption, results in rotational instability
III - Symphysis diastasis >2.5 cm, with complete disruption of the anterior and posterior SI ligament, results in complete rotational and vertical instability

Vertical shear:
Vertical displacement of symphysis and sacroiliac joints resulting in complete rotational and vertical instability

Gustillo Open Fracture Classification

Type I: Clean wound <1 cm in diameter, simple fracture pattern, no skin crushing. Low-energy mechanism

Type II: Laceration length >1 cm but without significant soft tissue crushing, no flaps, degloving, or contusion. Fracture pattern may be more complex. Low-energy mechanism.

Type III: Wound length >1 cm, with significant soft tissue disruption. Involves high-energy trauma resulting in unstable fractures with varying degrees of fragmentation.

IIIA: Wound has sufficient soft tissue to cover the bone without the need for local or distant flap

IIIB: Inadequate soft tissue coverage with periosteal stripping. Disruption of soft tissue is extensive, such that local or distant flap coverage is necessary. Serial debridements are usually necessary

IIIC: Any open fracture associated with an arterial injury that requires repair

Mangled Extremity Severity Score (MESS)

Type	Characteristics	Injury	Points
Tissue injury			
1	Low energy	Stab wounds, simple closed fractures, small-caliber gunshot wounds	1
2	Medium energy	Open or multiple-level fractures, dislocations, moderate crush injuries	2
3	High energy	Shotgun blast (close range), high-velocity gunshot wounds, high-speed motor vehicle accident, severe crush injuries	3
4	Massive crush	Massive crush injuries (logging, railroad, oil rig accidents), gross contamination, soft tissue avulsion	4
Shock			
1	Normotensive	BP stable	0
2	Transiently hypotensive	BP unstable in field but responsive to fluid	1
3	Prolonged hypotension	SBP <90 mmHg in field and responsive to IV fluids in OR	2
Ischemia			
1	None	Pulsatile, no signs of ischemia	1
2	Mild	Diminished pulses without signs of ischemia	2
3	Moderate	No pulse on Doppler, sluggish capillary refill, paraesthesia, diminished motor activity	3
4	Advanced	Pulseless, cool, paralyzed, numb without capillary refill	4
Age			
1	< 30 yo		0
2	> 30 < 50 yo		1
3	> 50 yo		2

MESS score: six or less is consistent with salvageable limb, seven or greater generally has amputation as the eventual result

NISSSA Scoring System

Parameter	Finding	Description	Points
Nerve	Sensate	No major nerve injury	0
	Dorsal	Deep or superficial peroneal nerve, femoral nerve injury	1
	Plantar partial	Tibial nerve injury	2
	Plantar complete	Sciatic nerve injury	3
Ischemia	None	Good to fair pulses, no ischemia	0
	Mild < or = 6 hrs	Reduced pulses but perfusion normal	1
	Moderate < or = 6 hrs	No pulse, prolonged capillary refill, Doppler pulses present	2
	Severe < or = 6 hrs	Pulseless, cool, ischemic, no Doppler pulses	3
	Mild > 6 hrs		2
	Moderate > 6 hrs		4
	Severe > 6 hrs		6
Soft tissue	Low	Minimal to no contusion, no contamination	0
	Medium	Moderate injury, low velocity gunshot wound, moderate contamination, minimal crush	1
	High	Moderate crush, degloving, high velocity gunshot, injury may require soft tissue flap, considerable contamination	2

Parameter	Finding	Description	Points
	Severe	Massive crush, farm injury, severe degloving, severe contamination	3
Skeletal	Low energy	Minimal to no contusion, no contamination	0
	Medium energy	Transverse fracture, minimal comminution small caliber gunshot wound	1
	High energy	Moderate displacement, moderate comminution, high velocity gunshot wound, butterfly fragments	2
	Severe energy	Segmental, severe comminution, severe bone loss	3
Shock	Normotensive	Always >90 mmHg systolic	0
	Transient hypotension	Transient	1
	Persistent hypotension	Persistent hypotension despite fluids	2
Age	< 30 yrs	Young	0
	30-50 yrs	Middle age	1
	> 50 yrs	Older	2

Kampala Trauma Score (KTS)

Age	
< 5 yrs	1
6-55 yrs	2
>55 yrs	1
Number of serious injuries	
None	3
One	2
Two or more	1
Systolic blood pressure (mmHg)	
> 89	4
50-89	3
1-49	2
Undetectable	1
Respiratory rate (breaths/min)	
10-29	3
> 30	2
< 9	1
Neurological status	
Alert	4
Responds to verbal stimuli	3
Responds to painful stimuli	2
Unresponsive	1

PROCEDURES

Nasogastric tube procedure:

- If time allows, draw up viscous lidocaine in a 10 cc syringe and flush up patient's nose telling them to swallow. Wait a few minutes for it to take effect.
- If patient is awake, have them sit upright with chin to chest while slowly sipping on water through straw as you advance an 18 Fr tube into one nostril
- Once you believe the tube to be in place, push air through the tube and listen over the stomach (you should hear the rush of air)
- When you are confident that the tube is in proper position, hook it up to suction to make sure you get gastric contents and secure the tube well onto the patient's nose
- Use chest x-ray to make sure that the tube is below the diaphragm and in the stomach, and not above the diaphragm

Needle thoracentesis procedure:

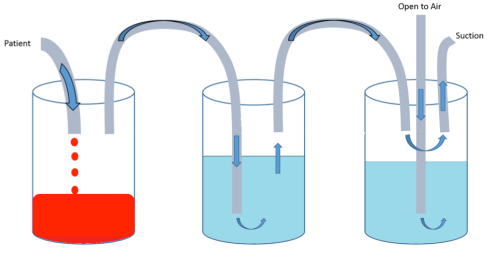
- Assess the patient's chest and respiratory status
- Administer high-flow oxygen and apply ventilation as necessary
- Identify the second intercostal space, in the midclavicular line on the side of the tension pneumothorax
- Surgically prepare the chest
- Locally anesthetize the area if patient is conscious and if time permits
- Place the patient in an upright position if a cervical spine injury has been excluded
- Keeping the Luer-Lok in the distal end of the catheter, insert an over-the-needle catheter (2 in or 5 cm long) into the skin and direct the needle just over (i.e superior to) the rib into the intercostal space
- Puncture the parietal pleura
- Remove the Luer-Lok from the catheter and listen for the sudden escape of air when the needle enters the parietal pleura, indicating that the tension pneumothorax has been relieved
- Remove the needle and replace the Luer-Lok in the distal end of the catheter. Leave the plastic catheter in place and apply a bandage or small dressing over the insertion site
- Prepare for a chest tube insertion

Chest tube procedure:

- Identify the correct side for chest tube placement and review imaging prior to beginning procedure if available
- Position patient with arm over head and/or in lateral decubitus position if possible
- Prep thorax and apply sterile drapes
- Palpate the 5th intercostal space just anterior to the mid-axillary line
- Inject lidocaine into the skin/subcutaneous tissue and then inject the deeper layers of the chest wall including periosteum and the intercostal space just above the rib
- Make a 2-3 cm incision through the skin and subcutaneous tissue and use a clamp to spread the intercostal muscle just above the rib. Use the clamp to pop into the pleural cavity and place a finger through to make sure there are no structures adherent to your point of entry.
- Hold the chest tube up to patient's thorax to gauge how deep the tube needs to be placed.
- Place the tip of the chest tube into the thoracic cavity and guide it posteriorly and superiorly with a clamp.
- Use the clamp to close off the open end of the chest tube.
- Secure your tube into place. Make sure that the skin is well approximated around the chest tube insertion site.
- Connect the chest tube to the collection chamber/suction and remove the clamp previously placed on the chest tube (watch the chest tube output to evaluate the total amount drained and to minimize the risk of re-expansion pulmonary edema and pain associated with lung re-expansion, check for air-leaks)
- Obtain chest x-ray (make sure to check for the eye of the tube, i.e. check the break in the radio-opaque line, position of the tube, pneumothorax/hemothorax/pleural effusion following tube placement)

Resource Limited Settings:

- In the absence of a chest tube drainage bottle, use this



Surgical airway

Needle cricothyroidotomy procedure:

- Assemble and prepare oxygen tubing by cutting a hole toward one end of the tubing. Connect the other end of the oxygen tubing to an oxygen source capable of delivering 50 psi or greater at the nipple, and ensure the free flow of oxygen through the tubing
- Place the patient in supine position
- Assemble a 12- or 14- gauge, 8.5 cm, over-the-needle catheter to a 6- to 12-mL syringe
- Surgically prepare the neck using antiseptic swabs
- Palpate the cricothyroid membrane anteriorly between the thyroid cartilage and the cricoid cartilage. Stabilize the trachea with the thumb and forefinger of one hand to prevent lateral movement of the trachea during the procedure
- Puncture the skin in the midline with a 12- or 14-gauge needle attached to a syringe, directly over the cricothyroid membrane (i.e., midsagitally)
- Direct the needle at a 45-degree angle caudally, while applying negative pressure to the syringe
- Carefully insert the needle through the lower half of the cricothyroid membrane, aspirating as the needle is advanced
- Note the aspiration of air, which signifies into the tracheal lumen
- Remove the syringe and withdraw the stylet, while gently advancing the catheter downward into position, taking care not to perforate the posterior wall of the trachea
- Attach the oxygen tubing over the catheter needle hub, and secure the catheter to the patient's neck
- Apply intermittent ventilation by occluding the open hole cut into the oxygen tubing with your thumb for 1 second and releasing it for 4 seconds. After releasing your thumb from the hole in the tube, passive exhalation occurs. Note: Adequate PaO2 can be maintained for only 30-45 minutes and CO2 accumulation can occur more rapidly
- Continue to observe lung inflation and auscultate the chest for adequate ventilation. Pay special attention to lung deflation in order to avoid barotrauma, which can lead to pneumothorax. If lung deflation is not observed, gentle manual rib cage compression to aid exhalation may be necessary

Surgical cricothyroidotomy procedure:

- Place the patient in a supine position with the neck in a neutral position
- Palpate the thyroid notch, cricothyroid interval, and sternal notch for orientation
- Assemble the necessary equipment
- Surgically prepare and anesthetize the area locally, if the patient is conscious
- Stabilize the thyroid cartilage with the left hand and maintain stabilization until the trachea is intubated
- Make a transverse skin incision over the cricothyroid membrane and carefully incise through the membrane transversely. CAUTION: Do not cut or remove the cricoid and/or thyroid cartilages
- Insert hemostat or tracheal spreader into the incision and rotate it 90 degrees to open the airway
- Insert a proper-size, cuffed endotracheal tube or tracheostomy tube into the cricothyroid membrane incision, directing the tube distally into the trachea
- Inflate the cuff and apply ventilation
- Observe lung inflation and auscultate the chest for adequate ventilation
- Secure the endotracheal or tracheostomy tube to the patient to prevent dislodging

Pericardiocentesis procedure:

- Monitor the patient's vital signs and electrocardiogram before, during, and after the procedure
- Surgically prepare the xiphoid and subxiphoid areas, if time allows
- Locally anesthetize the puncture site, if necessary
- Using a 16- to 18- gauge, 6-in (15 cm) or longer over-the-needle catheter, attach a 35 mL empty syringe with a three-way stopcock
- Assess the patient for any mediastinal shift that may have caused the heart to shift significantly
- Puncture the skin 1-2 cm inferior to the left of the xiphochondral junction, at a 45-degree angle to the skin
- Carefully advance the needle cephalad and aim toward the tip of the left scapula
- If the needle is advanced too far (i.e into the ventricular muscle), an injury pattern known as the "current of injury" appears on the ECG monitor (e.g., extreme ST-T wave changes or widened and enlarged QRS complex). This pattern indicates that the pericardiocentesis needle should be withdrawn until the previous baseline ECG tracing reappears. Premature ventricular contractions can also occur, secondary to irritation of ventricular myocardium
- When the needle tip enters the blood-filled pericardial sac, withdraw as much non-clotted blood as possible
- During the aspiration, the epicardium approaches the inner pericardial surface again, as does the needle tip. Subsequently an ECG current of injury pattern may reappear. This indicates that the pericardiocentesis needle should be withdrawn slightly. Should this injury pattern persist, withdraw the needle completely.
- After aspiration is completed, remove the syringe and attach a three-way stopcock, leaving the stopcock closed. Secure the catheter in place.