Approach To A Patient With Trauma

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The causes of trauma related injuries

1. **Motor vehicle accidents**
2. **Violence including: gun shot wounds and Stabs**
3. **Falling down**
4. **Others:**
   - **Burn: Thermal, electrical, chemical**
   - **drowning**
   - **Blast: e.g. bomb explosion**

The leading causes of death

"Data are for the U.S."

1) **Cardiovascular disease**
2) **Cancer**
3) **Chronic lower respiratory diseases**
4) **Stroke (cerebrovascular diseases)**
5) **Accidents (unintentional injuries)**

Epidemiology

* Traumatic injuries range from minor wounds to multiple organs injury.

* It is the leading cause of death in young adults worldwide

* It accounts for approximately 30 % of all (ICU) admissions.

* According to the World Health Organization (WHO), RTAs accounted for 1.25 million deaths in 2014

Deaths from trauma

1. Immediate deaths in the first minutes at the scene are either due to:
   - massive hemorrhage “laceration of great vessels”
   - massive CNS trauma

2. Early deaths during the ‘Golden hour’ are often due to the effects of hemorrhage or hypoxia and may be preventable

3. Late deaths are mainly due to sepsis and organ failure occur from 1 –7 days after trauma due to sepsis, septicemia, pulmonary embolism, or multiple organ failure.

*The "golden hour" refers to the first hour after major trauma in which there is an increased risk of death that can be prevented by rapid intervention.

TRAUMA SYSTEM

A coordinated National approach to trauma care

optimal care of a trauma patient requires effective and efficient communication and teamwork among all members that includes:

1. Access to care
2. Pre-hospital care
3. Hospital care
4. Rehabilitation
5. Injury prevention

The approach to the care of trauma patient

1. **Primary Survey :**

- **simultaneous assessment and Management**
- **Identify & treat what is lethal.**

2. **secondry survey :**

Proceed to identify all other injuries

3. **Definitive management :**

The definitive management plan

Primary Survey

1. **The aim of the primary survey is to detect and immediately treat life threatening problems.**

2. **Do not proceed to Secondary Survey until ABC's are stable**

3. **The primary survey must be repeated at any time when the patient's status changes, including changes in mental status or changes in vital signs.**

The primary survey
consists of the following steps:

1. **A**irway assessment and protection (maintain cervical spine stabilization when appropriate)

2. **B**reathing and ventilation assessment (maintain adequate oxygenation)

3. **C**irculation assessment (control hemorrhage and maintain adequate end-organ perfusion)

4. **D**isability assessment (perform basic neurologic evaluation)
5. **E**xposure, with environmental control (undress the patient and search everywhere for possible injury, while preventing hypothermia)

We have to keep the following points in mind while performing the primary survey

* Airway obstruction is a major cause of death immediately following trauma.
* The airway may be obstructed by the tongue, a foreign body, aspirated material, tissue edema, or expanding hematoma
* Definitive guidelines for tracheal intubation in trauma do not exist, when in doubt, it is generally best to intubate early, particularly in patients with hemodynamic instability, or those with significant injuries to the face or neck, which may lead to swelling and distortion of the airway

A: Airway

Assessment :

* Begin by asking the patient a simple question (eg, "What is your name?"). A clear accurate response verifies the patient's ability to ventilate

* Observe the face, neck, and chest, for signs of respiratory difficulty, including tachypnea, accessory or asymmetric muscle use, abnormal patterns of respiration, and stridor.

* Inspect the oropharyngeal cavity for disruption; injuries to the teeth or tongue; blood, vomitus, or pooling secretions.

* Inspect and palpate the anterior neck for lacerations, hemorrhage, swelling, or other signs of injury

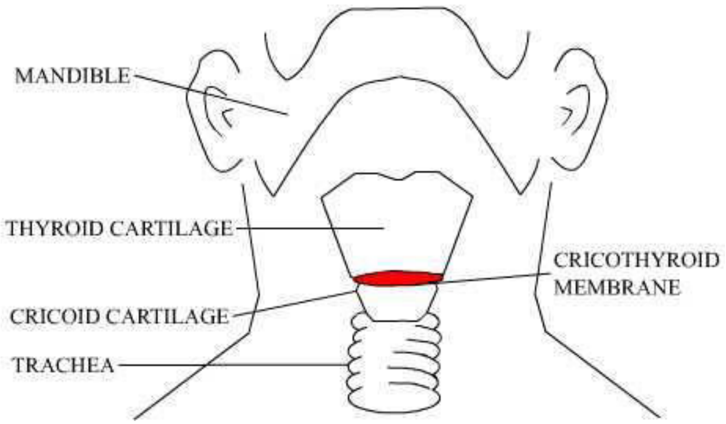
The possible causes of airway obstruction

- Vomitus
- Bleeding
- Loose or missing teeth
- Dentures
- Facial trauma
- backward tongue displacement

airway tools can be helpful when managing a trauma patient

- Remove 1st any tight clothes at the neck
- Suction :To clear the oropharynx of blood, mucus and foreign bodies
- Bag-valve mask attached to high flow oxygen
- Cricothyrotomy kit
- Endotracheal tubes in a range of sizes

Cricothyroidotomy



Cervical spine protection

- The high index of suspicion depends on the history of the accident.
- Avoid rough manipulation of the head and neck.
- Protection is initially provided by holding the head in a neutral position facing forward. and can be secured with a hard cervical collar.
- Obtain appropriate radiological evaluation which should be done only after the patient has been stabilized.

B. BREATHING AND VENTILATION

ventilation”“assessing the adequacy of oxygenation and

1. Inspect for symmetrical chest movements.
2. Palpate for :

 - the trachea for deviation

1. - the chest wall for bone crepitus “fractures” or air crepitus “surgical emphysema”.

Auscultate for breath sounds bilaterally.

The life-threatening problems to be identified

- Tension pneumothorax: Initial decompression with needle insertion through the 2nd or 3rd intercostal space anteriorly at the mid-clavicular line. Or Thoracostomy tube
- Massive Hemothorax : Thoracostomy tube
- Flail chest:

- Monitor pulse oximetry and blood gases,
- intubate and ventilate if there is hypoxia or respiratory distress.
- Consider early intubation in elderly or severe multi-trauma patients.

- Open pneumothorax: in which there is a sucking wound in the chest wall

C. CIRCULATION AND HEMORRHAGE CONTROL

- Assess BP, heart rate and evidences of bleeding or signs of shock.
- Control any external bleeding .
- If there is shock, insert one or two large intravenous lines and start fluid resuscitation and prepare blood to be transfused.

D: Disability and neurologic evaluation

It includes:

* description of the patient's level of consciousness using the (AVPU) scale or Glasgow Coma Scale (GCS) score,
* assessments of pupillary size, equality and reactivity to light
* gross motor and sensory function and, if a spinal cord injury is present, examine the level of sensation

E :Exposure and environmental control

*Be certain that the trauma patient is completely undressed and that his or her entire body is examined for any sign of injury .

*Regions often neglected include :

- the scalp" posterior scalp"
- the gluteal fold, axilary folds, perineum,
- abdominal folds in obese patients.

Penetrating wounds may be present anywhere

* While maintaining spine precautions, examine the patient's back.

ADJUNCTS TO PRIMARY SURVEY

* Pulse oximeter
* BP monitor
* ECG
* X-rays:
  C-spine, Chest, Abdomen and Pelvis
* Trauma blood work
* ABGs

SECONDARY SURVEY

*The secondary survey aims to detect and treat any other trauma injuries.

* the secondary survey should not be started until the primary survey is complete.

* It consists of quick history taking and a head-to-toe examination.

* Specialized diagnostic tests are performed when indicated

These tests include: extremity radiography, ultrasonography and CT scanning

* **In the secondary survey we have to take a quick medical history using the acronym**

<u>(AMPLE)</u>

Allergy

Medication

Past Medical History

Last food and drink

Events leading up to the situation

Top-to-Toe Examination

Head:

*Observe and palpate skull (anterior and posterior) for signs of trauma

look for deformities, wounds, bruising/bleeding, lacerations, Racoon eyes or Battle's sign.

*Check the face for deformity

* Check eyes for: equality and responsiveness of pupils, movement and size of pupils, foreign bodies, discoloration, contact lenses, prosthetic eye

* Check nose and ears for bleeding or CSF leaks

Neck:

look for any Swelling or Wounds

. jugular venous distention, use of neck muscles for respiration or tracheal shifting

Cervical Spine:

Bruise,swelling, tenderness or wounds

Top-to-Toe Examination

Chest

- Symmetrical expansion, Paradoxical movement
- Wounds/bruising
- Deformity

  Respiratory rate and depth

  Tenderness
- Breath sounds,

Abdomen

- Bruising/wounds
- Distension
- Tenderness
- Rigidity/guarding

  Bowel sounds

Pelvis/Genito-urinary:

- Deformity, Bruise: scrotal or perineal

  bleeding per urethra

Top-to-Toe Examination

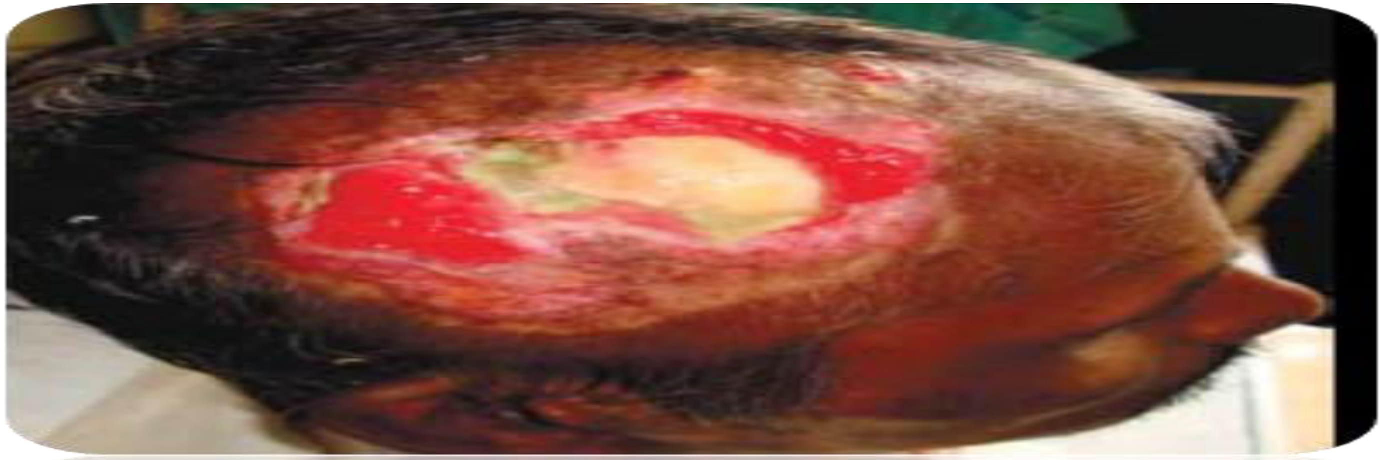
Back

- Wounds/bruising or swelling
- Tenderness

Arms and Legs

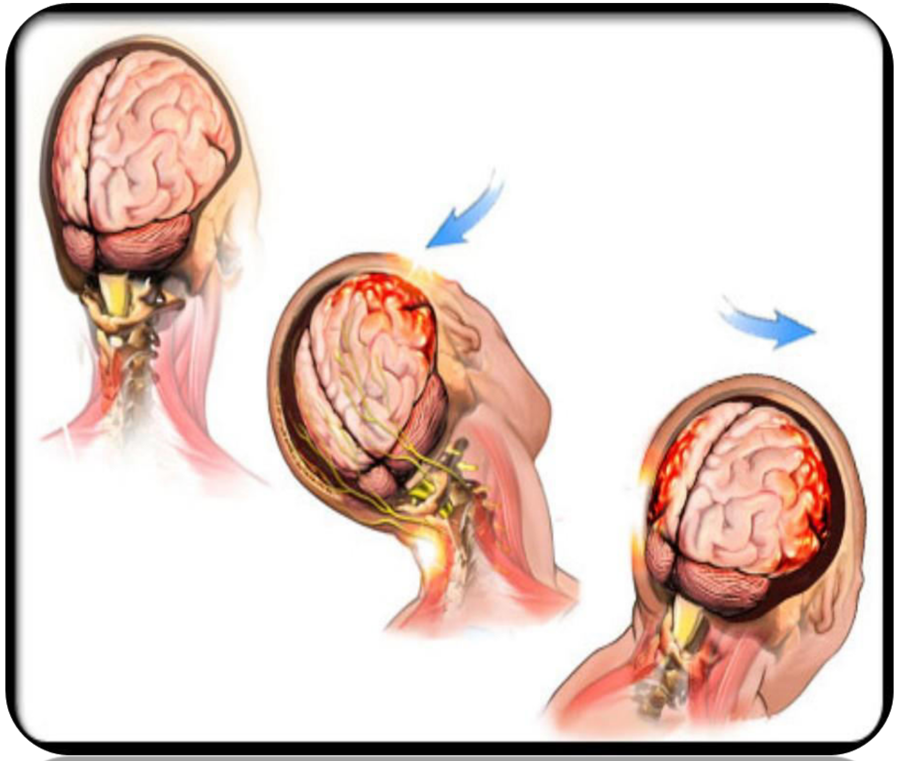
- Wounds
- Deformity
- Tenderness
- Movement
- Pulses
- Sensation

Head Trauma & Management

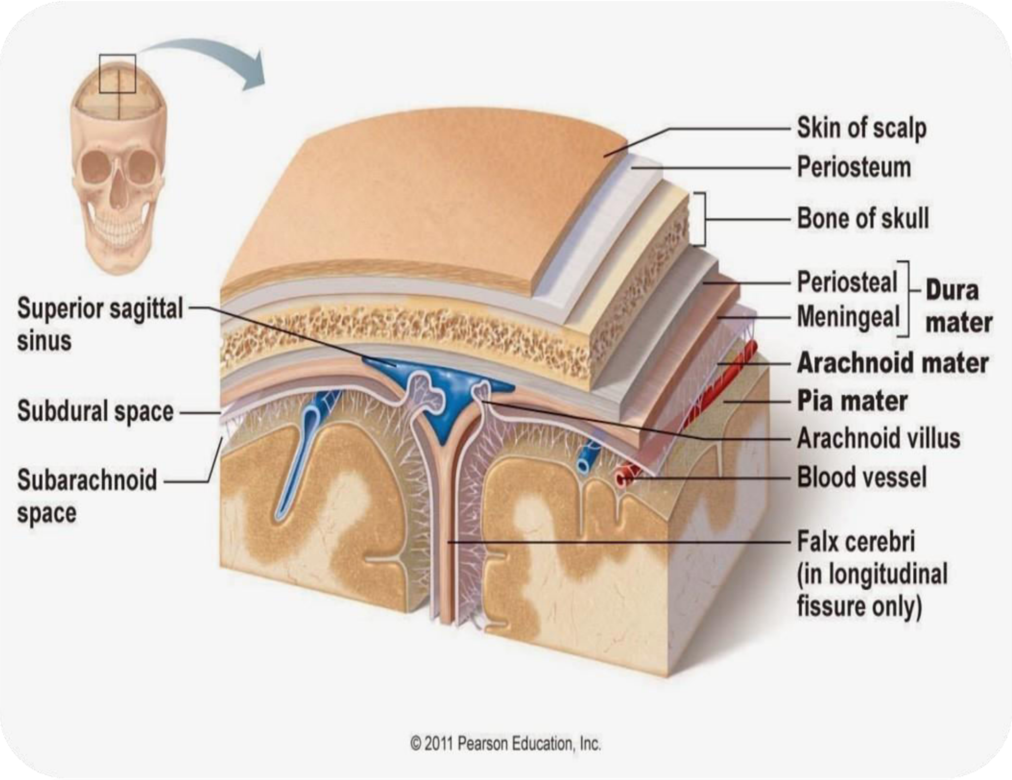


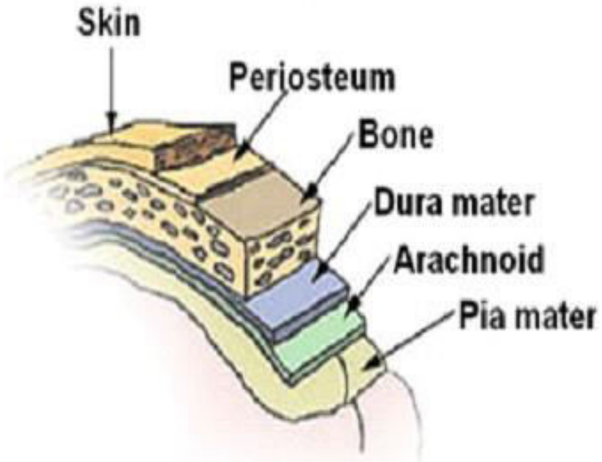
Definition

- **Head injury is defined as traumatic injuries involving the cranium and intracranial structures (i.e., Scalp / Skull or Brain).**
- **Traumatic Brain Injury (TBI) & Head Injury are often used interchangeably.**



Surgical Anatomy





Dura mater -- outer layer lining skull
Arachnoid (mater) -- contains blood vessels
Subarachnoid space -- filled with CSF
Pia mater -- covers brain

Epidemiology

- **Head injury continues to be an enormous public health problem, even with modern medicine in the 21st century.**
- **It is one of the most common cause of admissions to the A & E department worldwide.**
- **The most common causes include motor vehicle accidents , falls, assaults, sports-related injuries, and penetrating trauma.**
- **Head injuries occur in all age groups, with a peak incidence between the ages of 16 and 25 years and is more common in males than females.**

Pathophysiology

- The brain is contained within the skull, a rigid and inelastic container.
- Hence only small increases in volume within the intracranial compartment can be tolerated before pressure within the compartment rises dramatically.
- A second crucial concept in TBI pathophysiology is the concept of cerebral perfusion pressure (CPP), which is the difference between the mean arterial pressure (MAP) and the intracranial pressure (ICP).

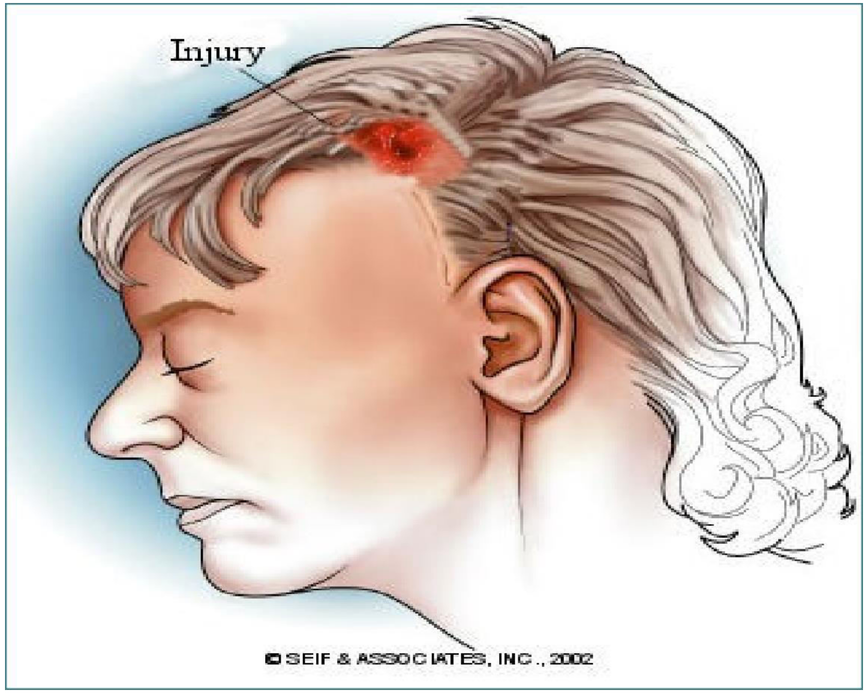
CPP = MAP – ICP

Classification

- **Type of injury: Open / Closed (or) Blunt /Penetrating**
- **Site of injury**
- **Pathology of injury**
- **Severity of injury**

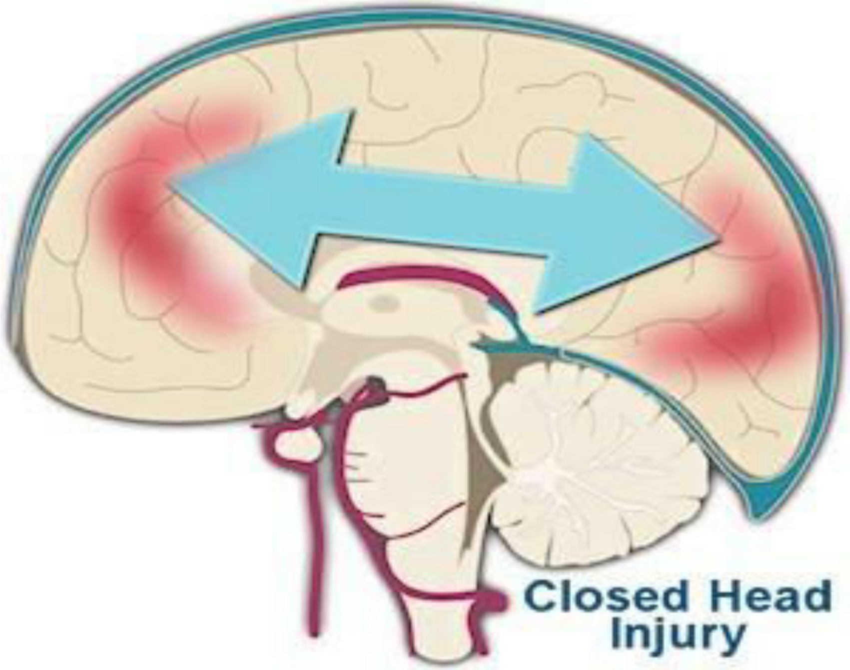
Open Injury

- **Obvious external wound**



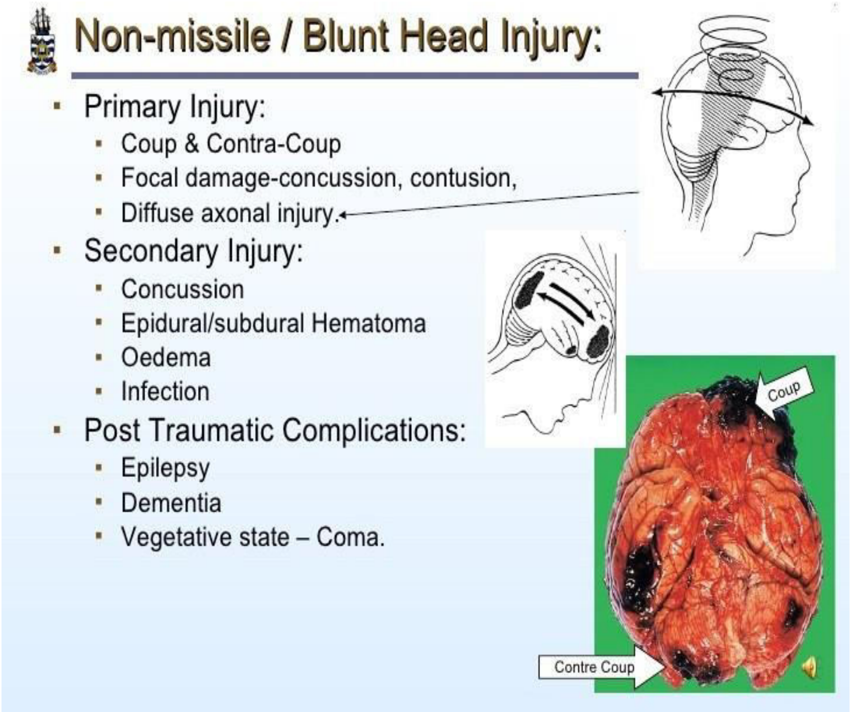
Closed Injury

- **No obvious external signs**



Blunt Head Injury

* A moving head strikes a fixed object or a moving object strikes an immobile head →scalp injury, fractures of the skull, contused brain etc.
* Injuries resulting from rapid deceleration of the head causing the brain to move within the cranial cavity and to come into contact with bony protuberances within the skull.

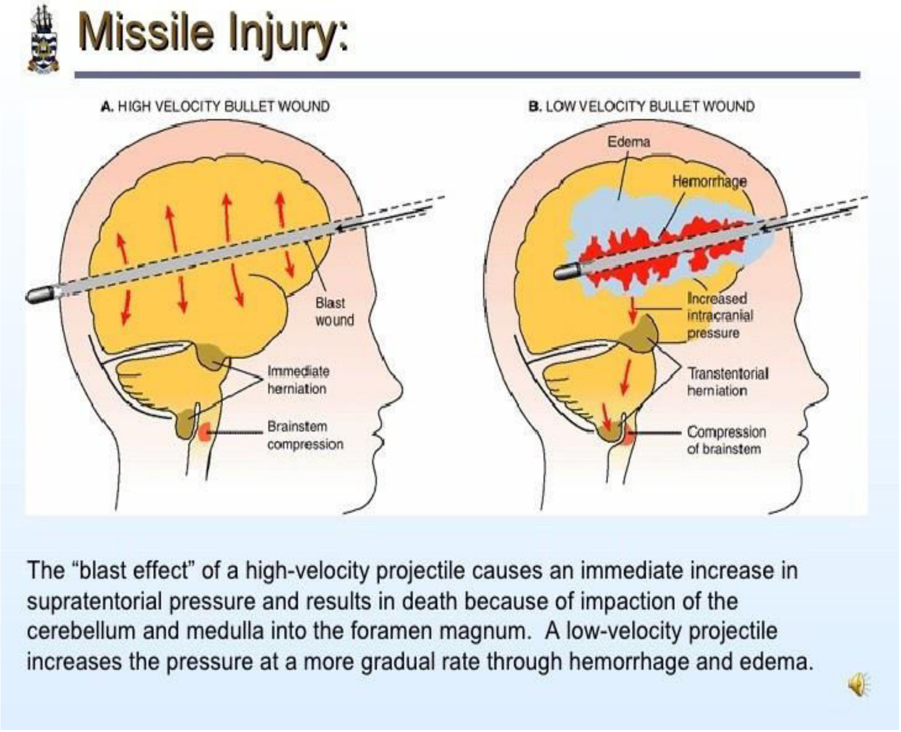


Penetrating Injury

Classified into 2 types - velocity

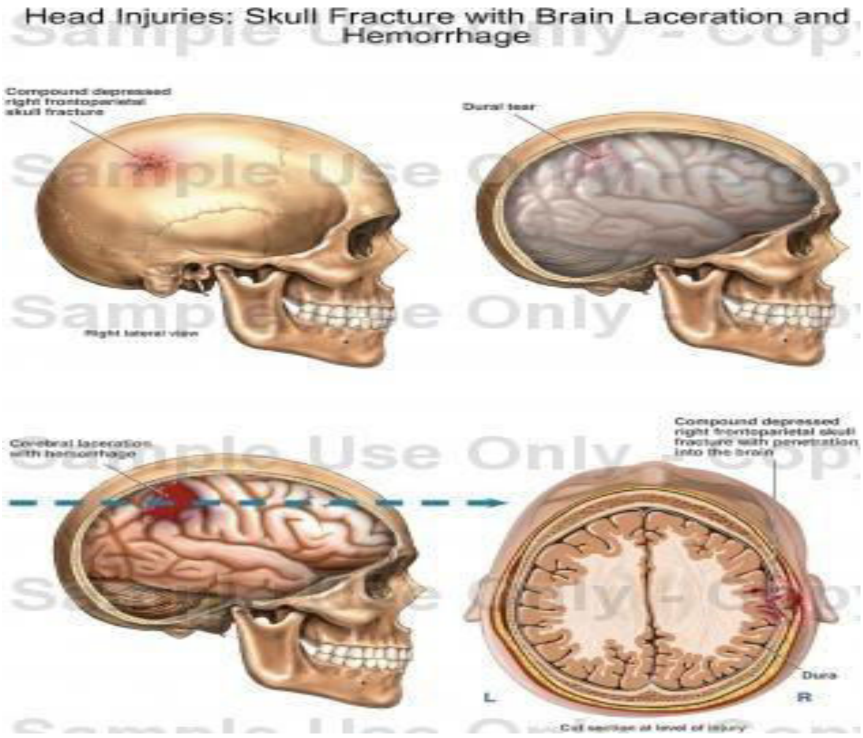
- High velocity - Bullets
- Low velocity injury

  - Knifes/Arrows/Screwdrivers etc.



Site of Injury

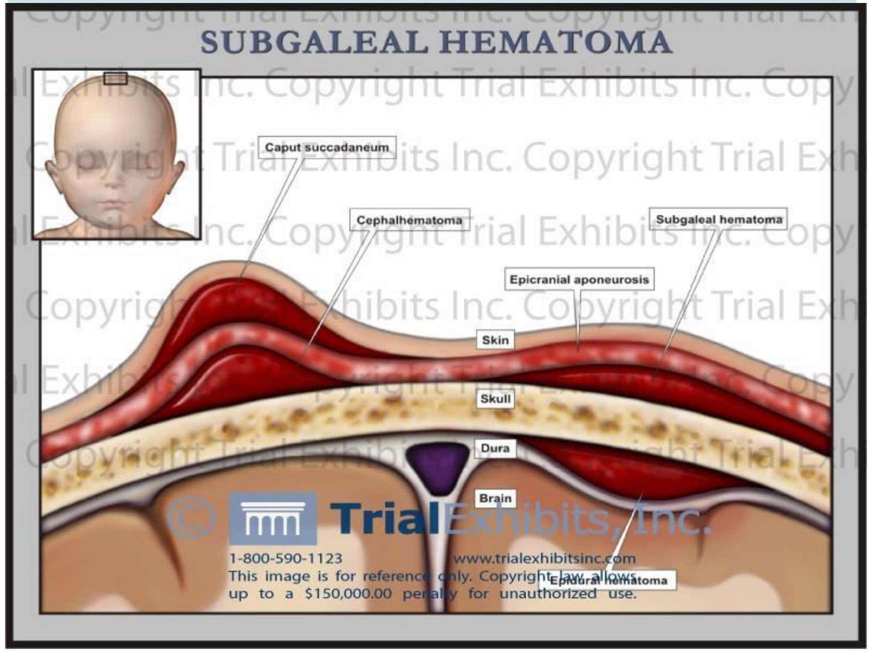
- Scalp injury
- Skull injury
- Brain injury
- Intracranial vascular injury



Scalp Injuries

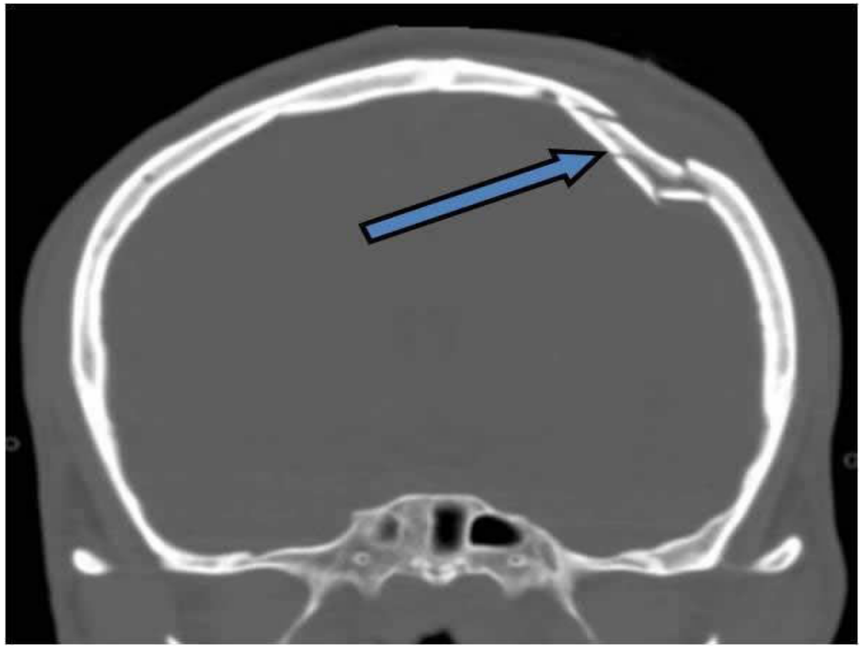
LACERATIONS

SUBGALEAL HEMATOMA

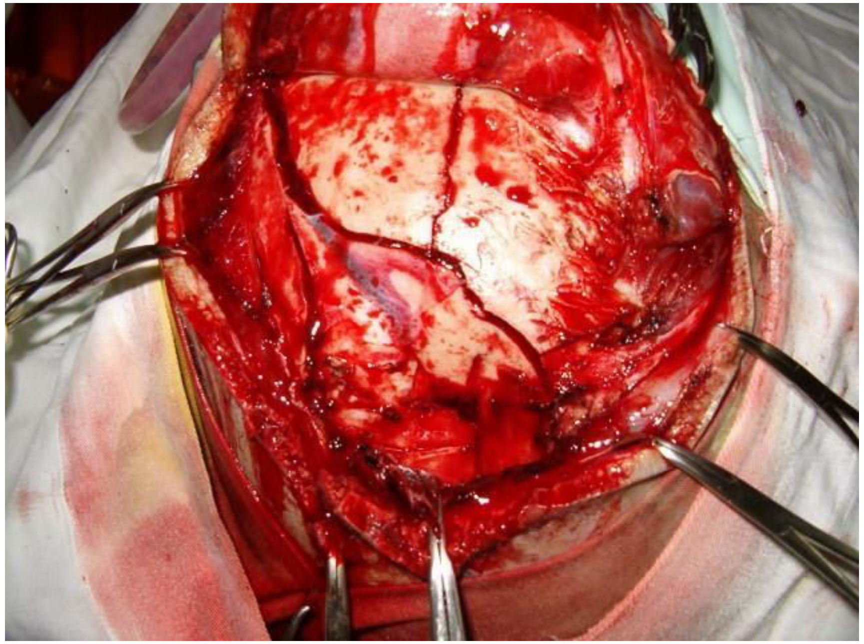


Skull Injuries – Fractures

OPEN FRACTURES



CLOSED FRACTURES



SKULL INJURIES

CLOSED FRACTURES

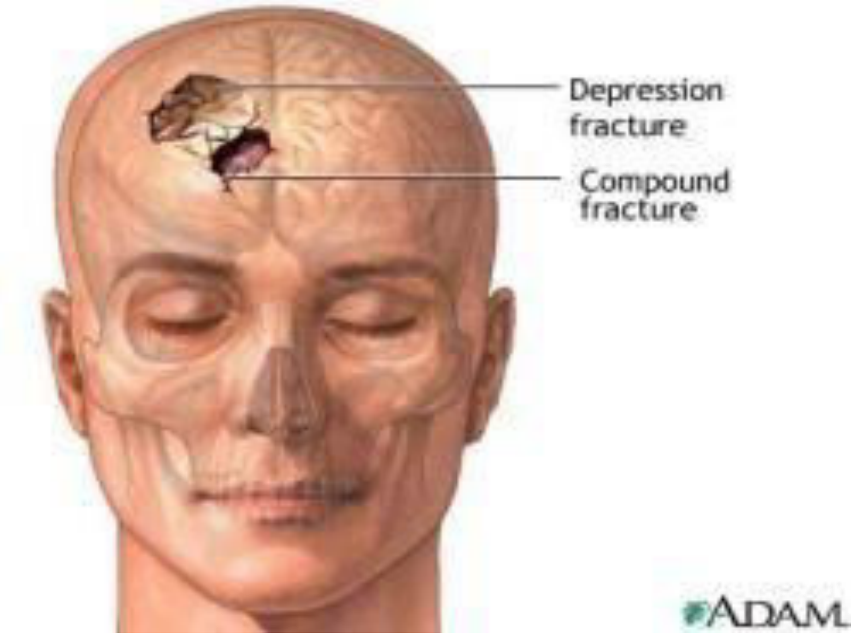
A closed fracture has a significant chance of associated intracranial haematoma.

OPEN FRACTURES

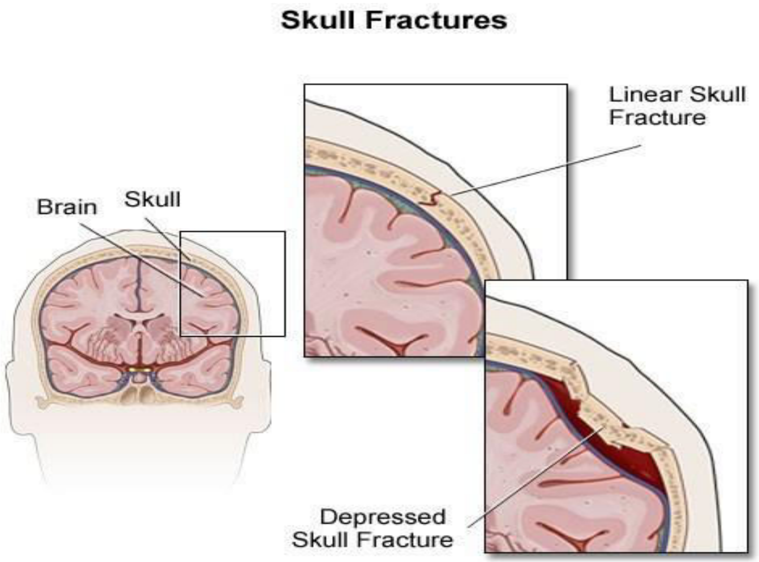
- Open fractures have potential for serious infection.
- Any foreign matter impaled in the skull should be left in place for removal by the neurosurgeons.
- Cover it lightly with a sterile dressing that has been moistened with a sterile saline.

Skull Injuries – Fractures

DEPRESSED FRACTURES



LINEAR FRACTURES



Skull Injuries – Basilar Fractures

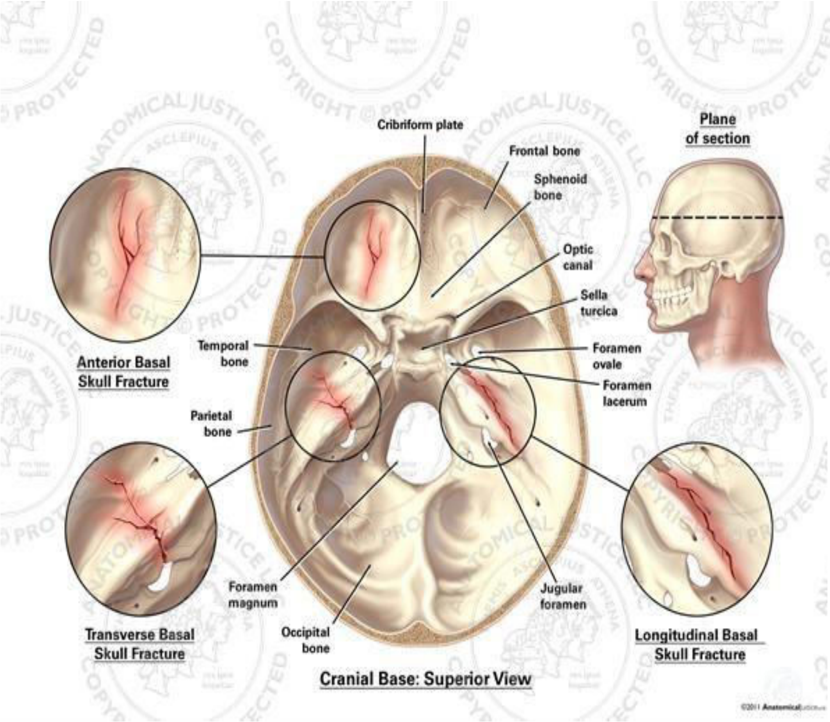


Figure 1. Eyelid ecchymosis and Battle sign.

Brain Injuries

PRIMARY

It is the initial damage that occurs *IMMEDIATELY* as result of trauma.

Cerebral concussion

Cerebral contusion

Cerebral laceration

Diffuse axonal injury

SECONDARY

It is the result of neurophysiological and anatomic changes, which occur from *MINUTES to DAYS* after the original trauma.

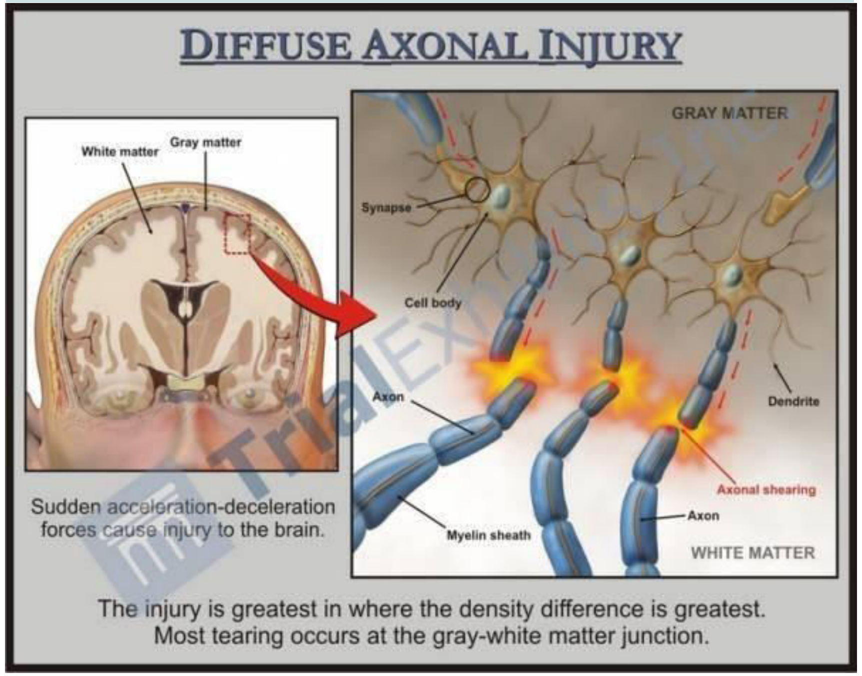
Cerebral edema
Intracranial hematoma
Brain herniation
Cerebral ischaemia
Infection
Epilepsy

Primary Brain Injury

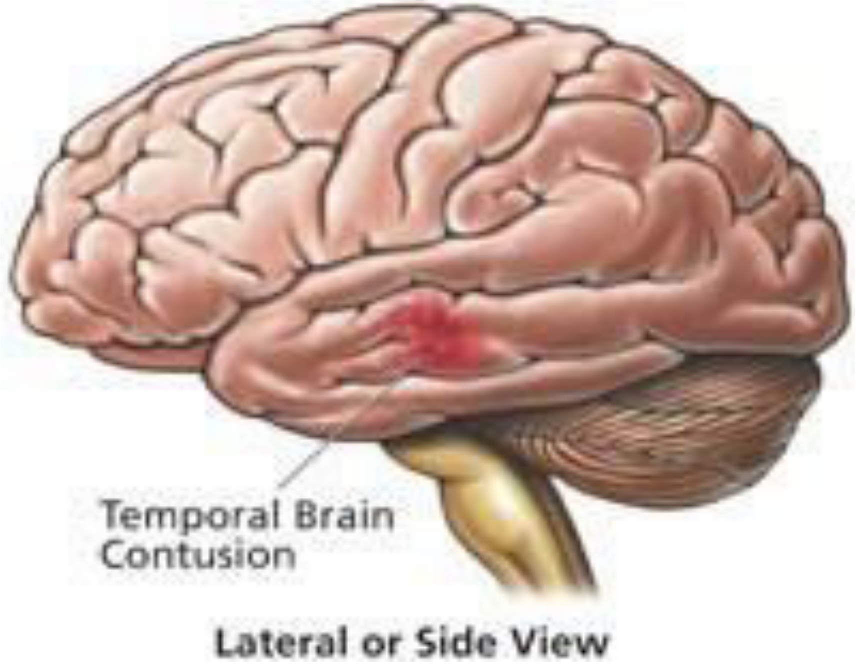
- **Cerebral concussion** is slight distortion causing temporary physiological changes leading to transient loss of consciousness with complete recovery.
- **Cerebral contusion** is more severe degree of damage with bruising and cerebral oedema leading to diffuse or localized changes.
- **Cerebral laceration** is tearing of brain surface with collection of blood in different spaces and with displacement of dural parts.
- **Diffuse axonal injury** - This type of brain damage occurs as a result of mechanical shearing following deceleration, causing disruption and tearing of axons, especially at the grey/white matter interfaces

Brain Injuries

DIFFUSE AXONAL INJURY

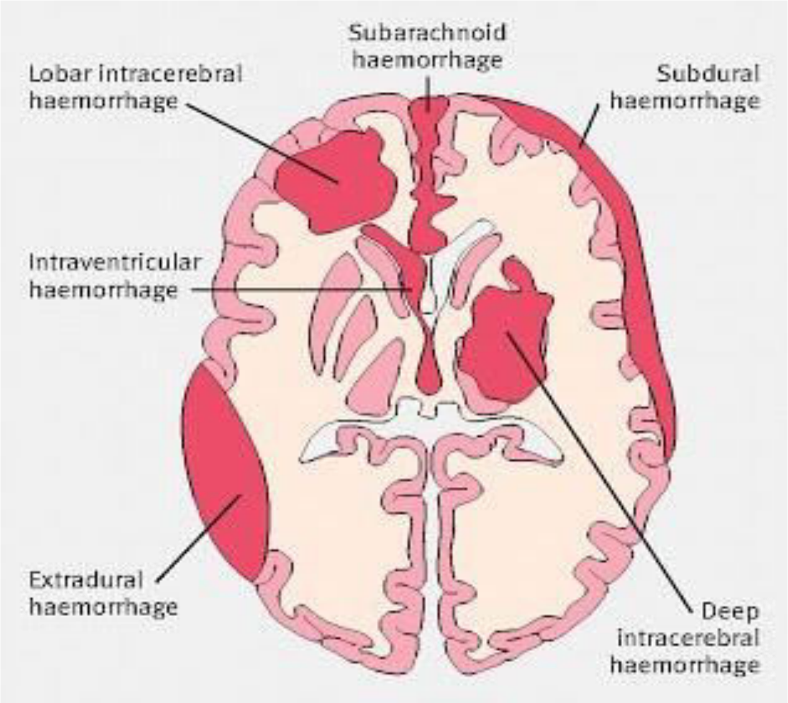


CONTUSION



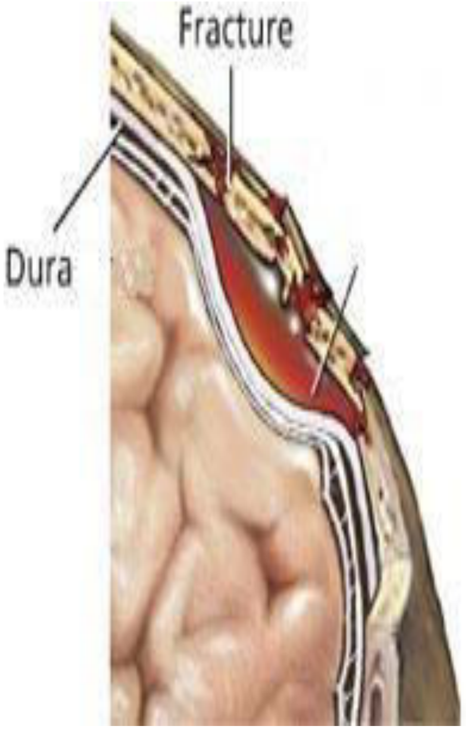
Intracranial Vascular Injury

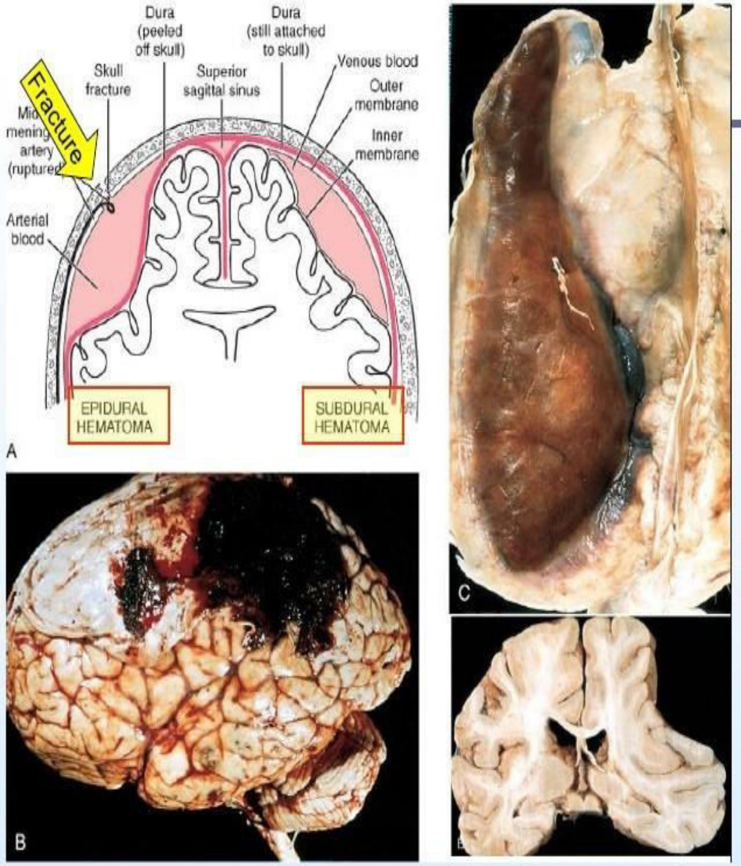
- **Epidural Haematoma**
- **Subdural Haematoma**
- **Sub – Arachnoid Haematoma**
- **Intracerebral Haematoma**



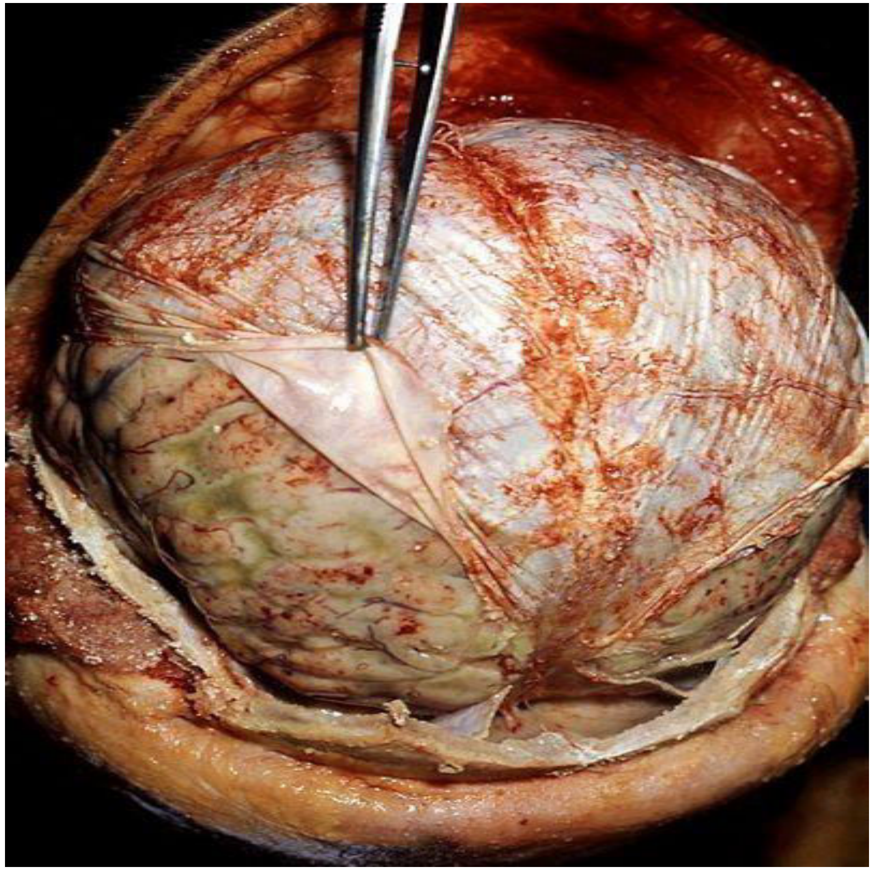
Extradural Haematoma – EDH

- Haematoma in extradural space
- Common site – Temporal region
- Tear of MMA
- - Commonly presents with "lucid interval" / Features of ↑ ICP
- CT scan - lentiform (lens shaped or biconvex) hyperdense lesion
- The treatment of an EDH is immediate surgical evacuation via craniotomy.



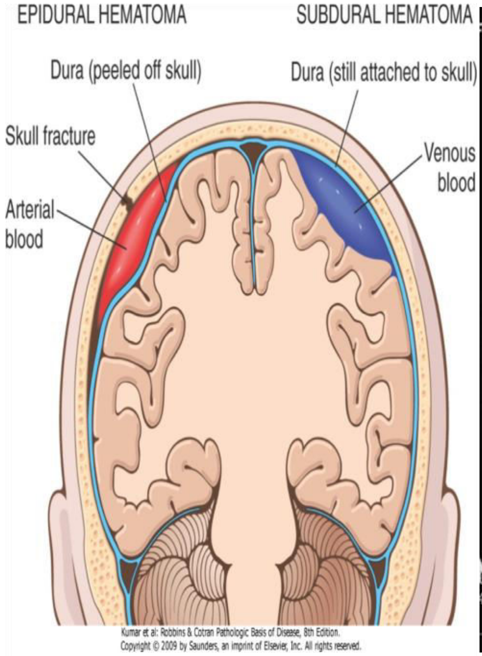


Epidural Hematoma

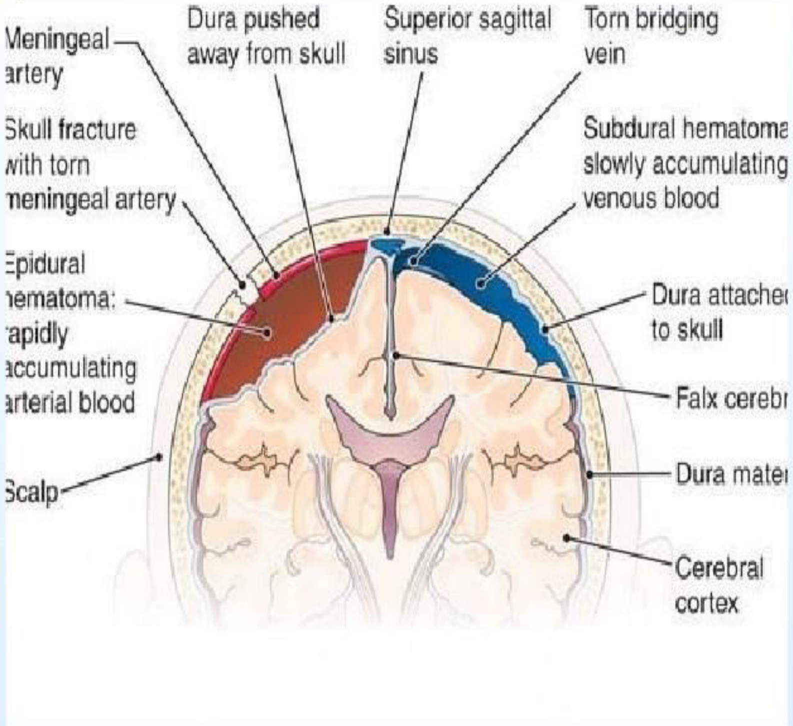


Subdural Haematoma – SDH

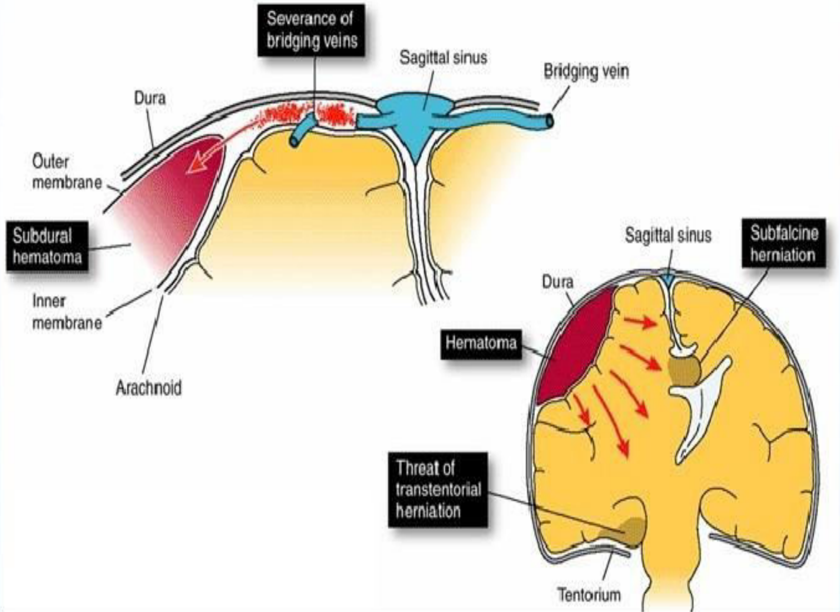
- Haematoma between dura & brain.
- Occurs as a result of tearing of cortical veins & due to cortical laceration.
- Described as acute or chronic depending
- on the age.
- ASDH usually present with an LOC from the time of injury & is progressive.
- Clinical features of CSDH include headache, cognitive decline, focal neurological deficits and seizures.
- CT scan – Concavo – convex lesion
- The treatment of an SDH is surgical evacuation via craniotomy.



Epidural - Hematoma - Subdural



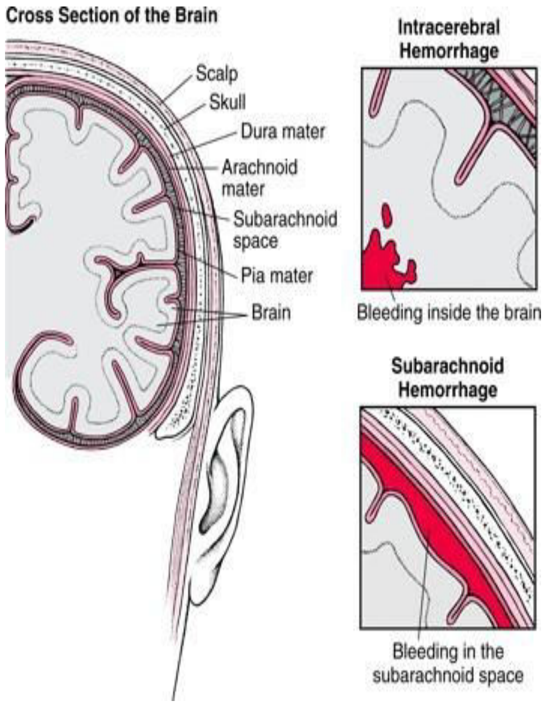
Subdural Hematoma:

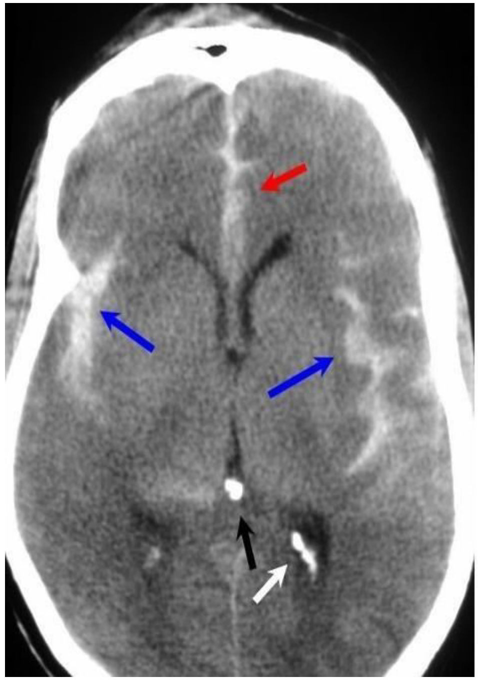


With head trauma, the dura moves with the skull, and the arachnoid moves with the cerebrum, . As a result, the bridging veins are sheared causing hematoma in the expansile subdural space.

Subarachnoid Haemorrhage – SAH

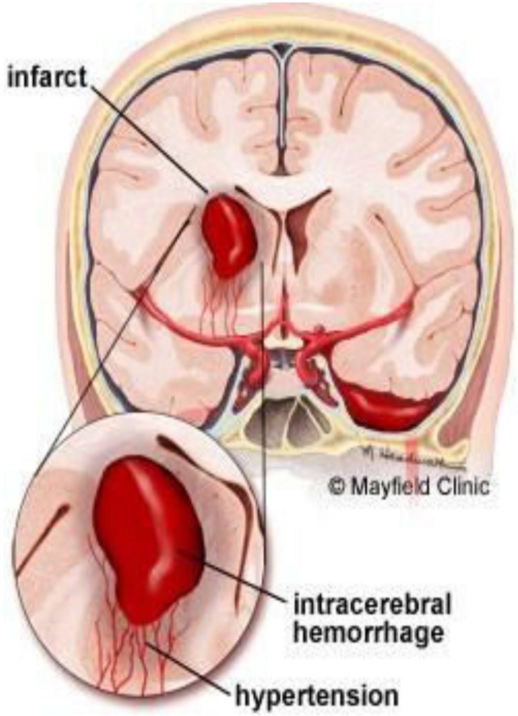
- Haematoma in the space between the arachnoid space and the pia mater [subarachnoid space]
- May be spontaneous / trauma
- Spontaneous – Intracranial Aneurysm
- Features of ↑ ICP
- LP / CT scan / Angiogram
- Clipping / Embolisation / Craniotomy





Intracerebral Haematoma – ICH

- Haematoma is formed within the brain parenchyma.
- Due to areas of contusion coalescing into a contusional haematoma.
- CT scan - appear as hyperdense lesions with associated mass effect and midline shift.



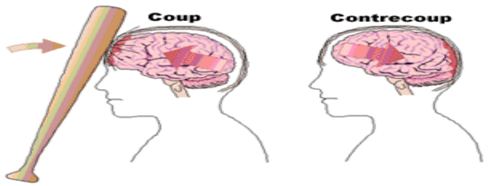
Severity

- **Minor**: GCS 15 / no amnesia or LOC
- **Mild**: GCS 14 or 15 + LOC or amnesia Impaired alertness or memory
- **Moderate**: 9-13 or LOC ≥ 5 min
- **Severe**: GCS 3 - 8

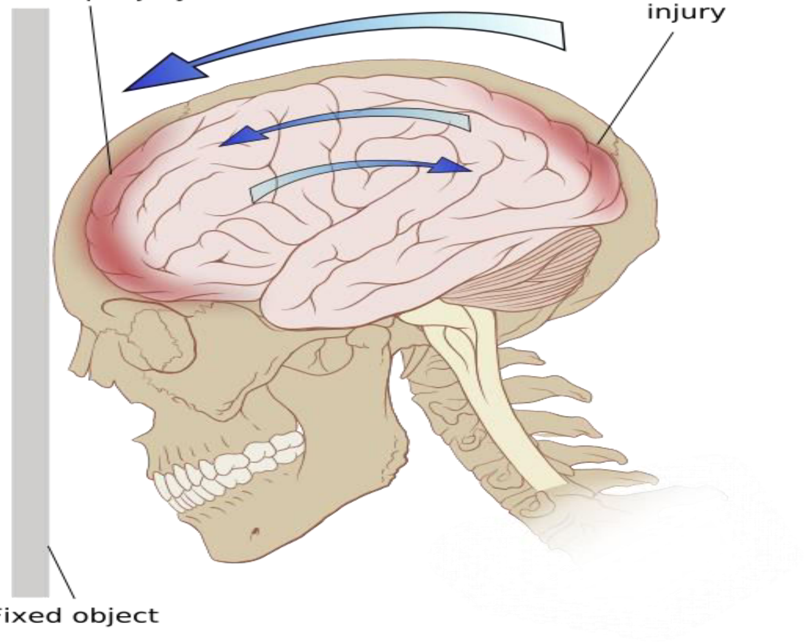
Effects of Brain Injury

- **Brain edema** is the accumulation of fluid, both intracellular and extracellular. It is due to congestion and dilatation of blood vessels. It may be diffuse or localized.
- **Brain necrosis** is of severe variety with destruction and is due to hemorrhagic infarction.
- **Brain ischemia** is due to increased pressure. This in turn leads to alteration in the perfusion of brain which itself aggravates the ischemia and this forms a vicious cycle, causing progressive ischemia of the brain.
- **Coup injury** occurs on the side of the blow to the head.
- **Contre-coup injury** occurs on the side opposite to the blow on the head.

Coup or Contrecoup injuries

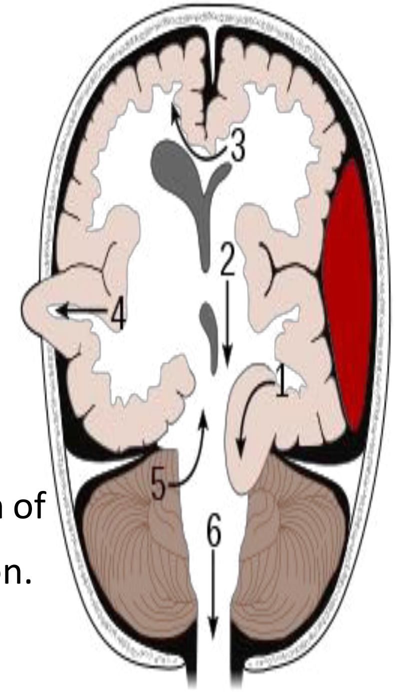


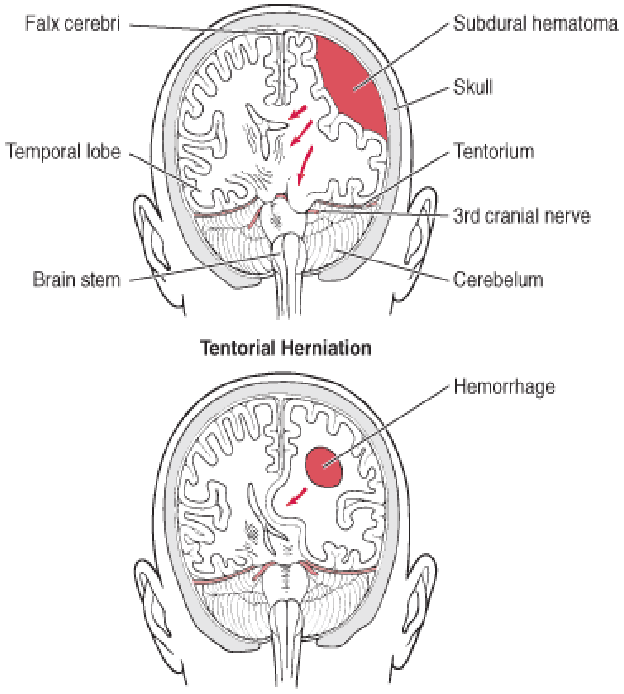
- **Damage may occur directly under the site of impact (COUP), or it may occur on the side opposite the impact (CONTRECOUP).**



Coning

- **It is due to ↑ ICP causing either:**
- Herniation of contents of supratentorial compartment through the tentorial hiatus (or)
- Herniation of the contents of infratentorial compartment through the foramen magnum.
- In **supratentorial herniation**, there is compression of ipsilateral III CN & Midbrain
- In **infratentorial herniation** there is obstruction of cerebral aqueduct with damage to brain function.





Tentorial Herniation

Subfalcine Herniation

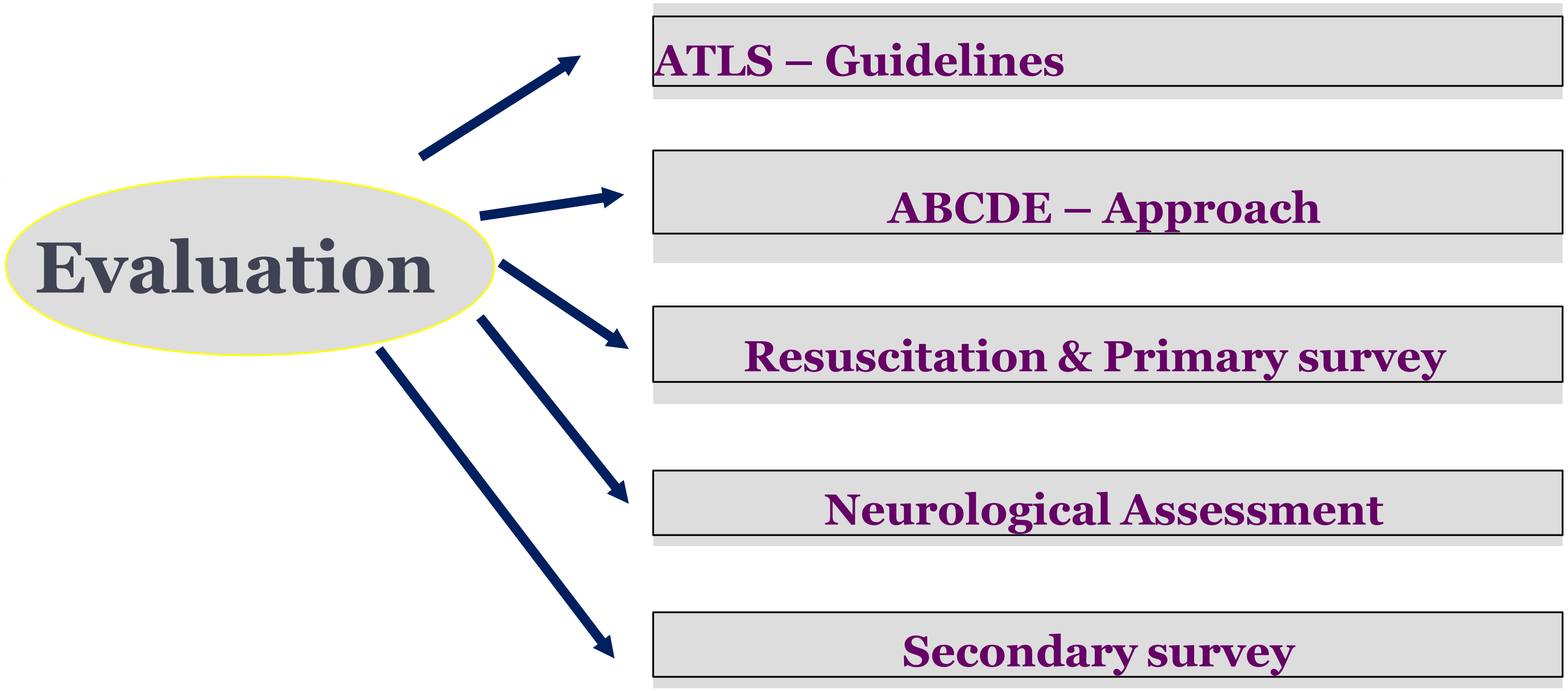
Clinical Approach

- **History**

- **Examination**

History Taking

- **Mechanism of injury**
- **Loss of consciousness or amnesia**
- **Level of consciousness at scene and on transfer**
- **Current symptoms / Evidence of seizures**
- **Probable hypoxia or hypotension**
- **Pre-existing medical conditions**
- **Medications (especially anticoagulants) / Allergies**


Evaluation
ATLS – Guidelines
ABCDE – Approach
Resuscitation & Primary survey
Neurological Assessment
Secondary survey

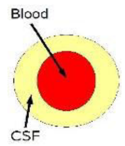
Examination

Neurological Assessment

- **Level of consciousness**
- **Glasgow coma scale**
- **Pupillary reaction to light and size**
- **Vital Signs**
- **Reflexes**
- **Limb movements—normal/mild weakness/ severe weakness/spastic flexion/extension/ no response**

Secondary survey

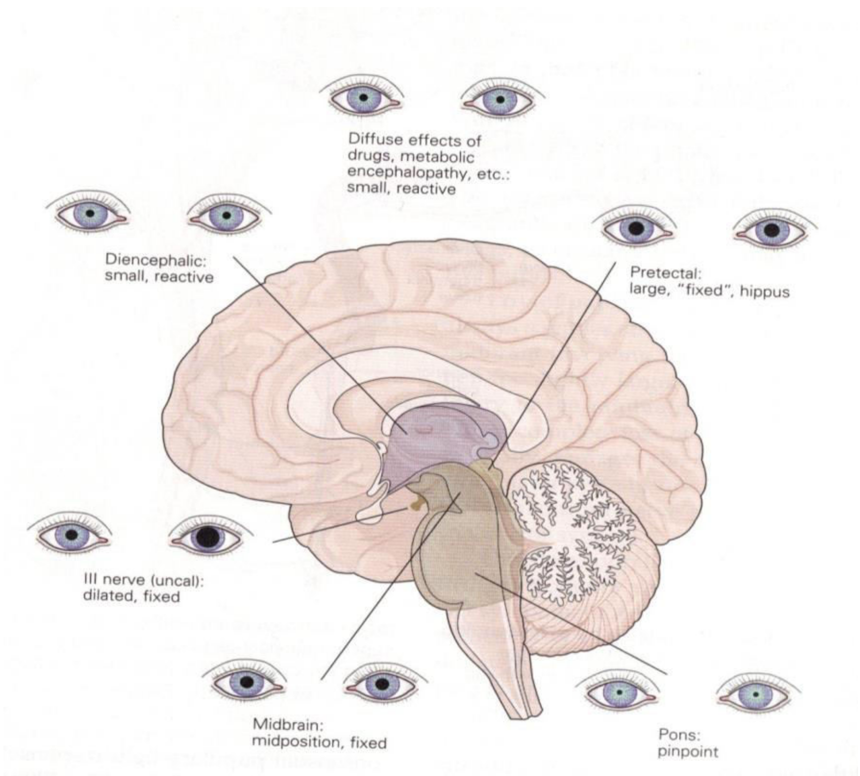
- Status and protection of airway.
- General assessment and other injuries like fractures, abdominal organ injuries, thoracic injuries are looked for.
- Presence of any scalp haematoma, fractures of skull bone which may be depressed has to be looked for.
- Any blood from nose or ear, CSF rhinorrhoea or CSF otorrhoea has to be looked for.



Glasgow Coma Scale

Eye opening	
Spontaneous	4
To loud voice	3
To pain	2
None	1
Verbal response	
Oriented	5
Confused, disoriented	4
Inappropriate words	3
Incomprehensible sounds	2
None	1
Best motor response	
Obeys	6
Localizes	5
Withdraws (flexion)	4
Abnormal flexion posturing	3
Extension posturing	2
None	1

Pupillary Response

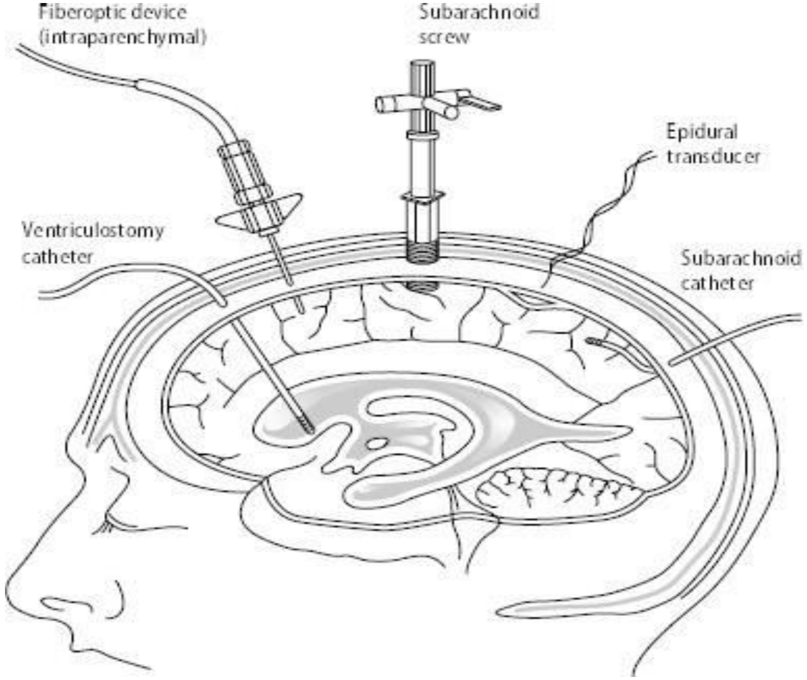


Investigations

- Basic Tests
- X-ray skull: To look for fracture, relative position of the calcified pineal gland.
- CT scan: Plain (not contrast) to look for cerebral oedema, haematomas,

  midline shift, fractures, ventricles, brainstem injury.
- Carotid arteriography / MRI scan
- Investigations for other injuries like ultrasound of abdomen.
- Monitoring of intracranial pressure

ICP – Monitoring



Criteria for Hospitalization

- **Any altered level of consciousness**
- **Skull fracture**
- **Focal neurological features**
- **Persistent headache, vomiting, systolic hypertension, bradycardia**
- **No CT scan available or abnormal CT Head**
- **Alcohol intoxication**
- **Bleeding from ear or nose**
- **Associated injuries**

Treatment – Mild Head Injury [14-15 GCS]

Discharge - Criteria

- GCS – 15 / 15
- No Focal neurological deficit
- Follow-up – A & E Dept

NICE Guidelines – CT-scan

- Glasgow Coma Score (GCS) < 13 at any point
- GCS 13 or 14 at 2 hours
- Focal neurological deficit
- Suspected open, depressed or basal skull fracture
- Seizure
- Vomiting > one episode

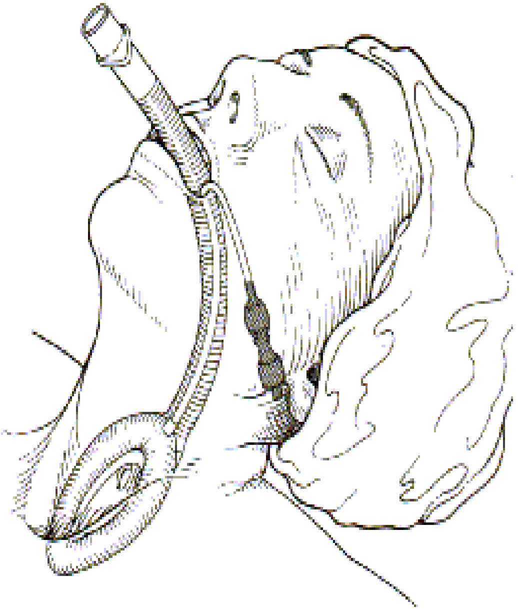
Treatment – Moderate to Severe Injury

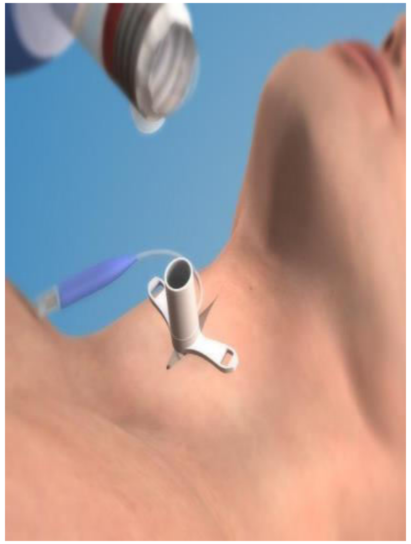
Aim (SBI)

- **Prevention of Hypoxia**
- **Control of ↑ ICP**
- **Maintenance of Perfusion**
- **Others**

Cervical Immobilization

Resuscitation





Control of ICP - Medical

Normal ICP = 8-12 mm Hg

- **Position head up 30⁰**
- **Avoid obstruction of venous drainage - head**
- **Sedation +/– muscle relaxant**
- **Normocapnia 4.5–5.0 kPa**
- **Diuretics: furosemide, mannitol**
- **Seizure control**
- **Normothermia**
- **Sodium balance**
- **Barbiturates**

Reverse - Trendelenberg

Control of ICP – Surgical

- **Early evacuation of focal haematomas:**

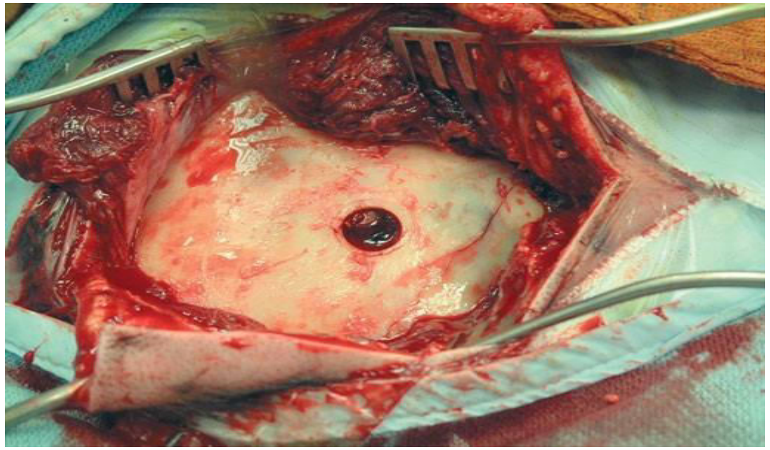
  EDH, ASDH [Burr-hole / Craniotomy]

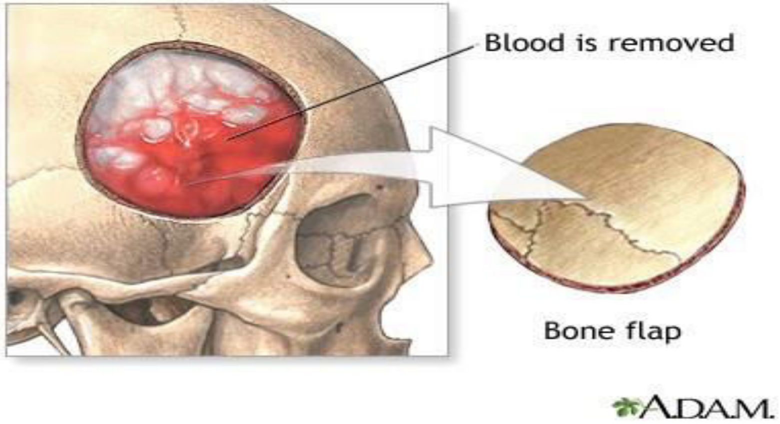
- **Cerebrospinal fluid drainage via**

  ventriculostomy

- **Delayed evacuation of swelling contusions**

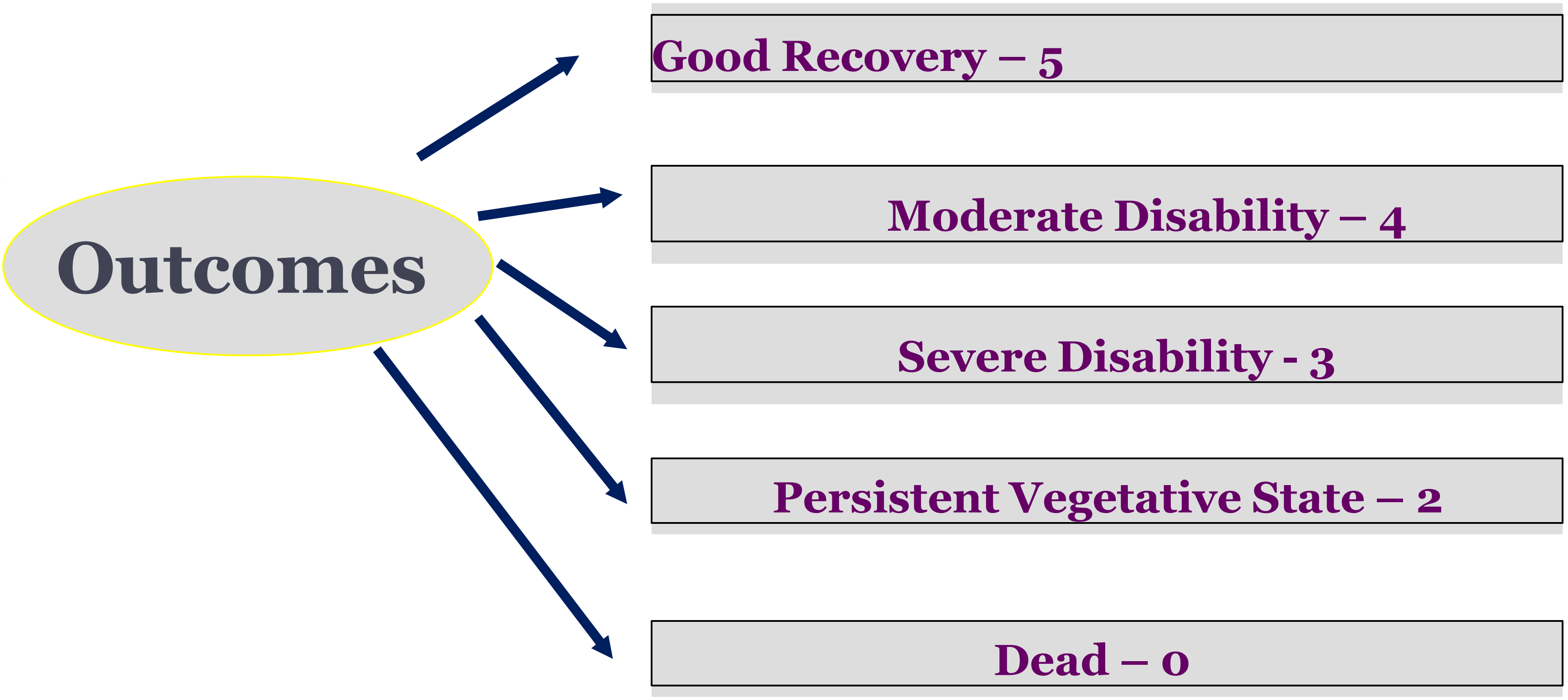
- **Decompressive craniectomy**





Complications

Early	Late
Brainstem injury—due to coning.	Chronic subdural haematoma.
Compression over cerebellum and medulla.	Early post-traumatic epilepsy—they need anticonvulsants for 3 years.
CSF rhinorrhoea / CSF - Leak	Late post-traumatic epilepsy is due
	Scarring and gliosis of cerebrum.
	Post-traumatic amnesia.
	Post-traumatic hydrocephalus.
	Post-traumatic headache.


Outcomes
Good Recovery – 5
Moderate Disability – 4
Severe Disability - 3
Persistent Vegetative State – 2
Dead – 0

Abdominal Trauma

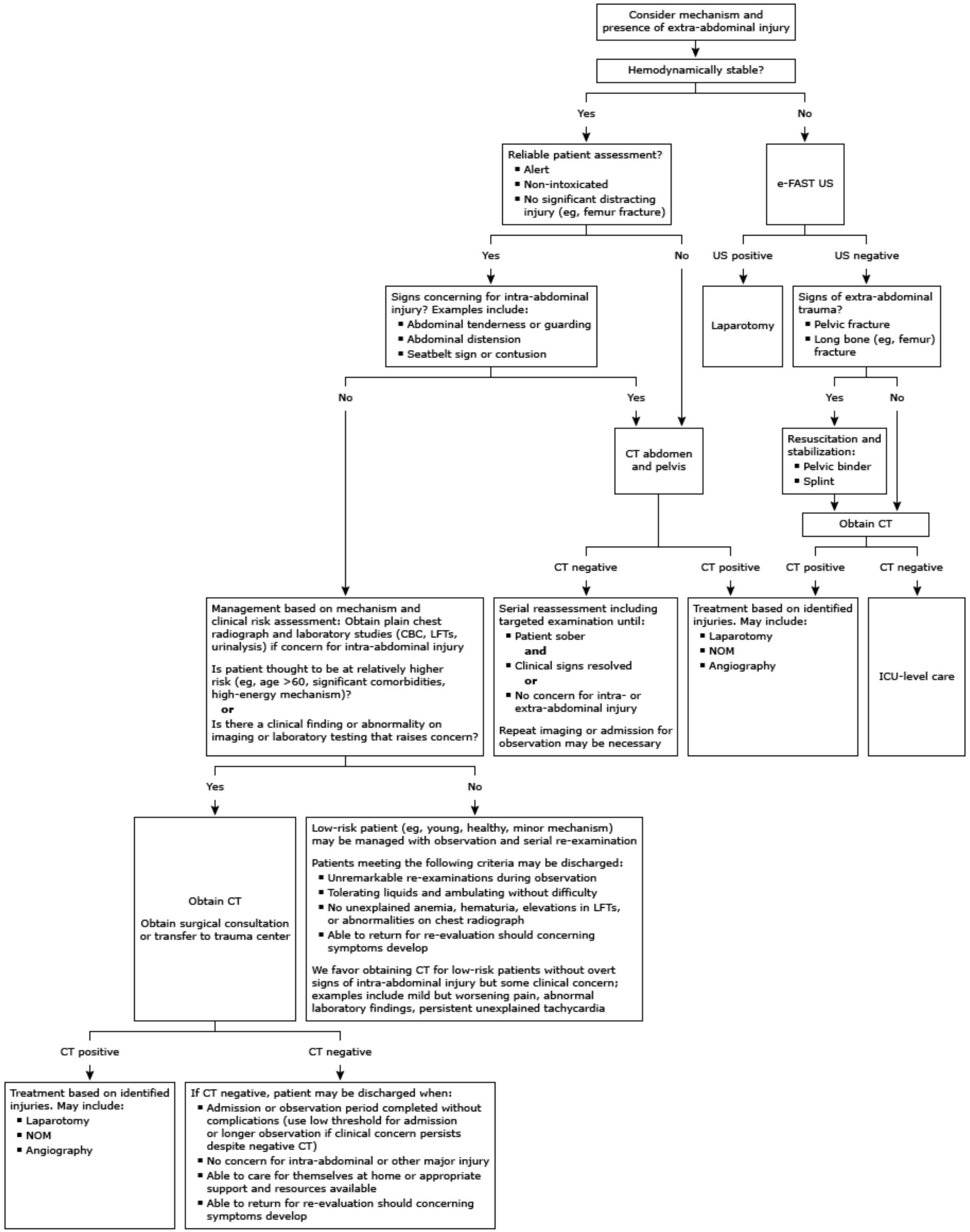
Leen Jalal Damra.

Blunt Trauma

- **Epidemiology** – The spleen and liver are the most commonly injured solid organs in blunt abdominal trauma (BAT). Delayed splenic rupture can occur. Injuries to the pancreas, bowel, mesentery, and diaphragm are less common but potentially dangerous and more difficult to diagnose than solid organ injury.
- **Mechanism of Injury --** Several pathophysiologic mechanisms can occur in patients with blunt abdominal trauma. A sudden and pronounced rise in intra-abdominal pressure created by outward forces can rupture a hollow viscus. Passengers wearing a lap-belt without a shoulder attachment can sustain injury from such a mechanism when the belt forcefully compresses the abdomen.
- Blunt forces exerted against the anterior abdominal wall can compress abdominal viscera against the posterior thoracic cage or vertebral column, crushing tissue. Solid organs (e.g., spleen and liver) are particularly susceptible to laceration or fracture by this mechanism. Older adults and alcoholic patients generally have lax abdominal walls and are more likely to sustain such injuries. Delayed splenic rupture can occur. Retroperitoneal structures, such as the duodenum or pancreas, may be injured.
- Shearing forces created by sudden deceleration can cause lacerations of both solid and hollow organs at their points of attachment to the peritoneum. They may also create tears at vascular pedicles or cause stretch injuries to the intima and media of arteries, resulting in infarction of the susceptible organ. The kidney is most susceptible to such stretch injury.
- Fractured ribs or pelvic bones can lacerate intra-abdominal tissue.

EVALUATION AND MANAGEMENT

Approach and management algorithm – Emergency clinicians managing blunt trauma must maintain a high degree of clinical suspicion for intra-abdominal injury, particularly in patients with suggestive mechanisms, signs of external trauma, or an altered sensorium due to head injury or intoxication. Prompt resuscitation of the unstable patient is performed in parallel with physical examination and diagnostic testing to determine the presence or absence of hemoperitoneum and organ injury. A basic algorithm for the management of blunt abdominal trauma is provided (algorithm 1).



History

- Fatality at the scene
- Vehicle type and velocity
- Whether the vehicle rolled over
- Patient's location within the vehicle
- Extent of intrusion into the passenger compartment
- Extent of damage to the vehicle; steering wheel deformity
- Whether seatbelts were used and what type (unrestrained victims are at higher risk of injury); whether air bags deployed

Clinical presentation and physical examination

- Examination findings associated with intra-abdominal injury include:
- Seatbelt sign, particularly if above the level of the anterior-superior iliac spine (ASIS)
- Rebound tenderness
- Hypotension
- Abdominal distension
- Abdominal guarding
- Severe distracting injury (eg, femur fracture)
- The absence of such findings does **not** exclude intra-abdominal injury. If the patient is awake, alert, and hemodynamically stable, and is free of abdominal pain or tenderness, intra-abdominal injury is unlikely.

Blood transfusion and laboratory testing

- Notify the blood bank immediately and directly. i.e., by telephone or in-person) of the need for transfusion should a BAT patient present with life-threatening bleeding. Order a blood type and screen for any victim of significant trauma.
- Routine hematology and chemistry laboratory tests are of limited value in the management the acute trauma patient but may be helpful in identifying patients at low risk for significant injury when used in combination with other clinical findings. We suggest obtaining a microscopic urinalysis in victims of BAT when the presence of intra-abdominal injury is unclear, as microscopic hematuria (>25 red blood cells per high power field) increases the likelihood of significant intra-abdominal injury.

Hematocrit

Leukocyte count

Pancreatic enzymes

Liver function tests

Urinalysis

Base deficit and lactate

Additional tests

Diagnostic imaging

The trauma patient must be stabilized before most abdominal radiographic studies (e.g., computed tomography [CT]) can be performed. Clinicians must pay careful attention to potential spinal cord injuries and guard against exacerbating such an injury during positioning. Patients must be closely monitored while in the radiology area. The indications, advantages, and disadvantages of the major modalities for imaging BAT are discussed above.

MANAGEMENT BY CLINICAL SCENARIO

Hemodynamically unstable patient

In the hemodynamically unstable patient, management hinges on determining the presence or absence of intraperitoneal hemorrhage. The emergency clinician performs a focused abdominal ultrasound (US) exam (or in some instances a diagnostic peritoneal tap [DPT]), to make this determination. Hemoperitoneum in the clinically unstable patient without other apparent injury mandates laparotomy. For patients without hemoperitoneum, clinicians search for extra-abdominal sites of hemorrhage.

Hemodynamically stable patient

Management of the hemodynamically stable patient depends upon the clinician's assessment of their risk for significant injury. Patients at increased risk based upon their presentation, examination findings, or laboratory study results are evaluated by CT. Several approaches may be used to assess low-risk patients and these are described in the text.

Clinical indications for laparotomy

- Nonoperative management (NOM) has become standard for all but the most severely injured BAT patients. Immediate laparotomy after injury from a blunt mechanism is rarely based solely on clinical parameters.
- Potential indications include the following:
- ●Unexplained signs of blood loss or hypotension in a patient who cannot be stabilized and in whom intra-abdominal injury is strongly suspected
- ●Clear and persistent signs of peritoneal irritation
- ●Radiologic evidence of pneumoperitoneum consistent with a viscus rupture
- ●Evidence of a diaphragmatic rupture
- ●Persistent, significant gastrointestinal bleeding seen in nasogastric drainage or vomitus
- Establishing the need for urgent celiotomy on clinical grounds is particularly problematic athe patient with multiple blunt injuries. Numerous extra-abdominal sources of hemorrhage may exist. Head injury or intoxication often coexist with abdominal trauma, further impairing the reliability of examination findings. Laparotomy may imperil the patient when more crucial diagnostic and therapeutic steps are delayed. Where confusion exists, we strongly prefer that corroborative diagnostic tests be performed.

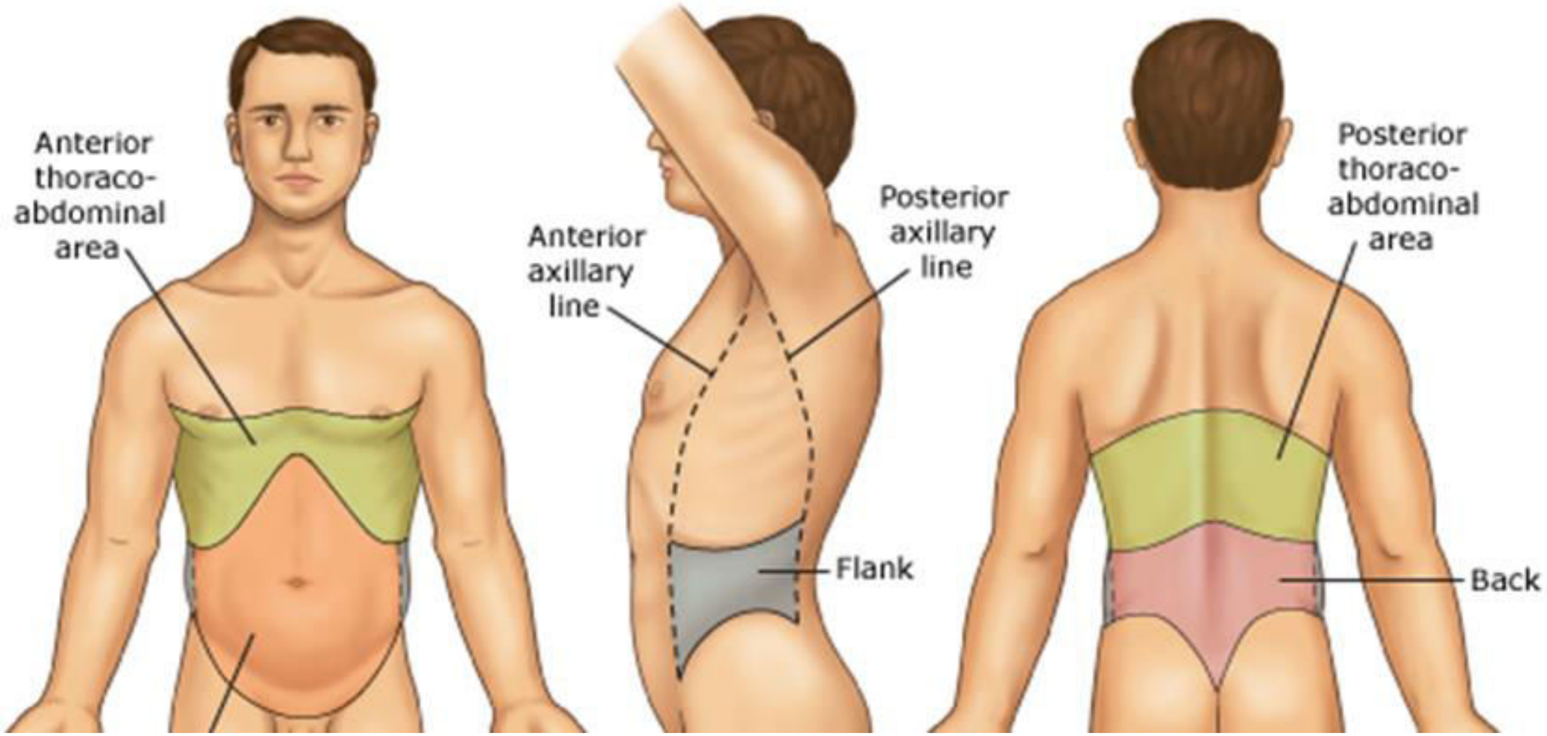
Special considerations

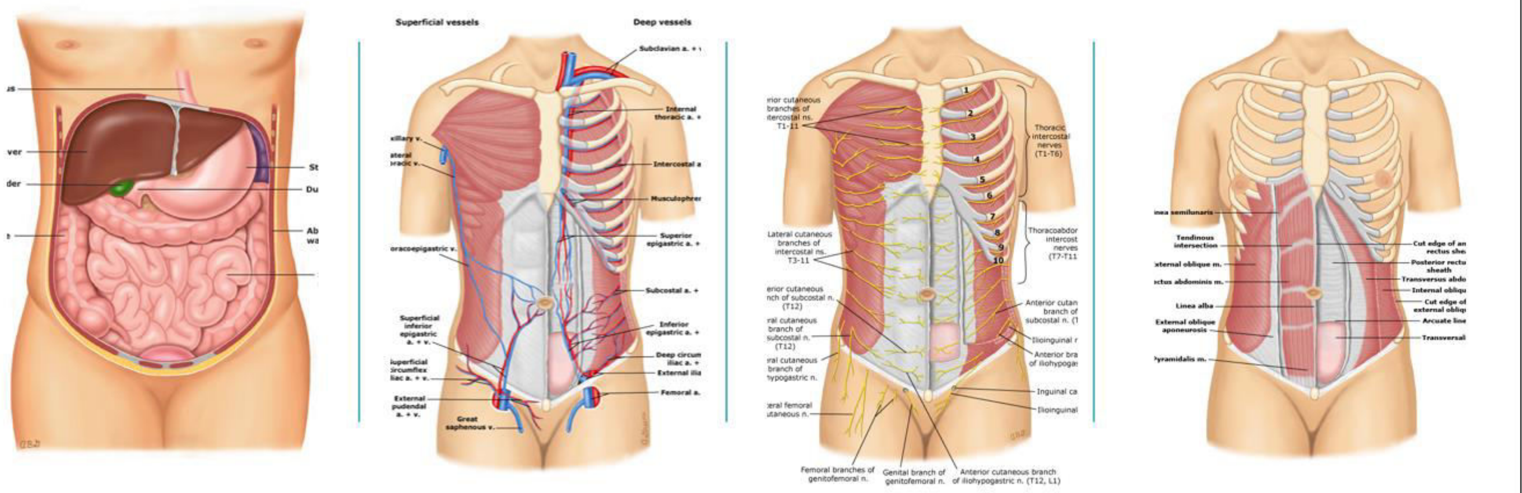
- Pelvic fracture
- Obese patient
- Geriatric patient
- Closed head injury
- Multiple system injury
- Pregnant patient
- Patient transfer

abdominal stab wounds

- **EPIDEMIOLOGY --** Although there will be regional variability in the mechanism of injury-producing abdominal trauma, most studies indicate that blunt abdominal trauma is more common than abdominal stab wounds, and that abdominal stab wounds are more common than abdominal gunshot wounds in the civilian population. Abdominal gunshot wounds, due to their higher kinetic energy, are associated with mortality rates approximately eight times higher than abdominal stab wounds.
- In children and adults alike, hollow viscus organs (intestines) are injured most often with abdominal stab wounds. The next most common sites of injury are the great vessels, diaphragm, mesentery, spleen, liver, kidney, pancreas, gallbladder, and adrenal glands. The specific organs at greatest risk from a stab wound depend upon the location and mechanism of the injury.
- **MECHANISM OF INJURY --** Any instrument that can impale may inflict a stab wound. Typically these are narrow, sharp, knife-like implements, but items that can inflict stab wounds range from scissors to coat hangers to animal horns. The given instrument can injure any tissue it traverses, including skin, fascia, solid organ, hollow viscus, blood vessel, nerve, muscle, and bone.
- According to one series, the majority of abdominal stab wounds with evisceration occurred in the left upper quadrant of the abdomen, followed by the left lower, the right upper, and the right lower. Posterior (ie, back) and flank stab wounds have a greater risk of injury to retroperitoneal structures, including the colon, kidneys, aorta, and inferior vena cava. Multiple stab wounds are present in 18 to 34 percent of patients, and as many as 30 percent of penetrating chest injuries traverse the diaphragm, potentially harming abdominal viscera. Accordingly, anterior stab wounds that are inferior to the nipple line (fourth intercostal space) and posterior stab wounds that are inferior to the tip of the scapula (seventh intercostal space) should be considered to involve potential diaphragm and intra-abdominal injuries in addition to chest injuries.

anATOMIC ZONES





History

- Important questions include:
- What instrument was used? how long and how wide was it?
- How was the patient positioned during the stabbing?
- What path did the implement travel (eg, upward, downward)?
- Was there substantial blood loss at the scene?
- When did the stabbing occur?

Clinical presentation and physical examination

- Undress completely any patient who sustains a stab wound. Stab wounds can often be obscured by body habitus, clothing, or bleeding, or be "hidden" in the axilla, scalp, or groin.
- Stab wounds to the abdomen, flank, or back are often amenable to local wound exploration (LWE) to evaluate their depth and tract. If a properly performed exploration to the deepest extent of the wound demonstrates that anterior rectus fascia is not violated, the patient may be discharged after appropriate wound care, assuming no additional or extra-abdominal injuries are present.
- If body habitus, multiple wounds, other injuries, or difficulty in performing LWE impedes visualization of the complete depth of the wound and all its margins, then peritoneal injury cannot be ruled out and further testing or observation must ensue.

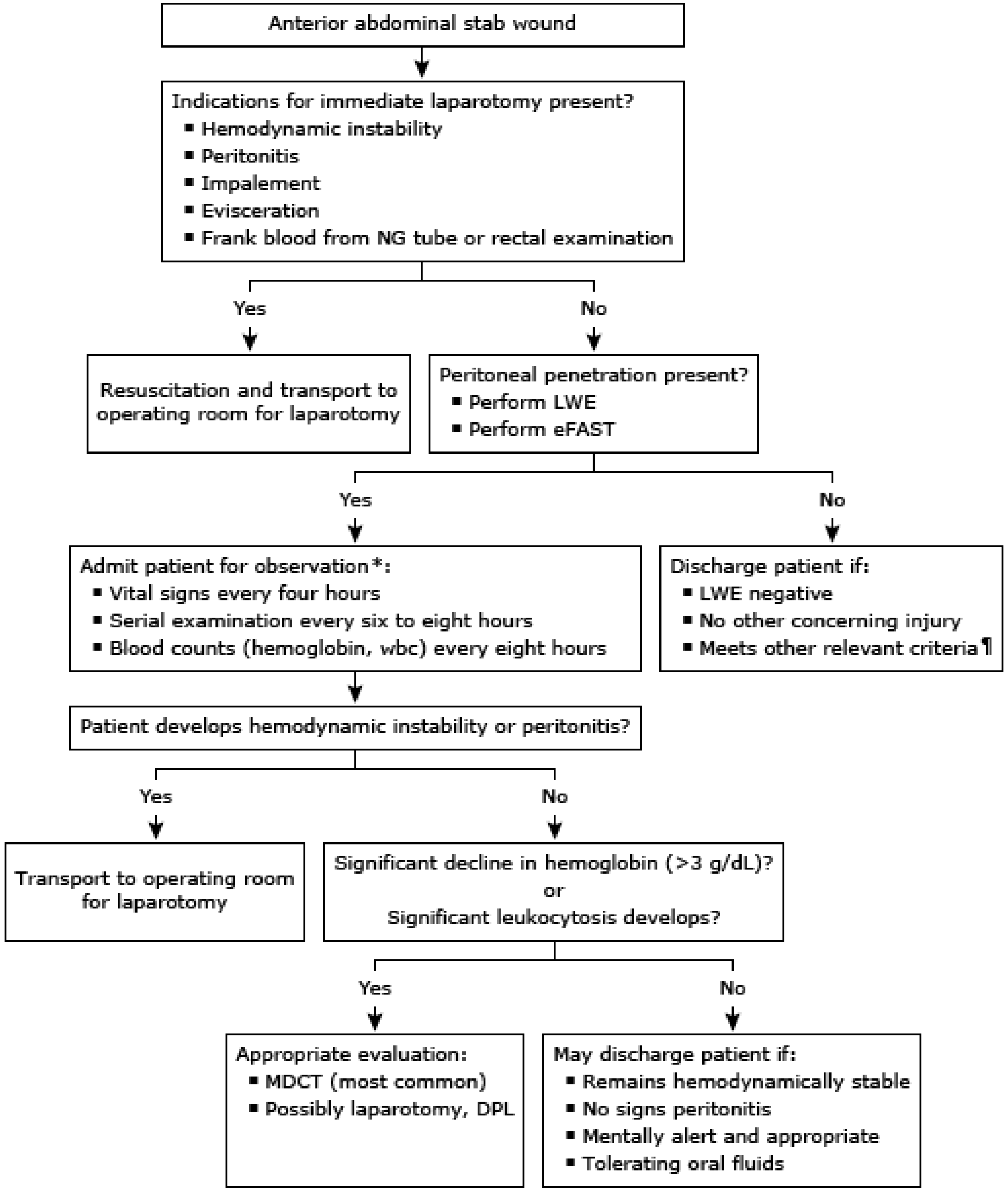
METHODS OF EVALUATION

METHODS OF EVALUATION

- Initial assessment
- Local wound exploration
- Plain radiographs
- Serial physical examination and observation
- Ultrasound
- Diagnostic peritoneal tap and diagnostic peritoneal lavage
- Computed tomography and magnetic resonance imaging
- Diagnostic laparoscopy

Clinical indications for laparotomy

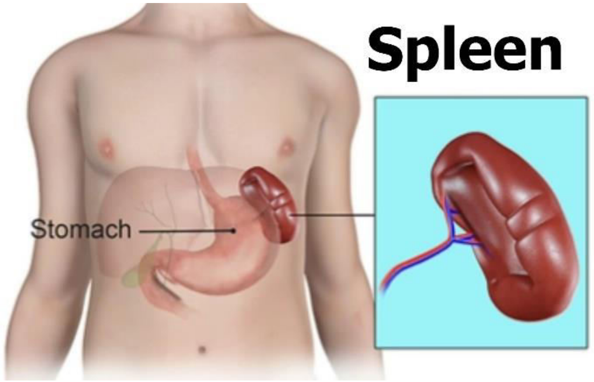
- Indications for emergency laparotomy include:
- •Hemodynamic instability
- •Peritoneal signs on physical examination
- •Signs of gastrointestinal hemorrhage
- •Implement in situ.
- Evisceration of intra-abdominal viscera or omentum is an indication for immediate laparotomy at most trauma centers but may be managed with diagnostic laparoscopy. Broad spectrum antibiotics are given to patients with penetrating abdominal injury requiring surgical management, but otherwise are not administered empirically. An algorithm to help guide the management of patients with an anterior abdominal stab wounds is provided (algorithm 1).



SPECIAL CONSIDERATIONS

- Flank and back stab wounds
- Thoracoabdominal stab wounds
- Right upper quadrant stab wound
- Stab wounds in pregnancy
- Patients on anticoagulants or antiplatelet therapy
- Law enforcement and social service issues

Splenic Trauma

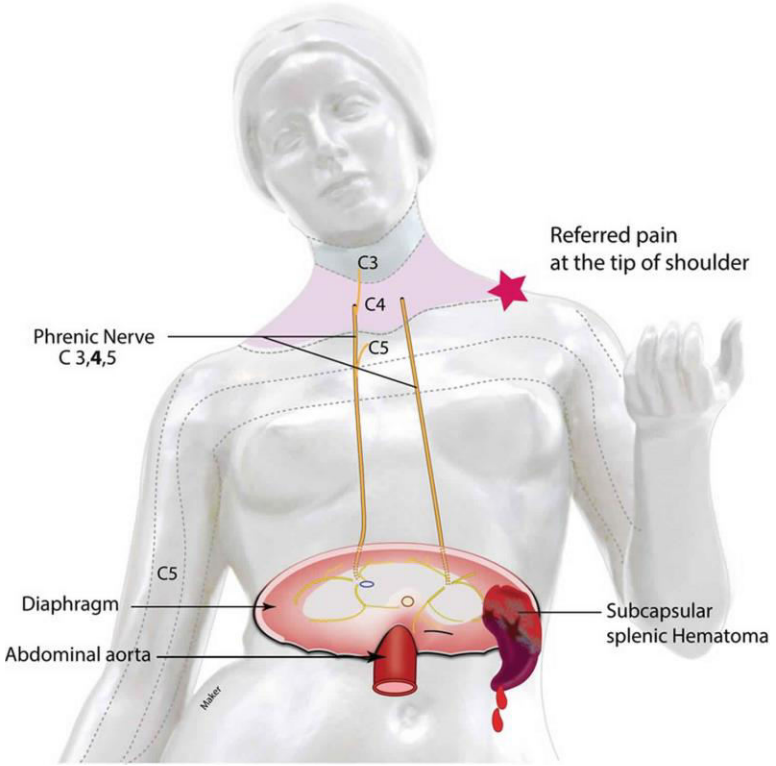


- **The spleen is the most common organ to be injured in abdominal trauma.**
- **Mechanisms of splenic injury** – Splenic injury can result from either blunt or penetrating chest or abdominal trauma; blunt mechanisms are more common. Splenic injury can also be due to iatrogenic injury during the course of another procedure involving the colon, stomach, pancreas, kidney, or with exposure and reconstruction of the proximal abdominal aorta; the risk is greatest for patients undergoing colon resection.
- **Clinical features** – A suspicion for splenic injury is increased with left upper quadrant and/or left chest trauma; however, clinical history and physical examination are not sufficiently sensitive or specific for the presence of splenic injury. Initial trauma evaluation is based upon protocols from the Advanced Trauma Life Support (ATLS) program
- •Findings indicative of splenic injury on focused assessment with sonography for trauma (FAST) examination include perisplenic or free intraperitoneal fluid.
- •CT scan findings consistent with splenic injury include splenic hypodensity, intraparenchymal or subcapsular hematoma, intravenous contrast blush, active intravenous contrast extravasation, or hemoperitoneum.

Balance's Sign: Dullness on percussion of the left upper quadrant ruptured spleen

Labia and Scrotum : Pooling of blood from abdominal and pelvic cavities.

Kehr Sign



Associated injuries — With blunt abdominal trauma, lower rib fractures, pelvic fracture, and spinal cord injury may also be present. Hollow viscous injuries are estimated to occur in 3 percent of patients with blunt splenic injury. Although the presence of rib fractures increases the likelihood of splenic injury, there is no association between the number of ribs fractured and splenic injury severity.

The types of injuries associated with penetrating trauma depend upon the type of implement or missile used and its trajectory. Injuries to adjacent organs including the heart, esophagus, aorta, stomach, diaphragm, pancreas, bowel, or left kidney can occur in conjunction with splenic laceration.

Classic Presentation of Rupture Spleen

- **Initial shock -** Lucid interval - Internal hemorrhage.
- **STAGE OF SHOCK**
- **GENERAL:** Tachycardia, Hypotension, Hypothermia, Decreased urine output.
- **LOCAL:**
- <u>Inspection:</u> Ecchymosis, Bruises, Fracture of ribs, Abdominal distention.
- <u>Palpation:</u> Rigidity, Tenderness, Rebound tenderness.
- <u>Percussion:</u> Shifting dullness.
- <u>Auscultation:</u> Diminished intestinal sounds.
- <u>DRE:</u> Fullness in retro-vesical pouch, Douglass pouch.

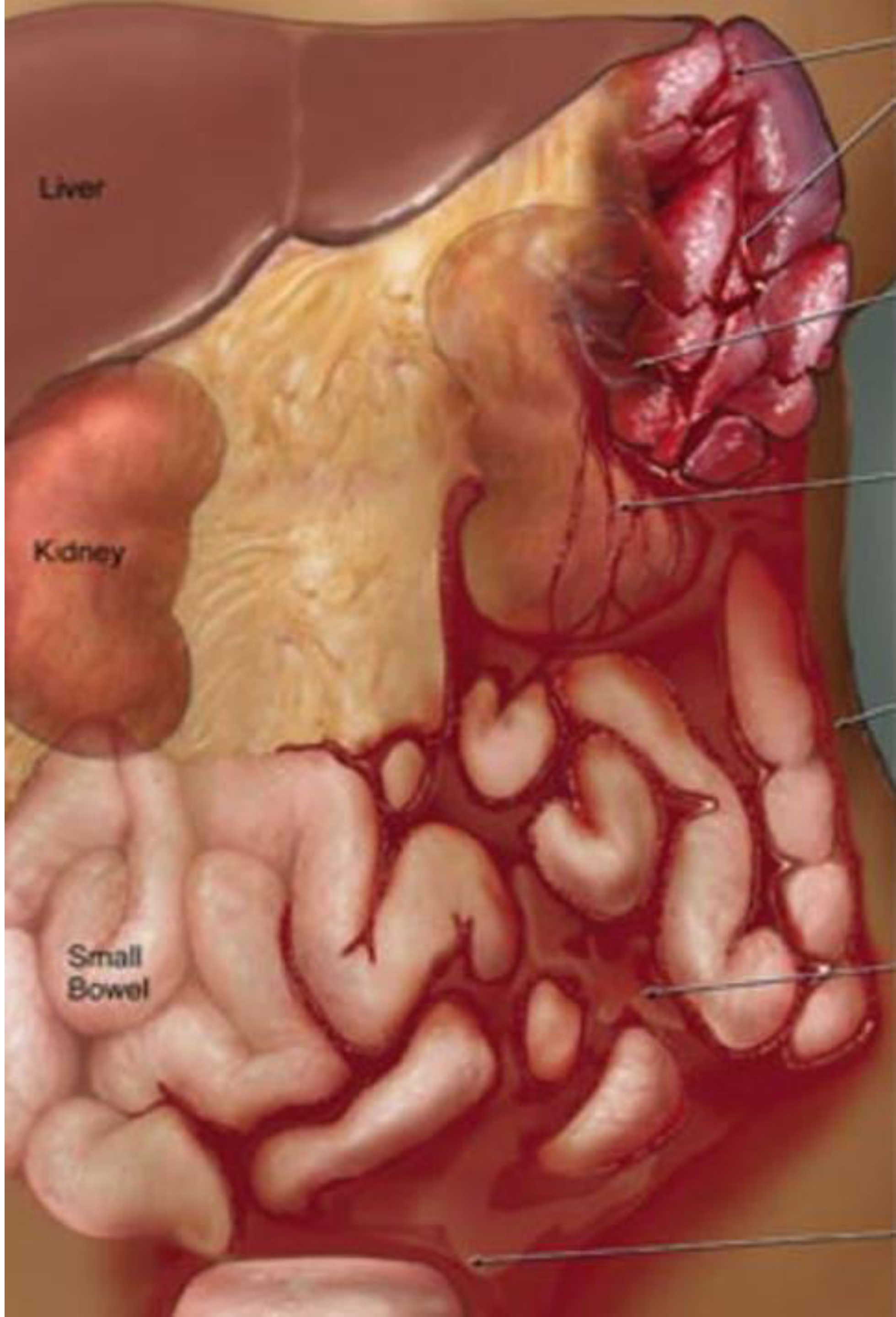


Table 25-2 OIS-AAST Grading Scale for the Spleen

Grade[a]	Type	Injury Description
I	Hematoma Laceration	Subcapsular, <10% surface area Capsular tear, <1 cm parenchymal depth
II	Hematoma Laceration	Subcapsular, 10–50% surface area, <5 cm in diameter 1–3 cm parenchymal depth not involving a trabecular vessel
III	Hematoma Laceration	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma, ≥5 cm or expanding >3 cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of the spleen)
V	Laceration Vascular	Shattered spleen Hilar vascular injury with devascularized spleen

[a]Advance one grade for multiple injuries, up to grade III.
Moore EE, Cogbill TH, Jurkovich GJ, et al. Organ injury scaling: spleen and liver (1994 revision). *J Trauma* 1995;38:323–324.

	Description
Class 1	Sub-capsular hematoma
Class 2	Superficial tears
Class 3	Deep tears
Class 4	Avulsion of pole of spleen
Class 5	Complete depulping of spleen
Class 6	Injury of a vascular pedicle

- We perform initial resuscitation, diagnostic evaluation, and management of the trauma patient with blunt or penetrating trauma based upon protocols from the Advanced Trauma Life Support (ATLS). The initial resuscitation and evaluation of the patient with blunt or penetrating abdominal or thoracic trauma.

Management of hemodynamically unstable patients – Per ATLS protocol, hemodynamically unstable patients with a positive FAST exam or diagnostic peritoneal lavage or aspirate (DPL/DPA) require operative surgical exploration to determine the source of life-threatening hemorrhage that may be due to splenic injury.

Management of hemodynamically stable patients – For hemodynamically stable patients with low-grade (I to III) injuries, we suggest nonoperative management over definitive surgical intervention (Grade 2C). Observation involves monitored care, serial abdominal examination, and serial hemoglobin assessment and may involve splenic angioembolization depending upon resources. Failure of nonoperative management indicates a need for angiographic embolization, if not initially used, or surgical exploration.

●***Vaccination*** – Asplenic patients (ie, postsplenectomy) have impaired immunity to encapsulated organisms and should be immunized against encapsulated organisms. For patients who have not undergone splenectomy, either because of successful nonoperative management (ie, observation with or without angioembolization) or operative splenic salvage, we suggest no immunization (Grade 2C)

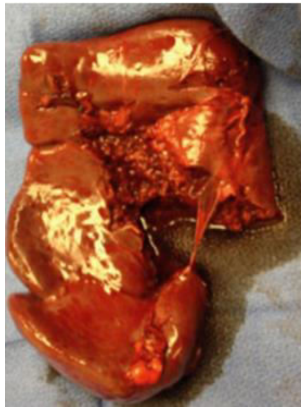


Figure showing Spleen after removal

Management of traumatic injury to the spleen

- ABC principles of the Advanced Trauma and Life Support™

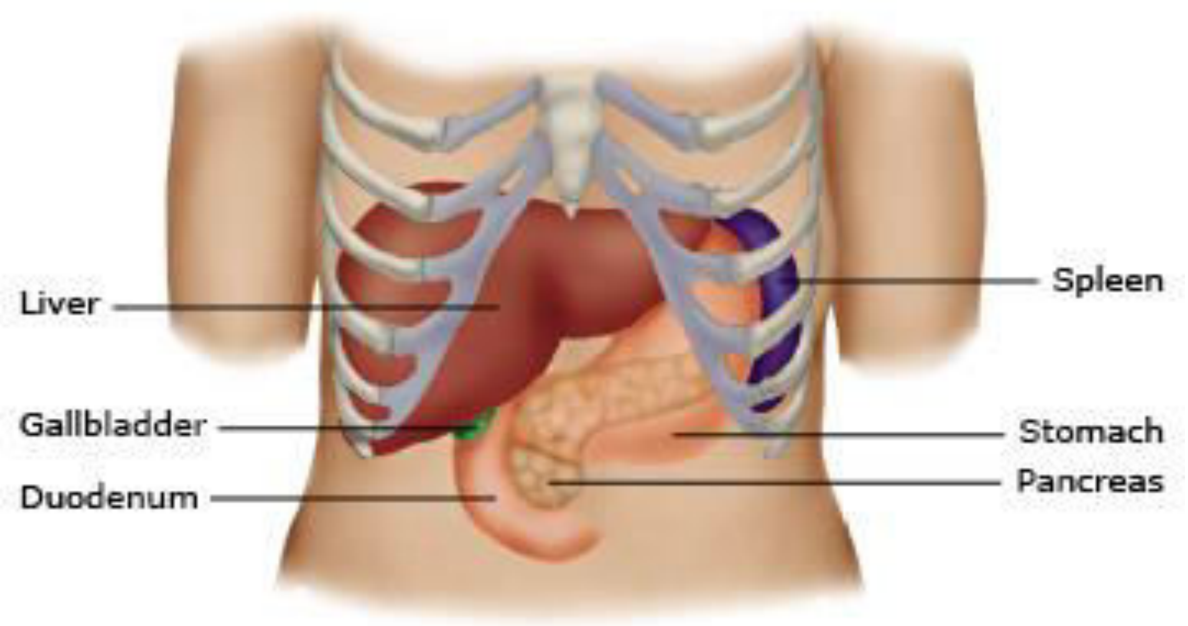
- Unstable patients – Abdominal distension, peritonitis, hypotension despite fluid resuscitation, require transfer to the Operating Suite for an emergency laparotomy.

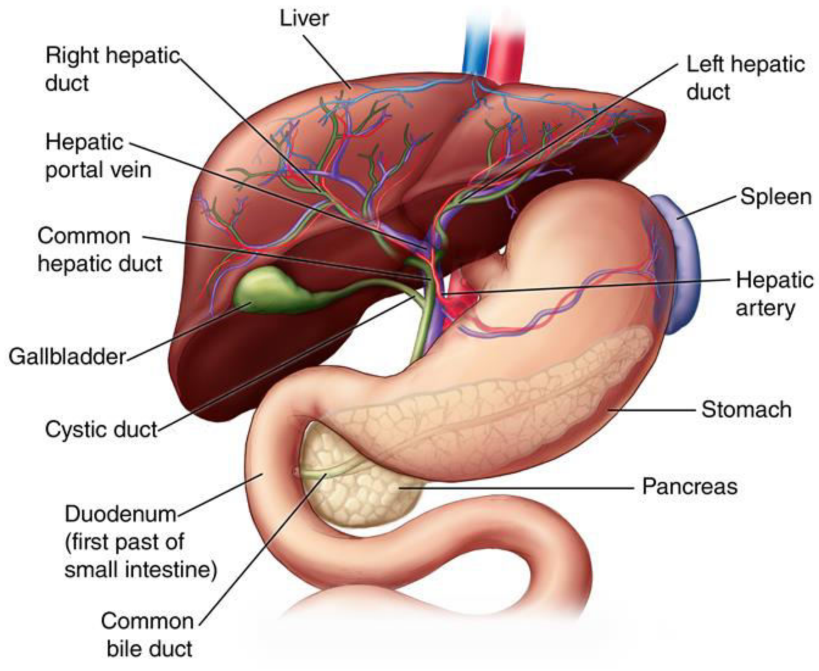
- Hemodynamically stable patients - CT is very sensitive and specific for splenic injuries

- 65–95% of adults and 87–98% of children can be treated conservatively.

Liver trauma

- - The liver is one of the largest organ in the body, weighing 1.7 kg in the average 80-kg man.
- - The liver is the second most common organ injured in abdominal trauma after the spleen.
- - The liver's large size makes it the organ most susceptible to blunt trauma, and it is frequently involved in upper torso penetrating wounds.





Etiology of liver injury

- Because of its size and location, the liver is frequently injure injured in both blunt and penetrating trauma
- The overall mortality rate ranges from 8% to 10% and the overall morbidity rate varies from 18 – 30 %
- Right Lobe >>> Left Lobe

  MORE COMMON

1) Blunt trauma

most liver injuries are due to blunt trauma , caused by direct blow , crushing or fall from height

The liver is solid organ and compressive forces can easily burst the liver substances being compressed between the force and rib cage and vertebral column

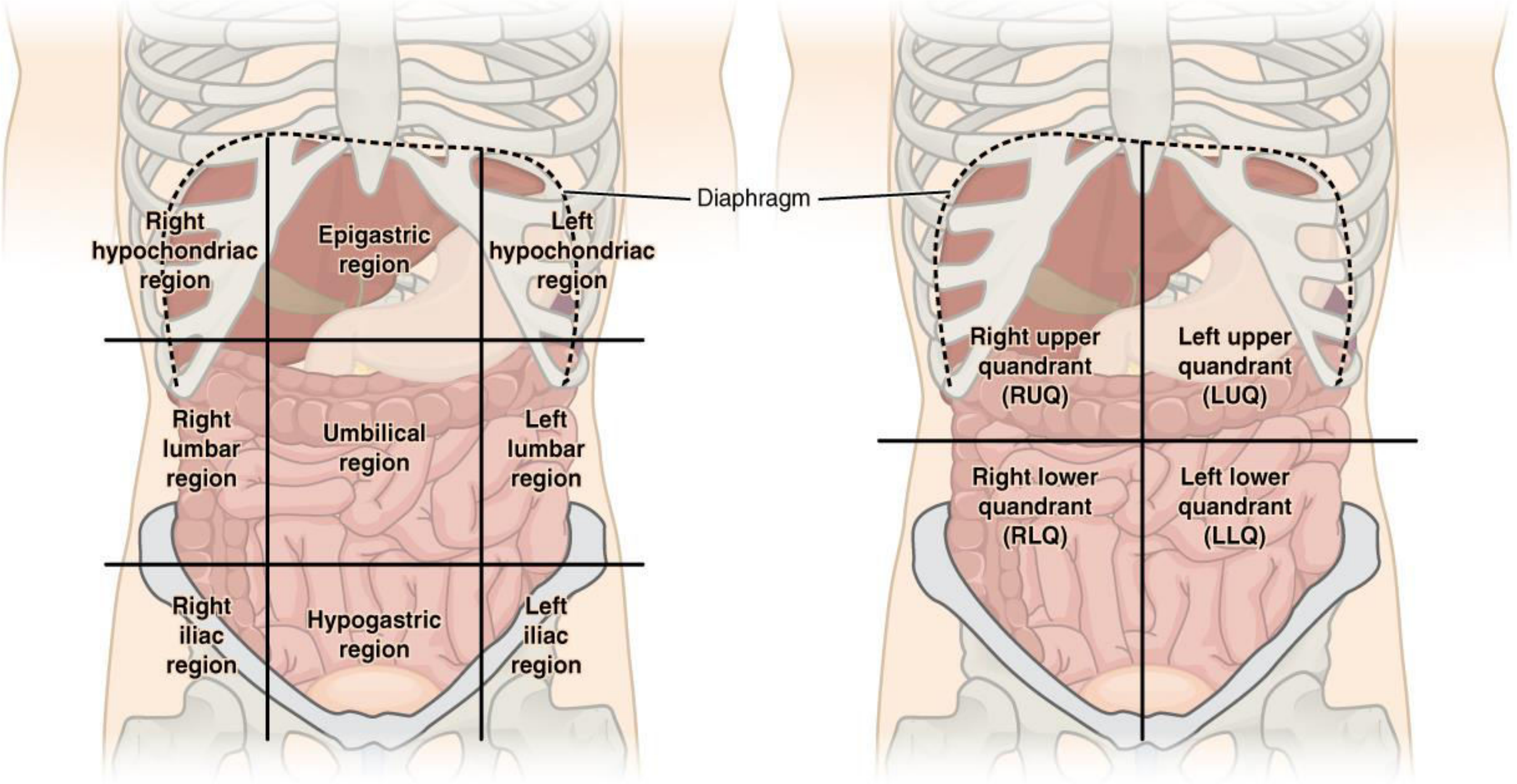
2) Penetrating injury

Stab wounds and gunshot wounds are often associated with chest or pericardial involvement.

3) Iatrogenic injury

Abdominal surgery, needle biopsy, laparoscopy.

Location of the liver in the abdomen

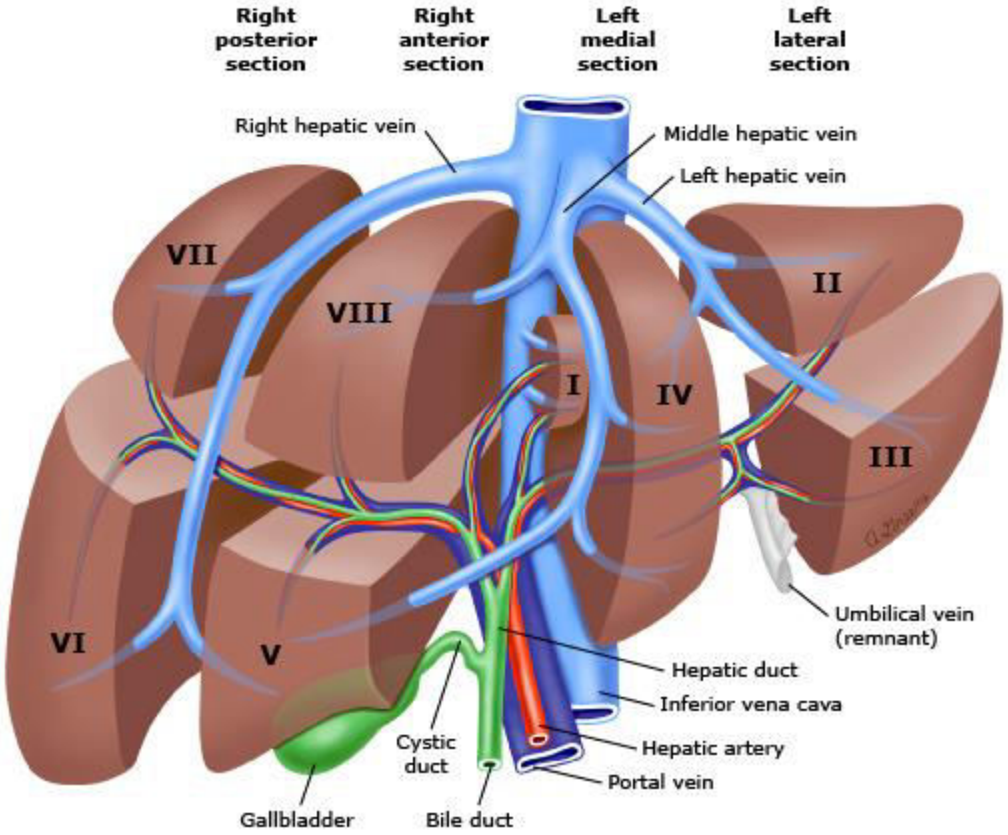


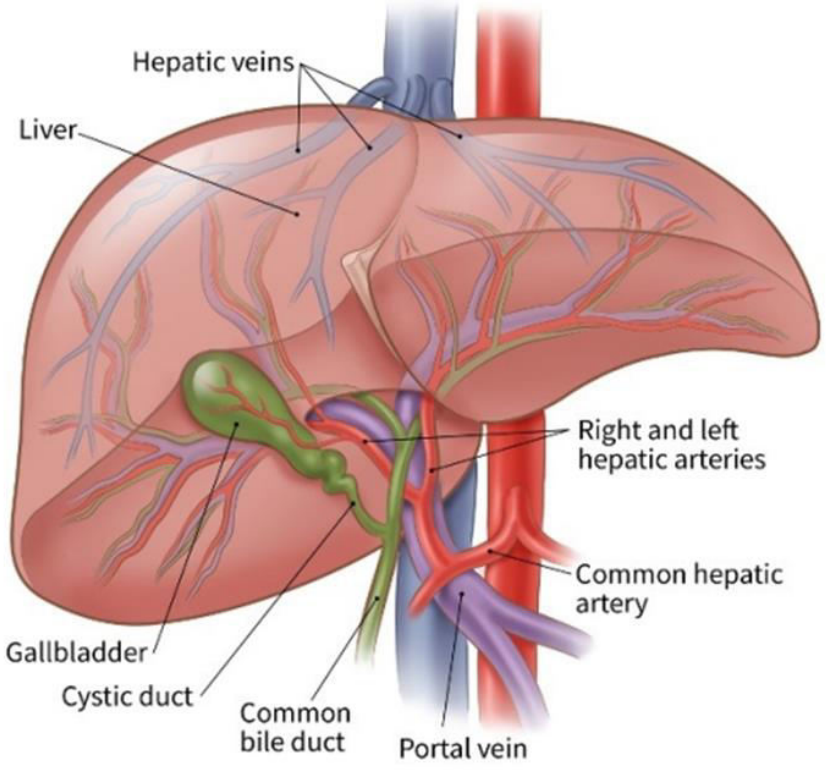
(a) Abdominopelvic regions

(b) Abdominopelvic quandrants

The hepatic veins drain the liver into the inferior vena cava.

- **Segmental anatomy of liver**
- The liver has four lobes (**right, left, caudate, and quadrate**.) & 8 segments





The liver receives the oxygen and nutrients it needs in blood that comes from two large blood vessels:

Portal vein.

Hepatic artery.

Sign and symptoms

- RUQ pain radiate to shoulder
- Rib fracture (The liver is an intraperitoneal organ found inferior to the diaphragm and deep to the **7th to 11th ribs**.)
- Guarding
- Peritonism
- Hypotension
- Altered mental status

Associations:

- Isolated liver injury occurs in less than 50% of patients.
- Blunt trauma→ 45% with spleen
- Rib fracture → 33% with Liver injury

Mild injuries heal in 3 months.
Moderate injuries heal in 6 months.
Sever injuries in 9-15 months

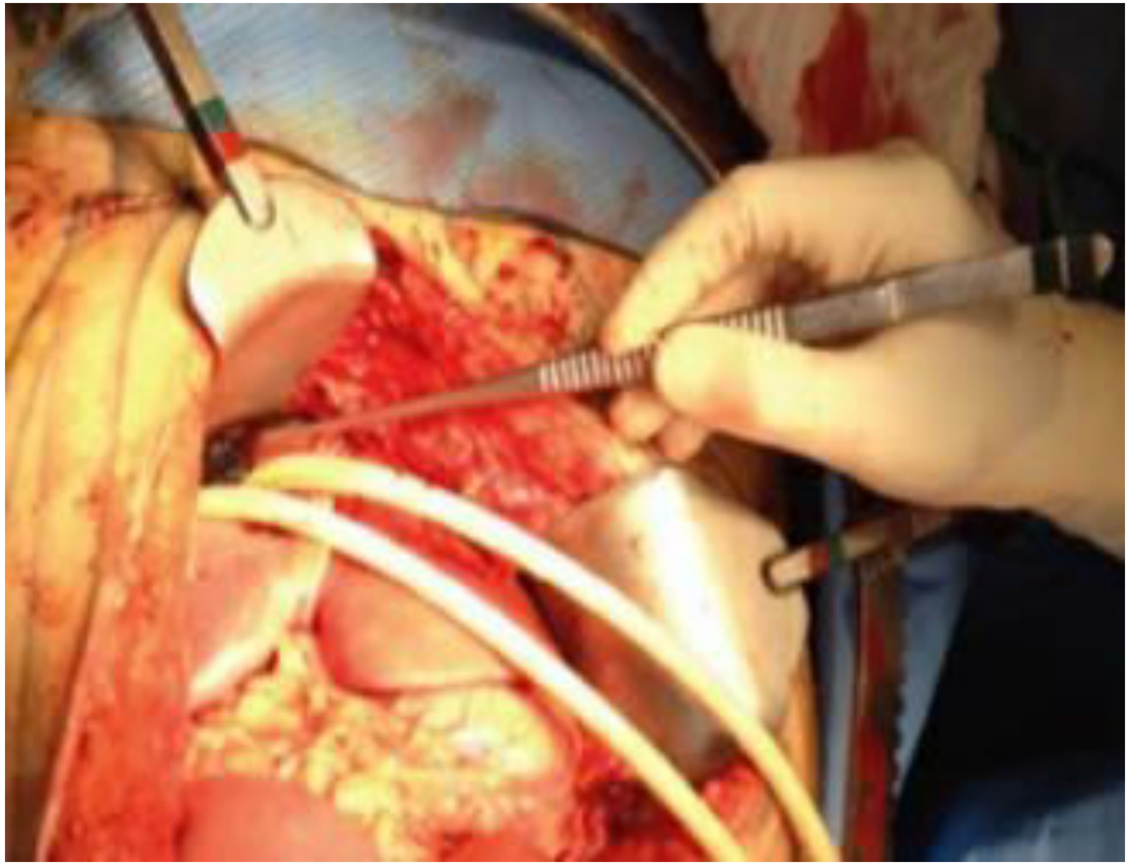


Figure showing gunshot injury through the center of liver requiring balloon tamponade using Foley catheters for damage control.

Table 25-1 OIS-AAST Grading Scale for the Liver

Grade*	Type	Injury Description
I	Hematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1 cm parenchymal depth
II	Hematoma	Subcapsular, 10–50% surface area;
	Laceration	intraparenchymal, <10 cm in diameter
		1–3 cm parenchymal depth, <10 cm in length
III	Hematoma	Subcapsular, >50% surface area or expanding;
	Laceration	ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma, >10 cm or expanding
		>3 cm parenchymal depth
IV	Laceration	Parenchymal disruption involving 25–75% of hepatic lobe or 1–3 Couinaud segments within a single lobe
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3
	Vascular	Couinaud segments within a single lobe
		Juxtahepatic venous injuries; that is, retrohepatic vena cava/ central major hepatic veins
VI	Vascular	Hepatic avulsion

*Advance one grade for multiple injuries, up to grade III.
Moore EE, Cogbill TG, Jurkovich GJ, et al. Organ injury scaling: spleen and liver (1994 revision). *J Trauma* 1995;38:323–324.

Diagnosis

Clinical suspicion of a possible liver injury is essential, as a laparotomy by an inexperienced surgeon with inadequate preoperative preparation is doomed to failure.

severe crushing injuries to the lower chest or upper abdomen and All lower chest and upper abdominal stab wounds should be suspect liver injury

Patients with free intraperitoneal fluid on FAST (Focused assessment with sonography for trauma) and hemodynamic instability, and patients with a penetrating wound, will require a laparotomy

Patients who are hemodynamically stable should have a contrast enhanced CT scan of the chest and abdomen as the next step.

This scan will demonstrate evidence of parenchymal damage to the liver or spleen, as well as associated traumatic injuries to their feeding vessels. Free fluid can also be clearly established. The chest scan will help to exclude injuries to the great vessels and demonstrate damage to the lung parenchyma.

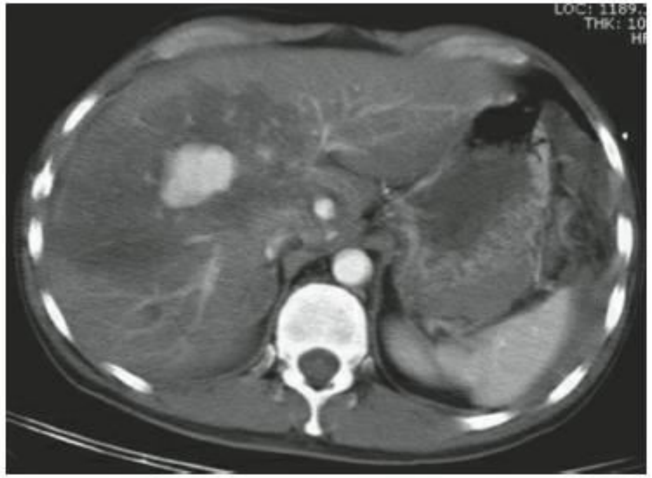
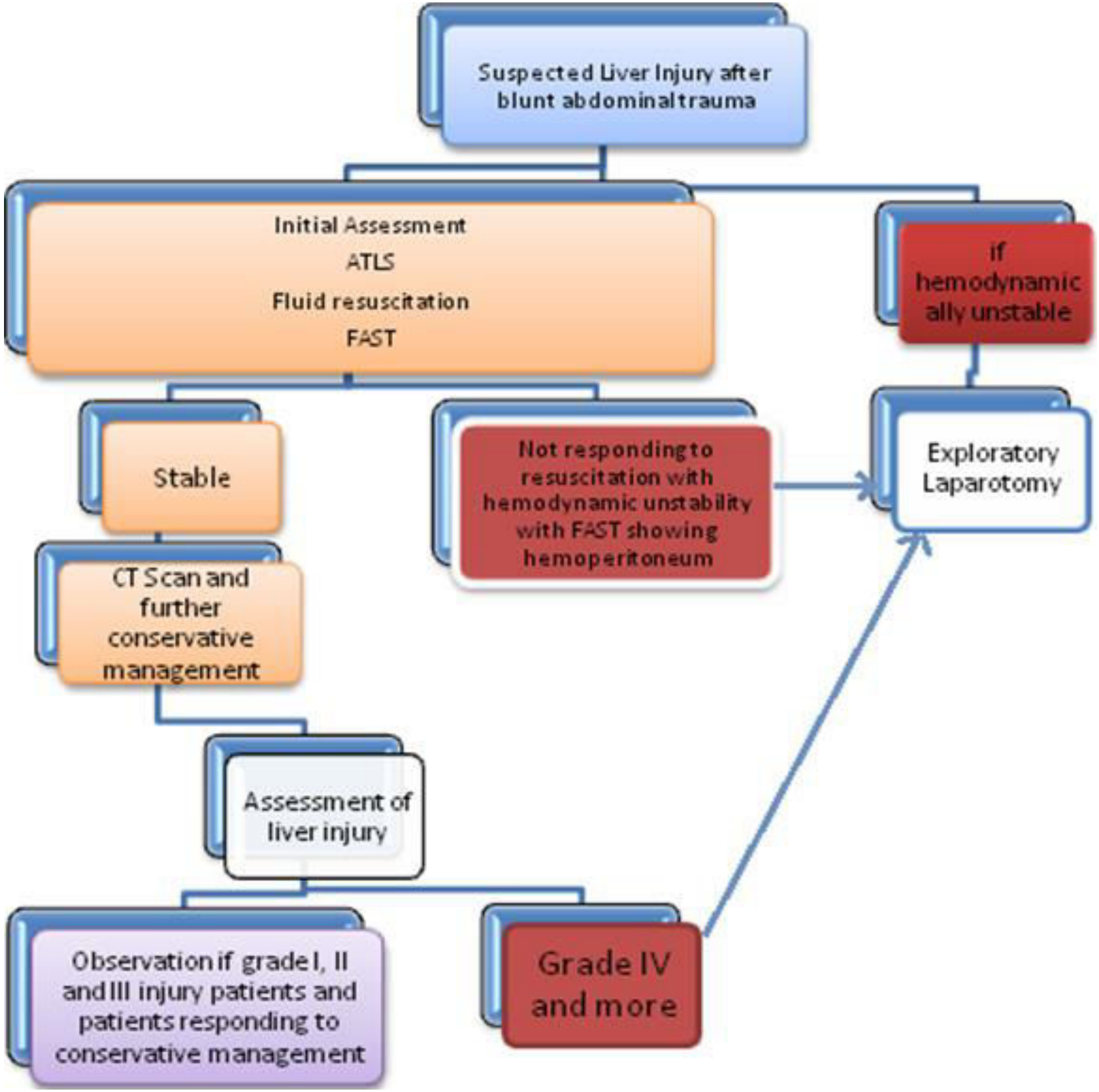


Figure showing a high-grade blunt liver injury with active contrast extravasation.


Suspected Liver Injury after blunt abdominal trauma
Initial Assessment
ATLS
Fluid resuscitation
FAST
if hemodynamically unstable
Stable
Not responding to resuscitation with hemodynamic unstability with FAST showing hemoperitoneum
Exploratory Laparotomy
CT Scan and further conservative management
Assessment of liver injury
Observation if grade I, II and III injury patients and patients responding to conservative management
Grade IV and more

Intestinal trauma

- Due to the potentially life-threatening nature of these injuries, providers should have a good understanding of the management of such injuries.
- Failure to recognize and properly treat intestinal trauma can result in significant morbidity and mortality to the patient.

EPIDEMIOLOGY

- Injury is one of the leading causes of death in people under the age of 44 years old. Like most traumatic injuries, the incidence is higher in males, with men accounting for approximately 80% of cases.
- Intestinal injury is the third most common injury associated with blunt abdominal trauma, following spleen and liver.
- In penetrating injury, the small bowel is the most commonly injured, followed by the colon.
- In patients with abdominal stab wounds, increased BMI is protective and is associated with a lower incidence of severe injury and need for operation.

•Etiology

- Intestinal injury can result from either blunt or penetrating trauma.
- The majority of blunt abdominal trauma does not result in intestinal injury.
- Approximately three percent of blunt abdominal trauma results in intestinal injury, with the small bowel being the most common location.
- Penetrating traumatic injury is less frequent than blunt trauma; however, it more frequently results in intestinal injury.

PATHOPHYSIOLOGY

- The pathophysiology of intestinal trauma is multifaceted including mechanical, ischemia/reperfusion, and signaling mediated mechanisms.
- Mechanical injury can be direct or indirect. Penetrating trauma causes trauma to the intestines by direct laceration of the tissue from the penetrating object.
- The severity of injury depends on the penetrating object, its velocity, and the site and trajectory of the path
- Blunt intestinal injury is usually caused by the intestine being crushed between external objects (e.g., car door, handlebars, etc.) and internal structures (e.g., vertebrae, pelvis, etc.).
- Indirect injuries in blunt trauma can also occur from acceleration/deceleration injuries when one part of the bowel is tethered in place and the other part is mobile.
- The duodenum-jejunum junction is a common site for this type of shear injury due to the stabilization of the duodenum by the ligament of Treitz.
- In patients with prior abdominal surgery, acceleration/deceleration injuries can be precipitated by underlying adhesions leading to an unpredictable pattern of traction injuries. Blunt injury can ultimately lead to devascularization of the affected segment of bowel, leading to intestinal necrosis.
- Another mechanism for indirect intestinal injury involves a low perfusion state and global hypotension from hemorrhagic shock or direct vascular trauma.
- Acute phase reactants activated as a result of bowel injury leads to an increase in the permeability of the capillaries

LIFE threatening conditions

- Peritonitis: inflammation of the peritoneum
- Without treatment peritonitis can cause sepsis
- Sepsis may leads to organ failure and death
- Shock

HISTORY & PHYSICAL

- All trauma patients should be evaluated in a standard format beginning with the primary survey, during the secondary survey, the patient's abdomen is assessed for visual signs of trauma.
- Concurrent with the physical exam, clinicians should monitor vital signs and gather information regarding the mechanism. Understanding the mechanism of injury can provide important information about what type of injury the patient sustained.

CLINICAL FEATURES

- Sites of injury (Gunshot, Stab wounds)
- Abdominal pain
- Abdominal guarding, decreased bowel sound(peritoneal irritation)
- Abdominal distention (hemorrhage, bowel perforation)
- Hemodynamic stability (hypotension, tachycardia, cyanosis, and shock)
- Ecchymosis (flank, periumbilical)

intra-abdominal bleeding

Subdiaphragmatic Air

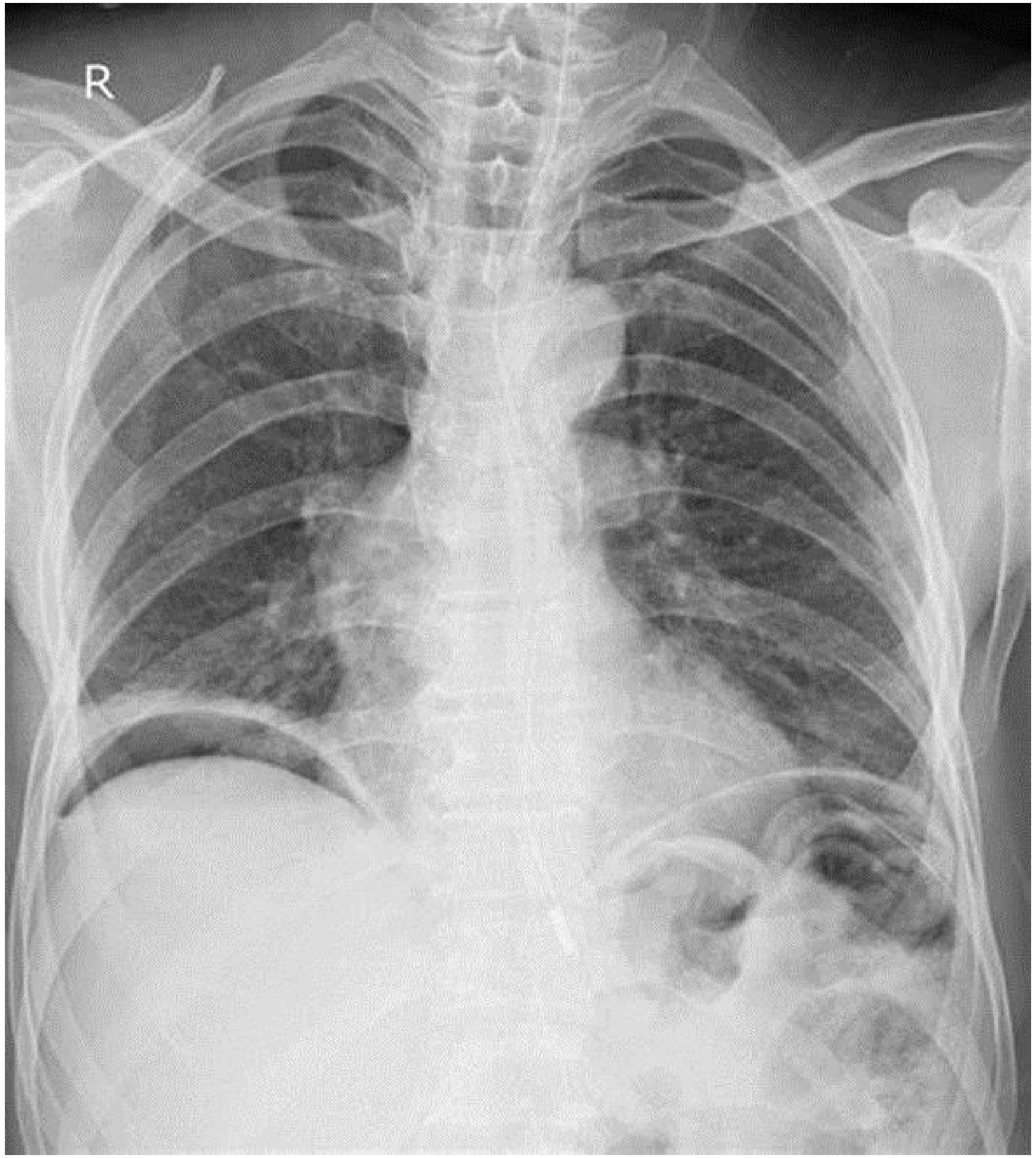


Figure showing Subdiaphragmatic Air

LABS

- CBC

HIGH WBC INDICATES INFLAMMATION

- CRP
- Hemoglobin level
- Evaluate electrolytes
- Evaluate acid level in the blood

TREATMENT &MANAGEMENT

Stable Blunt Injury

- Patients who have experienced blunt abdominal trauma, but remain stable should be managed in two main categories: Those with a reliable physical exam and those without. Factors that prevent a reliable clinical exam include brain injury, spinal cord trauma, sedation, altered mental status.
- If none of these factors are present, guidelines do not require any further imaging, and the patient can be admitted for serial abdominal exams over the next 24 hour.
- If the patient does not have a reliable physical exam, they should undergo CT scanning. If imaging is negative, these patients should still be admitted for 24 hours of serial abdominal examinations.
- If an intestinal injury is identified via the CT scan, the patient should be taken to the operating room for exploratory laparotomy.

• Stable Penetrating injury

- Patients who remain hemodynamically stable and have reliable physical exams may be managed non-operatively, CT scanning is recommended regardless of the reliability of the physical exam.
- Guidelines recommend further workup or exploratory laparotomy if any of these factors are present

TREATMENT &MANAGEMENT

- **Unstable Blunt Injury**
- Unstable patients who have experienced blunt abdominal trauma should undergo DPL or FAST examination. If either is positive, then the patient should be taken for exploratory laparotomy. If both are negative or non-diagnostic, then further workup should be completed. Further workup consists of CT imaging and evaluation for other injuries that could be causing the shock.
- **Unstable Penetrating Injury**
- Unstable patients suspected of having a gastrointestinal injury should be taken to the operating room immediately for exploratory laparotomy.

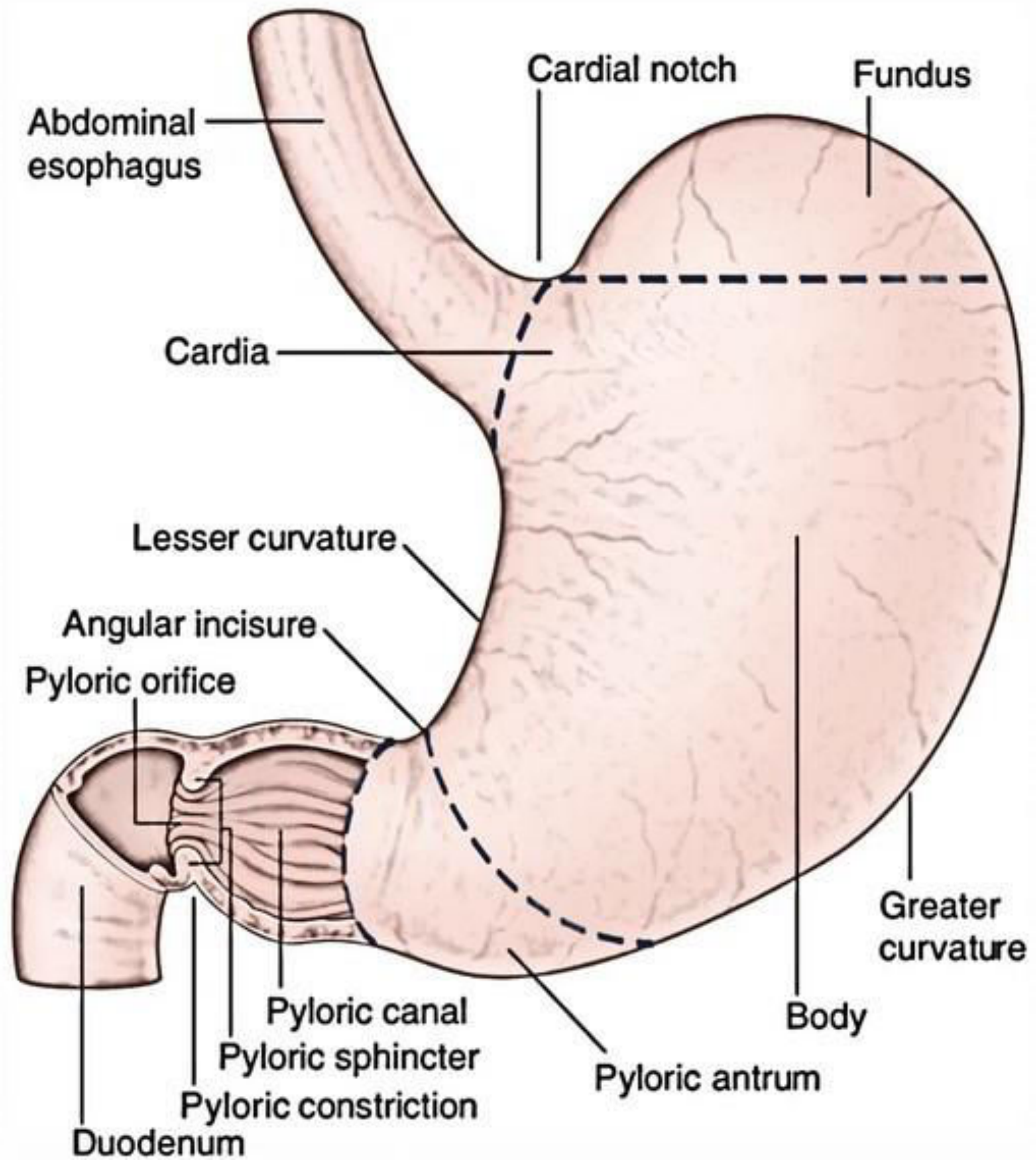
OPERATIVE & MANAGEMENT

- Antibiotics should be given perioperatively. The antibiotic regimen should be as specific as possible, but due to the nature of trauma, the exact injury may be unknown, in which case broad-spectrum antibiotics would be appropriate.
- guidelines have a level I recommendation for only 24 hours of prophylactic antibiotics after the repair of intestinal trauma.
- The exploratory laparotomy should be conducted in a systematic approach:
- 1) Control of hemorrhage
- 2) Control of contamination
- 3) Diagnosis of all injuries
- 4) Reconstruction.

OPERATIVE & MANAGEMENT

- Primary repair- Partial-thickness injuries, or full-thickness injuries less than 50% of the luminal circumference in the small bowel or colon can be repaired primarily.
- Resection and anastomosis- Multiple injuries within the same vicinity or greater than 50% of luminal circumference in the intestines should be resected with anastomosis as appropriate.
- Diversion

patients who are unstable and requiring blood products may require diversion.

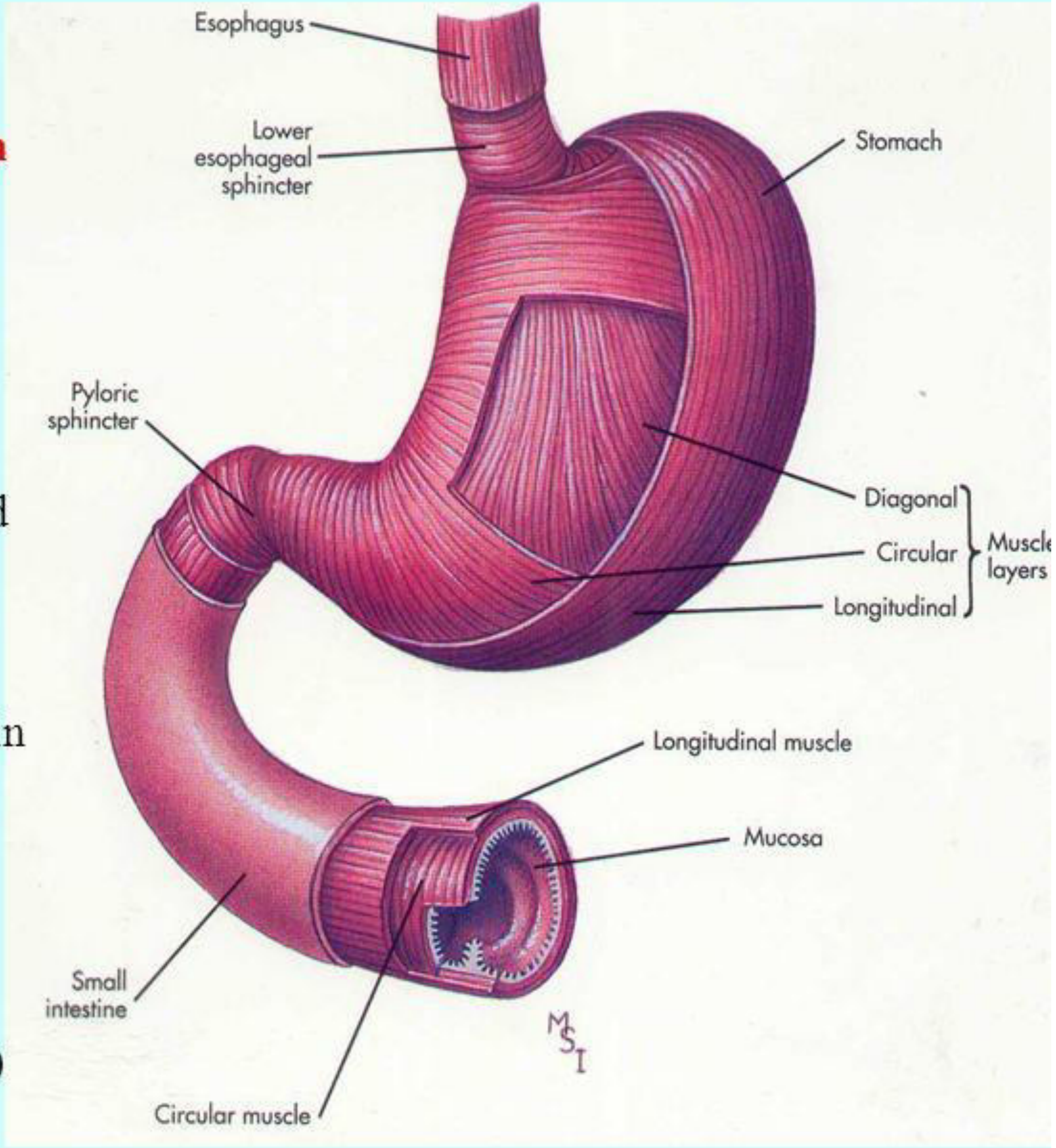

Abdominal esophagus
Cardial notch
Fundus
Cardia
Lesser curvature
Angular incisure
Pyloric orifice
Greater curvature
Body
Pyloric canal
Pyloric sphincter
Pyloric constriction
Pyloric antrum
Duodenum

Stomach

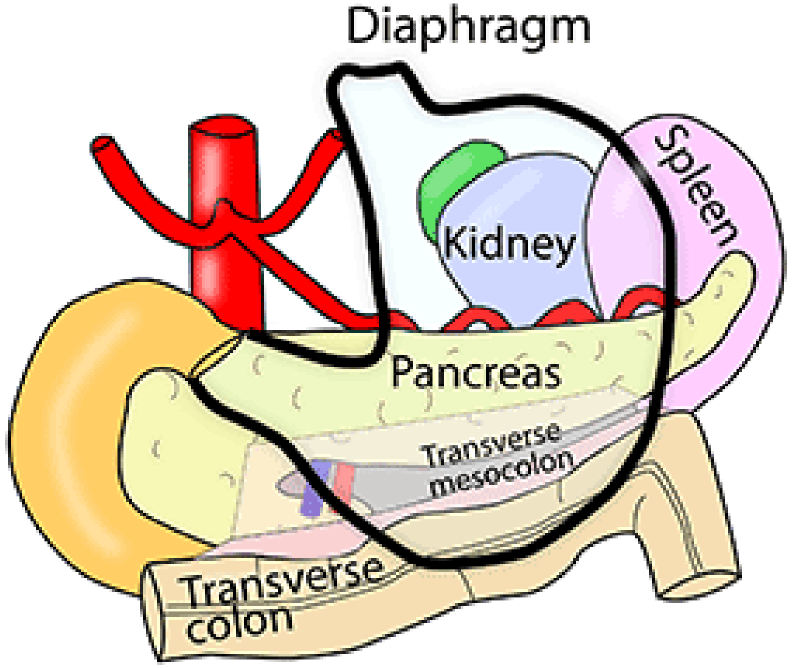
connects the **esophagus** to the **duodenum** (first part of the small intestine)

Functions:

1. serves as a mixing area for saliva, food and gastric juice
2. serves as a reservoir for holding food before release into the SI
3. secretes gastric juice (**HCL**, **pepsin**, **intrinsic factor**, **gastric lipase**)
   HCL kills bacteria, denatures protein
   pepsin begins digestion of proteins
   intrinsic factor aids absorption of vitamin B12
   gastric lipase aids digestion of triglycerides
4. secretes **gastrin** (digestive hormone) into the blood



STOMACH - RELATIONS

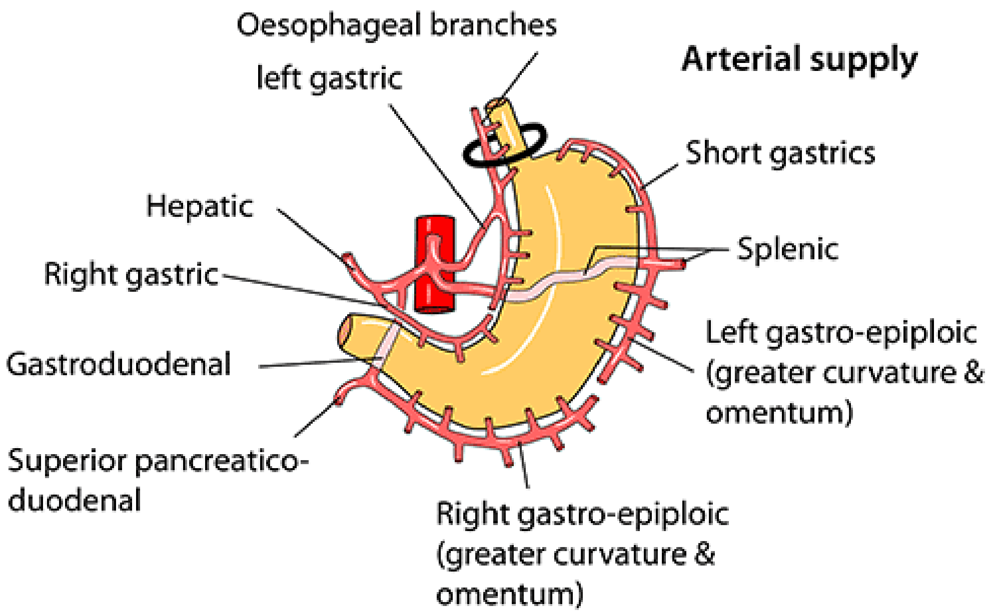


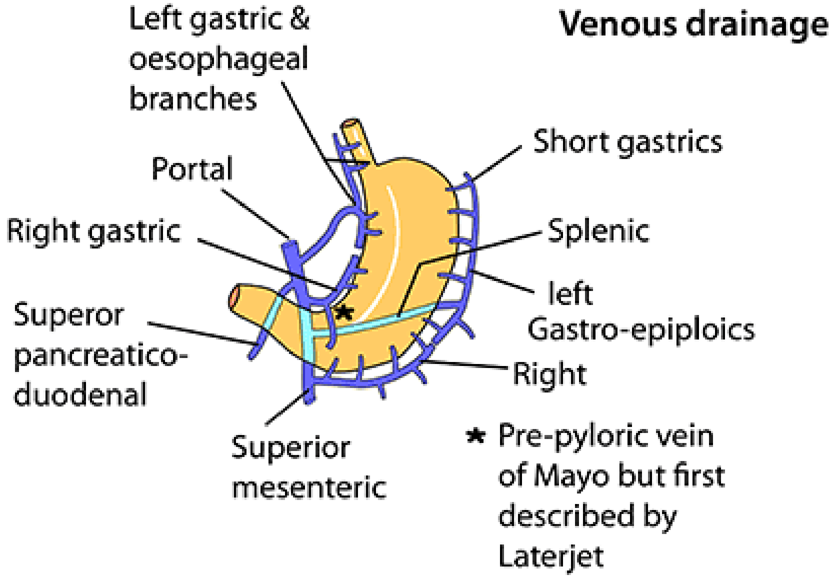
ANTERIOR
Abdominal wall
Left costal margin
Diaphragm
Left lobe of liver

SUPERIOR
Left dome of diaphragm

POSTERIOR
Lesser sac
Pancreas
Transverse mesocolon
Transverse colon
Left kidney/suprarenal gland
Spleen/splenic artery

STOMACH - BLOOD SUPPLY & VENOUS DRAINAGE





Stomach injuries

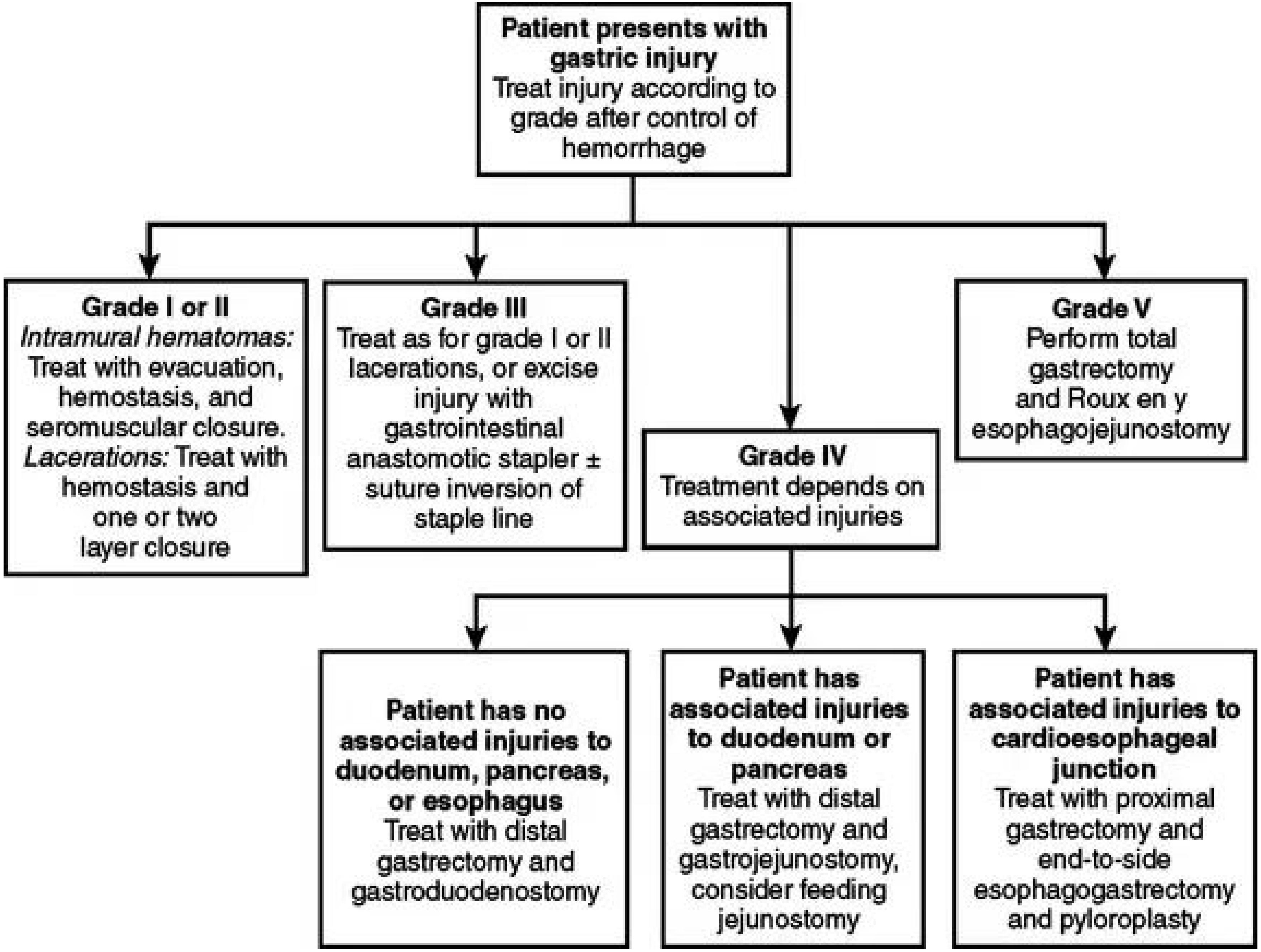
- ❖Gastric injuries following blunt abdominal trauma are rare, accounting for < 2% of all blunt abdominal injuries.
- ❖ Isolated blunt gastric ruptures are uncommon.
- ❖They are usually associated with other solid visceral injuries. Injuries to the stomach are associated with the highest mortality of all hollow viscus injuries.
- ❖ Severity of the injury, timing of presentation and presentation following the last meal as well as concomitant injuries are important prognostic factors. Imaging modalities may be unreliable in making a diagnosis in emergency situation

Summary of the features of gastric injury due to blun

Mechanisms of injury	Increase in intra gastric pressure
	Deceleration shear force tears
	Crush between anterior abdominal wall and vertebra
Location of injury	Anterior wall (40%)
	Greater curve (23%)
	Lesser curve (15%)
	Posterior wall (15%)
Most common associated injury	Spleen
Mortality	Increases with time to operative intervention
Complications	Abdominal abscess (24%) [more common in post-prandial trauma]
Diagnosis	Abdominal radiograph: pneumoperitoneum
	Peritoneal paracentesis: dark coloured fluid
	Ct : free fluid with thickened wall and mesenteric fat standing
Management	According to grade

Grading of gastric injuries

Grade I	Intramural hematoma < 3 cm	
	Partial thickness laceration	
Grade II	Laceration:	< 2 cm in GE junction/pylorus
		< 5 cm in proximal one-third
		< 10 cm in distal two-third
Grade III	Laceration:	> 2 cm in GE junction/pylorus
		≥ 5 cm in proximal one-third
		≥ 10 cm in distal two-third
Grade IV	Vascular:	Tissue loss/devascularisation ≤ two-third stomach
Grade V	Vascular:	Tissue loss/devascularisation ≥ two-third stomach



Patient presents with gastric injury
Treat injury according to grade after control of hemorrhage
Grade I or II
Intramural hematomas: Treat with evacuation, hemostasis, and seromuscular closure.
Lacerations: Treat with hemostasis and one or two layer closure
Grade III
Treat as for grade I or II lacerations, or excise injury with gastrointestinal anastomotic stapler ± suture inversion of staple line
Grade IV
Treatment depends on associated injuries
Grade V
Perform total gastrectomy and Roux en y esophagojejunostomy
Patient has no associated injuries to duodenum, pancreas, or esophagus
Treat with distal gastrectomy and gastroduodenostomy
Patient has associated injuries to duodenum or pancreas
Treat with distal gastrectomy and gastrojejunostomy, consider feeding jejunostomy
Patient has associated injuries to cardioesophageal junction
Treat with proximal gastrectomy and end-to-side esophagogastrectomy and pyloroplasty

Vascular Trauma

- EPIDEMIOLOGY AND MECHANISMS OF VASCULAR TRAUMA

- DIAGNOSIS OF VASCULAR INJURY

- MANAGEMENT OF THE PATIENT WITH VASCULAR TRAUMA

Epidemiology and mechanism of Vascular Trauma

The epidemiology of vascular trauma can be broadly categorized into

- Mechanism of injury (iatrogenic, blunt, penetrating, blast, and combination injuries)
- Anatomical site or location of injury (extremity, torso, and junctional).

Mechanism of Vascular Trauma

Vascular injuries are categorized as occurring from either blunt or penetrating mechanisms, which can disrupt, to varying degrees of severity, the normal integrity of the layers of the blood vessel wall (intima, media, and adventitia).

1. Blunt vascular trauma is produced by local tissue compression and/or acceleration-deceleration resulting in disruptive shear forces. Which are mainly caused by motor vehicle crashes.
2. Penetrating mechanisms typically result in direct injury of the vessel(s) causing either laceration or contusion of the wall as well as separation or destruction of soft tissues along the path of the object and those directly surrounding the vessel

DIAGNOSIS OF VASCULAR INJURY
Physical Examination

- The physical examination should include exposing and palpating the extremities and assessing for evidence of extremity fracture or dislocation, penetrating soft tissue wound, and/or hematoma.
- The extremity vascular examination should also include an assessment of distal perfusion, examining the appearance of the extremities, and palpating for the presence of pulses.
- In addition to assessing for penetrating wounds, examination of the abdomen and thorax (front and back) is important to identifying blood or fluid in these cavities with palpation and auscultation
- The neck and cervical region should be examined for signs of penetrating wounds, the presence of carotid pulses, and/or bruising or hematoma.

DIAGNOSIS OF VASCULAR INJURY
Physical Examination

- Depending on the degree of extremity ischemia, a patient may exhibit one or more of the classic six “P’s” including :
  1. Pulselessness
  2. Pain
  3. pallor,
  4. paresthesia,
  5. Paralysis
  6. poikilothermia.

DIAGNOSIS OF VASCULAR INJURY
Physical Examination

- When considering physical evidence of vascular trauma, especially in the extremities, it is useful to categorize it into hard and soft signs. Hard signs of vascular injury suggest near or complete disruption of the vessel in question Soft signs of vascular injury suggest only partial disruption of the vessel in question.

DIAGNOSIS OF VASCULAR INJURY

Physical Examination

Hard signs

- Pulsatile bleeding
- expanding hematoma
- palpable thrill
- audible bruit
- evidence of acute ischemia distal to the injury site.

Soft signs

- history or evidence of moderate hemorrhage that has stopped
- trauma in proximity to a named vessel
- diminished pulse distal to the site of injury
- nonexpanding hematoma
- severe bruising
- Peripheral neurologic deficit

DIAGNOSIS OF VASCULAR INJURY
Adjuncts to the Physical Examination

- Several simple, noninvasive tools exist which can greatly enhance one's ability to diagnose vascular injury including :
  1. blood pressure cuff and measurement of pressure in both arms
  2. chest radiograph
  3. Continuous wave Doppler
  4. Ultrasound
  5. CT & MRI
  6. Contrast Angiography

DIAGNOSIS OF VASCULAR INJURY
Injured Extremity Index (IEI)

- Noninjured extremity and the ratio of the occlusion pressure in the injured extremity compared to that in the noninjured extremity is recorded as the injured extremity index or IEI (also referred to as the ankle-brachial index (ABI)).
- The normal ABI or IEI is 0.9 or greater although caution should be used in interpreting. the ratio in patients who are hypotensive, in severe pain, or hypothermic.
- Peripheral vasoconstriction is a normal response to significant trauma and shock and may result in a transiently decreased ABI or IEI in the absence of an injured axial vessel.

Management of the patient with Vascular Trauma

Resuscitation of the trauma patient

- After the usual ABCD is completed and an inventory of injuries is initially acquired, priorities for injury management can be set.
- Physical examination should include assessment for hard and soft signs of vascular injury. An examination can be performed almost simultaneously with plain radiographs when needed.
- Hard signs mandate an immediate trip to the OR for hemorrhage control and/or restoration of flow to the ischemic limb.
- Venous access is also part of the initial management of the trauma patient. Large-bore catheters in peripheral veins of uninjured extremities are ideal and preferred over central access in the emergent setting.
- Radial or femoral arterial lines are also often accessed for hemodynamic monitoring.

Management of the patient with Vascular Trauma

General Intraoperative Considerations

1. Prep widely, considering any possible procedure including the need to obtain vascular conduit (i.e., saphenous vein).
2. Patients should receive preoperative antibiotics, based on local guidelines.
3. Longitudinal incisions that are parallel with neurovascular bundles should be used forthe widest exposure and best control. They may need to be S shaped over joint spaces.
4. Proximal and distal control for any vascular injury is critical. This may be obtained with a vessel loop, vascular clamps, or a Foley or Fogarty balloon. Temporary application of a lower extremity tourniquet may be helpful with multiple wounds or before control is attained

Management of the patient with Vascular Trauma
General Intraoperative Considerations

Vascular loop

Vascular Clamp

Fogarty balloon

Management of the patient with Vascular Trauma

General Intraoperative Considerations

5. Injury may require orthopedic surgeons to perform fracture reduction and limb stabilization prior to vascular, nerve, or soft tissue repair.

6. Systemic heparin use is individualized and depends on multiple factors: preoperative blood loss, hemodynamic stability, amount of ongoing bleeding, presence of brain injury, and status of patient with regard to acidosis, hypothermia, and coagulopathy. systemic heparin is not indicated in young patients with good vascular repairs

7. Exposure of the injury and vessels depends on the location, and can involve aggressive debridement of devitalized tissue for adequate visualization and postoperative healing

Vessel Injured	Exposure/Maneuver
Right subclavian artery Ascending aorta Innominate artery	Median sternotomy
Left subclavian artery Descending thoracic aorta	Left thoracotomy
Paravisceral, infrarenal aorta Left renal artery Left iliac artery	Left colon mobilization
Inferior vena cava Right renal artery Right iliac artery	Right colon mobilization, extended Kocher maneuver (duodenal mobilization)

Management of the patient with Vascular Trauma

General Intraoperative Considerations

8. Inflow and outflow must be assessed before beginning an anastomosis; thrombectomy with a Fogarty embolectomy catheter may be required.

9. Ensure bleeding has stopped, reassess the hemodynamic status of the patient, and complete repairs with correct prioritization (including artery before veins in most situations).

10. Decision is made on which tension-free repair to execute.

11. Compartment syndrome must be considered, and fasciotomies performed as needed.

Type of Repair	Uses, Indications
Lateral repair	<25% vessel compromise
Patch angioplasty	<50% vessel compromise
End-to-end anastomosis	<2 cm defect, ends mobilized, spatulated (smaller vessels)
Interposition graft	>2 cm defect, reversed vein or PTFE (if would be tension)
Extra-anatomic bypass	Extensive defect, multiple level injury, contamination

The Principles of Orthopedic Surgery for Trauma

- The Bleeding Pelvis
- Complicated Pelvic Injuries
- Open Fracture Principles
- Compartment Syndrome
- Indications for Amputation

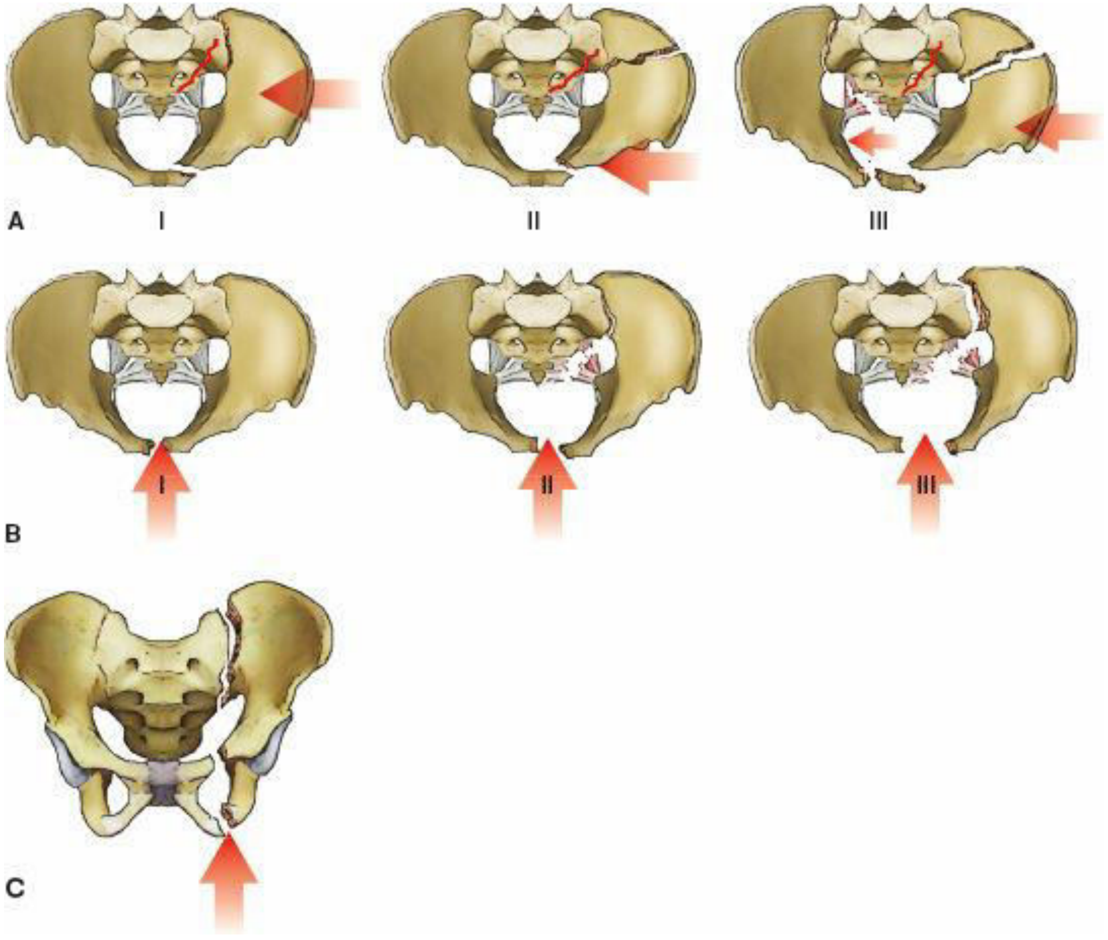
The Bleeding Pelvis

- patients with major pelvic ring injuries bleed to death. Often presenting after a high-energy injury, the pelvis as the source of major hemorrhage may be obvious with massive local swelling and clear instability.
- At presentation, a primary plain pelvic x-ray remains the best way to quickly understand the fracture.
- Pelvic fractures can be classified by two major systems. Young and Burgess presented a classification system based on the implied direction of the initial force and the Tile system considers the injury with regard to the resultant instability.

The Bleeding Pelvis

- They defined injuries essentially as anterior–posterior compression (APC), lateral compression (LC), and vertical shear (VS) injuries. This allows an assessment of the direction of the force applied, and the resultant instability and can predict mortality, transfusion requirements, and associated injuries.
- An “A”-type fracture has a stable pelvic ring and essentially includes more minor avulsion fractures and undisplaced mechanically stable pelvic ring injuries (includes APC I & LC I). “B”-type injuries are rotationally unstable but vertically stable with an intact posterior soft tissue hinge providing some stability (corresponding to APC II or LC II/III injuries) while “C”-type injuries are both rotationally and vertically unstable, implying that the posterior hinge is torn (corresponding to APC III and VS injuries). The latter carries the highest risk of bleeding and death.

The Bleeding Pelvis



Principles of Management of Major Pelvic Ring Injuries

	Mechanically Stable Pelvis	Mechanically Unstable Pelvis
Hemodynamically stable	Nonoperative	Early, planned operative stabilization of pelvic ring
Hemodynamically unstable	Likely extra-pelvic cause Angiography/ embolization	Emergent provision of mechanical stability +/– Packing/angio

The Bleeding Pelvis

Pelvic Packing

- emergency provision of posterior stability with emergent percutaneous sacroiliac fixation or application of a “C clamp” can be dramatically effective in restoring stability and markedly slowing the bleeding.
- Preperitoneal packing is done through a small anterior incision just above the pubis. After separating the rectus muscles, the cavity created by the trauma is entered, the hematoma is evacuated, and rapid mechanical stability is obtained.
- The cavity is then packed with as many packs as required. These should be placed as far back into the true pelvis as possible. Assuming hemostasis is achieved, the packs are left in, often for 48 hours and under an open but sealed abdomen before they are changed or simply removed depending on the physiologic response.

Complicated Pelvic Injuries

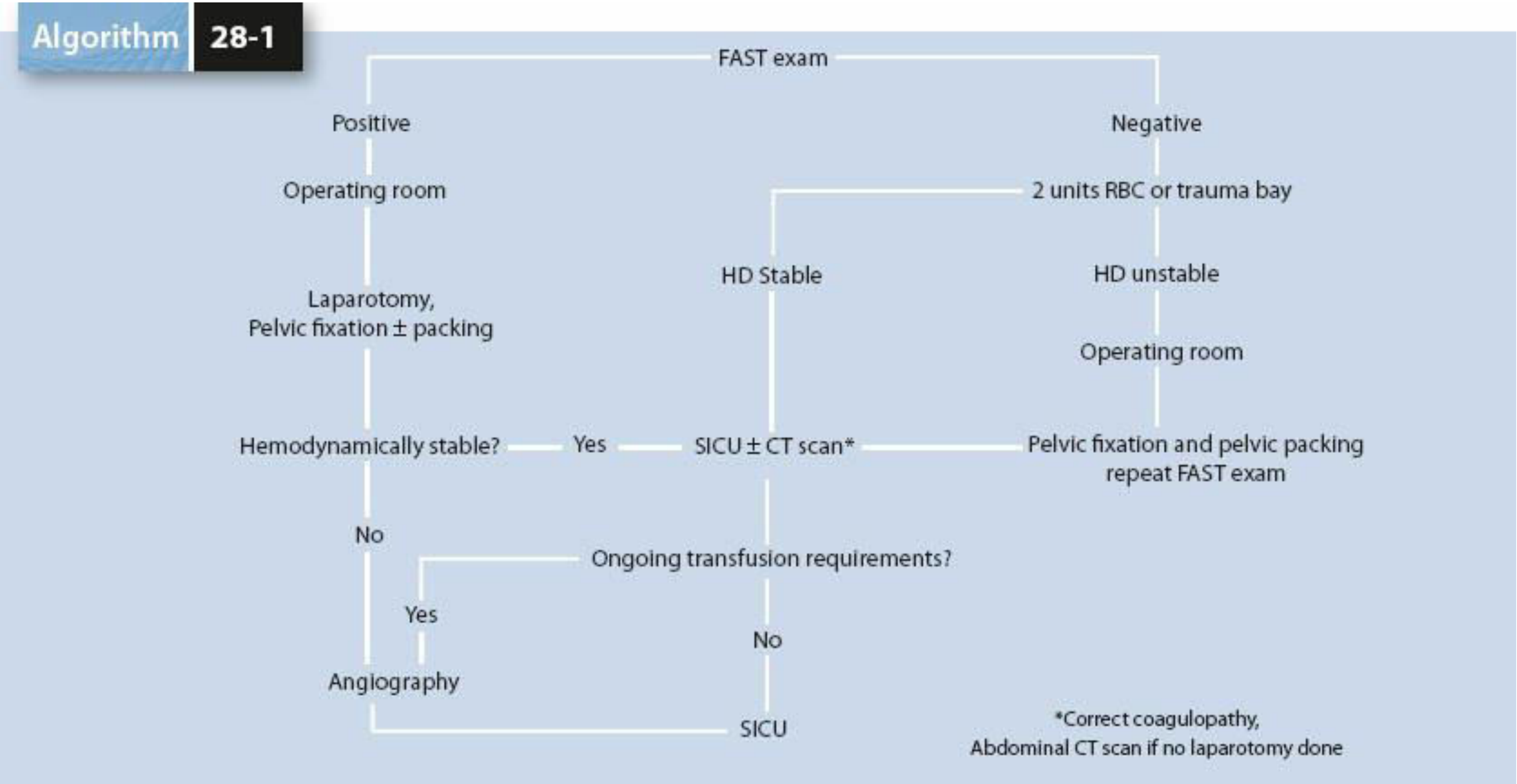
- The initial assessment of any patient with a pelvic fracture must include an inspection of the perineum with rectal and vaginal examination to check for complex open injuries or associated urologic injuries.
- In major pelvic injuries there is usually a massive trauma cavity where contamination and infection would prove fatal.
- Aggressive decontamination and protection of this extensive zone of injury from further contamination by diversion of the fecal stream may be essential.

Complicated Pelvic Injuries

- Complex urologic injuries are commonly seen with specific patterns of pelvic fracture. A significant APC injury is commonly associated with an extraperitoneal bladder rupture of the anterior bladder wall directly in line with the plane of injury.
- LC injuries may be associated with urethral tears as the inferior ramus cuts the male membranous urethra as it is forced across the midline by the injury. In all cases, the presence of hematuria or blood at the meatus is the pathognomonic sign of injury and necessitates appropriate investigation and joint management with the urologic service.

Complicated Pelvic Injuries

The Denver Protocol for management of major pelvic fractures



Open Fracture

- Open fractures can range from simple to destructive injuries but in all the important feature is that the fracture hematoma communicates with the outside environment and the fracture is thus potentially contaminated. Principles of management of open fracture involve debridement and lavage, skeletal stability, and healthy soft tissue cover.
- As such, their specific management revolves around limiting the chance of this contamination converting to established infection. General measures include the provision of tetanus cover, early broad-spectrum antibiotics, early splinting, wound dressing, and specific surgical management.
- The latter is designed to reduce the degree of contamination, to remove necrotic or threatened tissue likely to become infected and to protect the limb by making it unlikely to develop further infection due to an unstable open wound

Grade I	Small low-energy wound, <1 cm no high-energy features
Grade II	Small low-energy laceration over fracture 1–10 cm no high-energy features
Grade IIIa	High-energy open fracture (degloving, periosteal stripping, bone comminution) with adequate soft tissue cover
Grade IIIb	High-energy open fracture with inadequate soft tissue cover
Grade IIIc	Any open fracture with a vascular injury requiring repair for viability

Open Fracture Classification (Gustilo & Anderson)

Open Fracture

This is a III-C injury in a 12-year-old treated by immediate “fix and flap” incorporating the anastomosis for the Lattimus Dorsi free flap into the vascular repair.

Compartment syndrome

- A compartment syndrome is a major surgical emergency as the muscle is acutely ischemic due to an increased compartment pressure reducing tissue perfusion to below a critical level.
- Elevated fascial compartment pressures can be due to reperfusion, hematoma, swelling from a crush injury, or major fractures.
- Diagnosis is based on a high index of suspicion suggested by any of the following:
  1. >4 to 6 hours of ischemia
  2. crush injuries
  3. pain out of proportion and on passive motion
  4. Poikilothermy
  5. Pallor
  6. Paralysis
  7. Paresthesia
  8. Pulselessness

Compartment syndrome

- The definitive test for compartment syndrome is a direct measurement of the compartment pressure and comparison to the diastolic pressure.
- A commonly used cutoff is 30 mm Hg, but normal pressures with a concerning examination should not deter from pursuing treatment with fasciotomy.
- Postoperative considerations include :
  1. starting aspirin as soon as possible
  2. DVT prophylaxis
  3. elevation of the injured extremity,
  4. 24 hours of antibiotics,
  5. And starting rehabilitation as soon as appropriate in the patient’s condition
- Systemic heparinization is usually not required postoperatively, and DVT prophylaxis and/or antiplatelet agents can suffice.

Compartment syndrome

- Rarely compartment syndromes present late when muscle necrosis is established.
- There will be a high creatinine kinase level, myoglobinuria, and even frank renal failure if several compartments are involved and the presentation is delayed.
- If compartment syndrome is diagnosed after 12 to 24 hours, fasciotomy is not indicated as it will only expose the necrotic compartment to infection.
- Unless deemed that muscle debridement is the only way to reduce the myoglobin level and reduce the renal damage the tight limb should be simply observed, and the subsequent distal contracture more safely dealt with later by specific muscle or tendon releases.

Indications for Amputation

- The indications for amputation can be remembered as the three “D’s” referring to a limb that is :
  1. Dead,
  2. Dangerous
  3. Damn nuisance.
- In the early trauma situation, this may be clearly obvious and early amputation may be lifesaving while the latter refers to later reconstructive scenarios.
- While limb salvage is always an aim the surgery required may be protracted such that salvage should not be attempted if it puts life at risk

Pediatric Trauma

- Initial Assessment Resuscitation and Stabilization
- Nonaccidental trauma
- Injury prevention

Initial Assessment Resuscitation and Stabilization

- As in adults, the primary survey should focus on the identification of acute life threatening injuries. Attention to the airway, breathing, and circulation (ABCs) supersedes all other interventions in the initial resuscitation phase.
- Pediatric vital signs vary by age. Children are able to maintain normal blood pressure until late hemorrhagic shock (>30% blood loss), and, therefore, subtle changes in heart rate and respiratory rate must be noted. As a general rule, the lower limit of acceptable systolic blood pressure = Age × 2) + 70 mm Hg. For newborns, acceptable systolic blood pressure is 60 mm Hg or greater.

Broselow pediatric emergency resuscitation tape

Initial Assessment Resuscitation and Stabilization

	Pulse (Beats/Min)	Systolic Blood Pressure (mm Hg)	Respiration (Breaths/Min)
Newborn (<1 mo)	95–145	60–90	30–60
Infant (1 mo to 1 yr)	125–170	75–100	30–60
Toddler (1–2 yrs)	100–160	80–110	24–40
Preschool (3–4 yrs)	70–110	80–110	22–34
School age (4–12 yrs)	70–110	85–120	18–30
Adolescent (>12 yrs)	55–100	95–120	12–16

Initial Assessment Resuscitation and Stabilization
The "A"

- Airway control ("A") is the first priority. Cardiac arrest in a child is most often of respiratory etiology, and an injured child who is obtunded, unresponsive, or combativemay need to be intubated.
- Intubation must be performed with the jaw thrust technique and inline cervical stabilization.
- Keep in mind these key anatomic differences for intubation in children: larger tongue, more narrow and anterior glottis, and shorter trachea.
- The appropriate size of ETT can be estimated by the size of pinkie finger (or the formula = [age + 16]/4). Use an uncuffed ETT in a young child (<8 years of age or approximately 60 lb/27 Kgs), because the subglottic trachea is narrow and provides a sufficient seal. However, cuffed ETT may be used (except in newborns), if appropriate cuff pressures are used.

Initial Assessment Resuscitation and Stabilization
The "A"

- Rapid sequence intubation is similar to adults, including :
  1. Preoxygenation with 100% FiO_2
  2. Medication administration
  3. Cricoid pressure
  4. Cervical spine stabilization
  5. laryngoscopy, and
  6. Advancement of tube to an appropriate distance beyond the cords
  7. Confirm exhaled CO_2 and secure the tube
- In rare event of acute airway obstruction, needle cricothyroidotomy with a 14 g catheter is preferential to open cricothyroidotomy because of the increased incidence of subglottic stenosis.

Initial Assessment Resuscitation and Stabilization
The "B"

- After securing the airway, assess the child's breathing ("B"). If there is difficulty with respiration, assist the ventilation and assess for potential life-threatening thoracic injuries such as :
    1. Pneumothorax
    2. Hemothorax
    3. Flail chest/pulmonary contusions
    4. Rib fractures
- Children are diaphragmatic breathers and, therefore, gastric distension can be an unrecognized contributor to respiratory distress, especially in the young child who is distended from swallowing air while crying.
- If there are concerns for abdominal distension, a nasogastric tube should be placed to decompress the stomach. Use an orogastric tube in babies, who are obligate nose breathers.

Initial Assessment Resuscitation and Stabilization
The "B"

Injury	Diagnosis	Management
Airway obstruction	Apnea or stridor, maxillofacial trauma.	Definitive tracheal intubation (oro- or nasotracheal) or cricothyroidotomy.
Flail chest	Paradoxical chest wall motion.	Positive pressure ventilation.
Tension pneumothorax (PTX)	Respiratory distress, tracheal deviation, hypotension, distended neck veins, absent unilateral breath sounds, hyperresonance to percussion.	Needle decompression (2nd interspace, midclavicular line), followed by placement of chest tube (4th interspace, anterior axillary line).
Open pneumothorax	Open wound into chest→"sucking chest wound."	Sterile gauze (secure on three sides) and placement of chest tube.
Hemothorax	Absent breath sounds, dullness to percussion, hypotension.	Chest tube placement. Massive hemothorax necessitates thoracotomy.
Cardiac tamponade	Distended neck veins, muffled heart sounds, hypotension (Beck's triad), pulsus paradoxus.	Pericardiocentesis (or emergency thoracotomy if pulseless).

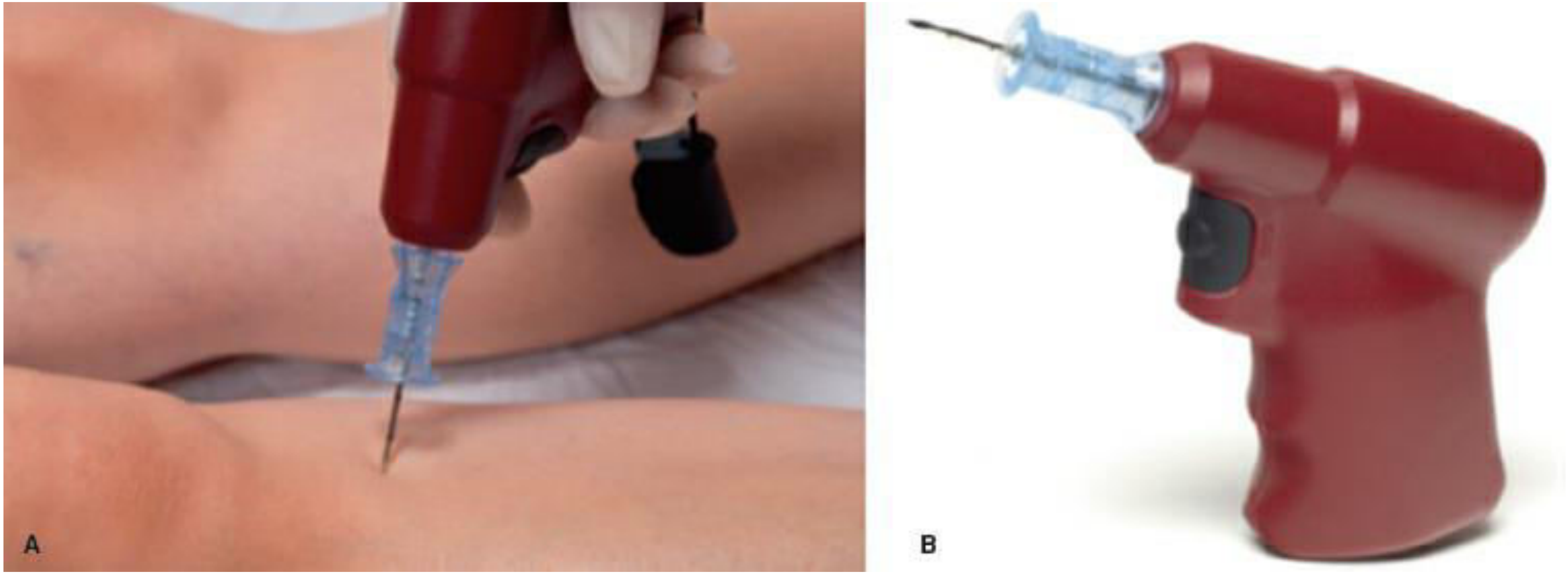
Initial Assessment Resuscitation and Stabilization
The "C"

- Hemorrhage is the most common etiology of Circulatory compromise ("C") in trauma, but do not overlook obstructive etiologies (cardiac tamponade and tension pneumothorax) and distributive etiologies (neurogenic shock).
- Early but subtle signs of blood loss are
  1. Tachycardia
  2. tachypnea
  3. altered level of consciousness
  4. poor peripheral perfusion
  5. mottled cool extremities
  6. weak thready pulses
  7. narrowed pulse pressure
  8. delayed capillary refill

Initial Assessment Resuscitation and Stabilization
The "C"

- Establishing vascular access in an injured child is a priority. Peripheral intravenous lines are ideal, but when they cannot be obtained, intraosseous lines are quick, reliable, and allow high-volume infusion of any fluid (crystalloid, blood products, and even medications, including pressors).
- An intraosseous line is placed in the anteromedial tibia,2- to 3-cm distal to the tibial tuberosity after a quick skin preparation for sterility.
- Avoid wounds, fractures, or infected areas. They should ideally be placed with a single attempt because multiple holes can lead to leakage of infusion fluids and resultant compartment syndrome.
- If contraindicated, definitive intravenous (IV) access can be obtained with a central line in the femoral vein or a peripheral vein.

Initial Assessment Resuscitation and Stabilization
The "C"



A: Intraosseous line placement. B: EZ-IO drive.

Initial Assessment Resuscitation and Stabilization
The "C"

- Initial fluid resuscitation is indicated when there are signs of hypovolemic shock. The initial bolus consists of 20 mL/kg of warmed normal saline or lactated Ringer's solution. This may be repeated if there is no response or only a transient response.
- All subsequent volume resuscitation should be performed with blood products (10 mL/kg = "1 unit") If there is no time for cross-matched, type-specific blood, "O-negative" blood is indicated.

Resuscitation Fluids (NS or LR)	
If hypotension or signs of shock:	Bolus 20 mL/kg. Repeat if transient or no response and then switch to blood transfusions (10 mL/kg).
Daily Maintenance Fluid Requirements (D5 1/2NS or D10 1/2NS)	
Weight <10 kg	100 mL/kg/day
Weight 11–20 kg	1,000 mL + 50 mL/kg/day (for every kg over 10)
Weight >20 kg	1,500 mL + 20 mL/kg/day (for every kg over 20)

Initial Assessment Resuscitation and Stabilization
The "D"

- A brief neurologic assessment is part of the primary survey ("D" for disability). Head injury accounts for the highest degree of morbidity and mortality in children and is the principal determinant of outcome after trauma.
- The Glasgow Coma Scale (GCS) is modified in young children who are preverbal to measure neurologic function and prognosis. The motor response scale tends to provide the most reliable assessment of function in a preverbal or intubated child.

	Infant	Child
Eye opening		
4	Spontaneous	Spontaneous
3	To verbal stimuli	To verbal stimuli
2	To pain only	To pain only
1	None	None
Verbal response		
5	Coos and babbles	Oriented, appropriate
4	Irritable cries	Confused
3	Cries to pain	Inappropriate words
2	Moans to pain	Incomprehensible sounds
1	None	None
Motor response[a]		
6	Moves spontaneously and purposefully	Obeys commands
5	Withdraws to touch	Localizes painful stimuli
4	Withdraws in response to pain	Withdraws in response to pain
3	Abnormal flexion posture to pain	Flexion in response to pain
2	Abnormal extension posture to pain	Extension in response the pain
1	None	None

[a]If patient is intubated, unconscious, or preverbal, the most important part of this scale is motor response and should be closely evaluated.

Initial Assessment Resuscitation and Stabilization
The “E”

- function in a preverbal or intubated child. In preparation for the secondary survey, the child must be Exposed (“E”) completely for a complete head-to-toe physical examination. Keep in mind that they also have a larger body surface area ratio and, therefore, lose heat and water quickly and can become hypothermic.
- Use warm fluids, bare huggers, warming lights, and warm ambient room temperature to prevent heat loss in a child and the secondary coagulopathy that is associated with hypothermia.
- Only after the primary assessment is complete, and ABCs are secured, do we move on to the full secondary survey
- In addition to a full physical examination, a brief history is essential and is often provided by emergency medical services (EMS) personnel or the parents. An “AMPLE” history helps the provider focus on essential information such as Allergies, Medications, Past medical history, Last meal, and Events surrounding the traumatic incident.

Nonaccidental Trauma(Child abuse)

- Nonaccidental trauma and abuse may be difficult to recognize and a high index of suspicion is needed when evaluating children with injuries.
- Features of the history that should increase suspicion include:
    1. unexplained significant injury
    2. denial of trauma
    3. changes in the story or differences in the story by different witnesses
    4. explanation that is inconsistent with the pattern, age, the severity of the injury or with the child's developmental capabilities
    5. Delay in seeking medical care

Nonaccidental Trauma(Child abuse)

- Findings on examination that may suggest abuse include:
  1. Any injury in a preambulatory infant
  2. Multiple organ system injuries
  3. Multiple injuries at different stages of healing
  4. Patterned injuries
  5. Injuries to unusual locations (mnemonic "TEN-4" = injury to torso, ears, or neck in a child younger than 4 years)
  6. Evidence of neglect (failure to thrive, dental caries, poor hygiene)
  7. Burns with sharply demarcated edges, bite marks, cigarette burns, and other markers of being hit with an object are high-risk injuries.

Nonaccidental Trauma(Child abuse)

- Skeletal survey is recommended in children younger than 2 years who have suspicion for abuse.
- Certain fracture patterns should raise concern for nonaccidental trauma including :
  1. fractures in nonambulatory infants
  2. multiple fractures
  3. rib fractures
  4. infants and toddlers with midshaft femur or humerus fractures
  5. unusual fractures such as scapular and metaphyseal fractures.

Injury Prevention

- There are many examples where comprehensive state and federal laws have resulted in statistical drops in injuries and deaths. Examples where federal mandates and state laws have been implicated in the reduction of pediatric injuries. :

  A. Smoke and Carbon Monoxide Detectors
  B. Drunken Driving laws
  C. Junior Driver/ Safe Driving Laws
  D. Child passenger Restraints

Trauma in pregnancy

trauma in pregnancy

- –

Trauma is the leading cause of nonobstetric death in pregnant patients worldwide. As the risk of death due to pregnancy-related complications has declined, trauma now accounts for nearly half of maternal deaths in the United States annually, with an up to fourfold increase in fetal mortality in some series.[1,2] Pregnant trauma patients have increased rates of preterm labor and placental abruption, and their infants are at increased risk of respiratory distress and fetal death.[3]

Pregnant patients also present special social and ethical issues in trauma. Interpersonal violence against the pregnant female is an underrecognized phenomenon

EPIDEMIOLOGY OF INJURY DURING PREGNANCY

Up to 37% to 46.3% of gravid maternal deaths in the United States are attributable to trauma, resulting in over one million deaths annually worldwide.

The majority of trauma occurs later in pregnancy, with greater than 50% occurring during the third trimester.Motor vehicle– related injuries are the most common cause of trauma and injury (up to 33.6%)

followed by falls and interpersonal violenceFetal death occurs in up to 50% of life-threatening traumatic injury to the mother, but due to the frequency of minor trauma, the majority of fetal loss occurs after minor traumatic injuries

EVALUATION AND MANAGEMENT

The evaluation and resuscitation begins with the primary survey, utilizing a systematic ABCDE approach, and followed by a complete assessment of injuries in the secondary survey. Basic tenets of surgical intervention and “damage control” techniques should be followed. The best outcomes for the fetus are achieved by the optimal evaluation, resuscitation, and treatment of the mother.

complete physical examination is essential. In addition to a complete examination for maternal injuries, complete examination of the fetus includes estimation of uterine size and fundal height, examination for vaginal bleeding, rupture of membranes, presence of bulging perineum, contractions, or abnormal fetal heart rate (FHR) or rhythm

monitoring and evaluation of the fetus

Pregnancies beyond 24 weeks of gestation are considered viable, and an expedient estimation of gestational age is required.

Close monitoring of the viable fetus is necessary. Continuous fetal monitoring is the only way to identify fetal distress in the acute setting.[39] The Eastern Association of Surgery for Trauma (EAST) guidelines recommend monitoring of all pregnant female with gestation >20 weeks for at least 6 hours after significant trauma.[40] Early involvement of the neonatal intensive care staff is recommended.

radiographic imaging in trauma

The ideal diagnostic imaging test in the pregnant patient should be fast, readily available, safe, and accurate. Selection of the appropriate test needs to balance the need for expedient diagnosis while minimizing risk to mother and fetus. During pregnancy, radiation exposure should be avoided or minimized whenever possible

Sonographic evaluation of both the mother and fetus is safe and useful in determining the extent of injuries. FAST ultrasound has excellent specificity and negative predictive value in detecting pericardial, pleural, and peritoneal free fluid in the hemodynamically unstable mother and poses no risk to the fetus.[42] Ultrasound is particularly useful in the evaluation of intrauterine contents, but can miss 50% to 80% of placental abruptions.[43] Fetal ultrasound should be performed to assess for gestational age, cardiac activity, and movement.

CT scans are rapid and sensitive for evaluation of traumatic injuries

Angiography and angioembolization may be useful in the event of life-threatening hemorrhage

MANAGEMENT

The optimal treatment of the pregnant patient requires special attention to the evolving anatomical and physiologic changes that occur during pregnancy. Evaluation and management should be tailored to the stage of pregnancy and requires a multidisciplinary, team approach. While fetal survival is best achieved by appropriate resuscitation and care of the mother, recognition of the unique patterns and complications of traumatic injury ensure the best possible outcome for the mother and fetus.

Special considerations

Pelvic fracture

Abruptio Placentae

Uterine Rupture

Amniotic Fluid Embolism

Preeclampsia/Eclampsia

Disseminated Intravascular Coagulation / emergent cs

Postinjury Management

Postinjury management predominantly focuses on two goals, early control of bleeding and resuscitation.

Hemorrhagic shock is the most common cause of mortality during the first 6 hours following trauma and 16% to 80% of those deaths may be preventable

ACUTE TRAUMATIC COAGULOPATHY

DETECTION OF TRAUMATIC COAGULOPATHY

DAMAGE CONTROL RESUSCITATION

ENDPOINTS OF RESUSCITATION

ABDOMINAL COMPARTMENT SYNDROME

TRAUMATIC BRAIN INJURY

TRAUMATIC BRAIN INJURY

tbi

TBI remains one of the leading causes of injury-related deaths. Initial management of TBI includes hyperosmolar resuscitation, intracerebral pressure (ICP) monitoring, and prevention of hypoxia and hypotension.

2ry brain injury

Injury prevention and better safety are the mainstays for primary brain injury. After the initial insult, the main goal is to prevent or minimize secondary brain injury. Secondary brain injury can be influenced by a cascade of inflammatory responses, occurring as a consequence of the primary injury

Hypotension at any point (even brief time periods) is associated with a doubling of mortality in patients with severe TBI. Although hyperventilation temporarily reduces intracranial pressure and may help to prevent herniation,

imaging in traumatic brain injury

Computed tomography (CT) scanning remains an essential tool in the initial evaluation and postinjury management of TBI. Patients with mild and moderate TBI who are examinable and not on any anticoagulant medications can be monitored by clinical examination without the need for routine serial CT scans of the head. With technologic improvements made to the CT scanners around the world, the incidence of TBI has been increasing. Small insignificant intracranial radiologic findings are the main reason for the increase in the diagnosis of TBI. With increased awareness of mild TBI and with the increased attention to mild TBI with posttraumatic stress disorder, CT scans of the head are being ordered more often and routinely

In trauma, the single most common reason for obtaining a CT scan of the head has been loss of consciousness

Coagulopathy in TBI

A decreased platelet count (less than 100,000/µL) and/or impaired platelet function after TBI is associated with progression of intracranial hemorrhage, need for neurosurgical intervention, and mortality.[97–99] Admission INR greater than 1.5 also predicts progression of intracranial hemorrhage. The treatment of coagulopathy after TBI is multipronged due to the complexity of the problem. Therapeutic strategies should focus on the treatment of the primary cause and controlling the progression of intracranial bleeding. fresh frozen plasma, platelets, recombinant factor VII, and PCC can be used in various combinations to improve outcomes

Antiplatelet and Anticoagulation Therapy in TBI

Brain Injury Guideline

Brain Injury Guidelines			
Variables	**BIG 1**	**BIG 2**	**BIG 3**
LOC	Yes/No	Yes/No	Yes/No
Neurologic examination	Normal	Normal	Abnormal
Intoxication	No	No/Yes	No/Yes
CAMP	No	No	Yes
Skull Fracture	No	Non-displaced	Displaced
SDH	$\leq$ 4mm	5 - 7 mm	$\geq$ 8 mm
EDH	$\leq$ 4mm	5 - 7 mm	$\geq$ 8 mm
IPH	$\leq$ 4mm, 1 location	3 – 7 mm, 2 locations	$\geq$ 8 mm, multiple locations
SAH	Trace	Localized	Scattered
IVH	No	No	Yes
THERAPEUTIC PLAN			
Hospitalization	No Observation (6hrs)	Yes	Yes
RHCT	No	No	Yes
NSC	No	No	Yes

BIG, brain injury guidelines; CAMP, Coumadin, Aspirin, Plavix; EDH, epidural hemorrhage; IVH, intraventricular hemorrhage; IPH, intraparenchymal hemorrhage; LOC, loss of consciousness; NSC, neurosurgical consultation; RHCT, repeat head computed tomography; SAH, subarachnoid hemorrhage; SDH, subdural hemorrhage

Antiplatelet medications, anticoagulants, and nonsteroidal anti-inflammatory drugs are among the most frequently encountered medications in TBI patients, especially the elderly. Existing evidence shows an increased risk of progression of intracranial bleeding in patients on high-dose aspirin and clopidogrel, whereas low-dose aspirin and ibuprofen do not cause progression on CT or neurologic examination

Seizure Prophylaxis after TBI

Penetrating Brain Injury

Gunshot wounds to the brain are the most lethal of all firearm injuries. Aggressive postinjury resuscitation is associated with significant improvement in both survival and organ donor eligibility.[116,117] Early aggressive management includes blood products, hyperosmolar therapy, vasopressors, and/ or PCC. Early aggressive T4 (levothyroxine) therapy and correction of coagulopathy increases the organ donation rate in nonsurvivable patient

Figure showing Spleen after removal

NUTRITIONAL AND METABOLIC SUPPORT

Nutritional support after injury imparts significant acute and long-term effects on outcomes. Understanding of the nutritional and metabolic derangements following injury has increased exponentially over the past few decades

Recent recommendations aim for early enteral nutrition. The definition of early varies in the literature, ranging from a few hours after injury up to 72 hours.Although the benefits are yet to be established, safety of early (within 24 hours of injury) enteral feeding is well documented. In patients with severe burns it is recommended to initiate enteral feeding within 18 hours of injury. Early feeding in this group of patients reduces the risk of gastroparesis. In the case of severe TBI enteral feeding is safe and should be administered early.

Nasogastric and nasojejunal routes are the preferred modes of initial nutritional access. If long-term nutritional support is required, the planning of feeding access should be based on individual patient circumstances. In patients undergoing laparotomy, insertion of a surgical feeding tube either in the stomach or small intestine is a feasible option. For patients in need of long-term nutritional support and not requiring surgical intervention the preferred route is via endoscopically guided percutaneous feeding tube. The percutaneous endoscopic route is increasingly popular, but the literature is not well established on its safety and complications

organ donation

A feasible goal for resuscitating any potential donors is to follow a rule of 100’s that is, maintaining a systolic blood pressure of >100 mm Hg, heart rate of <100 bpm, urinary output >100 mL/hr, and paO_2 >100 mm Hg. Along with hemodynamic resuscitation,

focus should also be given to pulmonary edema, coagulopathy, and hypothermia. Coagulopathy and hypothermia are not only associated with adverse outcomes in trauma patients but also render them ineligible for organ donation.

Figure showing gunshot injury through the center of liver requiring balloon tamponade using Foley catheters for damage control.

Environmental Injuries

epidemiology

of the 3,000 species of snakes worldwide, only 600 are venomous, with approximately 6 deaths per year in the United States caused by snakebite. In contrast, there are over 150,000 species of Hymenoptera in the world that cause approximately 40 deaths per year, mostly as a result of severe anaphylactic reactions.

- **Etiology**
- snakes
- spiders
- scorpios
- Insect Bites and Stings
-

Fire Ants

Centipedes and Millipedes


Snakebite

snake bite

. Snakebite produces immediate pain, edema, and erythema at the site. Spread of the swelling greater than 30 cm/hr indicates severe envenomation. Initial incision and suction and the use of a proximal tourniquet are contraindicated. Use of purified ovine antivenin is effective for serious Crotalidae envenomation and has replaced equine antivenin with its associated risk of serum sickness. Because of the presumed safety of the newer antivenom, overuse is more likely.

injecting venom similar to a hypodermic needle. This is in contradistinction to the Elapids in which the fangs are fixed and grooved – wicking the venom into the victim. Venomous snakes have a single row of caudal plates distal to the anal plate, whereas harmless snakes have a double row of caudal plates. There are 32 species of rattlesnakes in the New World

grading and MANAGEMENT

there are a number of snakebite severity indices (grading systems) published, a modification of the simple system proposed by Dart in 1996 is probably the most useful.[16] A grade 1 envenomation is limited to the immediate bite site, a grade 2 envenomation extends onto less than a full extremity and may have non–life-threatening symptoms such as nausea, vomiting, mild tachycardia, and mild hypotension. A grade 3 envenomation involves more than an extremity and includes systemic signs such as severe hypotension/tachycardia or blood dyscrasias or clinically significant clotting abnormalities

INITIAL MANAGMENT:

immobilization and splinting

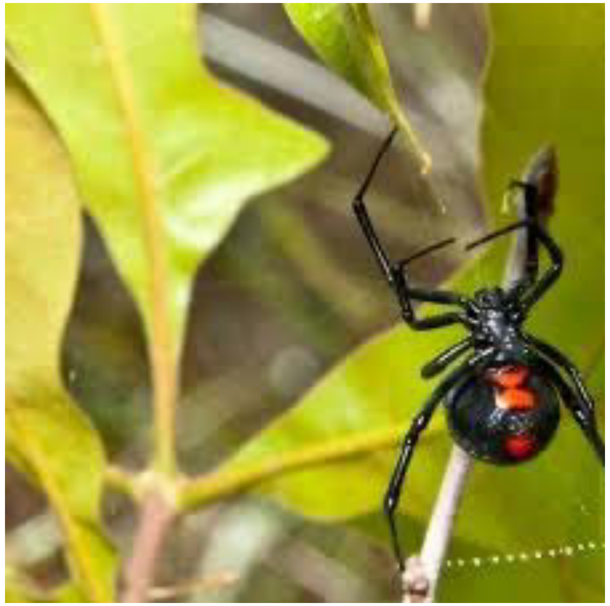
Limited cooling of the extremity may have some benefit

placement of a constrictor band may be of benefit

ANTIVENOM

(ELISAs) have been developed that can directly measure serum venom antigens as well as identify the offending snake

spider bites



- Spider bites produce toxicity by local tissue necrosis (brown recluse and hobo spiders) and painful muscle contractions (black widow spider). Death may be caused by stinging Hymenoptera, including bees (particularly aggressive Africanized bees), fire ants, and scorpions. The death is usually secondary to anaphylaxis, but occasionally massive envenomation occurs – especially with Africanized honeybees. The estimated lethal dose is approximately 20 stings/kg in most mammals.

hypothermia

- Hypothermia risk is high in the severely injured patient as a result of exposure, loss of normal protective metabolism (i.e., shivering), rapid massive infusion of cold fluids/blood, and open thoracic and abdominal cavities

HYPOTHERMIA

The initial response to hypothermia is an intensive sympathetic type reaction with tremulousness, profound vasoconstriction, marked increase in oxygen consumption, and accelerated heart rate and minute ventilation. As core temperature falls to 33°C and 30°C this response is lost, and deeper core hypothermia rapidly develops.

Hypothermia increases risk of mortality at every level of traumatic injury. There is no improvement in outcome when applied to the severe TBI, and patients rapidly rewarmed require less resuscitation volume and have improved survival.