



Mechanisms of trauma

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[Correction File](#)

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Introduction

what is trauma ?

“Trauma, or injury, is defined as cellular disruption caused by an exchange with environmental energy that is beyond the body’s resilience which is compounded by cell death due to ischemia/reperfusion.”

★ the most common cause of death for all individuals between the ages of 1 and 44 years common cause are RTAs 20% of it due to alcohol and drugs (abuse or prescription) also mobile phone use shown to increase it too.

Mechanisms and Patterns of Injury *two types*

PENETRATING	BLUNT
Classified into: 1.Stab wound 2.Gunshot wound 3.Shotgun =Damage is localized to the path of the bullet or knife.	Classified into: 1. High energy transfer e.g. Car Accident 2. Low energy transfer e.g. Fall from a bicycle usually might have abdominal injuries =Associated with multiple widely distributed injuries because the energy is transferred over a wider area during blunt trauma.

1-Pre-Hospital Care	2-Transportation	3-Primary Survey “the most important”
The objective of pre-hospital care is to prevent further injury , initiate resuscitation and transport the patient safely and rapidly to the most appropriate hospital. =Airway control =Fluid resuscitation (airway before fluid because patient might die within 5 minutes)	-Ground Ambulance -Helicopter	Initial Evaluation and Resuscitation of the Injured Patient in the ER is done by using primary survey and secondary survey The goal of primary survey is to identify and treat conditions that constitute an immediate threat to life <ul style="list-style-type: none"> • ATLS (advanced trauma life support) provides a structured approach to the trauma patient with standard Algorithms of care. The ATLS Course refers to the primary survey as assessment of the “ABC” (Airway with cervical spine protection, Breathing and Circulation). Although the concepts within primary survey are presented in a sequential fashion (ABC) in reality they often proceed simultaneously. <ul style="list-style-type: none"> • It emphasizes the “golden hour” concept that timely prioritized interventions are necessary to prevent death. • in reality they often proceed simultaneously (As a trauma team every member check one, one are checking the airways and the other is checking the circulation in the same time.. and like this) • NOTE:- Golden hour: it’s the first hour of the patient's arrival to the ER. Delay death : within 1 week, 2 weeks or 3 weeks due to sepsis or multi-organ failure in the ICU.

ABCs :

A) Airway Management with cervical spine protection

- a patent airway is the first priority in the primary survey
- all patients with blunt trauma require cervical spine immobilization until injury is excluded.

Table 7-1

Immediately life-threatening injuries to be identified during the primary survey

Airway	Airway obstruction Airway injury
Breathing	Tension pneumothorax Open pneumothorax Massive air leak Flail chest with underlying pulmonary contusion
Circulation	Hemorrhagic shock Massive hemothorax Massive hemoperitoneum Mechanically unstable pelvis fracture with bleeding Extremity blood loss
	Cardiogenic shock Cardiac tamponade Neurogenic shock
Disability	Intracranial hemorrhage/mass lesion Cervical spine injury

a) Conscious patient who do not show tachypnea and have **normal voice** do not require early attention to the airway. (So you proceed to the next step! Which is the Breathing)

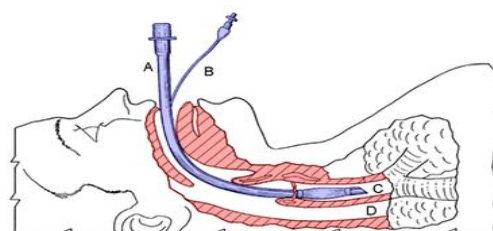
b) Patients with penetrating neck injuries and an :

- expanding hematoma,
- evidence of chemical or thermal injuries to the mouth, nares or hypopharynx,
- extensive subcutaneous **emphysema** (air in the neck),
- complex maxillofacial trauma
- airway bleeding,

in these cases *elective intubation (before losing airway)* early should be performed. These patients may initially have a satisfactory airway but they may become obstructed if soft tissue swelling , expanding hematoma formation, or edema progress. In the comatose patient, the tongue may fall backward and obstruct the hypopharynx; this can be relieved by either a .chin lift or jaw thrust

c) Establishment of a definitive airway (i.e. endotracheal intubation) is

- is indicated in patients with apnea, and inability to protect the airway due to altered mental status,
- also indicated in impending airway compromise due to inhalation injury, hematoma, facial bleeding, soft tissue swelling or aspiration, inability to maintain oxygenation.



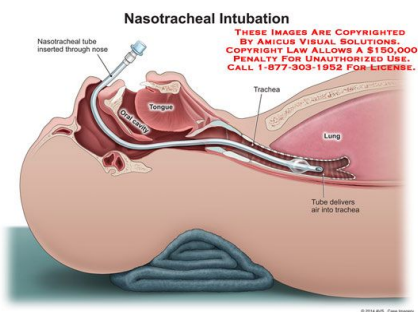
Altered mental status (loss of consciousness) is the most common indication for intubation.

Options for Endotracheal Intubation Include:

1) Nasotracheal intubation: usually not used in trauma cases because it is small and here we have to make sure that tube is on trachea.

It can be accomplished only in patients who are breathing spontaneously. The primary application for this technique in Emergency Department (ED) is in those patients requiring emergent airway support in whom chemical paralysis cannot be used. (because in orotracheal intubation we have to use muscle relaxant to control breathing).

- Disadvantages: can only be done in patients breathing spontaneously and is contraindicated in apneic patients.
- It is contraindicated in maxillofacial injuries, why? It may cause further injuries.



2) Orotracheal intubation: It is the most common technique used to establish a definitive airway.

- Advantages: direct visualization of the spinal cord. The tube used is larger and can be used in apneic patients.

-Because all patients are presumed to have cervical spine injuries, manual in-line cervical immobilization is essential.

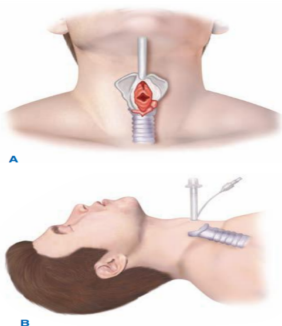
When intubating the patient it's very important to maintain the integrity of the cervical spine because excessive movement of the cervical spine can lead to cervical spine injury.

-Correct endotracheal placement is verified with (how to know if your tube is in the trachea):

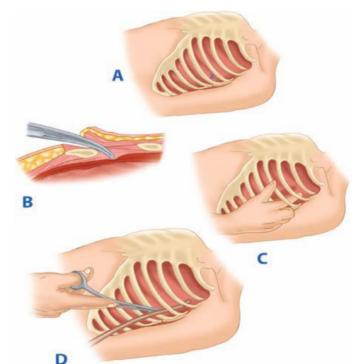
1. Direct laryngoscopy (look at the vocal cords)
2. Capnography (end respiratory CO₂) (is the monitoring of the concentration or partial pressure of carbon dioxide CO₂ in the respiratory gases.)
3. Audibility of bilateral breath sounds (most important clinically by auscultation)
4. And finally Chest X-Ray (patient has to be stable)

3) Surgical Routes:

a) **Cricothyroidotomy** (small incision through cricothyroid membrane): Patients in whom attempts at intubation have failed or who are precluded from intubation due to **extensive maxillofacial injuries**.



b) **Emergent Tracheostomy** Is indicated in a patient with **extensive laryngeal injury**. It may cause complications that might damage the vessels (stenosis).



ABCs :

(B) Breathing and Ventilation

Once a secure airway is obtained, adequate oxygenation and ventilation must be assured. All injured patients should receive **supplemental oxygen and be monitored by pulse oximetry.**

The following conditions constitute an immediate threat to life due to inadequate ventilation and should be recognized during the primary survey: three conditions can kill the patient:

1. Tension pneumothorax
2. Open pneumothorax
3. Flail chest with underlying pulmonary contusion

1. Tension Pneumothorax:

Diagnosis: Severe Respiratory distress and hypotension, (Because the lung will push the heart contralaterally→ heart will be twisted →as well as the SVC and aorta→decrease preload).

physical signs in patients with chest trauma:

Treatment:

Tracheal deviation away from the affected side.
Accumulation of air in the right lung will deviate the trachea to the left side.

- Lack or decreased breath sounds on the affected side.
- Subcutaneous emphysema on the affected side.
- Distended neck veins due to impedance of superior vena cava “Superior vena cava syndrome” , but the neck veins may be flat due to systemic hypovolemia.

Immediate needle thoracostomy decompression with a 14 gauge angiocatheter in **the second intercostal space in the midclavicular line** followed by :
Tube thoracostomy in the **fifth intercostal space in the midaxillary line** immediately in the emergency department before the chest radiograph.

In cases of tension pneumothorax:

1-the parenchymal tear in the lung act as a one-way valve, with each inhalation allowing additional air to accumulate in the pleural space.

2-The normally negative intrapleural pressure becomes positive which depresses the ipsilateral hemidiaphragm and shift the mediastinal structures into the contralateral chest.

3-Subsequently the contralateral lung is compressed and the heart rotates about the superior and inferior vena cava, this decreases venous return and ultimately cardiac output which results in **cardiovascular collapse.**

In tension pneumothorax, the patient collapses early

2. Open Pneumothorax (or sucking chest wound).

- This occurs with full-thickness loss of the chest wall, permitting free communication between the pleural space and the atmosphere.
- This compromises ventilation due to equilibration of atmospheric and pleural pressures which prevents lung inflation and alveolar ventilation and result in hypoxia and hypercapnia

In open pneumothorax, the patient collapses late.

Treatment:

Closure of the chest wall defect and tube thoracostomy.

3. Flail Chest. (fracture of 2 ribs in two different levels)

- It occurs when three or more contiguous ribs are fractured in at least two locations
- Main problem is lung injury and that is what determines the need for ventilation in such cases
- Paradoxical movement of this free-floating segment of chest wall may be evident in patient with spontaneous ventilation due to the negative intrapleural pressure of inspiration.
- Rarely the additional work of breathing and chest wall pain caused by the flail segment is sufficient to compromise ventilation.
- Resultant hypoventilation and hypoxemia may require intubation and mechanical ventilation.

Extra notes:

Most of the time flail chest is associated with contusion of the lung parenchyma.

The number of ribs that must be broken varies by differing definitions; some sources say at least two adjacent are broken in at least two places, some require three or more ribs in two or more places. The flail segment moves in the opposite direction as the rest of the chest wall: because of the ambient pressure in comparison to the pressure inside the lungs, it goes in while the rest of the chest is moving out, and vice versa. This so-called "paradoxical motion" can increase the work and pain involved in breathing.

ABCs :

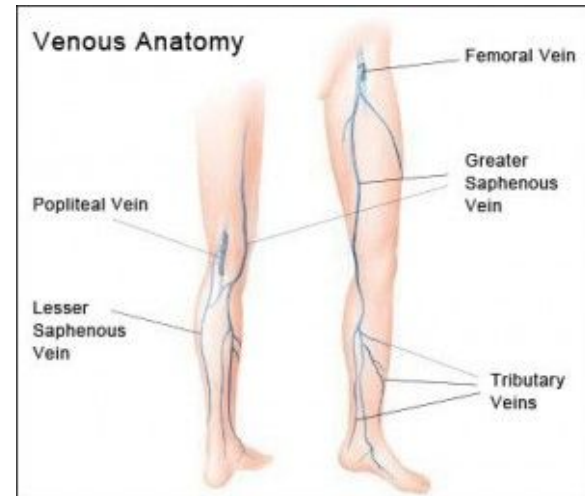
C) Circulation with Hemorrhage Control

- 1) Blood pressure and pulse should be measured manually at least every 5 minutes in patient with significant blood loss until normal vital signs values are restored.
- 2) Two peripheral catheters are inserted in the antecubital fossa, 16 gauge or larger in adults.
- 3) Fluid resuscitation.
- 4) Blood should be drawn simultaneously and send for measurement of hematocrit level, as well as for typing and cross-matching for possible blood transfusion in patient with evidence of hypovolemia.

5) If peripheral angiocatheter access is difficult (common in obese and females), saphenous vein cutdown at the ankle provide excellent access.

6) Additional venous access through femoral or subclavian vein (can be used for Central Venous Pressure measurement).

7) Intraosseous needle can be placed in the proximal tibia (preferred) or distal femur of an unfractured extremity for fluid resuscitation in patient under 6 years of age.(needle inserted in bone marrow space)



8) External control of hemorrhage should be achieved promptly while circulating volume is restored. Manual compression of open wounds with ongoing bleeding should be done with a single 4 x 4 gauze and a gloved hand. Blind clamping of bleeding vessels should be avoided, because it may damage the vessels.

During the circulation section of the primary survey **FOUR** life-threatening injuries that must be identified:

- a) Massive hemothorax *bleeding in the thorax*
- b) Cardiac tamponade * bleeding in the myocardium*
- c) Massive hemoperitoneum * bleeding in the abdomen*
- d) Mechanically unstable pelvic fracture *bleeding in the pelvic cavity*

THREE critical tools used to differentiate these in multisystem trauma patient are:

- a) Chest radiograph
 - b) Pelvis radiograph
 - c) **Focused Abdominal Sonography for Trauma (FAST)** most important and specific. US is done in all quadrant areas of the abdomen for **unstable** patient:
 - RUQ *marison's space between liver and right kidney*
 - LUQ *perisplenic and left perirenal*
 - Epigastrium: to check the pericardium for any bleeding with chest X-ray it will tell you where is the bleeding *perivascular*
 - Pelvic area
- *CT abdomen is done only in **stable** patients.

Immediate treatment:

a) Massive Hemothorax	b) Cardiac Tamponade
<p>Definition: bleeding of more than 1500 ml of blood once inserted chest tube all at once or after chest tube insertion there's continuous bleeding (200-300 ml) every several hours</p> <p>Clinically, If you listen to the chest there will be no breathing sounds on the affected side.</p> <p>Treat with tube thoracostomy to facilitate lung re-expansion</p> <p>Massive hemothorax (>1500 ml. blood) is an indication for operative intervention</p>	<p>-Pericardial drain under ultrasound guidance</p> <p>-Followed by operative intervention</p>
c) Mechanically Unstable Pelvis Fracture (life threatening condition)	d) Massive Hemoperitoneum with Hemodynamic Instability
<p>-Pelvic fracture</p> <p>-Immediate external fixation</p>	<p>-Fluid resuscitation</p> <p>-Immediate surgical intervention</p> <p>commonest bleeding of the abdominal organs: splenic rupture then liver.</p>

Shock Classification and Initial Fluid Resuscitation:

Classic signs and symptoms of shock : are tachycardia, hypotension, tachypnea, mental status changes, diaphoresis and pallor. The quantity of acute blood loss correlates with physiologic abnormalities.

Signs and Symptoms of Advancing Stages of Hemorrhagic Shock				
	Class I	Class II	Class III	Class IV
(Blood loss (ml	Up to 750	750 – 1500	1500 – 2000	> 2000
Blood loss (% (BV	Up to 15%	15 – 30%	30 – 40%	>40 %
Pulse Rate	<100	>100	>120	>140
Blood Pressure (mmHg)			Decreased	Decreased

Pulse Pressure	Normal or Increased	Decreased	Decreased	Decreased
Respiratory Rate	14 – 20	20 – 30	30 – 40	> 35
Urine Output ml/hr))	>3	20 – 30	5 – 15	Negligible
CN/Mental Status	Slightly anxious	Mildly anxious	Anxious and confused	Confused and Lethargic

1) **Tachycardia** is often the earliest sign of ongoing bleeding. (Hypovolemic shock is the worst type of shock to treat.) And it is not reliable in old patients or patients on beta-blockers

2) **Hypotension** is not reliable early sign of Hypovolemia, because blood volume must decrease by **≥30%** before hypotension occurs.

- Fluid resuscitation begins with a 2 L (Adult) or 20 ml/kg (child) IV bolus of isotonic crystalloid, typically Ringer's Lactate.
- For persistent hypotension, this is repeated **once in an adult and twice in a child before red blood cells (RBCs) are administered**.
- **Urine output** is a quantitative reliable **indicator of organ perfusion**. Adequate urine output is 0.5 ml/kg per hour in an adult, and 1 ml/kg per hour in child.
- Based on the initial response to fluid resuscitation, hypovolemic injured patients can be separated into three broad categories:
 1. Responders (**responded to fluid or blood resuscitation and is stabilized, and you have time for further investigation**)
 2. Transient responders (**example is splenic injury**) *BP will improve and then it will fall down again which means there is an active bleeding
 3. Non-responders (**major vessel injury, cardiac tamponade**)
- An evaluation of the patient's neck veins and central venous pressure (CVP) is an important maneuver. CVP determines right ventricular preload. A hypotensive patient with CVP < 5 has ongoing hemorrhage, however; a hypotensive patient with CVP > 15 is likely to be in cardiogenic shock.
- In trauma patients the DDX of cardiogenic shock are:
 - Tension pneumothorax (most common)
 - Pericardial tamponade
 - MI
 - Air embolism

Before you go to the secondary survey you have to make sure that there is **no life threatening condition is missed.**

Secondary Survey:

- Once the immediate threats to life have been addressed, a thorough history is obtained and the patient is examined from top to toe to ensure that no wound, bruise or swelling is missed.
- The back and spine are examined with the patient “log-rolled”, looking specifically for localized tenderness, swelling, bruising or a “step”.
- The perineum is examined and a **rectal examination** is performed to evaluate for sphincter tone, presence of blood, rectal perforation, or high riding prostate, this is particularly critical in patients with suspected spinal cord injury, pelvic fracture , or transpelvic gunshot wounds.
- Vaginal examination** with speculum should be performed in women with pelvic fractures to exclude an open fracture.

In addition to physical examination the following should be done:

1. Vital Signs Monitoring
2. CVP¹ Monitoring
3. ECG Monitoring
4. **Nasogastric Tube Placement:**
 - **Contraindicated in complex maxillofacial injury and should be passed orally**
 - It evaluate the stomach content for blood which may suggest gastroduodenal injury.
 - If it passed to the chest it may suggest diaphragmatic injury.

5 . **Foley Catheter Placement**

- To monitor the urine output. Foley Catheter placement should be deferred after urological evaluation in patients with signs of urethral injury. Contraindications are:
 - **Blood at the meatus**
 - **perineal or scrotal hematoma**
 - **high riding prostate**

In cases like this you can insert a suprapubic catheter.

6. Repeat FAST as needed
7. Laboratory Measurement
8. Radiographs

¹ Continued Process Verification

Selective radiography and laboratory tests are done early after the primary survey. It's important to rule out pancreatic injury in abdominal injury.

For patients with severe blunt trauma the following radiograph should be done:

- Lateral Cervical Spine X-R (this is important)
- Chest X-R
- Pelvis X-R

For patients with truncal gunshots wound, anterior-posterior and lateral radiographs of the chest and abdomen should be done with marking the entrance and exit sites with metallic clips or staples.

In critically injured patient blood sample for:

- Type (blood group) and Cross- Matching. (mix the donor's blood with serum blood)
- Complete Blood Count
- Blood Chemistry
- Coagulation Studies
- Lactate Level (most sensitive test for tissue perfusion, if high this indicates tissue hypoperfusion b/c the lactate is the end product of anaerobic metabolism)
- Arterial Blood Gas Analysis

Surgical Recall

What is the protocol used in trauma care?

Advance trauma life support ATLS

What are its main 3 elements ?	1 primary survey \ resuscitation 2 secondary survey 3 definitive care
ALTS history	AMPLE Allergies medication Past medical history Last meal Events (the trauma)
What is primary survey ?	ABCDEs and spinal immobilization and securing

<p>A=Airway</p>	<p>check airway (ask to speak if alert) if not established Do maneuvers Chin lift than jaw thrust not established endotracheal intubation No results cricothyroidotomy(incise cricothyroid membrane between thyroid and cricoid cartilages) than adequate ventilation 100% O2</p>
<p>B=Breathing:</p>	<p>what are the goals in assessing breathing? Securing oxygenation and ventilation. Treating life-threatening thoracic injuries</p> <hr/> <p>What comprises adequate assessment of breathing?</p> <ul style="list-style-type: none"> ● Inspection for air movement, respiratory rate, cyanosis, tracheal shift, jugular venous distension ● Auscultation of breath sounds ● Percussion for hyperresonance or dullness ● Palpation for presence of subcutaneous emphysema and flail segments. <hr/> <p>What are the most life-threatening conditions that must be diagnosed & treated in this step?</p> <ul style="list-style-type: none"> ● tension pneumothorax ● open pneumothorax ● massive hemothorax <hr/> <p>Pneumothorax injury to the lung resulting in the release of air into pleural space between visceral and parietal pleura How to diagnose it ? tension pneumothorax : dyspnea - jpv distension - tachypnea - pleuritic chest pain How it looks on X-ray? loss of lung markers How to treat ? rapid thoracotomy incision than tube thoracostomy (chest tube)</p> <hr/> <p>Flail chest two separate fracture in in there or more consecutive ribs How to diagnose ? paradoxically (opposite) chest wall movement in the area How to treat ? intubation with positive pressure - ventilation</p>

	let the ribs heal on their own
C=Circulation:	<p>goal: securing adequate tissue perfusion + treatment of external bleeding</p> <p>Check : pulses , blood pressure ,capillary refill, urinary output , mental status , skin</p> <p>If abnormal : give 2 bolus of I.V lactate ringer</p> <p>Also if urinary output is absent insert foley cath.</p> <p>Gastric decompensated : insert NG tube</p>
Disability :	<p>Check neurological disability by checking (mental status “Glasgow coma scale” ,pupils ,motor\sensory)</p> <p>Exposure and environment :keep warm , inspect all patient for checking</p>
Secondary survey : check for all systems	

MCQs.

What is the most common indication of endotracheal intubation ?

- A-Loss of consciousness
- B-Apnea
- C-Facial bleeding
- D-Hematoma

Which of the following is one of the sign of Tension pneumothorax ?

- A- Tracheal deviation toward affected side
- B- Mediastinal shift toward opposite side
- C- Decreased in breath sounds over affected side
- D- B+C

What is the immediate treatment of Cardiac tamponade ?

- A-Surgical intervention
- B-Tube tracheostomy
- C-Pericardial drains
- D-Fluid resuscitation

Answer : 1-A, 2-D , 3-C