ALUATION

Gross assessment may be difficult as damage is often internal.

The patient should be examined physically followed by **ultrasound, x-ray, and/or CT scanning**.

Sometimes before an x-ray is performed a paper clip is taped over entry and exit wounds[48].

The patient is treated with intravenous fluids and/or blood.

Surgery is often required; impaled objects are secured in place so that they do not move and they should only be removed in an operating room.

Foreign bodies such as bullets may be removed, but if there is a possibility that they may cause more damage, they should be left in place.

Wounds are debrided to remove tissue that cannot survive and will lead to infection.

ANAGEMENT

The presentation of a patient with penetrating abdominal injury may reveal shock, hypotension, narrow pulse pressure, tachypnea, oliguria, and an apparent trajectory or open wound.

Examination in awake patients may reveal signs of peritonitis such as guarding or rebound tenderness.

The approach to patients with penetrating abdominal trauma depends on the type of instrument that caused the injury and hemodynamic status.

In general, gunshots to the abdomen are usually associated with hollow viscus injury and usually require exploration.

Knife wounds are associated with lower incidence of intra-abdominal injury, and hence, their work-up requires clinical judgment and experience.

- Many protocols exist for evaluating patients with a stab wound to the abdomen.
- Blood work is always done but is nonspecific.
- The use of DPL and FAST can be performed to assess the stable patient with a knife or gunshot wound, but both these modalities have a high rate of false negatives.
- **CT scan** is used in patients with wounds of the flank and back and can help assess solid organ injury.
- The diagnostic test of choice is a **triple contrast CT scan** in hemodynamically stable patients.
- Other imaging tests may be done to assess for any associated head or skeletal injury.
- In most hospitals, penetrating trauma is handled by a trauma team. After the ABCs are completed, most gunshot patients require an exploratory laparotomy. This view is now changing, and stable patients with gunshot wound with no signs of peritonitis who have been evaluated by a triple contrast CT scan may be observed if there is no evidence of intra-abdominal injury.
- The indications for surgical intervention include:
  - Patient with hemodynamic instability,
  - Development of peritoneal findings such as involuntary guarding, point tenderness or rebound tenderness, and
  - Diffuse abdominal pain that does not resolve[49].
- Patients with a stab wound with clear signs of peritonitis similarly require a laparotomy.
- Stable patients with stab wounds may be locally explored or undergo a triple contrast CT scan.
- The prognosis of patients with penetrating abdominal trauma is variable and depends on the extent of injury and time of presentation to the emergency department.

DIFFERENTIAL DIAGNOSIS

- Abdominal compartment syndrome
- Hemorrhagic shock
- Trauma to pelvis, diaphragm or genitourinary system
- Sepsis

COMPLICATIONS

- Open wounds
- Sepsis
- Fistulas
- Wound dehiscence
- Colostomy/ileostomy
  Short bowel syndrome

[48] Wortman JR, Uyeda JW, Fulwadhva UP, Sodickson AD. Dual-Energy CT for Abdominal and Pelvic Trauma. Radiographics. 2018 Mar-Apr;38(2):586-602.

[49] Tarchouli M, Elalaoui M, Njoumi N, Essarghini M, Echarrab M, Chkoff MR. Liver trauma: What current management? HBPD INT. 2018 Feb;17(1):39-44.

II. BLUNT ABDOMINAL TRAUMA

INTRODUCTION

- In civilian practice approximately 20% of trauma injuries requiring surgery involve the abdomen[50].
- Abdominal trauma may be blunt or penetrating, but generally in civilian practice, blunt trauma is more common than penetrating and usually follows a road traffic crash. However, in the American urban civilian practice penetrating trauma is more common than blunt trauma, gunshot wounds being more frequent than stab wounds[51].
- In the UK stab wounds predominate[52]. In military practice, penetrating abdominal wounds are greater than blunt with a high mortality from the high velocity missile/bullet/fragment wounds.
- The diagnosis of abdominal injury by clinical examination is unreliable and, thus in the initial management of abdominal trauma in adults following rapid assessment and resuscitation selection of appropriate investigations is of key importance[53].

PATTERNS OF INJURIES

- Particular pattern of injuries occur with blunt abdominal trauma.
- Steering wheel injuries commonly involve the sternum (with the risk of myocardial contusion), liver and spleen.

[50] Gilroy D (2005) Deaths from blunt trauma, after arrival at hospital: What goes around comes around. Injury 36: 47-50.

[51] Buckman RF, Scalea TM (1999) International approaches to trauma care. Trauma Quarterly, USA.

[52] Greaves I, Porter KM, Ryan JM (2001) Trauma London: Arnold, UK

[53] National Confidential Enquiry into Perioperative Deaths (NCEPOD) (2007) Trauma: who cares?, UK.

- Pelvic fractures are associated with urethral a urinary bladder injuries and with rupture of t diaphragm.
- Different types of lumbar vertebral fractures fro acceleration or deceleration injuries, a associated with various abdominal injuries.
- Transverse spinous process fractures may occur w renal trauma and horizontal fractures of t vertebrae through the body are associated w pancreatic, duodenal or small bowel mesente injuries.
- It is important to understand the concept of t trimodal distribution of death (%) during a ro traffic crash:
  - The first phase is death within seconds to minut (40%) from the impact of the crash (ener being converted from one form to the oth according to the first law of thermodynamic causing instant damage to the brain, heart a great vessels and cervical cord.
  - The second phase is the 'golden hour' as dea occurs within minutes to hours (30%) and th can clinically be acted upon, influenced a death prevented. **This 'golden hour' phase** for the basis of the primary survey (ABCDE) of t Advanced Trauma Life Support (ATLS) system management in which immediately li threatening injuries are identified and treated the correct order[54].
  - The third phase is death within days to wee (30%) from infection, multiple organ failu abdomen (haemorrhage) and injury to t skeleton (pelvis and long bones).

ABDOMINAL ANATOMY

Region	Organs potentially injured
Lower chest	• Liver, Spleen, Diaphrag Stomach
Anterior abdomen	• Liver, Spleen, Colon, Bladder • Stomach, Pancreas, • Transverse colon, Ileu Jejunum
Flank	• Kidneys, Ureters, • Ascending and Descendi colon
Posterior abdomen	• Great vessels, Duodenum, • Pancreas, Spinal Cord

[54] Committee on Trauma (1981) Field Surgery Pocket Book. London, UK.

SSESSMENT

The initial assessment and resuscitation of the injured patient should follow the ATLS sequence of airway, breathing and circulation as airway compromise causes death within seconds, breathing derangement causes death within minutes and circulatory impairment causes death within hours[55].

Shock, in the presence of obvious abdominal injuries, should prompt a laparotomy for haemorrhage control (resuscitation laparotomy) during the circulation stage of the primary survey.

The assessment of the trauma patient following resuscitation includes obtaining a detailed history of the event from pre-hospital personnel. Knowledge of accident details (e.g. use of seat belts, estimated speeds, injuries to other passengers or any deaths) may enable the clinician to build a picture of likely injury patterns[56]. A thorough examination of the abdomen is part of the secondary survey and must include rectal, penile and vaginal examination.

Physical examination of the abdomen in the trauma patient is unreliable and a single negative examination does not exclude serious injury.

Regular review and documentation of findings are therefore essential as physical findings may undergo subtle changes with time[57].

Many injuries are not an immediate threat to life but will become fatal if not diagnosed and treated expeditiously. Thus, the role of the secondary survey. The decision on which injuries mandate an urgent operation apart from obvious and exsanguinating bleeding is frequently difficult and best made by an experienced surgeon.

VESTIGATIONS

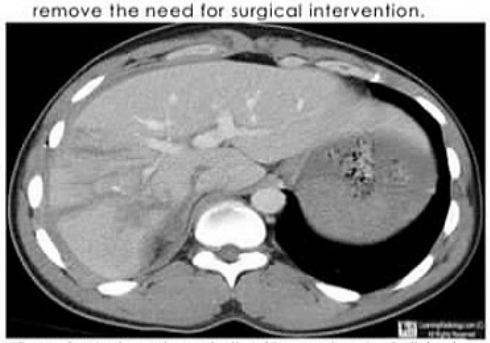
If patient's primary survey is intact, the adjuncts to the primary survey and resuscitation begins. The adjuncts to the primary survey include any of the following as necessary: EKcG, ABG, chest Xray, pelvis xray, urinary catheter, eFAST exam, and/or DPL and computed tomography.

Bedside sonography should be used to perform an eFAST exam. The sole purpose of FAST **is to detect free fluid**. In the setting of hypotension, free fluid on the eFAST exam suggests hemoperitoneum, necessitating emergent surgical intervention.

- The sensitivity of FAST in abdominal trauma is 88% and it is therefore an ideal screening investigation for all trauma patients who do not need to go directly to theatre and patients who are unstable because of its rapid assessment[58].
- A normal FAST does not exclude injury as signs of blood loss and hollow viscus injury may initially be subtle. If the patient remains cardiovascularly stable, this can be augmented by computed tomography (CT) scan either to confirm the negative FAST or determine organ injury for non-operative management[59].
- As it will also miss injuries not associated with intra-abdominal fluid, FAST may not be very useful in haemodynamically stable patients.
- It is therefore the investigation of choice in the haemodynamically unstable patient whereas CT is the investigation of choice in the haemodynamically stable patient.

1. LIVER

- Liver injuries account for 15-20% of intra-abdominal organ injuries but up to 50% of mortality, and 45% have associated splenic injury. **Conservative management** is appropriate in 80% of cases, with surgical intervention reserved for ongoing and uncontrolled bleeding.
- If hepatic or splenic injuries are detected on CT, the source of any ongoing bleeding can be detected through angiography.
- Through interventional radiology it can be possible to embolise the bleeding vessel and remove the need for surgical intervention.



CT scan showing laceration to the liver (Courtesy Learning Radiology)

merican College of Surgeons (1997) ATLS for Doctors: Student Course manual. edn, Chicago, USA.

Doersch KB, Dozier WE (1968) The seat belt syndrome: the seat belt sign, stinal and mesenteric injuries. Am J Surg 116: 831-833.

nsan JO, Yule SR, Loudon MA (2008) Investigation of blunt abdominal trauma. 336: 938-942.

[58] Myers J (2007) Focused assessment with sonography for trauma (FAST): The truth about ultrasound in blunt trauma. J Trauma 62: 528

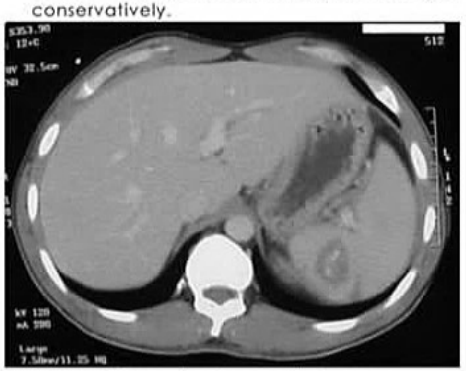
[59] Rodriguez C, Barone JE, Wilbanks TO, Rha CK, Miller K (2002) Isolated free fluid on computed tomographic scan in blunt abdominal trauma: a systematic review of incidence and management. J Trauma 53: 79-85

2. SPLEEN

- **Splenic injury is graded according to CT findings and treatment is guided by grade:**

Grade 1	*Minor subcapsular tear or haematoma*
Grade 2	*Parenchymal injury not extending to the hilum*
Grade 3	*Major parenchymal injury involving vessels and hilum*
Grade 4	*Shattered spleen*

- The spleen contains approximately one unit of blood at any time.
- Grade 1 or 2 injuries can usually be managed conservatively.



CT scan showing ruptured spleen

3. PANCREAS

- Injury to the pancreas may cause pancreatitis, which may develop over days.
- Blunt pancreatic injury may not be immediately recognised. It is relatively uncommon, occurring in around 10% of blunt abdominal injuries but it is rarely an isolated injury due to the position of the pancreas.
- Amylase elevation will often not occur until 3-4 hours after injnury, if at all, and lipase is no more specific for pancreatic trauma.

4. HOLLOW VISCUS

- Peritoneal contamination with bowel contents will produce peritonism.
- There may be accompanying blood loss but the degree of hypovolaemia is generally less significant than in solid organ injury.
- Damage to the retroperitoneal portion of the bowel will not produce classical signs of peritonism as the leak will be contained.

5. VASCULAR STRUCTURES

- Catastrophic blood loss may occur with inju to any of the large vessels in the abdomen.
- **Aortic injury** is usually fatal, but may b tamponaded if it occurs retroperitoneally.
- Injury to the **inferior vena cava** is likely to b associated with more insidious blood lo unless there is a large tear.

6. GU TRACT

- Bruising, haematuria or meatal blood a often the only signs of a GU injury.
- Injury to the intraperitoneal portion of th bladder may result in chemical peritonitis.

ED MANAGEMENT

All trauma patients must be managed in accordan with Advanced Trauma Life Support (AT algorithms[60]:

- **A (Airway with c-spine protection):** Is the patie speaking in full sentences?
- **B (Breathing and Ventilation):** Is the breathi labored? Bilateral symmetric breath sounds a chest rise?
  - O2 – Nasal cannula, Face Mask
- **C (Circulation with hemorrhage control):** Puls present and symmetric? Skin appearance (co clammy, warm well perfused)
  - IV – 2 large bore (minimum 18 Gaug Antecubital IV
  - Monitor: Place patient on monitor.
- **D (Disability):** GCS scale? Moving all extremities?
- **E (Exposure/Environmental Control):** Complet expose the patient. Rectal tone? Gross blood p rectum?

- Early consultation by relevant speciali teams (surgeons, radiologists, anaesthetis theatre staff, critical care) and transfer tear if definitive care is not available in yo hospital. In a trauma centre, early trauma should be carried out, ideally once th patient has been haemodynamica stabilised through fluid resuscitation.

  If a patient remains unstable despi resuscitation then senior members of th trauma team (emergency, surgical a anaesthetics) should make a team decisi weighing up the merits of CT vers immediate theatre.

[60] ATLS: Advanced Trauma Life Support for Doctors (Student Course Manual). N ed. American College of Surgeons; 2013.

7. Thoracic Trauma

. TENSION PNEUMOTHORAX

FINITION AND CONTEXT

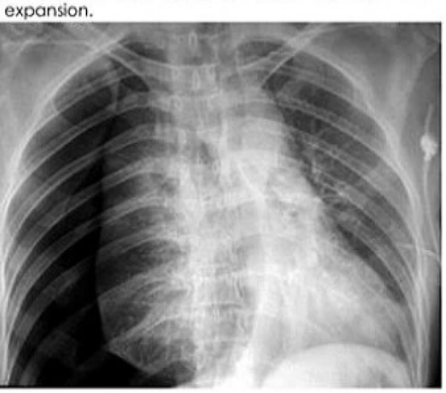
A tension pneumothorax is a life-threatening condition that develops when air is trapped in the pleural cavity under positive pressure, displacing mediastinal structures and compromising cardiopulmonary function.

Tension pneumothorax arises from numerous causes and rapidly progresses to respiratory insufficiency, cardiovascular collapse, and, ultimately, death if not recognized and treated. Therefore, if the clinical picture fits a tension pneumothorax, it must be emergently treated before it results in hemodynamic instability and death.

Given that the expansion is dynamic, be vigilant in patients with a chest x-ray proven small pneumothorax in whom you elect not to insert a chest drain.

INICAL ASSESSMENT AND IDENTIFICATION

Symptoms and signs depend on where your patient is on the expanding pneumothorax continuum – clinical features become more obvious with expansion.



FOR AWAKE PATIENTS:

Universal features of tension pneumothorax are **chest pain** and **respiratory compromise**, neither of which are discriminatory of course.

Low oxygen saturations may be an early feature; **hypotension** tends to be late. Both may have other causes.

- Lateralising the pneumothorax may not be straightforward – listen for **decreased breath sounds on the affected side**.
- Listen in the axillae rather than over the anterior chest wall. Note the classical signs of **hyper-resonance** and **tracheal deviation** are soft and difficult to elicit.

B. FOR VENTILATED PATIENTS:

- Early reliable signs are: **↓SPO2, ↓BP, ↑HR, ↑VP**
  - Decrease in oxygen saturations – this is likely to be prompt
  - Decrease in BP, Tachycardia
  - Look too for raised ventilation pressure (VP>40) – ensure that the ventilator pressure alarm settings are set appropriately.
  - **Lateralising signs** are the same as for awake patients.
- A portable CXR is recommended for tension pneumothorax, unless the patient is critical
- Radiological evidence of tensioning does not necessarily correlate clinically

ED MANAGEMENT[39]

- **Emergent Needle Thoracentesis**
  - Do not wait for Chest XRay
  - Use 14 gauge (5 cm long) angiocatheter in children and 10 gauge (7.5 cm long) angiocatheter in adults
  - Insert angiocatheter over the top of the third rib in the mid-clavicular line
- **Chest Tube**
  - Perform immediately after needle decompression
  - Insert over the top of the 5th rib in the mid-axillary line

Needle thoracocentesis is advocated for tension pneumothorax in the first instance in the ATLS manual.

- Potential drawbacks to this strategy are:
  - **It tends to get over used**, particularly in stable resus room patients in whom portable CXR is readily available and chest drain is the preferred treatment.

[39] *2012 ATLS 9th ed, American College of Surgeons, Committee on Trauma, p. 96-9*

- **A lack of hiss** (or bubbling, if you have put some saline in a syringe attached to the needle) might be considered as evidence of no tension pneumothorax – the procedure doesn't have 100% sensitivity.

Three potential drawbacks to the recommendation of using needle thoracocentesis:

- A (4.5 cm) 14-gauge cannula may not reach the pleural space via the second intercostal space.
- The cannula can kink and cease to function.
- A pneumothorax may be caused if the diagnosis is incorrect.

2. Thoracostomy (Finger)

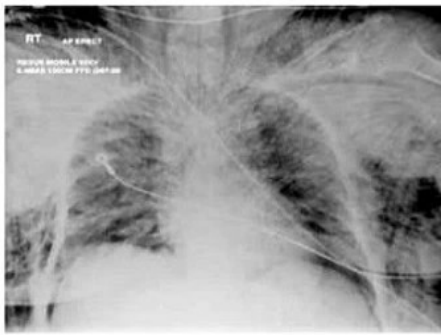
- Avoid needle thoracocentesis in peri-arrest patients with suspected tension pneumothorax – thoracostomy is the better option.

3. Chest drain insertion

- The most common cause of serious injury (and death) as a result of chest drain insertion, is insertion at the incorrect site, usually too low
- Confirm that the drain lies within the chest wall cavity by looking for fogging of the tube and swinging of the chest drain with respiration.
- Do not clamp the chest drain or apply suction
- The underwater seal needs to remain below the insertion site at all times

LEARNING POINTS

- If you do perform needle thoracocentesis, ha some saline in the syringe to demonstrate bubbli when the tension is hit. Gross surgical emphyser with pneumomediastinum (as per CXR) and a ch drain that continues to bubble, sugge **tracheobronchial injury.**
- If there is good clinical and radiological eviden of significant lateral chest wall injury, consider t second intercostal space anteriorly for the ch drain insertion – it's safer for the operator and l painful for the awake patient.
- One third of initial CXRs in trauma will not dete pneumothorax; anaesthetic colleagues need to aware of this if your patient leaves for theatre.
- Cardiac tamponade may give similar signs clinica shock, with distended neck veins.
- A combination of your FAST skills, urgent CXR a consideration of the mechanism of injury shou help you distinguish the two.



- Beware other pathology masquerading as lar (possibly tensioning?) pneumothorax on the CX for example an emphysematous bulla gastrothorax.
- Reconsider the clinical presentation and consid CT where the CXR diagnosis remains in doubt.

I. OPEN PNEUMOTHORAX

EFINITION AND CONTEXT

Think hole in the chest. It is also known as a **communicating pneumothorax** or **sucking chest wound**.

A hole of only 1 or 2 cm in radius may cause serious respiratory compromise, particularly in patients with comorbidities, and/or other injuries

Rarely, it is caused by ballistic (shot gun) injury.

Clearly, this unlikely to be missed clinically.

As the patient takes a breath in, the hole in the chest competes with the normal airway (mouth/nose to trachea) for delivery of air.

INICAL ASSESSMENT AND IDENTIFICATION

Prompt clinical inspection front and back; a small sucking chest wound is usually audible.

MANAGEMENT[40]

Apply a sterile Occlusive Dressing to wound

- Tape dressing on 3 of the 4 sides (Valve effect)
- Offers only temporary stabilization until Chest Tube can be placed
- Chest Tube is the primary management for an open chest wound
- Do not completely occlude the wound until Chest Tube is in place (Tension Pneumothorax risk)

Place Chest Tube remote from open wound

- Typical Chest Tube placement is over the 5th rib in the mid-axillary line
- Do not use the wound site for insertion of Chest Tube (contamination risk)

Surgical Consultation

- Provides definitive chest wound closure

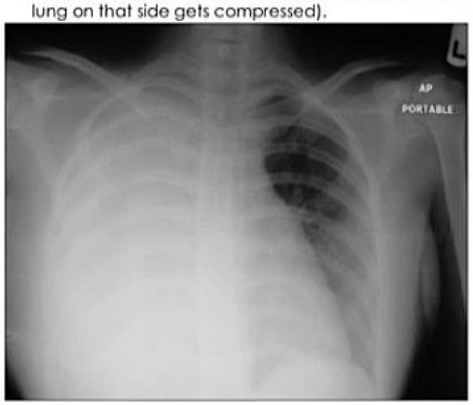
- **Early intubation:** IPPV solves the respiratory embarrassment created by the hole in the chest
- For small open pneumothoraces, insert a **chest drain** remote from the wound on that side; this is practically easier once the patient is anaesthetised.
- Do not insert a chest drain in patients with a large open pneumothorax since muscle flaps may be needed for closure and can be damaged in the procedure. Definitive treatment is surgical repair.

2012 ATLS 9th ed, American College of Surgeons, Committee Trauma, p. 96-9

III. MASSIVE HAEMOTHORAX

DEFINITION AND CONTEXT

- Massive Haemothorax is a haemothorax with a **volume greater than 1500 ml**, or greater than **one third of the patient's blood volume**.
- This is an uncommon injury which can be caused by blunt or penetrating trauma, and is unlikely to be missed radiologically.
- It creates a problem because of shock (haemorrhagic and impaired venous return from the vena cava) and decreased ventilation (the lung on that side gets compressed).



CLINICAL ASSESSMENT AND IDENTIFICATION

- Think of the concept of expanding haemothorax (another continuum!): the signs will be less reliable in moderate haemothorax.
- Listen at the lung bases (Figure above).

- There should be clear signs of shock prompting y to rule out the diagnosis.
- Use CXR and FAST to guide you.
- You may underestimate the size of t haemothorax on a supine CXR.

- **FAST SIGNS:**
  - **The absence of a mirror image of liver/ lung spleen/lung** across the diaphragm suggests haemothorax;
  - Alternatively, free fluid in the abdomen alo should prompt you to reconsider the source haemorrhage.

TREATMENT[41]

- **ABCD approach.**
- **Intravenous fluid** resuscitation
- Consider autotransfusion device (e.g. hemova cell saver)
- Large bore Chest Tube (36-40 french) at the 5 intercostal space in the midaxillary line
- Operative management as below

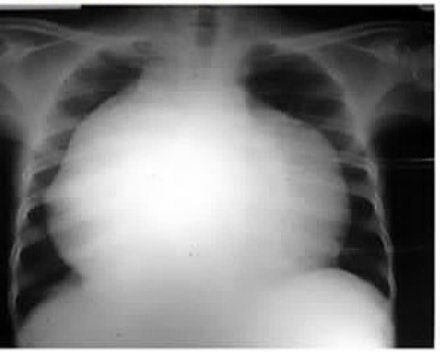
ATLS indications for Thoracotomy

- *Chest Tube output >1500-2000 cc total or*
- *Chest Tube output 150-200 cc/hour for several hours or*
- *Refractory hemodynamic instability or*
- *Penetrating anterior Chest Trauma medial to the nipple line*

[41] 2012 ATLS 9th ed, American College of Surgeons, Commit on Trauma, p. 96-9

V. CARDIAC TAMPONADE

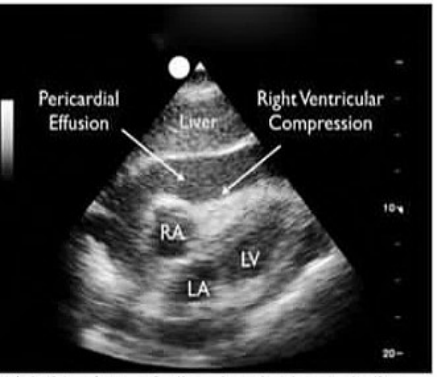
FINITION AND CONTEXT



Cardiac tamponade is a collection of fluid (blood in the context of trauma) in the pericardial sack causing haemodynamic compromise.

When faced with a penetrating injury to chest, back or upper abdomen, **think tension pneumothorax, think massive haemothorax, and think cardiac tamponade.**

Exclude or confirm tamponade with a FAST scan.



oxiphoid view of the heart demonstrating a oderate sized pericardial effusion.

Cardiac tamponade is not an on/off phenomenon (yet another continuum), though the progression to PEA cardiac arrest may be rapid.

50 to 200 ml of blood in the pericardial sac may be enough.

Cardiac tamponade as a result of blunt injury is exceptionally rare in those patients reaching hospital alive.

CLINICAL ASSESSMENT AND IDENTIFICATION

- FAST has particularly high sensitivity (about 95% according to ATLS).
- Do note that there are drawbacks in detecting and interpreting the classical clinical signs **(Beck's Triad):**
  - **Neck veins** may not be distended if the patient has haemorrhagic shock
  - **Hypotension** (and a raised respiratory rate) may have other causes
  - **Muffled heart sounds** unlikely to be heard in the ED!

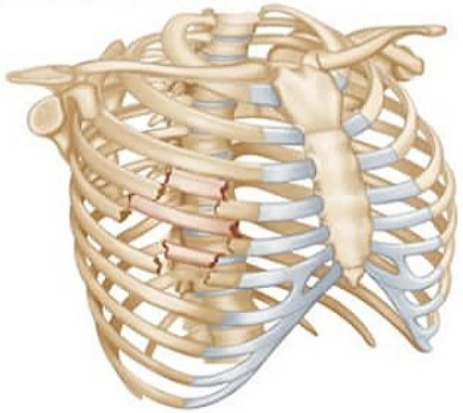
TREATMENT[42]

- **ABCD approach** with **Fluid resuscitation** to increase pre-load
- **Immediate Pericardiocentesis under Ultrasound gui dance (ATLS)**
  - Emergency Pericardiocentesis
  - Sub-xiphoid approach
  - Needle angled toward left Shoulder
  - Constant suction applied to syringe on entry
  - Send fluid for cytology if not Traumatic in origin
- **Emergency Thoracotomy**
  - Indicated in Cardiac Tamponade due to Trauma (especially penetrating), refractory to Pericardiocentesis
- **Emergent Cardiothoracic surgery**
  - Pericardial window placement and other definitive management
- **Intravenous Fluids**
  - Transient stabilization to increase venous pressure
- **Precautions**
  - Avoid Positive Pressure Ventilation until after decompression with Pericardiocentesis
    - Negative intrathoracic pressure is the last safeguard maintaining venous return in Pericardial Tamponade
    - Positive Pressure Ventilation eliminates negative intrathoracic pressure
    - Pulseless Electrical Activity arrest (PEA arrest) results
  - Avoid measures that reduce cardiac filling
    -
    - Avoid inotropes (increased Heart Rate decreases filling time)

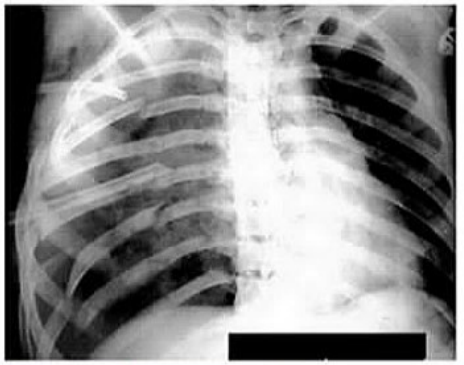
[42] *Mallemat and Swadron in Herbert (2013) EM:Rap 13(12): 10-11*

V. FLAIL CHEST

DEFINITION AND CONTEXT



- Chest Trauma resulting in 2 or more contiguous Rib Fractures at 2 or more sites along each rib resulting in paradoxical chest wall movement and associated with other lung injury (Lung Contusion, pain with Splinting and Atelectasis)and Results in hypoventilation and Hypoxia
- This injury is relatively common – small flails may be missed clinically.
- Beware **underlying pulmonary contusions** which are inevitable, and may cause significant morbidity and mortality in any age group
- Considerable force is required to create a flail chest in young people look carefully for other injuries, both intra and extra-thoracic.
- Multiple rib fractures are a potential source of significant haemorrhage.



CLINICAL ASSESSMENT AND IDENTIFICATION

- By palpation as well as inspection.
- A CXR might identify associated pneumothor haemothorax and pulmonary contusions.
- The appearance of early pulmonary contusions particularly worrying: evidence of further a perhaps extensive contusion (with physiologic effect) may evolve.

TREATMENT

- Treatment options depend largely on t respiratory embarrassment caused: consider yo patient's clinical condition, the size of the flail che associated injuries, age, co-morbidities a destination from resus (theatre, CT scan, ITU ward)

If no life-threatening injuries[43]:

- Stabilize flail segment
- Supplemental Oxygen
- Pain management
  - Narcotic Analgesics (e.g. Dilaudid or Morphine Sulfate)
  - Consider intercostal Nerve Block
  - Consider intrapleural or extrapleural anesthesia
  - Consider Epidural Anesthesia
- Consider intubation
  - Indicated for Respiratory Failure

- **For patients with major trauma (Life-threatening):**
  - **Intubation and ventilation (IPPV):** This enab you to take better control of respirato compromise,
  - **Pain management** (remember to give **adequa morphine post RSI**) and facilitates clinic procedures e.g. chest drain insertion and scan.
  - Insert a **chest drain** for associat pneumothorax and haemothorax
  - **CT** is likely to pick up occult pneumothorac whilst usually small, chest drain insertion recommended if the treatment option ventilation
  - Judicious **fluid resuscitation** since excessive flu floods injured lung tissue
  - **Definitive surgery** (internal fixation of ribs) at t discretion of cardiothoracic surgeons.
  - Discuss treatment options with **ICU and thorac surgical** colleagues.

[43] *2012 ATLS, ACOS, Chicago, p. 99*

VI. PULMONARY CONTUSION

EFINITION AND CONTEXT

Bruised lung; unlikely to be missed radiologically unless the CXR is early.

Potentially life threatening since:

- The patient is at **risk of hypoxaemia**
- Because of the force involved to cause the injury, **associated injuries are common**
- Injured lung is **vulnerable to flooding** from aggressive fluid resuscitation
- Patients with co-morbidities and/or advanced age are particularly at risk from this injury.

INICAL ASSESSMENT AND IDENTIFICATION

Look for patchy white areas progressing to frank consolidation on the CXR (aspiration and haemorrhage are differential diagnoses)

Contusions visible on the initial CXR suggests significant injury, with further radiological changes and blood gas derangement likely to follow.

Look for associated rib fractures and haemo/pneumothorax

Rib fractures do not always co-exist, particularly in the young (where their existence indicates that significant force created the injury)

TREATMENT

- **A&B: IPPV with Positive End Expiratory Pressure** (PEEP) for the sicker patients
- **C: Judicious use of fluids**
  - Consider insertion of a central line and arterial line
  - **Avoid colloids** since these will breach injured lung tissue and worsen hypoxia
- **D:** No evidence for steroids or prophylactics antibiotics
- Discuss disposition of each patient with **ITU and thoracic surgical colleague**

VII. MYOCARDIAL CONTUSION

EFINITION AND CONTEXT

Myocardial bruising caused by blunt injury, including deceleration and ballistic mechanisms.

The key problem with interpreting the literature is the lack of a diagnostic gold standard (apart from post mortem).

CLINICAL ASSESSMENT AND IDENTIFICATION

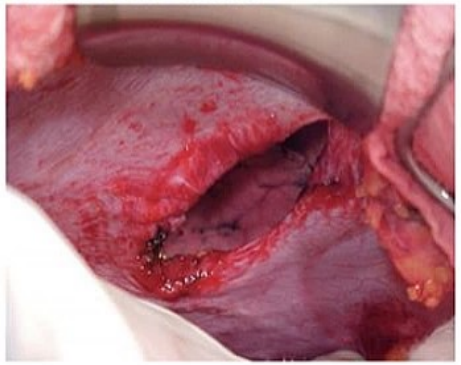
- A normal ECG effectively rules out the condition.
- Unexplained tachycardia may be a clue.
- Look too for atrial and ventricular ectopics.
- Consider bedside echocardiogram.
- Consider troponin.
- Beware labelling ST changes as myocardial contusion; there may have been a primary cardiac event that precipitated the accident.

TREATMENT

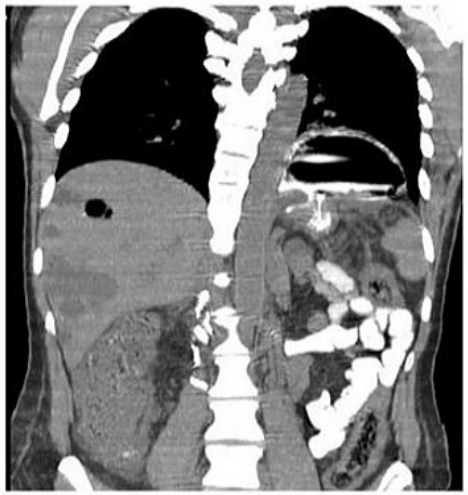
- There is no direct ED-based intervention to treat the myocardial contusion itself; treat the following if identified:
  - Hypoxaemia
  - Acidaemia
  - Fluid status
  - Low haemoglobin
- Monitor ECG.
- Consider a central and arterial line.

VIII. DIAPHRAGMATIC INJURY

DEFINITION AND CONTEXT



- Diaphragmatic injury is usually caused by penetrating rather than blunt injury.
- It is easily missed both clinically and radiologically.
- In blunt injury it is three times more common on the left (the right hemi-diaphragm being protected by the liver) and nearly always at the weakest point, posterolaterally.
- A diaphragmatic breach will not heal spontaneously because of the differential pressure gradients between chest and abdomen.
- Abdominal content herniation is a possibility and may be picked up years later.



CLINICAL ASSESSMENT AND IDENTIFICATION

- Symptoms are likely to be masked by associat injuries.
- Diaphragm injuries resulting from knives or bull are more likely to be detected on surgic exploration.
- In blunt injuries, particularly those causing an abru rise in intra-abdominal pressure, be careful not interpret a gastrothorax for a large pneumothor both will cause respiratory embarrassment.

Right diaphragmatic hernia

Right diaphragmatic hernia

TREATMENT

- **Insert a nasogastric tube** gently to drain stoma content.
- A cautiously placed **chest drain** using the traditio open technique, not Seldinger, is indicated.
- **Surgical repair** needs to be considered in t context of associated injuries.

VI. PULMONARY CONTUSION

EFINITION AND CONTEXT

Bruised lung; unlikely to be missed radiologically unless the CXR is early.

Potentially life threatening since:

- The patient is at **risk of hypoxaemia**
- Because of the force involved to cause the injury, **associated injuries are common**
- Injured lung is **vulnerable to flooding** from aggressive fluid resuscitation
- Patients with co-morbidities and/or advanced age are particularly at risk from this injury.

INICAL ASSESSMENT AND IDENTIFICATION

Look for patchy white areas progressing to frank consolidation on the CXR (aspiration and haemorrhage are differential diagnoses)

Contusions visible on the initial CXR suggests significant injury, with further radiological changes and blood gas derangement likely to follow.

Look for associated rib fractures and haemo/pneumothorax

Rib fractures do not always co-exist, particularly in the young (where their existence indicates that significant force created the injury)

TREATMENT

- **A&B: IPPV with Positive End Expiratory Pressure** (PEEP) for the sicker patients
- **C: Judicious use of fluids**
  - Consider insertion of a central line and arterial line
  - **Avoid colloids** since these will breach injured lung tissue and worsen hypoxia
- **D:** No evidence for steroids or prophylactics antibiotics
- Discuss disposition of each patient with **ITU and thoracic surgical colleague**

VII. MYOCARDIAL CONTUSION

EFINITION AND CONTEXT

Myocardial bruising caused by blunt injury, including deceleration and ballistic mechanisms.

The key problem with interpreting the literature is the lack of a diagnostic gold standard (apart from post mortem).

CLINICAL ASSESSMENT AND IDENTIFICATION

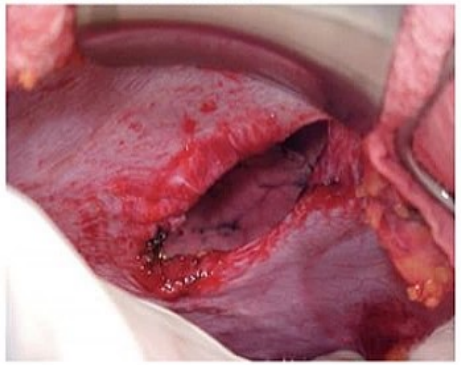
- A normal ECG effectively rules out the condition.
- Unexplained tachycardia may be a clue.
- Look too for atrial and ventricular ectopics.
- Consider bedside echocardiogram.
- Consider troponin.
- Beware labelling ST changes as myocardial contusion; there may have been a primary cardiac event that precipitated the accident.

TREATMENT

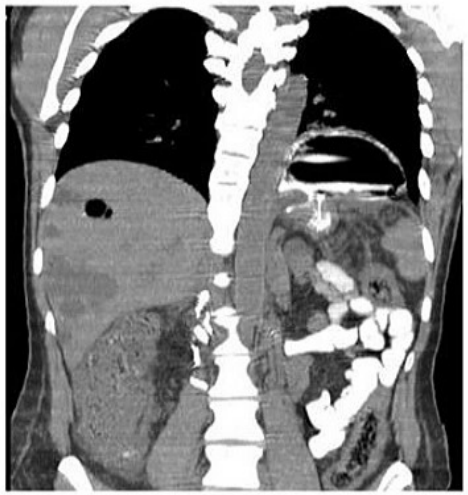
- There is no direct ED-based intervention to treat the myocardial contusion itself; treat the following if identified:
  - Hypoxaemia
  - Acidaemia
  - Fluid status
  - Low haemoglobin
- Monitor ECG.
- Consider a central and arterial line.

VIII. DIAPHRAGMATIC INJURY

DEFINITION AND CONTEXT



- Diaphragmatic injury is usually caused by penetrating rather than blunt injury.
- It is easily missed both clinically and radiologically.
- In blunt injury it is three times more common on the left (the right hemi-diaphragm being protected by the liver) and nearly always at the weakest point, posterolaterally.
- A diaphragmatic breach will not heal spontaneously because of the differential pressure gradients between chest and abdomen.
- Abdominal content herniation is a possibility and may be picked up years later.



CLINICAL ASSESSMENT AND IDENTIFICATION

- Symptoms are likely to be masked by associat injuries.
- Diaphragm injuries resulting from knives or bull are more likely to be detected on surgic exploration.
- In blunt injuries, particularly those causing an abru rise in intra-abdominal pressure, be careful not interpret a gastrothorax for a large pneumothor both will cause respiratory embarrassment.

Right diaphragmatic hernia

Right diaphragmatic hernia

TREATMENT

- **Insert a nasogastric tube** gently to drain stoma content.
- A cautiously placed **chest drain** using the traditio open technique, not Seldinger, is indicated.
- **Surgical repair** needs to be considered in t context of associated injuries.

X. OESOPHAGEAL INJURY

This rare injury is often initially missed both clinically and radiologically.
Other associated injuries will normally predominate the clinical presentation e.g. a neck stabbing with tracheal and vascular disruption.

EATMENT

Operative repair or endoluminal stenting should be considered in the context of other associated injuries.

TRACHEAL/BRONCHIAL INJURYDEFINITION ND CONTEXT

This rare injury is typically caused by significant deceleration injuries; most patients die at the scene of the accident.
It is unlikely to be missed clinically or radiologically in survivors, since clinical effects are usually dramatic.

INICAL ASSESSMENT AND IDENTIFICATION

A massive air leak is suggested by **gross surgical emphysema**, **pneumomediastinum** and **a vigorously bubbling chest drain** that has failed to alleviate respiratory compromise.
Haemoptysis is an additional clue.

TREATMENT

- Discuss **intubation strategy** with senior anaesthetic colleagues (consider single or double cuffed tubes, use of fibre optics, etc).
- Consider **additional large bore chest drain** on the affected side (one intercostal space further up).
- Do not attach suction to the chest drain.
- Other significant patient injuries may influence your resuscitation strategy.

XI. SIMPLE PNEUMOTHORAX

FINITION AND CONTEXT

This is a common injury which is readily missed on CXR and subsequently discovered on CT.
Small, asymptomatic/occult pneumothoraces may be observed, even if the patient is ventilated.
About a third may deteriorate clinically, necessitating a drain.
No guideline regarding the safe timing for flying following a simple traumatic pneumothorax exists.
A pragmatic approach may be to adopt British Thoracic Society guidelines for spontaneous pneumothorax: **flying is permissible, once chest x-ray confirms resolution of the pneumothorax**

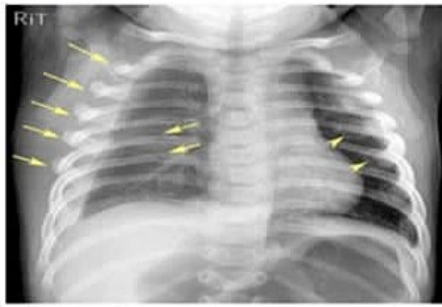
XII. RIB FRACTURES

DEFINITION AND CONTEXT

- Significant force is required to break ribs in the young; underlying injury is typical, especially lung contusions.
- Whilst less force is required in the elderly, even an isolated rib fracture can result in significant morbidity (e.g. secondary pneumonia) particularly in those with pre-existing comorbidities.

TREATMENT

- In addition to standard therapy consider the role of patient-controlled **analgesia**, **thoracic epidural** and **physiotherapy** for vulnerable patients.



XIII. STERNAL FRACTURES

DEFINITION AND CONTEXT

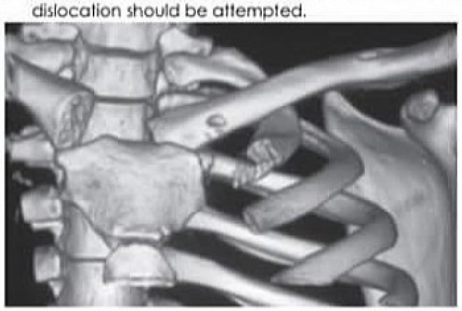
- These are relatively benign injuries but may be associated with underlying myocardial or pulmonary contusion.

TREATMENT

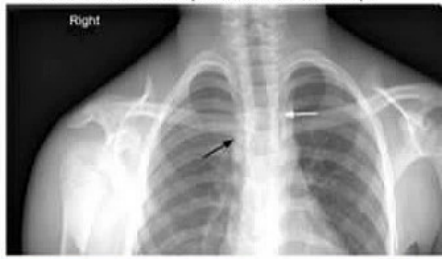
- Consider the role of patient-controlled **analgesia** or **local anaesthetic** via a sternal catheter in vulnerable patients.

XIV. POSTERIOR STERNOCLAVICULAR JOINT DISLOCATION

- This an exceptionally rare injury.
- It is clinically important since the medial clavicular head may compromise the airway or major vessels.
- If there is evidence of compromise, reduction of the dislocation should be attempted.



- Abduct the arm to 90° and extend 10-15° a apply traction (with counter attraction to the to from another colleague); maintain traction and p the medial end of the clavicle forward with yo fingers and thumb.
- If this fails, prepare the skin with iodine and loc anaesthetic and repeat with a towel clip.



10. Abdominal Trauma

I. PENETRATING ABDOMINAL TRAUMA

INTRODUCTION

- Penetrating abdominal trauma is seen in many countries. The most common cause is a stab or gunshot. The most common organs injured are the small bowel (50%), large bowel (40%), liver (30%), and intra-abdominal vascular (25%).
- When the injury is close range, there is more kinetic energy than those injuries sustained from a distance. Even though most gunshot wounds typically have a linear projection, the high-energy wounds are associated with unpredictable injuries.
- There may also be secondary missile injuries from bone or bullet fragments. Stab wounds that penetrate the abdominal wall are difficult to assess.
- Occult injuries can be missed, resulting in delayed complications that can add to the morbidity[46].

ETIOLOGY

- Penetrating trauma occurs when a foreign object pierces the skin and enter the body creating a wound. In blunt or non-penetrating trauma the skin is not necessarily broken. In penetrating trauma, the object remains in the tissue or passes through the tissues and exits the body.
- An injury in which an object enters the body and passes through is called a perforating injury.
- Perforating trauma is associated with an entrance wound and an exit wound[47].
- Penetrating trauma suggests the object does not pass through. Penetrating trauma can be caused by violence and may result from:
  - Fragments of a broken bone
  - Gunshots
  - Knife wounds
- Penetrating trauma often causes damage to internal organs resulting in shock and infection. The severity depends on the body organs involved, the characteristics of the object, and the amount of energy transmitted. Assessment includes x-rays, CT scans, and MRI. Treatment involves surgery to repair damaged structures and remove foreign objects.
- Puncture and penetration are similar.
  - A puncture is different from a penetration wound in that there is no exit wound in a puncture.
  - This type of trauma is seen in a stabbing or a gunshot wound in which a low-velocity pistol bullet was used.

HISTORY AND PHYSICAL

- Penetrating abdominal trauma is due to stabbings, ballistic injuries, and industrial accidents.
- These injuries may be life-threatening because abdominal organs bleed profusely.
- If the pancreas is injured, further injury occurs from autodigestion.
- Injuries of the liver often present in shock because the liver tissue has a large blood supply.
- The intestines are at risk of perforation with concomitant fecal matter complicating penetration. Penetrating abdominal trauma may cause hypovolemic shock and peritonitis.
- Penetration may diminish bowel sounds due to bleeding, infection, and irritation, and injuries to arteries may cause bruits.
- Percussion reveals hyperresonance or dullness suggesting blood. The abdomen may be distended or tender indicating surgery is needed.
- The standard management of penetrating abdominal trauma is a **laparotomy.**
- A greater understanding of mechanisms of injury and improved imaging has resulted in conservative operative strategies in some cases.

---

[46] *Taghavi S, Askari R. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Jan 13, 2019. Liver Trauma.*

[47] *Revell MA, Pugh MA, McGhee M. Gastrointestinal Traumatic Injuries: Gastrointestinal Perforation. Crit Care Nurs Clin North Am. 2018 Mar;30(1):157-166.*