Trauma Surgery
Clerkship Guide
Trauma Triage

Trauma Code 1

i. Systolic blood pressure ≤ 90mmHg
ii. Glasgow Coma Scale ≤13 or loss of consciousness >5min.
iii. Respiratory rate <10 or >29
iv. Respiratory or airway compromise, intubated patients, needle chest decompression or cricothyroidotomy in the field
v. Penetrating injury to the head, neck, chest, abdomen, back, buttocks or extremities proximal to the elbow or knee.
vi. Flail chest
vii. Transfer from other hospitals receiving blood to maintain vital signs
viii. Burns >15% of total body surface area or high voltage electrical injury
ix. 2 or more long bone fractures
x. Crushed, degloved, mangled, or pulseless extremity
xi. Traumatic amputation proximal to the wrist or ankle
xii. Known or suspected pelvic fracture
xiii. Open or depressed skull fracture
xiv. Extremity paralysis suggestive of spinal cord injury
xv. Judgment of the Emergency Medicine Physician, Trauma Surgeon, or Emergency Department RN

b. Expected to be in room upon patient arrival if adequate notice has been given, commonly 10 minutes is ample time

c. If the notification is short or the activation is initiated after the patient has arrived, the trauma team is expected at bedside within 15 minutes of notification.

Trauma Alert

i. History of loss of consciousness following a traumatic event
ii. Fall >20 feet or 2 stories
iii. High risk auto crash
   1. Intrusion >12 in occupant site or >18in any site
   2. Ejection from vehicle
   3. Death in same vehicle
iv. Pedestrian or bicyclist struck, thrown or run over by a vehicle
v. Motorcycle crash >20mph
vi. Traumatic amputation distal to the wrist or ankle
vii. Open long bone fracture
viii. Pregnancy >20wks with significant mechanism of injury
ix. EMS provider judgment or emergency department RN.

Trauma Consult

i. Mandatory Trauma Consult
   1. Emergency Medicine Physician Evaluates and if the patient meets any of the following criteria the Trauma Team must be consulted
      a. 2 or more systems injured
      b. 1st or 2nd rib fracture or 2 or more rib fractures
      c. Abdominal seatbelt sign
      d. Gross hematuria
ii. Discretionary Trauma Consult
1. The trauma service may be consulted at the discretion of the emergency medicine physician or surgical subspecialist based on but not limited to:
   a. Mechanism of injury
   b. Clinical concern
   c. Need for surgical co-management

ATLS
Primary Survey
A: Airway
   A. Evaluate patency and ensure that the patient can protect and maintain their airway.
      a. Appropriate verbal response indicates that the airway is patent, ventilation is adequate and brain perfusion is intact.
   B. Assess for airway obstruction
      a. Retraction.
      b. Use of accessory muscles.
      c. Abnormal sounds may indicate obstruction (snoring, gurgling, stridor, hoarseness)
      d. Agitation or belligerence may be signs of hypoxia.
      e. Obtundation may suggest hypercarbia.
      f. Cyanosis (late sign).
   C. Management
      a. Maintain manual immobilization of head and neck in neutral position. Chin lift or jaw thrust. Suction secretions, remove foreign bodies. Oral or nasopharyngeal airway if needed and tolerated by the patient. Mask assisted ventilation, 100% oxygen.
      b. Indications for definitive airway:
         i. Actual impending or potential airway obstruction (e.g. neck hematoma, laryngeal injury, stridor, potential inhalation injury, upper airway edema).
         ii. Risk for aspiration (e.g. bleeding, vomiting).
         iii. Decreased level of consciousness (e.g. closed head injury with GCS ≤ 8).
         iv. Hemodynamic instability/shock.
         v. Severe maxillofacial injuries.
         vi. Inadequate respiratory effort (e.g. tachypnea, apnea, hypoxia, hypercarbia).
         vii. Combativeness threatening patient safety or impeding workup.
      c. Establish a definitive airway
         i. Endotracheal intubation.
         ii. Cricothyroidotomy.
            1. Definitive airway is needed, and intubation is unsuccessful.
      d. Anterior neck injury, stridor, potential upper airway obstruction.
         i. Suspect laryngeal crush injury or laryngotracheal separation.
ii. Consider awake, fiberoptic intubation, awake tracheostomy in the OR or emergent cricothyroidotomy depending on the urgency of the situation.
e. Maintain manual immobilization of the cervical spine in neutral position using a second person when establishing a definitive airway. Replace cervical collar if removed while establishing a definitive airway.

**B: Breathing**

1. Evaluate rate and depth of respirations
2. Inspect and palpate the neck and chest for wounds, chest movement, use of accessory muscles, crepitus or tracheal deviation.
3. Percuss the chest for dullness or hyperresonance.
4. Auscultate for breath sounds bilaterally
5. Attach a pulse oximeter.
6. Management
   a. Administer high concentration oxygen.
   b. Mechanical ventilation if ventilation is inadequate.
      i. Bag-valve mask initially
       ii. Endotracheal intubation if ventilator effort remains inadequate.
      iii. Verify ET tube position by auscultation and end tidal CO₂ determination.
         iv. Ventilator support with ventilator.
7. Tension pneumothorax
   a. Immediate needle thoracostomy (14 or 16 gauge IV catheter in second intercostal space, midclavicular line) or tube thoracostomy.
   b. Tube thoracostomy to follow needle thoracostomy, if performed.
   c. Chest X-ray is contraindicated prior to treatment if patient has hemodynamic compromise.
8. Open pneumothorax
   a. Cover defect with Vaseline occlusive dressing.
   b. Tube thoracostomy.
9. Hemothorax
   a. Thoracostomy tube, 32 F or larger.
   b. Plan for possible autotransfusion if applicable.
10. Simple pneumothorax
    a. Tube thoracostomy after confirmation by chest X-ray.
11. Indications for thoracotomy
    a. Immediate thoracotomy in the ED.
       i. Penetrating neck or torso wound with potential for thoracic penetration
          1. —and—
       ii. Loss of pulse with signs of life < 10 minutes prior to arrival
          1. —or—
          iii. Non-resuscitation BP (<50) in ED.
    b. *Signs of life include reactive pupils, spontaneous movement, respiratory effort, and organized cardiac electrical activity.
C: Circulation
   a. Identify and control sources of external hemorrhage with direct pressure.
   b. Assess for signs of shock as indicated by vital signs or evidence of inadequate organ perfusion (mental status, skin perfusion).
   c. Consider potential sources of occult, internal hemorrhage;
      a. Chest cavity
      b. Abdominal cavity
      c. Pelvic fracture
      d. Long bone fracture
   d. Shock in trauma is almost always due to hemorrhage.
   e. Management
      a. Insert 2 large bore (16 gauge) IV catheters.
      b. Simultaneously draw blood for labs and type and cross
      c. Initiate IV fluid with warm crystalloid solution, initially 2L LR or NS, then consider blood.
      d. Consider large bore central venous access
      e. Prevent hypothermia.
      f. If large volume resuscitation or transfusion anticipated, use Level 1 Rapid Infuser and attempt to limit further crystalloid administration.
      g. If massive hemorrhage situation, consider activating Massive Transfusion Protocol.
      h. With head or lung injury give adequate fluid resuscitation to maintain normal BP and pulse, but avoid over-resuscitation.
      i. Consider cardiac tamponade.
         i. Especially with penetrating anterior chest injury.
         ii. Occasionally with blunt chest trauma.
         iii. Hypotension with reduced pulse pressure.
         iv. May respond transiently to volume loading.
         v. Neck vein distention, facial and upper extremity cyanosis.
         vi. Elevated CVP > 20 cm H2O in the presence of hypotension.
         vii. Rule out tension pneumothorax, since this is more likely than tamponade in blunt trauma.
         viii. Document with FAST.
         ix. If BP >50 proceed emergently to OR for pericardial window, followed by median sternotomy if pericardial blood present.
      j. ED thoracotomy should not be done for cardiac arrest following blunt trauma: survival is zero.
      k. Cardiac arrest following blunt trauma: treat potentially reversible causes:
         i. Secure airway.
         ii. Consider placement of bilateral chest tubes.
         iii. Fluid resuscitation including uncrossmatched blood.
         iv. ACLS protocol.
         v. No X-rays or OR unless patient stabilizes with sustained BP.

D: Disability
   a. Assess Glasgow Coma Scale
      a. Best Eye Response ( remember “4 eyes”)
1. No eye opening
2. Eye opening to pain
3. Eye opening to verbal command
4. Eyes open spontaneously
b. Best verbal response
   1. No Verbal response
   2. Incomprehensible sounds
   3. Inappropriate words
   4. Confused
   5. Oriented
c. Best motor response (remember 6 cylinder motor)
   1. No motor response
   2. Decerebrate posturing (extension)
   3. Decorticate posturing (flexion)
   4. Withdrawal from pain
   5. Localize to pain
   6. Obeys commands
ii. Intubation for GCS ≤ 8.
iii. If the patient is currently intubated the score is followed by a T, for example 3T.
b. Evaluate pupils
c. Evaluate movement of extremities
d. Consider urgent neurosurgery consult for:
   a. Persistent GCS < 14.
   b. Unequal pupils not explained by local injury or peripheral nerve palsy.
   c. Focal motor or sensory deficit suggestive of intracranial mass lesion or spinal cord injury.
e. Maintain oxygen saturation >95%
f. Continue resuscitation to maintain euvolemia.
g. Ventilation to achieve pCO₂ of 40 mmHg.
h. Medication:
   a. Sedate patient to avoid agitation and protect airway.
   b. Consider mannitol 1 g/kg in patients with possible severe head injury to prevent brain swelling.
i. Consider immediate CT scan of head in patients with signs suggestive of an intracranial mass lesion.
   a. Unequal pupils.
   b. Focal or lateralizing signs.

E: Exposure
1. Logroll to examine back.
2. Remove backboard.
3. Prevent hypothermia.
   a. Warm resuscitation room (80°F) prior to patient arrival.
   b. Warm IV fluids and blood products.
   c. Warm blankets.
   d. Baer Hugger.
Other Primary Survey

a. Insert nasogastric/orogastric tube and Foley catheter, as indicated and after rectal exam.
b. Consider chest X-ray and AP pelvis X-ray at this point in patients with blunt trauma

Secondary Survey

The secondary survey does not begin until the primary survey has been completed, immediately life-threatening issues have been dealt with, resuscitative efforts are underway and vital functions have begun to stabilize. Physical examination follows a head-to-toe sequence.

a. Head/Maxillofacial
   i. Evaluate head and scalp for lacerations, contusions and fractures, control bleeding with closure or packing.
   ii. Assess pupils and eye movement; remove contact lens.
   iii. Assess for bony crepitus or instability of the facial bones.
   iv. Look in nose, mouth and ears.
   v. Assess for soft tissue contusion, swelling or tenderness.
   vi. Place NGT/OGT if indicated: avoid NGT in any patient with significant head or facial trauma or possible facial/skull fractures.

b. Neck
   i. Maintain in-line stabilization of neck if the cervical collar is removed for examination
   ii. Inspect for wounds, contusion, and/or swelling. For penetrating wounds assess whether platysma has been violated.
   iii. Palpate for tenderness, crepitus, tracheal deviation and pulse.
   iv. Auscultate for bruits.
   v. If there is significant bruising or abrasion of the neck, consider CT angiogram to evaluate for arterial injury.
   vi. Consider clearing C-spine clinically if no significant injuries and clinical criteria met (see Practice Guideline: Cervical Spine Clearance).

c. Chest
   i. Inspect front and back of chest for signs of injury, open wounds, use of accessory muscles, bilateral chest excursion, flail chest.
   ii. Palpate chest wall for tenderness or crepitus.
   iii. Auscultate breath sounds and heart sounds.
   iv. Percuss chest for hyperresonance or dullness.

d. Abdomen
   i. Inspect anterior abdomen, flank and back for penetrating wounds, contusions, abrasions or distention.
   ii. Palpate abdomen to evaluate for tenderness or peritoneal signs.
   iii. Consider FAST exam to supplement physical examination in blunt trauma.
   iv. Determine need for further evaluation of the abdomen: if unstable, consider DPL or laparotomy if FAST shows hemoperitoneum; if stable, consider CT abdomen and pelvis.

e. Pelvis
   i. Palpate for pain or instability
ii. If known pelvic fracture from previous X-ray, avoid unnecessary palpation and movement to minimize bleeding.

iii. Consider wrapping of pelvis to facilitate stabilization and tamponade.

iv. If evidence of bleeding, consider angiographic embolization or external fixation.

v. Evaluate for signs of urethral injury prior to inserting Foley.
   1. Blood at the meatus.
   2. High riding prostate on rectal examination.
   3. Perineal or scrotal hematoma.

vi. Rectal examination:
   1. Anal sphincter tone.
   2. High riding prostate.
   3. Rectal wall disruption.
   4. Penetrating bony fragments.
   5. Presence of gross blood (avoid introducing blood into rectum from external blood on perineum).

vii. Vaginal examination:
   1. Vaginal lacerations.
   2. Bony penetration.
   3. Remove tampons.

f. Extremities
   i. Inspect extremities for contusions, lacerations and deformity.
   ii. Palpate extremities for tenderness and crepitation.
   iii. Palpate peripheral pulses.
   iv. Control bleeding from wounds.
   v. Reduce fractures and apply splints or traction until Orthopedic Surgeon arrives.
   vi. Evaluate muscle compartments for compartment syndrome. Consider compartment pressure measurement if clinical findings concerning. Distal pulses may be palpable even if the presence of a compartment syndrome.
   vii. Antibiotics for open fractures.

g. Spine
   i. Inspect and palpate the thoracic and lumbar spine for deformity, tenderness, contusions and lacerations.

h. Neurologic
   i. Reevaluate pupils.
   ii. Determine repeat GCS score.
   iii. Evaluate motor and sensory function of extremities.
   iv. Observe for lateralizing signs.

After stabilization

a. Prioritize injuries.
   a. Life threatening.
   b. Stable but potentially life threatening.
   c. Limb threatening.
   d. Non-life or limb threatening.

b. Determine sequence of management.
   a. OR
   b. Imaging
c. Interventional Radiology.
d. Intensive Care Unit.
e. Floor

c. Frequent Reassessment
   i. Reevaluate airway, breathing and circulation for signs of deterioration.
   ii. Vital signs: frequent reassessment of vital signs, determined by severity of injury.
   iii. Outputs: serial outputs from chest tube, and Foley should be monitored closely for any concerning trends.
   iv. Serial Labs: consider initial frequent determinations, especially in patients with shock, significant blood loss or potential for bleeding: H/H, lactate, ABG. Non-correcting elevation of serum lactate or metabolic acidosis may indicate persistent shock/end organ hypo perfusion.

Tertiary survey
   a. The purpose of a tertiary survey is to ensure thorough examination and to avoid missing any injuries. It typically occurs 24 hours after admission and is a full head to toe exam.

Massive Transfusion Protocol (MTP)
   1. The activation of the MTP will be based upon but not limited to the following:
      a. Blood loss exceeding 5000 ml
      b. Ongoing blood loss with profound hypovolemia, anemia, or hypotension
      c. Adult patients requiring more than 4 units of PRBCs in the first hour of resuscitation or likely to require >10 units of PRBCs in the first 6 hours of resuscitation.
      d. Hereditary or acquired hemostatic disorder of plasma coagulation or platelet defects and bleeding secondary to traumatic injury.
   2. EQUIPMENT AND SUPPLIES:
      a. Blood Products
      b. Blood Warmer
      c. Rapid Infuser
         i. Obtain the IV warming/rapid infuser equipment STAT for administration of PRBC and plasma (Do not transfuse Platelets through warming or rapid infusion equipment).
      d. Laboratory equipment – tubes
      e. Patient Labels
      f. Blood administration tubing
   3. Ensure 2 large bore (18 gauge or larger) IVs (or comparable access) are patent and secure. PICC lines can NOT be used for transfusions.
   4. A 1:1:1 ratio of PRBCs, Plasma and Platelets will be the goal of component transfusion once the MTP is activated unless otherwise specified by the Trauma Surgeon (or designee).
   5. Uncrossmatched red blood cells will be type O Negative blood for females under 55 years of age. Other patients may receive O Positive blood.
   6. The MTP packs will be prepared in the Blood Bank as follows:
      i. Pack 1 will include:
1. 6 units of PRBCs
2. 6 units of Plasma

ii. Pack 2 will include:
   1. 6 units of PRBCs
   2. 6 units of Plasma
   3. 1 unit of Apheresis Platelets

iii. Pack 3 will include
   1. 6 units of PRBCs
   2. 6 units of Plasma
   3. 1 unit of Apheresis Platelets
   4. 2 packs of Cryoprecipitate

iv. Subsequent Packs will include:
   1. 6 units of PRBCs
   2. 6 units of Plasma
   3. 1 unit of Apheresis Platelets
   4. Odd number packs will include 2 packs of Cryoprecipitate

b. MTP Packs will be delivered every 20 minutes until the MTP is terminated.

7. Discontinuation of MTP
   a. The MTP will continue until the Trauma Surgeon, Anesthesiologist, or
      Critical Care Physician determines the protocol is no longer needed.

8. See Appendix for MTP algorithm

TEG: Thromboelastogram

a. Used to monitor coagulation
b. **R time** (reaction time aka time to clot)
   i. Increased by
      1. Factor deficiency
      2. Anti-Coagulation
      3. Severe hypofibrinogenemia
      4. Severe thrombocytopenia
   
   a. **Treatment**: FFP

   ii. Decreased by
      1. Hypercoagulability syndromes
      2. Slow clotting speed

   c. **Angle or alpha** (slope between R and K)
      i. Rate of clot formation aka thrombin burst
      ii. K= kinetics and is the rate to a certain clot strength.
      iii. Decreased angle

     1. **Treatment**: Cryoprecipitate

d. **Maximum Amplitude (MA)**
   i. Measures fibrin and platelet bonding aka platelet function
   1. Decreased MA
      a. Can be caused by
         i. Thrombocytopenia
         ii. Thrombocytopenia
         iii. Fibrinolysis
iv. Hypofibrinogenemia

b. Treatment: Platelets

e. See appendix for examples of TEG shapes

Traumatic Brain Injuries (TBI)

*Information in the following section from the ACS TQIP Best Practices in the Management of Traumatic Brain Injury.*

1. Glasgow coma scale
   a. A score of $\geq 13$ correlates with a mild brain injury
   b. 9-12 is a moderate injury
   c. $\leq 8$ a severe brain injury.
   d. Any person in the field with a GCS $\leq 13$ should be immediately taken to the highest level trauma center.

2. Management
   a. Pulse Ox $\geq 95\%$
   b. PaO$_2$ $\geq 100$ mmHg
   c. PaCO$_2$ 35-40 mmHg
   d. pH 7.35-7.45
   e. Avoid hypotension and monitor systolic blood pressure and MAP
      i. SBP $\geq 100$ mmHg
   f. Body temperature 36-38°C.
      i. Lethal Triad of Trauma
         1. Hypothermia
         2. Acidosis
         3. Coagulopathy
   g. Avoid hyponatremia due to the risk of increasing cerebral edema.
      i. Goal sodium 135-145.
   h. TBI patients are at risk of Diabetes insipidus and SIADH be sure to monitor serum sodium and osmolality.
   i. Monitor blood glucose, hyper and hypoglycemia can worsen the outcome for TBI patients. Goal range is 80-180mg/dL
   j. Transfuse at Hgb $< 7$
      i. Anemia and coagulopathy are common complications in TBI.
      ii. Evaluate early for coagulopathy using INR. Goal INR $\leq 1.4$, Platelets $\geq 75 \times 10^3$/mm$^3$
      iii. At St. Vincent TEG can also be utilized.
   k. DVT prophylaxis
      i. Modified Berne-Norwood Criteria
         1. Low risk
            a. No moderate or high risk criteria
               i. Initiate pharmacologic prophylaxis if CT stable at 24 hrs
         2. Moderate risk
            a. Subdural or epidural hematoma $> 8$ mm
            b. Contusion or intraventricular hemorrhage $> 2$ cm
c. Multiple contusions per lobe subarachnoid hemorrhage with abnormal CT angiogram Evidence of progression at 24 hrs
   i. Initiate pharmacologic prophylaxis if CT stable at 72 hrs

3. High Risk
   a. ICP monitor placement Craniotomy Evidence of progression at 72 hrs
      i. Consider placement of an IVC filter

l. ICP monitoring
   i. Elevated ICP is a predictor of a poor outcome.
      1. Normal ICP is 5-15 mmHg
   ii. Patients with a GCS ≤8 with evidence of structural brain damage should be monitored.
   iii. External ventricular drain (EVD) is the preferred method for monitoring ICP
      1. It can measure ICP and allow for drainage.
      2. At St. Vincent you will often see a Camino
   iv. ICP in TBI should be kept ≤20 mmHg, with a range of 20-25 mmHg as a trigger for treatment of intracranial hypertension.
   v. Cushing’s reflex: is a physiologic response to elevated ICP
      1. Hypertension
      2. Bradycardia
      3. Decreased RR.

m. Cerebral Perfusion Pressure (CPP)
   i. CPP = (Mean Arterial Pressure – ICP)
   ii. CPP is a marker of cerebral blood flow, goal in TBI is a CPP ≥60 mmHg
   iii. Adjusting the CPP can help restore cerebral perfusion and oxygenation

n. Treatment of Intracranial Pressures: a 3 tier approach
   i. Tier 1
      1. Head of bed elevated at 30 degrees (reverse Trendelenburg) to improve cerebral venous outflow
      2. Sedation and analgesia using recommended short-acting agents (for example, propofol, fentanyl, midazolam) in intubated patients
      3. Ventricular drainage performed intermittently. Continuous drainage is not recommended unless an additional ICP monitor is placed, as when the drain is open, it does not accurately reflect the true ICP
      4. Repeat CT imaging and neurological examination should be considered to rule out the development of a surgical mass lesion and guide treatment
      5. If ICP remains ≥ 20 - 25 mmHg proceed to Tier 2
   ii. Tier 2
      1. In patients with a parenchymal ICP monitor an EVD should be considered to allow for intermittent CSF drainage
2. Hyperosmolar therapy should be given intermittently as needed for ICP elevation and not on a routine schedule
   a. Mannitol should be administered in intermittent boluses (0.25 - 1 gm/kg body weight). Caution should be taken in the hypovolemic patient when osmotic diuresis is instituted with mannitol. The serum sodium and osmolality must be assessed frequently (every 6 hours) and additional doses should be held if serum osmolality exceeds 320 mOsm/L. Mannitol may also be held if there is evidence of hypovolemia
   b. Hypertonic saline may be administered in intermittent boluses of 3% sodium chloride solution (250 ml over 1/2 hour) or other concentrations (e.g., 30cc of 23.4%). Serum sodium and osmolality must be assessed frequently (every 6 hours) and additional doses should be held if serum sodium exceeds 160 mEq/L
3. Cerebral autoregulation should be assessed. If the patient is not autoregulating, the CPP goal should be lowered to reduce ICP (to no less than 50 mm Hg). Additional neuromonitoring (e.g., PbtO2, SjvO2, CBF) may help determine optimal CPP
4. PaCO2 goal of 30 - 35 mmHg should be maintained, as long as brain hypoxia is not encountered. Additional neuromonitoring (e.g., PbtO2, SjvO2, CBF) may help determine optimal PaCO2
5. Repeat CT imaging and neurological examination should be considered to rule out development of a surgical mass lesion and guide treatment
6. Neuromuscular paralysis achieved with a bolus “test dose” of a neuromuscular blocking agent should be considered if the above measures fail to adequately lower ICP and restore CPP. If there is a positive response, continuous infusion of a neuromuscular blocking agent should be employed (Tier 3)
7. If ICP remains ≥ 20 - 25 mmHg proceed to Tier 3
   iii. Tier 3
   1. Decompressive hemi-cranietomy or bilateral craniectomy should only be performed if treatments in Tiers 1 and 2 are not sufficient or are limited by development of side effects of medical treatment
   2. Neuromuscular paralysis via continuous infusion of a neuromuscular blocking agent can be employed if there is a positive response to a bolus dose. The infusion should be titrated to maintain at least two twitches (out of a train of four) using a peripheral nerve stimulator. Adequate sedation must be utilized
   3. Barbiturate or propofol (anesthesia dosage) coma may be induced for those patients who have failed to respond to aggressive measures to control malignant intracranial hypertension; however it should only be instituted if a test dose of barbituate or propofol results in a decrease in ICP, thereby identifying the patient as a
“responder.” Hypotension is a frequent side effect of high dose therapy with these agents. Meticulous volume resuscitation should be ensured and infusion of vasopressor/inotropes may be required. Prolonged use or high dose of propofol can lead to propofol infusion syndrome. Continuous EEG may be used to ensure targeting of the infusion to burst suppression.

4. Hypothermia (<36 °C) is not currently recommended as an initial TBI treatment. Hypothermia should be reserved for “rescue” or salvage therapy after reasonable attempts at ICP control via the previous Tier 3 treatments have failed.

1. Subdural Hematoma
   a. Blood collection under the dura, acute or chronic
   b. Tearing of the bridging veins
   c. Think of elderly who fall while on blood thinners or alcoholics.
   d. Concave/Crescent shaped hematoma
   e. CT without contrast. Do not perform lumbar puncture on patients with subdural or epidural hematoma, as it will increase the risk of herniation.
   f. Tx: surgical drainage or supportive therapy for small bleeds.

2. Epidural Hematoma
   a. Collection of blood between the skull and the dura
      i. Biconvex/ lens shaped
   b. Loss of consciousness followed by a lucid interval
   c. Most commonly middle meningeal artery
   d. Commonly associated with an ipsilateral blown pupil
   e. Dx: CT scan without contrast, do not perform a LP.
   f. Tx: surgical evacuation

3. Subarachnoid (SAH)
   a. Bleeding between the pia and arachnoid membrane.
   b. Commonly due to trauma or rupture of arterial aneurysm
   c. “Worst headache of my life”
   d. LP will show RBC
   e. Dx: CT without contrast, MRA or angiography to localize the bleed.
   f. Tx: prevent increased ICP, anticonvulsants, possible surgical clipping or embolization of aneurysm.

4. Cerebral contusion
   a. Coup: injury at the site of impact
   b. Contrecoup- injury at the site opposite of the impact.

5. Diffuse Axonal Injury (DAI)
   a. Shear injury to brain parenchyma
   b. Often from rapid deceleration
   c. May lead to a persistent vegetative state in trauma patients
   d. Dx: MRI

6. Skull Fractures
   a. Linear Fracture
      i. Most common, often detected on CT.
b. Depressed Fracture  
   i. Object strikes the head deforming and depressing segments of the skull.

c. Comminuted  
   i. Multiple fractures, often at the point of impact.  
   ii. Resembles and egg shell.

d. Basilar skull fracture  
   i. Battles sign  
      1. Bruising over the mastoid process  
   ii. Raccoon eyes  
      1. Orbital bruising

e. Indications for surgery  
   i. Contaminated wound  
   ii. Severe deformity  
   iii. Impingement of cortex  
   iv. Open fracture  
      1. Treatment  
         a. Antibiotics  
         b. Phenytoin  
         c. Surgery
   v. CSF leak

Blunt Cerebro-Vascular Injury BCVI:  
Injury to the extracranial carotid and/or vertebral arteries following a blunt mechanism of injury. These injuries include intimal flaps, intramural thrombus, dissection, pseudoaneurysm, occlusion or transaction.

   a. Up to 2/3 of patients are asymptomatic at the time of diagnosis and in most the first symptom will be a stroke.  
      i. Early recognition of injuries and treatment with anticoagulation or antiplatelet agents, when possible, appears to reduce the stroke rate from somewhere between 20 and 60% to less than 1%.
   b. To screen for BCVI a CTA of the neck should be ordered.
   c. Signs and symptoms of BCVI  
      i. Potential arterial hemorrhage from the nose, mouth or neck  
      ii. Cervical bruit in patient <50 years old  
      iii. Expanding cervical hematoma  
      iv. Focal neurologic deficit: TIA, hemiparesis, vertebrobasilar symptoms, Horner’s syndrome  
      v. Neurologic deficit: inconsistent with head CT  
      vi. Acute stroke on CT or MRI
   d. Risk Factors for BCVI  
      i. LeFort II or III midface fractures  
      ii. Mandible fracture  
      iii. Basilar skull fracture, occipital condyle fracture, other complex skull fracture  
      iv. CHI consistent with diffuse axonal injury and GCS<6
v. Any cervical body or transverse foramen fracture, any subluxation or ligamentous injury, any fracture of C1-3
vi. Near hanging with anoxic brain injury
vii. Clothesline injury, seatbelt abrasion or direct blow to the neck with significant swelling, pain or altered mental status
viii. Scalp de-gloving
ix. Thoracic vascular injuries
x. Blunt cardiac rupture
e. Treatment of BCVI
   i. Most patients will undergo anticoagulation as treatment of BCVI. A small percentage of patients may undergo surgical repair or endovascular stent.

Facial injuries
1. Mandible fractures
   a. 2nd most common facial fracture (1st is nasal bone fra
   b. Dx: CT face
   c. Signs
      i. Trismus
      ii. Malocclusion
         1. Misalignment of the teeth.
      iii. Numbness
      iv. Loose or missing teeth
      v. Hematoma on floor of the mouth
   d. Tx: ± maxillomandibular fixation (MMF)
2. Le Fort Fractures
   a. Le Fort 1
   b. Le Fort 2
   c. Le Fort 3
      i. Complete Craniofacial separation.
3. Tripod Fracture
   a. Fracture of the zygomatic complex that involves the 4 following fractures
      i. Frontozygomatic Suture
      ii. Inferior orbital rim
      iii. Zygomaticomaxillary suture
      iv. Zygomaticotemporal suture
4. Orbital fractures
   a. Blowout fracture
      i. Loss of support of the orbital floor
      ii. Patient often has enophthalmos
   b. Complications
      i. Entrapment of extraocular muscles
      ii. Loss of extraocular muscle mobility
         1. Lateral tracking
      iii. Diplopia
C-Spine Clearance

1. Patients should be considered to be at risk for a cervical spine injury if they present with any of the following:
   a. A history of direct trauma to the head or neck
   b. Significant deceleration mechanism such as:
      a) MVC associated with high speed, rear end collision, extensive damage, rollover or ejection
      b) Fall from height
      c) Pedestrian, bicycle or MCC with history of significant impact
   c. Pain in the cervical spine or paraspinous muscles
   d. Tenderness to palpation of the cervical spine
   e. Traumatic brain injury or skull fracture
   f. Facial injuries such as fractures, extensive soft tissue injury, severe lacerations or loss of teeth.
   g. Neurologic deficits in the arms, legs or torso suggestive of spinal cord injury.
   h. Spine fractures at other levels.

2. The NEXUS Clinical Criteria: The National Emergency X-Radiography Utilization Study (NEXUS) was a prospective, observational study of stable patients with blunt trauma who were at risk for cervical spine injury. The presence of any one of the following findings was considered to be evidence that the patient was at increased risk for cervical spine injury and required radiographic evaluation:
   1. Posterior midline cervical spine tenderness
      a. Midline posterior bony cervical spine tenderness is present if the patients complains of pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or pain is evinced with direct palpation of any cervical spinous process
   2. Evidence of intoxication
      a. Patients should be considered intoxicated if they have either of the following:
         i. a recent history by the patient or an observer of intoxication or intoxicating ingestion; or
         ii. evidence of intoxication on physical examination such as odor of alcohol, slurred speech, ataxia, dysmetria or other cerebellar findings, or any behavior consistent with intoxication. Patients may also be considered to be intoxicated if tests of bodily secretions are positive for drugs (including but not limited to alcohol) that affect level of alertness.
   3. Decreased level of alertness
      a. An altered level of alertness can include any of the following:
         i. Glasgow Coma Scale score of 14 or less
         ii. Disorientation to person, place, time, or events
         iii. Inability to remember 3 objects at 5 minutes
         iv. Delayed or inappropriate response to external stimuli
   4. Focal neurologic deficit
      a. Any focal neurologic complaint (by history) or finding (on motor or sensory examination).
   5. Painful distracting injury
a. No precise definition for distracting painful injury is possible. This includes any condition thought by the clinician to be producing pain sufficient to distract the patient from a second (neck) injury. Examples may include, but are not limited to:
   i. Any long bone fracture
   ii. Visceral injury requiring surgical consultation
   iii. Large laceration, degloving injury, or crush injury
   iv. Large burns
   v. Any other injury producing acute functional impairment. Physicians may also classify any injury as distracting if it is thought to have the potential to impair the patient's ability to appreciate other injuries.

3. In the absence of any of the above NEXUS Clinical Criteria, the C-collar may be removed.
   a. If the patient can demonstrate voluntary flexion and extension of the neck, and rotation of the head 45° both ways without pain, the C-spine may be considered clinically cleared and the C-collar left off.

4. Radiologic Evaluation
   a. With a significant mechanism of injury and the presence of any one of the NEXUS Clinical Criteria should undergo radiologic evaluation
      1. The primary screening modality for the radiologic evaluation of the C-spine is CT scan from the occiput to T1 with sagittal or coronal reconstructions.
      2. Plain X-rays contribute no additional information and should not be obtained.
   b. If the CT of the C-spine demonstrates any abnormality, Neurosurgery consultation should be obtained. Isolated transverse process fractures do not require consultation. Any fracture involving a cervical transverse process foramen requires CTA imaging of the neck to rule out blunt injury to the vertebral artery.
   c. A conscious patient without neurologic deficit suggestive of possible spinal cord injury, who has neck pain or tenderness, distracting injuries, chemical alteration or inability to provide full ROM should undergo a CT of the C-spine.
      1. If the CT is normal, the C-spine is considered to be cleared and the C-collar can be removed. The patient may wear a hard or soft collar for comfort if they have persistent neck pain
      2. If the CT is abnormal, Neurosurgery consultation should be obtained.
   d. A conscious patient with neurologic deficits suggestive of possible spinal cord injury should undergo CT of the C-spine
      1. If the CT is abnormal, Neurosurgery consultation should be obtained
      2. If the CT is normal, a stat MRI of the C-spine should be obtained.
         a. If the MRI is abnormal, Neurosurgery consultation should be obtained.
         b. If the MRI is normal, Neurology consultation should be obtained.
   e. Obtunded, comatose or intubated patients should all undergo CT of the C-spine to rule out injury. Virtually all of these patients will also undergo CT of the head.
1. If there are no detectable clinical signs of cervical spinal cord or root abnormalities
   a. And the CT of the C-spine shows no acute abnormality, leave C-collar in place until able to examine and clear clinically. If unable to clear clinically after 48 hours, the C-Spine may be considered cleared and the C-collar removed. The final CT report describing no acute abnormality should be confirmed prior to removing the C-collar
   b. If the CT of the C-spine is abnormal, Neurosurgery consultation should be obtained.

2. If there are clinical signs of cervical spinal cord or root abnormalities, Neurosurgery consultation should be obtained even if the CT of the C-Spine is negative. An MRI may be obtained at their discretion.
   f. If an MRI of the C-spine is negative, the cervical collar may be safely removed.

5. Delay in C-spine clearance and the prolonged use of semi-rigid cervical collars carries significant risks including:
   a. Decubitus pressure ulceration of the occiput and chin area
   b. Intubation and airway maintenance is more difficult
   c. Cervical venous obstruction may occur, exacerbating elevated intracranial pressure in patients with associated head injury
   d. Central venous access and maintenance is more difficult
   e. Performance of tracheostomy is more difficult
   f. Restrictions in mobility and physical therapy regimens may increase the risk of venous thromboembolism and ventilator-associated pneumonia
      i. Therefore C-spine clearance should be completed as expeditiously as possible

6. See appendix for C-spine algorithm

<table>
<thead>
<tr>
<th>Penetrating Neck Injuries</th>
<th>Boarders</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone III</td>
<td>Extends from the angle of the mandible to the base of the skull</td>
<td>CTA of Neck</td>
</tr>
<tr>
<td>Zone II</td>
<td>Extends from the cricoid cartilage to the angle of the mandible</td>
<td>CTA of neck or Surgical exploration</td>
</tr>
<tr>
<td>Zone I</td>
<td>Extends from the sternal notch and clavicles to the cricoid cartilage</td>
<td>CTA of neck and chest</td>
</tr>
</tbody>
</table>

1. Airway compromise will be the most immediately life threatening issue. The airway should also be evaluated for impeding or potential compromise, as bleeding within the tight fascia compartments of the neck can rapidly precipitate an airway emergency.
   a. Options for airway control:
      i. Orotracheal intubation is the preferred method.
ii. Emergency cricothyroidotomy in the E.D. if unable to intubate. Risk of releasing a contained hematoma, but establishing an airway is the first priority.

iii. Surgical airway in the OR. Tracheostomy under local anesthesia in the OR may rarely be considered if airway is patent but threatened and intubation not possible.

2. Indications for emergent exploration in the OR:
   i. Shock.
   ii. Active hemorrhage.
   iii. Expanding or pulsatile hematoma.
   iv. Need for surgical airway.
   v. Obvious tracheal or esophageal injury.
   vi. Impalement injury.

3. Physical signs of significant injury
   i. Bleeding.
   ii. Bruit or thrill.
   iii. Dysphagia.
   iv. Dysphonia: Hoarseness or stridor.
   v. Subcutaneous emphysema.
   vi. Hematoma, especially for enlargement.
   vii. Oropharyngeal bleeding.
   viii. Hemoptyis.
   ix. Neurologic deficit.
   x. Absent or diminished pulses

**Blunt Chest Wall Trauma**

1. Mechanism
   a. External blunt force
   b. Rapid deceleration

2. Signs/Symptoms
   a. Pain
   b. Tachypnea/respiratory distress
   c. Tachycardia
   d. Hypotension
   e. Distended neck veins
   f. Tracheal deviation
   g. Diminished/absent breath sounds
   h. Absent or Paradoxical chest wall moment
   i. Hemoptyis
   j. Chest wall deformity
   k. Chest wall contusion/hematoma/laceration
   l. Crepitus/subcutaneous emphysema
m. Severe trauma to head and abdomen/pelvis should prompt consideration of chest injuries

B. Airway management is a priority
   1. Intubate early for distress/obstruction
   2. Positive pressure ventilation will worsen pneumothorax and pneumomediastinum
   3. Be prepared for needle decompression or tube thoracostomy for tension pneumothorax

C. Diagnostic Studies to obtain
   1. AP CXR
      a. If the patient is transferred from another facility, always repeat CSR to rule out new hemo/pneumothorax, mediastinal widening, or displaced tubes.
   2. U/S pericardium to look for fluid/tamponade
   3. CT + contrast
   4. EKG

Lung Trauma
   a. Tension Pneumothorax
      i. Physiology
         1. Respiratory and hemodynamic compromise from increased intrapleural pressure
      ii. Clinical diagnosis –
         1. Tracheal deviation
         2. Hyperresonance
         3. Respiratory distress
         4. Absent breath sounds
         5. Hemodynamic instability due to impaired venous return
      iii. Management
         1. Consider needle decompression if unstable. Tube thoracostomy for definitive management.
   b. Open pneumothorax
      i. Physiology
         1. During inspiration, a chest wall defect preferentially allows air to be pulled into the pleural cavity rather than into the trachea
      ii. Assessment: Sucking chest wound
      iii. Management
         1. Intubation and mechanical ventilation
         2. Tube thoracostomy (not through wound)
         3. Cover wound and consider surgical repair of the defect
   c. Hemothorax
      i. Physiology
         1. Hemorrhage leading to hemodynamic and respiratory compromise. Usual source of bleeding in blunt trauma is chest wall
      ii. Assessment
1. Diminished breath sounds
2. Dullness to percussion
3. Shock
4. “White Out” on CXR

iii. Management
   1. Tube thoracostomy
   2. Initial output <1500ml – observation
   3. Initial output >1500ml or >200ml/hr – consider operative intervention

d. Pulmonary contusion
   i. Physiology
      1. Intraparenchymal bleeding leading to decreasing lung compliance and poor gas exchange
   ii. Assessment
      1. Often seen in the presence of rib fractures
      2. May not be visible on CXR initially
   iii. Management
      1. Observation for limited injury
      2. Mechanical ventilation for distress/hypoxemia

e. Diaphragm Disruption
   i. Physiology
      1. Respiratory compromise from loss of diaphragmatic contractility and movement of abdominal contents into pleural cavity
   ii. Assessment
      1. Dyspnea
      2. CXR – viscera in chest
      3. Chest CT
   iii. Management
      1. Intubation/Mechanical ventilation for respiratory distress
      2. Surgical repair via laparotomy or thoracotomy

f. Tracheobronchial disruption
   i. Physiology
      1. Respiratory compromise from air leak or inability to ventilate through disrupted airway
   ii. Assessment
      1. Massive pneumomediastinum or pneumothorax
      2. Severe air leak after tube thoracostomy
   iii. Management
      1. Bronchoscopy to localize injury
      2. Chest tube for pneumothorax
      3. Thoracotomy for repair

Rib Fractures
5. Rib fractures/Flail chest
   a. Physiology
      1. Instability in the thoracic cage compromises ventilation
2. Radiographic flail chest is when 3 or more contiguous ribs are broken in 2 or more places.

b. Assessment
1. Dyspnea
2. Tachypnea
3. Pain (rib fractures are extremely painful)
4. Tenderness
5. Crepitus
6. Expect underlying pulmonary injury

c. Management
1. Pain control, consider epidural analgesia, and pulmonary toilet
   a. Incentive spirometry is essential in preventing complications like pneumonia. It is crucial for pain to be well controlled to allow for deep breathing and coughing.
2. Drain associated effusion or hemothorax
3. Mechanical ventilation for respiratory distress/hypoxemia
4. Consider operative stabilization of large flail segment or multiple displaced fractures

Cardiac Injury
1. Blunt cardiac injury
   i. Physiology
      1. Myocardial contusion can lead to conduction abnormalities and decreased contractility
   ii. Assessment
      1. Check EKG and echo
      2. Telemetry too monitor for arrhythmias
   iii. Management
      1. Antiarrhythmic or inotropic therapy as indicated

2. Cardiac Tamponade
   i. Physiology
      1. Intrapericardial fluid results in decreased venous return and reduced cardiac output
   ii. Assessment
      1. Tachycardia
   2. Beck’s Triad
      a. Distended neck veins
      b. Hypotension
      c. Distant heart sounds
      3. Pericardial fluid on FAST or echo
   iii. Management
      1. IV fluid bolus
      2. Pericardial window (rarely pericardiocentesis)
      3. Sternotomy or thoracotomy for control of ongoing hemorrhage

3. Aortic disruption
   i. Physiology
1. Results from severe deceleration, aorta tears at points of fixation, most commonly at distal arch
2. 81% dead on scene, 50% of initial survivors die within 24 hours

ii. Assessment
1. Shock, widened mediastinum, pleural effusion
2. CTA – periaortic hematoma contained by adventitia or pleura vs. frank rupture with massive hemothorax

iii. Management
1. Operative repair vs. stent graft

4. Thoracic Aortic Injury Signs
   a. Widened mediastinum
   b. Apical capping
   c. Loss of AP window
   d. Depressed left main stem bronchus
   e. NG tube/ tracheal deviation
   f. Pleural fluid
   g. High speed mechanism

5. Ruptured esophagus
   a. Physiology
      i. Sepsis from reflux of oral/gastric contents into mediastinum and pleural cavity
   b. Assessment
      i. Pneumomediastinum
      ii. Pleural effusion (gastric contents in chest tube)
      iii. Contrast esophagram
   c. Management
      i. EGD
      ii. VATS drainage and stent
      iii. Thoracotomy and primary repair


Blunt Abdominal injury
1. The assessment and diagnosis of abdominal trauma is part of the secondary survey. Perform physical examination of the abdomen, including the flank and back, and rectal exam. A single negative abdominal examination does not necessarily rule out intra-abdominal injury.
2. Immediate exploratory laparotomy
   a. Diffuse peritoneal irritation suggestive of peritonitis.
   b. Shock with abdominal distention suggesting source of blood loss is in the abdomen. This may be confirmed with FAST exam.
   c. Ruptured diaphragm on chest x-ray.
   a. Abdominal pain with or without peritoneal signs on physical examination.
b. External signs of abdominal wall trauma
   i. Contusions
   ii. Seat belt sign
   iii. Lacerations

c. Pelvic fracture
d. Rib fractures
e. Mediastinal injury (e.g. aortic transection, mediastinal hematoma)
f. Thoracolumbar spine fractures
g. Unexplained hemorrhage or shock, even if transient
h. Fractures above and below the diaphragm
i. Gross or microscopic hematuria

4. Patients who are hemodynamically unstable and source of hemorrhage is uncertain a FAST exam should be performed.
   a. FAST exam
      i. Focused Assessment with Sonography in Trauma
      ii. Using ultrasound to detect blood collections of greater than 500cc in 4 key areas.
         1. Subxyphoid: Pericardial window
         2. Left Upper quadrant: Splenorenal, Pleural, subphrenic, inferior pole of the left kidney
         3. Right Upper Quadrant: Hepatorenal (Morison’s pouch), Pleural, subphrenic, inferior pole of the right kidney.
         4. Suprapubic: retrovesicular recess/ pouch of Douglas
      iii. If FAST exam is positive for intra-abdominal blood and the amount of blood is enough to explain the hemodynamic instability, go to the OR for exploratory laparotomy.
      iv. Negative or equivocal FAST exam: continue to evaluate for other causes of shock and hemorrhage.

5. In patients who are hemodynamically stable (or transiently unstable but become stable after limited resuscitation), and have significant mechanism of injury and/or risk factors as outlined above:
   a. CT scan abdomen and pelvis with IV contrast only
   b. Patients with gross hematuria should undergo CT cystogram.
   c. FAST exam may or may not also be performed.
   d. If CT scan is positive for solid organ injuries, most will be managed non-operatively
   e. Hemoperitoneum will result in varying degrees of peritoneal irritation but will usually not become significantly worse with serial physical examination. If the patient develops progressive signs of peritonitis, exploratory laparotomy will need to be considered.
   f. If CT scan shows free fluid in the abdomen with no solid organ injuries, consider possibility of hollow viscus injury. Other causes of free fluid include:
      i. Minimal solid organ injury not visible on CT
      ii. Mesenteric laceration
      iii. Pelvic fracture with disruption of retroperitoneal hematoma.

6. Patients who are hemodynamically stable with no risk factors and a minimal mechanism
of injury, can be managed by serial physical examination.

Summary of Blunt Abdominal Injury Patient Management

<table>
<thead>
<tr>
<th>Patient Status</th>
<th>Unstable Uncertain source of hemorrhage</th>
<th>Stable + Significant mechanism of injury</th>
<th>Stable No Risk factors Minimal mechanism of injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>FAST EXAM</td>
<td>CT scan w/ IV contrast ± FAST</td>
<td>Serial Physical Exams</td>
</tr>
</tbody>
</table>

Liver Injury

1. Grading of Liver Injuries (AAST)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Subcapsular hematoma &lt;10% of surface area</td>
</tr>
<tr>
<td></td>
<td>Capsular tear &lt;1 cm in depth</td>
</tr>
<tr>
<td>2</td>
<td>Subcapsular hematoma 10-50% of surface area</td>
</tr>
<tr>
<td></td>
<td>Intraparenchymal hematoma &lt;10 cm in diameter</td>
</tr>
<tr>
<td></td>
<td>Capsular tear 1-3 cm parenchymal depth, &lt;10 cm in length</td>
</tr>
<tr>
<td>3</td>
<td>Subcapsular hematoma &gt;50% of surface area</td>
</tr>
<tr>
<td></td>
<td>Intraparenchymal hematoma &gt;10 cm</td>
</tr>
<tr>
<td></td>
<td>Ruptured subcapsular or intraparenchymal hematoma</td>
</tr>
<tr>
<td></td>
<td>Laceration &gt;3 cm in depth</td>
</tr>
<tr>
<td>4</td>
<td>Laceration involving 25-75% of hepatic lobe or 1-3 segments</td>
</tr>
<tr>
<td>5</td>
<td>Lacerations involving &gt;75% of hepatic lobe or &gt;3 Couinard segments</td>
</tr>
<tr>
<td></td>
<td>Juxtahepatic venous injuries (IVC, hepatic veins)</td>
</tr>
</tbody>
</table>

1. Recommendations
   a. Patients who are hemodynamically unstable or who have diffuse peritonitis after blunt abdominal trauma should be taken urgently for laparotomy.
   b. A routine laparotomy is not indicated in the hemodynamically stable patient without peritonitis presenting with an isolated blunt hepatic injury.
      1. In the hemodynamically stable blunt abdominal trauma patient without peritonitis, an abdominal CT scan with intravenous contrast should be performed to identify and assess the severity of injury to the liver.
   c. Angiography with embolization may be considered as a first-line intervention for a patient who is a transient responder to resuscitation as an adjunct potential operative intervention.
   d. Angiography with embolization should be considered in a hemodynamically stable patient with evidence of active extravasation (a contrast blush) on abdominal CT scan.
      i. Hepatic Angiography and Embolization
         1. Efficacy of angioembolization to control bleeding after blunt hepatic injury is greater than 80%.
         2. Complications of angioembolization of hepatic injuries occur commonly (up to 60%) and include:
            a. Delayed hemorrhage (2-3%)
            b. Contrast induced renal insufficiency
c. Localized hepatic necrosis or abscess
d. Necrosis of the biliary tract with leakage of bile or biloma (3%)
e. Missed injuries
f. Ischemic cholecystitis
g. Minor (pain, fever, pleural effusion)

3. Complication rates increase with the grade of injury:
   a. Grade III: 1%
   b. Grade IV: 21%
   c. Grade V: 63%
e. Operative intervention should be considered in the following clinical situations:
   i. Patients who are hemodynamically unstable (non-responders) and have evidence of intra-abdominal hemorrhage on FAST or CT
   ii. Signs of diffuse peritoneal irritation suggestive of perforated viscus
   iii. Ongoing transfusion requirements and/or worsening abdominal distention suggestive of persistent hemorrhage.

### Splenic Injury
Grading of splenic injuries (AAST):

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
</table>
| Grade 1 | Subcapsular hematoma <10% surface area  
Capsular tear <1 cm in depth |
| Grade 2 | Subcapsular hematoma 10-50% surface area  
Intraparenchymal hematoma <5 cm in diameter  
Capsular tear 1-3 cm in depth, does not involve trabecular vessels |
| Grade 3 | Subcapsular hematoma >50% surface area  
Intraparenchymal hematoma >5 cm  
Ruptured subcapsular or intraparenchymal hematoma  
Capsular tear >3 cm in depth or involving trabecular vessels |
| Grade 4 | Laceration involving segmental or hilar vessels producing devascularization of >25% of spleen |
| Grade 5 | Completely shattered spleen  
Hilar vascular injury that devascularizes the spleen |

1. Recommendations
   a. Patients with splenic injuries who have diffuse peritonitis or who are hemodynamically unstable after blunt abdominal trauma should be taken urgently for laparotomy.
   b. A routine laparotomy is not indicated in the hemodynamically stable patient without peritonitis presenting with an isolated splenic injury.
   c. In the hemodynamically normal blunt abdominal trauma patient without peritonitis, an abdominal CT scan with intravenous contrast should be performed to identify and assess the severity of injury to the spleen.
   d. Angiography should be considered for patients with:
      i. Grade IV or V injuries
      ii. Presence of contrast blush or extravasation
iii. Moderate hemoperitoneum
iv. Evidence of ongoing splenic bleeding
   1. Non-operative management of splenic injuries should only be considered in an environment that provides capabilities for monitoring, serial clinical evaluations, and an operating room available for urgent laparotomy
v. Complications of angioembolization of splenic injuries occur in 20% of patients and include:
   1. Failure to control bleeding (11-15%)
   2. Contrast-induced renal insufficiency (27%)
   3. Missed injuries
   4. Splenic infarction or abscess
   5. Minor (pain, fever, pleural effusion)

2. Failure of Non-operative Management
   a. Patients with the following criteria are thought to be at high risk of failure of non-operative management:
      i. Vascular extravasation or blush, or pseudoaneurysm on CT scan
      ii. Grade III splenic injuries with large hemoperitoneum
      iii. Grade IV or V splenic injuries
   3. Of those patients who fail non-operative management, 75% fail within 48 hours of injury and 93% within 1 week.
   4. Operative intervention should be considered in the following clinical situations
      a. Worsening signs of diffuse peritoneal irritation suggestive of perforated viscus
      b. Persistent tachycardia or hypotension despite moderate crystalloid loading (1-2 l) in the absence of other sources of ongoing bleeding.
      c. Recurrent tachycardia or hypotension despite moderate crystalloid loading (1-2 l) in the absence of other sources of ongoing bleeding.
      d. Requirement of 2 units of PRBC’s within the first 48 hours to maintain Hb >7.
   5. Patients undergoing splenectomy should receive the triple vaccine (Pneumococcus, Meningococcus, Hemophilus influenzae) prior to discharge and should be counselled on the small, lifelong risk of Overwhelming Post-Splenectomy Infection (OPSI) due to one of these organisms and the precautions to take to initiate early treatment.

Pelvic Fractures
1. Mechanism: High energy blunt trauma
3. Bleeding from pelvic fracture is most commonly a venous bleed.
4. May present with hemodynamic instability (hypotension, tachycardia)
5. Pelvic binder
   a. Initial management of unstable pelvic fracture to reduce volume.
   b. Placed over greater trochanters with or without internal rotation of lower extremities
c. Expectant surgical intervention
   i. If binder is left on for too long skin necrosis may result
6. Imaging
   a. Plain Film, FAST exam, CT scan
7. Treatment
   a. Depending on type and other injuries
      i. Angioembolization
      ii. External fixation
      iii. Internal fixation
      iv. Non-op potentially LC1 and APC1
      v. LC 2 and 3, APC 2 and 3, and VS go to the OR.
8. Lateral Compression fracture
   a. Type 1
      i. most common lateral fracture, often seen in the elderly
      ii. Posteriorly applied force
      iii. causes sacral impaction
      iv. low energy and stable.
   b. Type 2
      i. Posterior SI joint fracture and dislocation
      ii. Anteriorly applied force
      iii. Commonly associated with head and abdominal injuries
   c. Type 3
      i. Unstable
      ii. Usually from direct lateral force or crush with one side trapped or immobile.
         1. An example would be getting run over by a car
9. Anterior-Posterior Compression fracture
   a. Type 1
      i. <2.5cm of pubic symphysis
   b. Type 2
      i. “Open Book” fracture
      ii. >2.5cm of diastasis
      iii. Significant resuscitation requirements
   c. Type 3
      i. Unstable
      ii. Complete disruption
10. Vertical Shear
    a. Unstable, Significant retroperitoneal
    b. Fall from height

Bladder and Urethral Injuries
1. More common in the presence of the following findings
   a. Diastasis of pubic symphysis
   b. Diastasis of SI joint.
   c. Fracture of Ilium, pubic rami or sacrum.
2. Increased risk of bladder injury
   a. Extremes of age: elderly and babies due to location of bladder
b. Those with full bladders i.e. EtOH and MVC.

3. Intraperitoneal bladder injury
   a. Mechanism
      i. Usually due to blunt trauma with a full bladder.
      ii. Bladder ruptures at the dome and fluid travels into peritoneal cavity.
   b. Signs
      i. Hematuria
      ii. Acute abdomen
   c. Imaging
      i. Cystography
         1. Contrast outlines bowels, can extend up to the liver.
         2. Smooth contours
         3. Scalloped appearance
      ii. If blood at meatus obtain retrograde urethrogram.
   d. Treatment
      i. Surgical repair

4. Extraperitoneal
   a. Commonly occurs secondary to pelvic fracture.
   b. Mechanism
      i. Shearing force to base of bladder
      ii. Injury secondary to bony fragments
      iii. Fluids travel to soft tissues, perineum, scrotum, thigh etc.
   c. Signs
      i. Hematuria
      ii. Pelvic instability (2/2 pelvic fracture)
      iii. Suprapubic tenderness
   d. Imaging
      i. Cystography
         1. Contrast in lower half of pelvis
         2. Irregular, flamed shape, spreading along fascial planes.
      ii. If blood at meatus obtain retrograde urethrogram.
   e. Treatment
      i. Conservative management: bladder catheter

5. Urethral injuries
   a. More common in males
   b. Can be a result of straddle injuries or pelvic fractures
   c. Signs
      i. High riding prostate on digital rectal exam
      ii. Blood at the meatus
      iii. Scrotal or perineal ecchymosis
      iv. Inability to void
   d. Management
i. If there is blood at the external meatus you must order a retrograde urethrogram or cystogram. Do not place a Foley catheter.

e. Treatment (dependent on severity of injury)
   i. Surgical Repair
   ii. Suprapubic catheter
   iii. Foley catheter

f. Complications
   i. Stricture
   ii. Erectile dysfunction

Spinal cord injuries
1. Anterior cord syndrome
   a. Flexion injuries
   b. Full or partial loss of bilateral motor, pain, and temperature sensation
   c. Intact light touch, position and vibratory senses.

2. Brown-Sequard syndrome
   a. Hemisection of the spinal cord
      i. Penetrating injury
      ii. Disc protrusion
      iii. Hematoma
      iv. Tumor
   b. Ipsilateral loss of motor function, position, vibratory and light touch
   c. Contralateral loss of pain and temperature

3. Central cord syndrome
   a. Commonly seen in patients with a preexisting narrowing of the spinal canal
   b. Hyperextension injuries
   c. Weakness in the upper extremities worse than the lower extremities. With distal weakness worse than proximal weakness.
   d. Recovery
      i. First lower extremities progressing to upper extremities then hands recover.

Fractures
a. Cervical Spine
   i. Imaging: AP and lateral films that include full visualization of C1-T1.
   ii. Most common fracture location is C5
   iii. Most common subluxation is C5 on C6
   iv. Jefferson fracture
      1. C1 atlas burst fracture
      2. Fracturing of both the anterior and posterior rings
   v. Odontoid Fractures
      1. Type 1: only the tip of the dens
      2. Type 2: only the base of the dens
      3. Type 3: fracture of the base and body of C2

b. Thoracic/lumbar Spine
i. Most fractures occur between T10-L5 and are typically due to hyperflexion.

ii. Chance fracture
   1. Horizontal fracture through the vertebral body, spinous process, laminae, pedicles, and tearing of the posterior spinous ligament.
   2. Often from MVC while wearing a single lap belt.
   3. Commonly associated with blunt small bowel injury.

iii. Jumped Facets
   1. Dislocation of facet joint where the inferior articular process ‘jumps’ over the superior articular process of the vertebra below and becomes locked in place.

   c. Open fracture management
      i. Prophylactic antibiotics
      ii. Surgical debridement
      iii. Wound irrigation in less than 6hrs post accident
      iv. Tetanus
      v. Open reduction and fixation

d. Lower Extremity
   i. Femur
      1. May have blood loss of 1.5L in closed femur fractures.
   ii. Tibia
      1. Greater risk of compartment syndrome

e. Compartment syndrome
   i. The 6 P’s
      1. Pain
      2. Pallor
      3. Paresthesias
      4. Pulses weak/absent
      5. Poikilothermia
      6. Paralysis
   ii. Treatment
      1. Fasciotomy
   iii. Most common in the anterior tibial compartment
      1. If compartment syndrome is missed can cause foot drop.

Burns
   Assessment
   2. ABCDE
      a. Be very suspicious of inhalation injury. Have a low threshold for intubation.
         i. Burns can cause airway edema, which can lead to a difficult airway if you wait to intubate.
   3. Determine degree of burn and Total Body (Burn) Surface Area TBSA
      a. Degree
<table>
<thead>
<tr>
<th>Depth</th>
<th>Injury</th>
<th>Symptoms</th>
<th>Prognosis</th>
<th>Treatment</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st degree</td>
<td>Superficial</td>
<td>Confined to the epidermis with an intact epidermal barrier</td>
<td>Painful, erythematous, blanches</td>
<td>Does not result in scaring</td>
<td>Sunburn, scald</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Aimed at comfort, topical soothing salves and NSAIDS.</td>
<td></td>
</tr>
<tr>
<td>2nd degree</td>
<td>Superficial</td>
<td>Epidermis and superficial dermis</td>
<td>Painful, erythematous, blanch, and blisters.</td>
<td>Heal in 1-2 weeks. May have slight skin discoloration</td>
<td>Scald, flash flame</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deep</td>
<td>Through the epidermis and deep into the dermis to the reticular dermis</td>
<td>Painful, pale, mottled, does NOT blanch</td>
<td>Severe scarring. Heal in 2-5 weeks.</td>
<td>Excision and grafting</td>
</tr>
<tr>
<td>3rd degree</td>
<td>Full thickness</td>
<td>Through the epidermis and dermis</td>
<td>Hard, leathery eschar, PAINLESS, black, white or cherry red.</td>
<td></td>
<td>Excision and grafting</td>
</tr>
<tr>
<td>4th degree</td>
<td>Involves organs beneath the skin</td>
<td>Muscle, bone, brain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Total Body Surface Area
   a. Rule of 9’s
      i. Each upper limb 9%
      ii. Each lower limb 18%
      iii. Anterior and posterior trunk 18% each
      iv. Head and neck 9%
      v. Perineum and genitalia 1%
   b. Palmer method
      i. The area of the patient’s palm is equal to 1%
   ii. Fluid Resuscitation
      1. Parkland Burn Formula
         a. To calculate initial fluid resuscitation in burn patients with ≥20% TBSA
         b. Volume (mL) = TBSA (%) × Weight (Kg) × 4
         c. Half of the volume calculated is given in the first 8 hours.
         d. The other half is given in the next 16 hours.
      2. Crystalloid or LR is the fluid of choice.
      3. Burn Shock
a. Burns cause leaky capillaries, which increases fluid loss from the intravascular space. Which is why crystalloid is the fluid of choice.

iii. Initial management
1. Clean dry dressing or sheet to cover burned area
2. Damp dressings should not be used.
3. Patient should be wrapped in blanket to minimize heat loss.
4. Do not use intramuscular narcotics for pain, peripheral vasoconstriction leads to decreased drug absorption
5. Use small doses of IV morphine after complete assessment.

iv. Complications
1. Hypermetabolic response
   a. **Ebb phase**
      i. 1st phase occurring within 48hrs, lasting ~5 days
      ii. Decrease in cardiac output, oxygen consumption, metabolic rate
      iii. Impaired glucose tolerance associated with hyperglycemic state
   b. **Flow phase** (plateau): 2nd phase
      i. Hyperdynamic circulation and hypermetabolic state
      ii. 2x the insulin release → leading to insulin resistance
   c. The hypermetabolic state has been thought to last until wound closure but recently it has been found to last for up to 12 months.
   d. Severely burned patients resting metabolic rate exceeds 140% of normal upon admission.
   e. Increase in catabolism results in loss of total body protein, decreased immune defense, and decreased wound healing
   f. Approximately 28% of patients with more than 30% TBSA burns will develop severe multiorgan dysfunction.
2. Cardiac
   a. Immediately after injury there is a decreased cardiac output from loss of plasma volume, increased peripheral vascular resistance. Severe burn patients with >40% TBSA have increased cardiac output and tachycardia that decreases over time.
3. Renal
   a. Decreased blood flow and GFR. Stress induced hormones angiotensin, aldosterone and vasopressin further reduce renal blood flow leading to oliguria which if untreated can lead to ATN and renal failure.
   b. There are two periods of risk, the initial phase however with early aggressive fluid resuscitation the incidence has greatly decreased. Then a second phase 2-14 days post injury.
   c. Renal failure is marked by decreasing urine output, fluid overload, electrolyte abnormalities, including metabolic acidosis and hyperkalemia, the development of azotemia, and increased serum creatinine levels.
   d. Urine output of more than 1 mL/kg is an adequate measure of renal perfusion in the absence of underlying renal disease.
   e. The indications for dialysis are volume overload or electrolyte abnormalities not amenable to other treatments
4. Hepatic
a. After severe burn injury, the liver increases in size to more than 200% of normal.
b. If the liver starts to fail protein concentrations of the coagulation cascade decrease to critical levels and the patient becomes coagulopathic. Toxins are not cleared from the bloodstream and bilirubin concentrations increase
c. Coagulopathy, treatment should be directed at replacement of factors II, VII, IX, and X. Albumin replacement may also be required.
d. Attention to obstructive causes of hyperbilirubinemia (acalculous cholecystitis), should be considered. Initial treatment of this condition should be gallbladder drainage, which can be done percutaneously.

5. Hematologic
   a. Burn patients may become coagulopathic through two mechanisms, depletion and impaired synthesis of coagulation factors or thrombocytopenia.
   b. Factors associated with factor depletion are through disseminated intravascular coagulation associated with sepsis. Treatment should include the infusion of fresh-frozen plasma and cryoprecipitate.
   c. Thrombocytopenia is common in severe burns from depletion during burn wound excision. Platelet counts lower than 50,000/µL are common and do not require treatment. Only when the bleeding is diffuse and is noted to occur from IV sites should the administration of exogenous platelets be considered.

6. Infections
   a. Common organisms
      i. *Staph. aureus*
         1. Onset 2-5 days, loss of wound granulation, disorientation, fever, \( \uparrow \uparrow \) WBC count, modest hypotension. Best prognosis.
      
      ii. *Pseudomonas*
         1. Rapid onset 12-36hrs, wound necrosis patchy black, severe hypotension, ±fever, ± WBC count, modest CNS signs.
      
      iii. *Candida albicans*
         1. Onset over days, minimal exudate, worst prognosis 30-50% mortality.
   
   b. Treatments
      i. Antimicrobial Salves
         1. **Silver sulfadiazine** (Silvadene): Broad-spectrum antimicrobial; painless and easy to use; does not penetrate eschar; may leave black tattoos from silver ion; mild inhibition of epithelialization
         2. **Mafenide acetate** (Sulfamylon): Broad-spectrum antimicrobial; penetrates eschar; may cause pain in sensate skin; wide application may cause metabolic acidosis; mild inhibition of epithelialization
      
      ii. Antimicrobial Soak
1. **Sodium hypochlorite 0.025% (Dakins solution)** Effective against almost all microbes, particularly gram-positive organisms; mildly inhibits epithelialization

7. **Compartment syndrome**
   a. Escharotomy May be necessary in deep second and third degree wounds that encompass the circumference of an extremity, due to the possibility of the peripheral circulation being compromised.  
   b. Watch for numbness and tingling in the limb and increased pain of the digits. Evaluate Doppler signals, and capillary refill. In the trunk it can compromise respiratory function.  
   c. The procedure is performed bedside requiring lateral and medial aspects of the extremity to be incised longitudinally along the entire constricting eschar.

8. **Tetanus**
   a. All burn patients unless immunized in the past 12 months require tetanus prophylaxis

9. **Curling’s Ulcer**
   a. Mucosal atrophy, changes in digestive absorption, increased intestinal permeability. Atrophy of the small bowel mucosa occurs within 12hrs of injury proportional to burn size. Curling’s ulcer may develop.
   
b. **Electrical Burns**
   i. High voltage (>1000 V) or low voltage (<1000 V)
   ii. Muscles sustain most of the damage. The most significant damage is within the deep tissue. The wound itself may not appear to be that impressive and there could be edema in deep tissues that could be detrimental. Cardiac arrhythmias/arrest may develop. Be sure to monitor cardiac function in the first 24hrs. Muscle damage can lead to myoglobin release and ultimately an obstructive nephropathy.
   
c. **Chemical Burns**
   i. Lavage the wound with 15-20L of tap water. Monitor the Ph if you are unsure of chemical composition.

**Common procedures and complications**

d. **Central Venous Line**
   i. **Indications**
      1. CVP monitoring  
      2. Fluid resuscitation/ frequent blood products  
      3. Difficult peripheral venous access  
      4. TPN  
   
   ii. **Contraindications**
      1. Uncooperative/combative placement  
      2. Distorted anatomy  
      3. Bleeding disorder (uncorrected)  
      4. Skin infection over desired site  
      5. Pneumothorax/hemothorax/ on contralateral side  
   
   iii. **Sites**
      1. Internal jugular
2. Subclavian
3. Femoral
   a. From lateral to medical Navel nerve, artery, vein, empty space, lymphatic.

iv. Complications
1. Pneumothorax/hemothorax
   a. Always get post placement film
2. Infection
3. Malposition of catheter
4. Arterial puncture
5. Thrombosis
6. Cardiac tamponade/arrhythmias
7. Catheter embolism
8. Air emboli

v. Post placement film pneumothorax

vi. Pearls
1. Never ever let go of the guide wire
2. Trendelenberg will aid in the placement of IJ and subclavian lines.

E. Chest Tube (thoracostomy tube)
   i. Most common procedure performed to manage thoracic trauma.
   ii. Indications
      1. Pneumothorax/hemothorax
      2. Pleural effusion
      3. Empyema
      4. Chylothorax
   iii. Procedure
      1. Incise between 4-5th intercostal space between the mid and anterior axillary lines
      2. Blunt dissection OVER the rib into the pleural space
      3. Finger exploration to confirm intrapleural space.
      4. Place tube posteriorly and superiorly.
      5. In most adults 10-12cm
      6. Once resistance is met stop. Do not force against resistance.
      7. Suture in place and apply occlusive dressing. Connect to closed system container.
   iv. Post placement film
      1. To ensure proper placement
   v. Complications
      1. Subcutaneous (vs. intrathoracic) placement
      2. Bleeding from intercostal vessels
      3. Injury to intercostal nerves
      4. Infection
      5. Lung laceration
      6. Diaphragm injury
      7. Liver injury
   vi. Removing a chest tube
1. No air leak and less than 150ml in 24hrs.

2. Supplies
   a. Vaseline gauze, 4x4, suture kit, tape
   b. Cut the stich
   c. Ask patient to exhale completely
   d. Pull tube with Vaseline gauze covering to maintain seal.
   e. Cover and tape

vii. Post pull film
   1. 4 hours post pull to check for pneumothorax.

viii. Chest tube chambers/ language
   1. Collection chamber
   2. Water seal
      a. One way valve
   3. Suction
   4. Tidaling
      a. Looking at the water seal chamber fluid should move with respirations when off suction
      b. Tidaling stops or decreases when pleura seals off the chest tube

5. Checking for air leak
   a. On suction look at the water chamber
      i. If bubbles pass through the water seal= large air leak
   b. In no air leak is present turn off suction and ask patient to cough
      i. If air bubbles through the water seal a small air leak is present.

6. Chest tube sizes
   a. Hemothorax: 36 French
   b. Adult pneumothorax: 24 French or pigtail.

f. Tracheostomy and Cricothyroidotomy
   i. Indications (in the context of trauma surgery)
      1. Prolonged intubation/mechanical ventilation >2weeks
      2. Upper airway obstruction
         a. Anatomic
         b. Angioedema
         c. Burns
         d. Failed intubation
         e. Infection leading to obstruction
         f. Laryngeal dysfunction
         g. Neck irradiation
         h. Neoplasm
         i. Neurologic dysfunction or injury
         j. Traumatic obstruction

3. To aid in pulmonary toilet
   a. Aspiration
b. Excessive secretions
4. Decreases the work of breathing compared to endotracheal intubation, which makes weaning the ventilator easier.

ii. Contraindications
1. Skin or soft tissue infection
2. Conditions leading to distorted anatomy

iii. Percutaneous dilatational tracheostomy
1. Can be performed at bedside

iv. Open tracheostomy
1. Performed under general anesthesia
2. Often preformed in conjunction with other operations.

v. Emergent Cricothyroidotomy
1. Performed when airway needs to be obtained and endotracheal intubation has failed.
2. This is only a temporary airway and should be converted to a tracheostomy once the patient is stable.
3. Appendix D

vi. Early complications (within 7 days)
1. Hemorrhage
2. Pneumothorax
3. Pneumomediastinum
4. Subcutaneous emphysema
5. Infection
6. Airway fire (avoid electrocautery once the trachea is entered)
7. Loss of airway (accidental decannulation)
8. Airway obstruction
   a. Commonly from mucus plugging of the tracheostomy or malposition of the tub against the tracheal wall.

vii. Late complications (>7 days)
1. Laryngotracheal stenosis
2. Fistula
3. Delayed stoma closure
4. Tracheomalacia
5. Vocal cord paralysis

g. Percutaneous Endoscopic Gastrostomy (PEG)
i. Indications
1. Feeding with functional GI tract
2. Those expected to require mechanical ventilation for >4 weeks
3. Severe facial trauma or inability to swallow

ii. Contraindications
1. Gastric varices
2. Gastric pathology, gastroparesis, outlet obstruction gastric resection.
3. Ascites, drain before PEG placement
4. Increased risk of aspiration for those not alert
5. Relative contraindications prior abdominal surgery, obesity, and lack of transillumination.

iii. Procedures
1. May be placed endoscopically, surgically or radiologically.
2. Bolster on the external tubing should be placed so that 1-2cm of movement can be achieved.

iv. Types of gastrostomy tubes
1. Bard
   a. Flexible soft disc at bumper
   b. High patient tolerance
   c. Can be removed at bedside or in office
2. Kendall Dobbhoff
   a. Firm plastic bumper
   b. Good to use in obese, confused or agitated patients due to it being harder to pull out.
   c. Repeat endoscopy is required for removal.

v. Complications
1. Pressure necrosis and gastrostomy site breakdown is the bolster is too tight compressing the tissues.
2. Buried Bumper syndrome, the internal bumper erodes through the gastric wall and becomes between the gastric wall and skin.
3. Infection
4. Bleeding
5. Displacement
6. GERD
7. Gastric or colonic perforation
8. Aspiration
9. Pneumonia

vi. Pearls
1. Gastric distention secondary to insufflation may cause bradycardia and hypotension (vagal reflex), decrease insufflation immediately.
Appendix

MTP Algorithm

Initiate MTP Contact Blood Bank & complete computer order entry

Massively bleeding patients with ongoing significant blood loss, profound hypovolemia, anemia or coagulopathy, or hypotension.

Yes

No

Transfuse as needed

Administer Second:
- MTP Blood Product Pack II
  - 6 units PRBC
  - 6 units FFP
  - 1 unit apheresis Platelets

Bleeding Stopped?

Yes

No

Administer Third:
- MTP Blood Product Pack III
  - 6 units PRBC
  - 6 units FFP
  - 1 unit apheresis Platelets
  - 2 packs Cryoprecipitate

Bleeding Stopped?

Yes

No

<Every 60 minutes> obtain MTP Coag Panel (CBC with platelets, Fibrinogen, PT, PTT, INR, D-dimer), pH, pCO₂, Electrolytes, Na⁺, K⁺, Ca²⁺.

<Every 4 hours> obtain Lactate and ABG.

Terminate MTP after consulting with ordering physician
- Notify Blood Bank
- Return all unneeded blood products
- Complete blood product administration charting & associated paperwork.

Continue MTP Blood Product Administration Alternating Packs II and III & Repeating labs.

Consider use of Factor VIII

Bleeding Stopped?

Yes

No
C – Spine Clearance Guideline

- Definition of Neurologic Deficits: Clinical Signs of Cervical Spinal Cord or Root Abnormalities
- Definition of Normal CT C-Spine: Final report showing no acute abnormality to suggest injury

Patient at risk for C-Spine Injury

Conscious Patient without Neurologic Deficit
- No Neck Pain or Posterior Midline Tenderness
- No Evidence of Intoxication
- No Distracting injuries
- Full ROM
  - No need for Radiographic Imaging
  - CT C-Spine
    - Normal
    - Abnormal
      - Neurosurgery Consult
      - C-Spine Clear
  - C-Spine Clear
    - Can have collar for comfort if neck pain

Conscious Patient with Neurologic Deficit
- Neck Pain or Posterior Midline Tenderness
- Evidence of Intoxication
- Distracting Injury, or Inability to Perform Full ROM
  - CT C-Spine
    - Normal
    - Abnormal
      - STAT MRI C-Spine
      - Neurosurgery Consult
      - No Neurologic Deficits
        - Neurosurgery Consult
        - Neurology Consult
        - If unable to clear clinically and still no Neurologic Deficits after 48 hours, C-spine considered clear
          - Remove C-collar

Unconscious Patient
- CT C-Spine
  - Normal
  - Abnormal
    - Neurosurgery Consult
    - Neurology Consult
    - If unable to clear clinically and still no Neurologic Deficits after 48 hours, C-spine considered clear
      - Remove C-collar

Updated by AP 4/23/14
Examples of TEG Shapes

**Normal**
R; K; MA; Angle = Normal

**Anticoagulants/hemophilia**
Factor Deficiency
R; K = Prolonged;
MA; Angle = Decreased

**Platelet Blockers**
Thrombocytopenia/
Thrombocytopathy
R ~ Normal; K = Prolonged;
MA = Decreased

**Fibrinolysis (UK, SK, or t-PA)**
Presence of t-PA
R ~ Normal;
MA = Continuous decrease
LY30 > 7.5%; WBCL30 < 97.5%;
Ly60 > 15.0%; WBCL60 < 85%

**Hypercoagulation**
R; K = Decreased;
MA; Angle = Increased

**D.I.C**
Stage 1
Hypercoagulable state with secondary fibrinolysis

Stage 2
Hypo-coagulable state

Figure:
http://lifeinthefastlane.com/ccc/thromboelastogram-teg/
Cricothyroidotomy
Current Surgical Therapy, Airway Management in the Trauma Patient

A

B

C

D

E
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