



# Trauma

- Written By: Nicholas E. Kman, MD, The Ohio State University
- Edited By: David Manthey, MD, Wake Forest Medical School
- Last Updated: 2008

## Introduction

*“We have a motor vehicle accident 5 minutes out per EMS report.”*

*47 year old male unrestrained driver, ejected 15 ft from car arrives via EMS. Vital Signs: BP: 100/40, RR: 28, HR: 110. He was initially combative at the scene, but now difficult to arouse. He does not open his eyes, withdrawals only to pain, and makes gurgling sounds. EMS placed a C-collar and Backboard, but could not start an IV.*

*What do you do?*

Trauma is the leading cause of death in the first four decades of life in most developed countries. To this end, there are more than 5 million trauma-related deaths each year worldwide. Motor vehicle crashes cause over 1 million deaths per year. Injury accounts for 12% of the world's burden of disease.

## Objectives

Upon completion of this self-study module, you should be able to:

- Perform an accurate rapid assessment with focus on ABCDE's
- Resuscitate and stabilize by priority
- Discuss secondary survey
- Head/ CNS Trauma
- Cervical Spine
- Chest
- Abdomen
- Musculoskeletal
- Discuss appropriate labs and ancillary studies to the trauma injured patient
- Learn disposition

## Initial Actions

What initial actions should you take to care for the trauma patient?

- Assess the primary survey, with focus on ABCDE's
- Address problems with any portion of the survey before moving on
- Log roll the patient
- Xray and FAST Exam
- Secondary Survey
- Resuscitation and stabilization

## Primary Survey

As with all of your patients, your assessment should always begin with addressing airway, breathing and circulation. Each problem is addressed prior to moving to the next priority (ie, manage airway prior to treating hemorrhage).

- A: Airway Maintenance with CERVICAL SPINE protection
- B: Breathing and Ventilation
- C: Circulation with hemorrhage control / shock assessment
- D: Disability: Neurological status
- E: Exposure/Environmental control

#### Airway

First you'll need to judge if the airway patent?

- Have the patient speak to you to establish patency and to evaluate for voice change and stridor
- Is there evidence of pooling secretions or cyanosis?

While you may have an intact airway now, look for problems which may cause the patient to lose that airway in the near future. It is usually easier to act now before the airway is gone, then to deal with a patient who progressed to an inability to ventilate or oxygenate.

- facial injury causing obstruction or bleeding
- laryngeal fractures
- expanding hematomas
- GCS of 9 or less requires intubation

If you feel the patient's airway isn't intact, you'll need to act!

- ALWAYS MAINTAIN C-SPINE IMMOBILIZATION
- Consider performing jaw thrust to establish patency of the airway.
- Consider use of a naso or oro-pharyngeal airway during bag-valve mask ventilations (BVM)
- Rapid Sequence intubation if needed for airway stabilization or protection (e.g. for GCS of 9 or less)
- Evaluate neck for landmarks associated with cricothyroidotomy and to assess the patient for subcutaneous emphysema or tracheal deviation.

## Breathing

A patent airway DOES NOT mean adequate ventilation! Ventilation requires adequately functioning lungs, chest wall, and diaphragm to produce the depth and rate of respiration as well as the appropriate gas exchange.

In order to assess for adequate breathing, you'll need to look, listen and feel the chest.

- Inspect: look for cyanosis, JVD (tension pneumothorax or cardiac tamponade), asymmetric movement of the chest (flail chest), accessory muscle use (tension pneumothorax) or open chest wounds (open pneumothorax).
- Auscultate: listen for stridor (upper airway injury), lung breath sounds (pneumo or hemothorax)
- Percuss: feel for hyper-resonance (pneumothorax) or dullness (hemothorax), subcutaneous emphysema (airway injury), paradoxical movements (flail chest) crepitance & point tenderness(rib fractures) or bruising (pulmonary contusion).

## Tension Pneumothorax

Tension Pneumothorax presents as progressive deterioration and worsening of a simple pneumothorax, associated with the formation of a one-way valve at the point of a rupture in the lung.

Air becomes trapped in the pleural cavity between the chest wall and the lung, and builds up, putting pressure on the lung and keeping it from inflating fully. Hypotension due to:

- Increased intrathoracic pressure decreasing preload
- Loss of left heart blood flow due to loss of pulmonary vasculature to affected lung
- Compression of mediastinum
- Tension pneumothorax is a CLINICAL diagnosis and Xrays are not appropriate in this setting. If tension pneumothorax is suspected, immediate needle decompression is undertaken

The treatment is a needle decompression using 14-16 gauge long angiocath inserted at midclavicular line in the second intercostal space, over the rib to avoid the neurovascular bundle (shown in picture below).

## Massive Hemothorax

This is another emergency which may require urgent intervention during the primary survey. A systemic or pulmonary vessel disruption leads to:

- > 1500 mL blood loss initially
- > 400 cc per hour for 2 hours

Neck veins are expected to be flat but may be full due to supine position or associated tension pneumothorax or tamponade. Consider a massive hemothorax in patients in shock with no breath sounds and/or percussion dullness.

The treatment consists of placing a large (36 f) chest tube and possibly a trip to the operating room (OR) for hemorrhage control.

#### Circulation

The goal here is to establish that the patient is getting adequate tissue perfusion and oxygenation. Any active hemorrhage should be controlled with direct pressure.

First feel for pulses. If a radial pulse is palpable, it suggests a systolic blood pressure of at least 80 mm Hg. If the femoral or carotid are palpable, these suggest a systolic blood pressure of at least 60 mm Hg. Note if they are thready versus bounding.

Many patients may not mount a tachycardic response.

- Neurogenic shock to sympathetic cord disruption
- Beta blockade, Calcium channel blockade
- Elderly
- Children and young adults
- Conditioned athletes start with a lower basal level. Doubling their resting heart rate of 45-50 shows a falsely reassuring heart rate of 90-100.

**ATLS Classifications of hemorrhagic shock**

	<b>Heart Rate</b>	<b>Blood Pressure</b>	<b>Findings</b>	<b>Blood Loss</b>	<b>Treatment</b>
<b>Class I</b>	Normal- fast	Normal		<15%	Normal Saline
<b>Class II</b>	Normal- fast	Normal- low	Narrowed Pulse Pressure	15 – 30%	Normal Saline
<b>Class III</b>	Fast	Low	Altered Mentation	30 – 40%	NS + Blood

<b>Class IV</b>	Fast	Low	Obtunded	>40%	NS + Blood
-----------------	------	-----	----------	------	------------

Disability

The “D” for disability represents a quick check to assess neurologic status. You can quickly assess mental status via the AVPU scale:

- Alert – a fully awake patient.
- Voice – the patient responds when verbally addressed. Response to voice can be verbal, motor, or with eyes.
- Pain – the patient makes a response on any of the three component measures only when pain stimulus is delivered.
- Unresponsive – If the patient does not give any Eye, Voice or Motor response to voice or painful stimuli.

Perform a gross motor/sensory examination to determine if CNS is intact. This is not a full neurologic examination. For example, trauma team leader will ask the patient to wiggle their toes to assess motor response to a verbal command. A full neurologic exam is done later in the secondary survey.

Assess pupils for size, symmetry and reactivity. Uncal herniation will present as a “blown pupil.” This results from the paralysis of parasympathetic fibers of pupillary constrictors of CN III. You will see a dilated pupil due to unopposed sympathetic activity. The picture shows a dilated pupil in a head-injured patient.

The Glasgow Coma Score (GCS) evaluates mental status via assessment of eye opening, motor response, verbal response. Each are given a score from 1 to 3-4-or-5. The best possible score 15, worst score 3. You cannot have a score of zero.

<b>Glasgow Coma Scale</b>		
<b>Eyes</b>	<b>Verbal</b>	<b>Motor</b>
4 – Spont 3 – Loud voice 2 – To Pain 1- None	5 – Oriented 4 – Confused 3 – Inapprop words 2 – Incomprehensible sounds	6 – Obeys 5 – Localizes to pain 4 – Withdraws to pain 3 – Abnormal flexion posturing 2 – Abnormal extension

	1 – No Sounds	posturing 1 – None
--	---------------	-----------------------

Finally, log roll the patient using spinal immobilization to palpate the spine for step-offs or pain.

#### Exposure/Environment

Completely disrobe patient to assess for any hidden injury. Keep patient warm to prevent coagulopathy.

#### Adjuncts to the Primary Survey

These are tests which can be done during the primary survey:

- Standard Trauma X-rays: such as an AP chest, AP pelvis
- FAST Exam (Focused Assessment Sonography in Trauma) is rapid non invasive, inexpensive and 86-97% accurate (operator dependent). There are four views taken the sub-xiphoid cardiac view, spleno-renal, hepato-renal, and bladder views. Any blood detected during the FAST exam may represent peritoneal penetration. If the patient is unstable, they should go to OR and NOT to CT scanner. Conversely, a negative FAST does not exclude injury.

## Secondary Survey

The Secondary Survey is not started until all aspects of the primary survey have been addressed and vital signs have been addressed.

#### History:

Start with the AMPLE history:

- Allergies
- Medications
- Past illnesses
- Last meal

- Events / Environment / Mechanism of injury

### Physical

Next, initiate a head to toe directed assessment focusing on:

### Secondary Survey In Trauma

<b>Head/ CNS Trauma</b>	looking for skull fractures, axonal injuries, contusion, concussion, or hemorrhage. Look for Battle's sign (left, ecchymosis behind ear indicative of basilar skull fracture) or Raccoon's eyes (right, periorbital ecchymosis without edema indicative of basilar skull fracture).
<b>Motor/ Strength Grading</b>	<ul style="list-style-type: none"> <li>• 0: Total paralysis</li> <li>• 1: Palpable/visible contraction</li> <li>• 2: FROM w/gravity eliminated</li> <li>• 3: FROM against gravity</li> <li>• 4: FROM, less than normal strength</li> <li>• 5: Normal strength</li> </ul>
<b>Facial Trauma</b>	Link to come
	<p>Blunt Trauma may result in crushed larynx, tracheal disruption, expanding hematoma, esophageal leak.</p> <p>Penetrating trauma may result in injury to major vascular structures, pharynx, larynx, trachea, esophagus</p> <p>Flexion, extension, rotational injuries may injure spine</p> <p>Obstruction secondary to trauma may be due to direct trauma to larynx or neck. The presentation may be of inspiratory stridor (supraglottic) or expiratory stridor (subglottic), muffled voice, difficulty handling secretions. Exam may be misleading as neck trauma may show subtle symptoms and signs prior to obstruction.</p>

<p><b>Cervical Spine / Neck Exam</b></p>	<p>In order to clear the cervical spine and remove the patient's collar, they must have the following findings:</p> <ul style="list-style-type: none"> <li>• Alert, not intoxicated</li> <li>• Absence of neck pain</li> <li>• Absence of midline neck tenderness</li> <li>• Absence of distracting injury</li> <li>• Absence of sensory or motor complaint</li> </ul> <p>Cervical spine pearls</p> <ul style="list-style-type: none"> <li>• 5% of brain injuries have associated C-spine injury</li> <li>• 55% spinal injuries are cervical</li> <li>• 10% of patients with C-spine fx will have a second noncontiguous vertebral fracture</li> </ul>
<p><b>Chest</b></p>	<p>Inspect for obvious injuries with consideration for mechanism.  Palpate for subcutaneous emphysema, chest wall stability.  Percuss for dullness or hyperresonance.  Auscultate for diminished breath sounds (pneumo- or hemothorax)</p> <p>Some life threatening conditions:</p> <ul style="list-style-type: none"> <li>• A tracheobronchial tree disruption will present on physical as subcutaneous emphysema. You may notice that after placing a chest tube, the lung refuses to inflate. There may be a persistent air leak. You may need to place a second chest tube, and if this fails, the patient needs to go to the OR.</li> <li>• A pulmonary contusion may initially present as mild hypoxia but after fluid resuscitation, the corresponding pulmonary edema worsens and so does the hypoxia. This can be diagnosed on chest x-ray (or CT) and is treated by proper oxygenation and ventilation (often with intubation), and maintaining normovolemia.</li> <li>• A blunt cardiac injury is difficult to diagnosis. Often the only sign may be an abnormal</li> </ul>

	<p>ECG or tracing on the cardiac waveform. Echocardiography may show a hypokinetic heart. Treatment consists of medicating dysrhythmias that effect hemodynamics.</p> <ul style="list-style-type: none"> <li>• A traumatic aortic disruption is caused by a rapid acceleration (or deceleration) causing a tear in the aorta. Normally this is immediately fatal, but those who survive may show a widened mediastinum on CXR. This can be confirmed with CT scan or angiography of the aorta and requires prompt surgical correction.</li> <li>• A flail chest is caused by two or more fractures in 2+ contiguous ribs creating a free-floating segment of chest wall. This segment will move in the opposite direction of the rest of the chest wall during inspiration and expiration and disrupts the normal negative-pressure ventilatory mechanics.</li> <li>• Chest x-ray is performed in between the primary survey and the secondary survey. <ul style="list-style-type: none"> <li>• Blunt: &lt; 10% of patients require surgery</li> <li>• Penetrating: 15-30% require surgery</li> <li>• Majority: Require simple procedures</li> <li>• Most life-threatening injuries are identified during the primary survey</li> </ul> </li> </ul>
<p><b>Abdomen</b></p>	<p>Inspect for bruising patterns (Cullen’s sign of periumbilical bruising or Grey-Turner’s sign of flank bruising, both associated with retroperitoneal hemorrhage) or a seat belt sign. Auscultate for absent or tympanic bowel sounds. Palpate and percuss for rebound tenderness, guarding or diffuse dullness (peritoneal signs).</p> <p>Frequent re-evaluations are important since the process may progress.</p>
<p><b>Pelvis</b></p>	<p>Presents with pain/instability on palpation or unequal leg lengths. If the pelvic ring is disrupted, it may shear blood vessels such as the pelvic venous plexus or internal iliac arterial system. This can lead to severe hemorrhage, and the pelvis can hide a lot of blood (5 L).</p>

	Treatment involves stabilizing the pelvis by wrapping a sheet around it (to compress), longitudinal traction, pelvic binders, MAST trousers (falling out of favor).
<b>Perineum, Rectum, and Genital Exam</b>	Examine perineum for contusions, scrotal hematomas, lacerations, or blood at the urethral meatus which can be sign of urethral disruption. On the rectal exam, look for diminished sphincter tone which can be a sign of a spinal cord injury. Exam prostate to check position as a high-riding prostate can be sign of a pelvic fracture or urethral injury. Finally, assess for rectal wall integrity and gross blood.
<b>Musculoskeletal</b>	Always check for distal perfusion and neurovascular status. Be sure to document that each extremity is “neurovascularly intact.” The worrisome diagnosis of the extremity is a compartment syndrome (an increased pressure in a closed fascial space). This presents eventually with the five P’s (Pallor, Pain, Paresthesia, Poikilothermic, Pulseless (late finding)). Injuries prone to developing compartment syndrome include forearm and tibial injuries, tight dressings with underlying increasing swelling, prolonged external pressure or crush injuries, or circumferential burns. The treatment is a fasciotomy.

## Differential Diagnosis

At this point you should already have your differential diagnosis established as this will guide your further management. It should include all the life threatening critical diagnoses:

The diagnoses you must consider in patients with trauma are many. Discussion of each of these will be presented in further details in other chapters. Some include:

- Airway obstruction/insufficiency
- Tension pneumothorax
- Open pneumothorax
- Flail chest
- Cardiac tamponade
- Massive hemothorax
- Traumatic Aortic Disruption

## Trauma Diagnostic Studies

### Type and Cross

A Type and Crossmatch is most important lab in trauma patient, as it procures blood for potential transfusion. This does take time to perform, though.

- Fully crossmatched blood: 1 hour processing time
- Type-specific blood: ABO and Rh only tested, 10 minute processing time.
- Type O Negative (males may receive O Positive blood): is immediately available

### Other labs

Other lab studies to consider in most trauma patients based on injuries suspected:

- CBC to check hemoglobin, hematocrit and platelets
- ABG and Lactate to screen for shock
- Chemistry panel
- Urinalysis
- EtOH
- EKG if indicated.

### Standard Trauma X-rays

- AP chest and AP pelvis x-rays are done as adjuncts to the primary survey.
- Cervical Spine Xrays: lateral view (detects 80% fractures), AP, open mouth “Odontoid” view, and obliques

### Other imaging & Testing

- CT scan (may be performed of head, face, C-spine, chest, abdomen and pelvis)
- FAST (see dedicated section in primary survey)
- X-rays (see dedicated section in primary survey) plus other

- EKG (especially for fall, drowning, syncope or single car MVA)
- Retrograde-urethrogram if concern for urethral injury.

### Diagnostic Peritoneal Lavage

This invasive test has mostly replaced by Ultrasound (rarely performed today) but may be used for a hypotensive, unstable patient. It is 98% sensitive for bleeding and is used to detect bowel injury (often missed on CT).

A test is considered positive if it returns

- Gross blood (10 ml)
- 100,000 RBCs/mm<sup>3</sup>
- More than 500 WBCs/mm<sup>3</sup>
- Positive Gram stain
- Food fibers
- Bacteria, bile, feces

It is invasive and does miss retroperitoneal injuries.

### Trauma Disposition

- Significant trauma should be cared for at a level one trauma center
- Process for transfer started as soon as need for transfer is identified.
- Life threatening injuries should be evaluated & addressed prior to transfer.
- Consider securing airway and treating borderline injuries for transfer.

### Case Conclusion

*47 year old male unrestrained driver, ejected 15 ft from car then arrives via EMS, Vital Signs: 100/40, RR 28, HR110. Initially combative at the scene, but now difficult to arouse. He does not open his eyes, withdrawals only to pain, and makes gurgling sounds. EMS placed a C-collar and Backboard, but could not start an IV.*

*As you move the patient over to the gurney, you notice tracheal deviation, paradoxical chest movement, and a large boggy right parietal scalp hematoma. You realize you have to move quickly using what you've learned!*

*What do you do first?*

*You scream out "ABC's, IV, O2, Monitor!" as you tend to the patient's primary survey.*

- *A: Is Airway intact? No, patient needs to be intubated with inline stabilization as he is altered and combative*
- *B: Is Breathing intact? No, gurgling breath sounds with increased respiratory rate and tracheal deviation. This patient needs a needle decompression followed by a chest tube.*
- *C: Are there signs of shock? Yes, tachycardia and hypotension with altered mental status. These resolved when you placed the chest tube.*
- *D: What is the GCS? Eyes closed (1), withdraws only to pain (4), makes incomprehensible sounds (2)=total of 7. Less than 8, intubate!*
- *E: Upon exposure you see a cold, blue right foot. You reduce the foot to regain pulses.*

*Next you perform a Secondary Survey*

- *HEENT: large boggy right parietal scalp, the pupils are sluggish and there's hemotympanum on the right side. You note no facial trauma. The trachea is also deviated to the left.*
- *Chest: absent breath sounds on right*
- *Heart: tachy*
- *Abdomen: soft, no guarding or obvious tenderness*
- *Extremities: Left ankle open, dislocated cold, no pulse*
- *Neck/Back: normal*

*You begin to resuscitate with 2 liters IV Normal Saline, order Type and cross, cbc, chem 7, u/a, and coags. Noting the tracheal deviation to the left and decreased breath sounds on the right, you quickly perform a needle decompression and place a chest tube. They come to shoot your chest x-ray and you now note a resolving R sided simple PTX. Pelvis xray is negative. FAST is negative.*

*You order Antibiotics, tetanus booster and call ortho. When the patient is stabilized you move to CT scan where the following scans are obtained: CT of the Head, C spine, Chest, Abdomen and Pelvis.*

*The rest of his scans reveal the resolved pneumothorax and chest tube you placed, several broken ribs on the right, no visceral injuries and no pelvic trauma. He is taken emergently to the OR for treatment of his epidural hematoma as well as washout of his open ankle fracture/dislocation.*

*He spends several days in the SICU with an excellent hospital course, is extubated, and has normal neurological function. His chest tube is pulled and he is discharged home in excellent condition.*