THE NORTHERN HOSPITAL

CHEST TRAUMA (HEMOTHORAX)

"Charlotte Corday", oil on canvas, Paul Jacques Aime Baudry, 1860, Musée des Beaux-Arts, Nantes, France.

At 10.00 o'clock on the morning of July 13th 1793 Charlotte Corday knocked on the door of 30 Rue des Cordeliers, in the old quarter of Paris. Marat's sister in law Catherine Evrard answered the door. Charlotte demanded to see citizen-deputy Marat as she had important news for Marat's ears only. The door was promptly shut in her face.

Corday decided to take a different tack. She returned to the Hotel de la Providence and scribbled out a note addressed to Marat, saying that she had come from Caen with vital information on plots against the revolution that were being hatched by escaped Girondins. She would await his reply. She delivered it to the desk clerk, at Marat's address, who promised he would deliver it to the deputy within the hour. In the meantime at a fashionable clothes shop in a nearby arcade, she changed her clothes and her hair style. She put on a tight fitting, low cut bodice of Indian muslin. A hairdresser bunched her hair so that the tresses spread and hung to her waist in the fashion of the day, and then powdered it ash-blonde. She replaced her prim white Caennaise bonnet with a stunning Parisian black hat streaming with green ribbons. She would make these colours the eventual symbol of counter-revolution, prohibited to the ruin of drapers and clothiers of the day. Finally at a cutler's shop, she bought a wooden-handled kitchen knife, with a formidable five inch blade, and slipped it through the top of her dress.

At seven o'clock in the evening, for the second time that day, she knocked on the door of 30 Rue des Cordeliers. A startled Simone Evrard the sister of Catherine refused her entrance, but Charlotte raised her voice trying to catch the attention of Marat. Suddenly Marat's voice called out, "Let her in". If Girondins were plotting against the revolution, he wanted to know about it. Charlotte immediately rushed up the stairs to Marat's room. As she burst through the door both would have been momentarily taken aback. Marat, with his ugly and diseased body, was in his bath, with a wet cloth soaked in vinegar tied around his head to soothe a chronic skin condition, whilst he was preparing the latest edition of his journal, "The People's Friend". Charlotte, on the other hand presented a stunning contrast, tall, blonde, seductively dressed, aristocratic…beautiful. Marat, after an involuntary gasp, quickly regained his composure and began to question Charlotte about the counter-revolutionaries plotting in Caen. She recited a long list of "suspects". "Good" replied Marat, "in a few days I will have them all guillotined". Just then she bent over him, took the knife from the top of her dress and ferociously plunged it into his chest with all her strength. He cried out, "A moi, ma chere amie", then promptly sunk back into his bath. Within minutes the "People's Friend" was dead.

The people of Paris were shocked that a "mere" woman could have assassinated the great Marat in his own home. At her subsequent trial before the revolutionary tribunal, the prosecutor Montane could not believe that she had acted alone, or that she was not a trained assassin. An extract from her trial reads:

Montane: *Was it from those newspapers that you learned that Marat was an anarchist?*

Corday: *Yes. I knew that he was perverting France. I have killed one man to save a hundred thousand. Besides he was a hoarder, at Caen they have arrested a man who bought goods for him. I was a Republican well before the Revolution and I have never lacked energy.*

Montane: *What do you mean by "energy"?*

Corday: *Those who put their own interests to one side and know how to sacrifice themselves for the patrie.*

Montane: *Didn't you practice in advance, before striking the blow at Marat?*

Corday: *Oh! The monster, (ie Montane), he takes me for a murderer! Here (says the court record) the witness appeared violently moved.*

Montane: *Nonetheless it was proven in the medical report that if you had struck the blow in this manner (demonstrating with a long motion), you would not have killed him.*

Corday: *I struck him just as you found. It was luck.*

As Charlotte was taken through the streets of Paris alone in a tumbrel to the Place de la Revolution, to be guillotined enormous crowds gathered to take a glimpse of the infamous "femme fatale". She stuck in imposing, stoic and dignified figure. A thunderstorm broke and within seconds saturated her scarlet shirt, the shirt worn by all assassins of "representatives" of the people. Its thin cloth clung revealingly to her breasts. Instead of the usual howls of verbal abuse as the condemned went by, the crowd was unusually quite. It was said that Robespierre himself watched her go by from a window, in company with Danton and Desmoulins. He was uncharacteristically agitated, constantly fidgeting and talking. She passed by Pierre Notelet's house who later wrote, "Her beautiful face was so clam, that one would have said she was a statue. Behind her young girls held each other's hands as they danced. For eight days I was in love with Charlotte Corday"

The majority of patients who suffer a penetrating chest wound, will have bleeding which is self-limiting, providing there has not been a cardiac or major mediastinal vessel injury. The single blow that Charlotte Corday struck to the chest of Marat was so powerful that he was killed almost instantly. The revolutionary tribunal scarcely believed that a "mere" woman could have inflicted such a wound with a single thrust of the knife. It is likely that Marat died of a cardiac or major mediastinal vessel injury.

CHEST TRAUMA (HEMOTHORAX)

Introduction

Traumatic hemothorax refers to bleeding into the **pleural space.**

It can be due to **penetrating injury** or **blunt injury.**

Detection of hemothorax can be problematic in the **supine** CXR, where significant bleeding can be missed.

CT scan (with contrast) is the best investigation for the detection of **hemothorax.**

In the majority of cases bleeding from intercostal vessels, internal mammary vessels or lung parenchyma will be self-limiting, and operative intervention will often not be required.

Patients who remain hemodynamically unstable despite resuscitation or who have significant ongoing bleeding will require operation.

Arrested patients may undergo thoracotomy in the ED, where the equipment and expertise exists for this.

It should be noted that despite traditional teaching thoracotomy may be done in these situations for not only penetrating injury but for blunt injury as well.

Terminology:

A hemothorax occurring with a pneumothorax is termed a **haemopneumothorax.**

A **tension hemothorax** refers to hemothorax that results from massive intrathoracic bleeding causing ipsilateral lung compression and mediastinal displacement towards the opposite side.

See also separate documents on:

- **Pneumothorax**
- **Traumatic cardiac tamponade**

Pathology

Serious intrathoracic haemorrhage may result from laceration of:

1. Intercostal vessels.
2. Internal mammary vessels.

3. Lung parenchyma.

4. Great vessels of the mediastinum, (less commonly, and usually rapidly fatal).

5. Myocardium (potentially salvageable if contained within the pericardial space - i.e cardiac tamponade)

The majority of haemothoraces however result from injury to lung parenchyma or venous injury and will stop bleeding without intervention.

Failure to adequately drain a haemothorax initially results in, clotted blood which will not drain via a chest tube.

If left untreated, these retained haemothoraces may become infected forming an empyema.

Even if they remain uninfected, the clot will organise and fibrose, resulting in a loss of lung volume which may result in impaired pulmonary ventilation.

It may also result in impairment of venous return to the heart.

Clinical Assessment

Important points of history include:

1. Circumstances of the event, (accidental, assault, self inflicted etc)

2. Time of injury

3. Past history/ co-morbidities/ medications

4. Symptoms, dyspnea, pain, "dizziness"

Important points of examination include:

1. Assess ABC

    - Check vital signs, including oxygen saturation levels.

2. Check for evidence of:

    - Pneumothorax, (including tension pneumothorax).

        - ♥ Including subcutaneous emphysema.

    - Flail segments.

    - Cardiac tamponade.

- Hemothorax:
    - ♥ Dull percussion note
    - ♥ Reduced breath sounds
    - ♥ Decreased chest expansion

    Note that all of these clinical signs may be subtle or absent in the **supine** trauma patient in the emergency department, and most hemothoraces will only be diagnosed after **imaging studies.**

    Massive hemothorax may be expected to result in signs such as an elevated JVP and a shift of the mediastinum (i.e the trachea) to the contralateral side, however these signs are unreliable. The JVP may not be elevated in a significantly shocked patient and a hemothorax only rarely can shift the mediastinum.

    In practice a massive hemothorax is usually indicated by a patient with the following 3 signs

    - ♥ Shock
    - ♥ Absent breath sounds on one side
    - ♥ Dull percussion note on one side

3. Assess penetrating chest wounds in relation to location, noting the following:
    - Wounds to the base of the neck or supraclavicular regions may result in apical lung injury including pneumothorax.
    - Wounds to the lower chest wall may have in fact penetrated the peritoneum, and wounds to the upper abdomen may have penetrated the pleura.
    - Anterior chest wounds, particularly located between the two mid-clavicular regions are high risk for a cardiac injury.
4. Assess the back and upper abdomen not just the chest.

Investigations

The extent and type of investigation will depend on how unwell the patient is and the index of suspicion for any given condition.

Blood tests:

1. FBE, (urgent Hb)
2. U&Es/ glucose
3. Blood group and cross match, as clinically indicated

ECG:

Should be done especially in:

- Suspected cardiac injury.
- The elderly or those with significant IHD, primarily to assess cardiac co-morbidity.

Plain radiography:

Important signs on CXR include:

1. Hemothorax:

   The ability to detect a hemothorax on plain radiography will depend on:

   - How the CXR was taken (erect versus supine).
   - The amount of blood that is present.

   Supine CXR:

   - Significant hemothorax (**up to 1000 mls**) can be missed on a **supine** CXR. [3]

     The only sign on a supine CXR may simply be a **general haziness of one hemithorax**, as compared to the opposite side, however even this may be difficult to appreciate, (see below).

     A major difficulty exists when there are significant **bilateral hemothoraces.** In this situation there is *no difference in appearance between the two sides* and so **significant bilateral hemothorax can be completely missed on a supine CXR.**

   Erect CXR:

   - Ideally the CXR should be taken erect when looking for a hemothorax

- Smaller amounts of hemothorax (< **250mls**) are not detectable on CXR, even when optimally taken, (ie erect). [3]

- The typical appearance of blood in the pleural cavity demonstrates a meniscus curved upward towards the lateral aspect of the chest wall.

  A perfectly horizontal line of blood indicates a hemo-pneumothorax.

2. Pneumothorax.

3. Pneumomediastinum or pneumopericardium.

4. Blunting of the costo-diaphragmatic margin:

   This may indicate

   - **Small hemothorax.**

   - **Diaphragmatic rupture.**

FAST Ultrasound

It may be difficult to detect small amounts of blood (< 250mls) on the plain chest radiograph.

ED ultrasound examination can detect smaller hemothoraces, although in the presence of a *pneumothorax* or *subcutaneous air* ultrasound may be difficult or inaccurate.

When examining the right and left upper quadrants, the examiner can usually view above the diaphragms to identify any fluid collections.

The significance of small hemothoraces that are not visible on plain films is not entirely clear.

CT scan with IV contrast:

CT scan will delineate injuries far more clearly than plain CXR.

It is especially useful to more fully assess thoracic injury in patients who cannot sit upright for an optimal erect CXR.

CT is better able to detect:

- Hemothorax, (it is especially useful in this regard in patients who are unable to sit erect for a CXR).

- Pneumothorax (again problematic on supine CXRs).

- Mediastinal injuries.
- Pulmonary contusions.
- Bone fractures: rib, sternal and spinal
- Diaphragm injuries.

CT may also be useful in differentiating hemothorax from other thoracic pathology such as pulmonary contusion or aspiration.

See also Appendix 1 below.

Echocardiography:

When available, this is the investigation of choice, if cardiac tamponade is suspected.

Management

1. ABC:
    - As in any multi-trauma, access and manage ABC.
    - Give supplemental oxygen, as clinically indicated.
    - **Establish IV access in all cases.**
    - Commence IV fluid resuscitation immediately as required.
    - Commence blood product resuscitation as required:

      For shocked patients with massive hemothorax, activate local "massive transfusion protocol" and commence O negative or type specific blood as necessary.
2. Establish monitoring:
    - ECG.
    - Pulse oximetry.
    - Non-invasive blood pressure.
3. Analgesia:
    - Titrate IV opioid to clinical effect.
4. Antibiotics:

- These should be given if the wound is grossly contaminated and/ or if the wound has entered the pleural cavity.

5. Intercostal catheter:

   - Acute hemothorax of significant degree should be treated with a larger bore intercostal catheter, (**28F-32F)**.

   - Evacuating blood reduces the risk of clotted hemothorax that may compromise respiration.

     It also allows for the initial quantification of blood loss and the monitoring of any ongoing bleeding.

   - Ensure that the patient has **received adequate fluid resuscitation**, *before* attempting to drain a hemothorax.

   - Apply **20 cm of suction** to facilitate drainage of blood.

   - An intercostal catheter will also allow for the monitoring of *ongoing* blood loss.

   Clamping the intercostal catheter:

   There is a school of thought that clamping closed the intercostal catheter in an attempt to tamponade bleeding in an unstable intubated and ventilated patient with massive and ongoing hemothorax will buy time if there are delays to thoracotomy. It should be noted however that this manoeuvre is not of any proven benefit and is yet to be validated in a controlled trial. [2]

6. Tetanus immunoprophylaxis, as clinically indicated.

7. Surgery:

   In the majority of cases bleeding from intercostal vessels, internal mammary vessels or lung parenchyma will be self-limiting, and operative intervention will often not be required.

   Indications for **thoracotomy** in cases of hemothorax include:

   - **1500 mls of blood drained (a class III hemorrhage or "massive hemothorax) immediately on chest tube insertion.**

   - **Ongoing drainage of > 200 mls per hour for more than 2 - 4 hours, (this is probably a more important factor than the initial amount that is drained)**

- **Ongoing hemodynamic instability, despite fluid - blood resuscitation.**

8. Video-assisted thoracoscopic surgery (VATS):

VATS can be useful for both primary diagnosis and therapy.

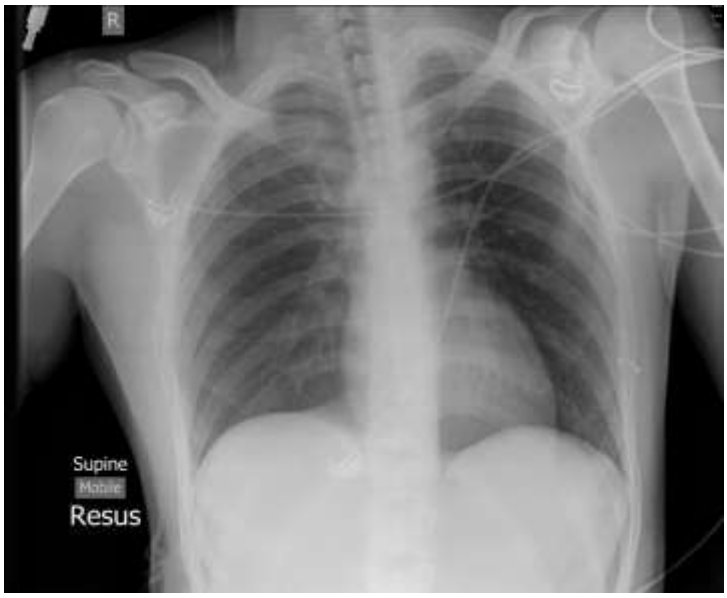
- VATS (as opposed to a second chest tube) should be strongly considered for evacuation of **retained** hemothorax when CT scan identifies 500 mL of blood.

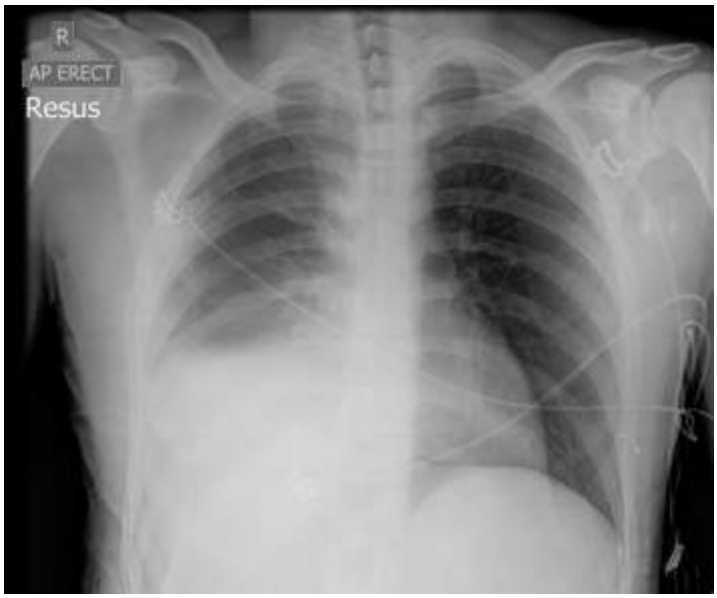
  VATS should ideally be performed within the first week after injury. Plain radiographs are insufficient to diagnose retained hemothorax, CT is the gold standard.

- It is effective in treating *persistent* post-traumatic pneumothorax.

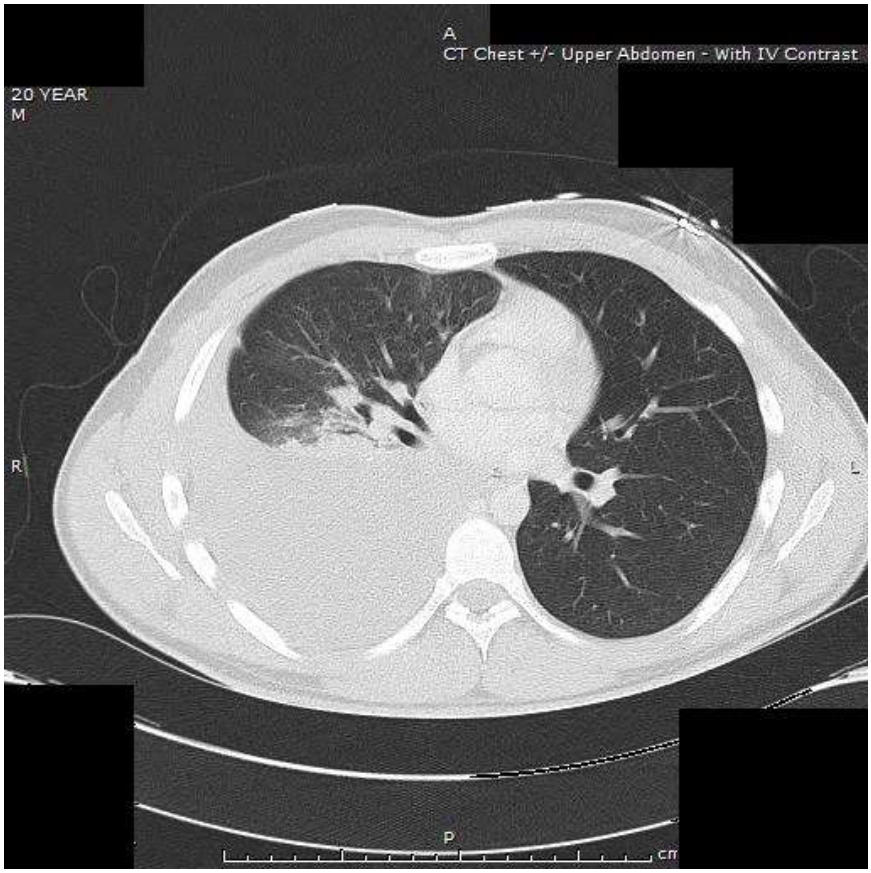
- It can be used for evacuation of late complicating empyemas.

Appendix 1



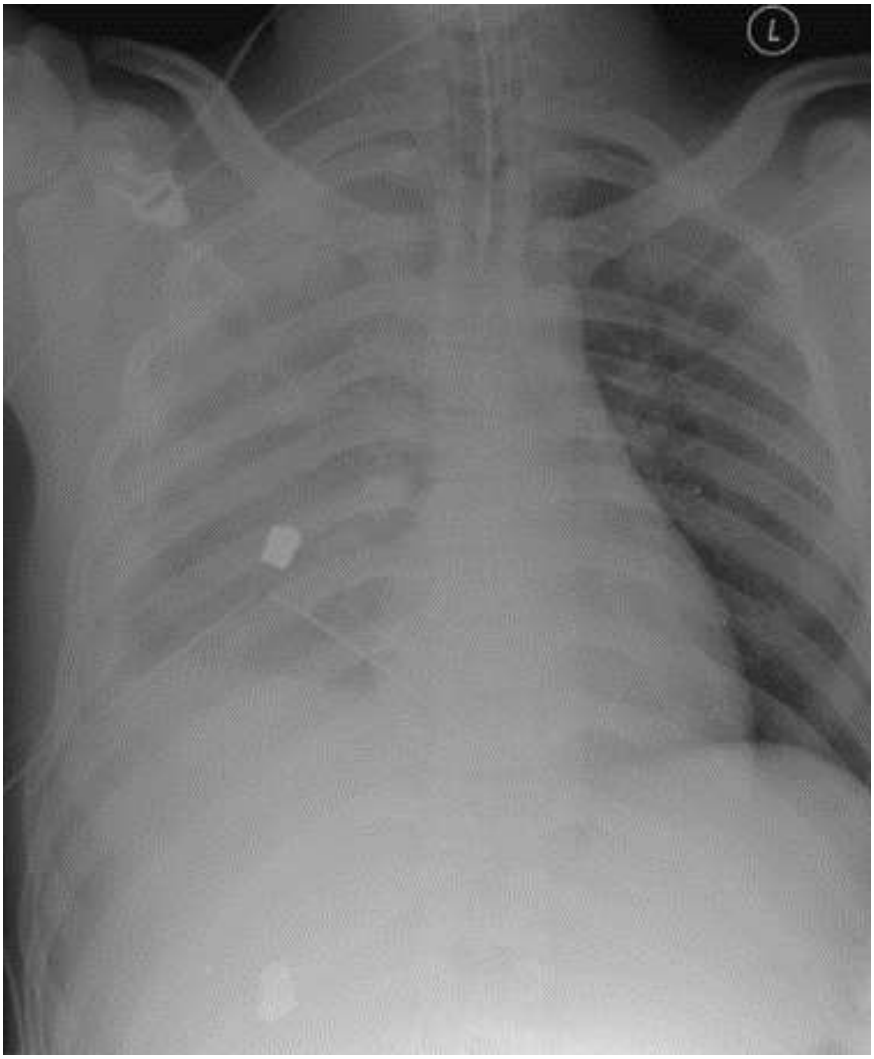


Supine CXR of a 20 year old male who had sustained multiple stab wounds to the right side of the chest. Radiologist report stated that the right hemithorax was "hazy" in comparison to the left hemithorax in keeping with a hemothorax. This is very subtle however, (and one suspects a degree of "retrospectoscopy" may have been applied!). The CXR on the right is erect and clearly shows a moderate right sided hemothorax.



CT scan with IV contrast of the chest of the patient above. The CT scan very clearly demonstrates a large right sided hemothorax.

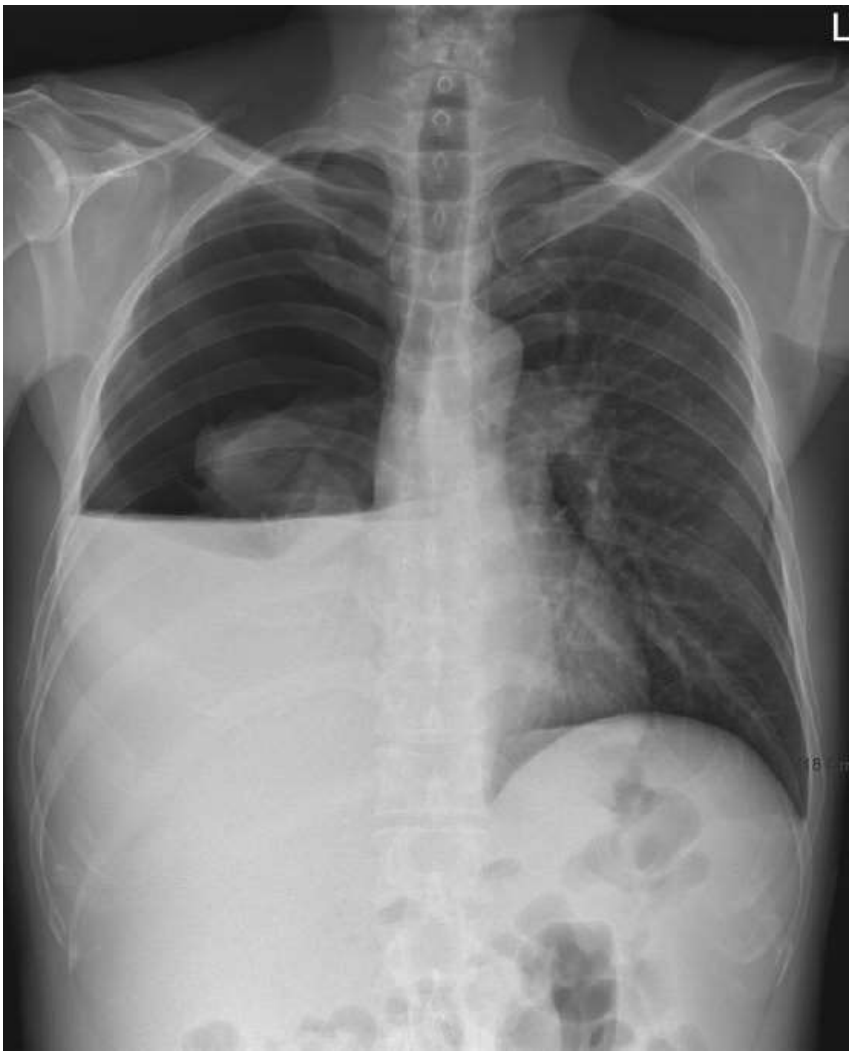
Appendix 2



A much clearer indication of significant right sided hemothorax in a supine CXR. Note the general haziness of the right hemothorax compared to the left. (Another possibility can sometimes be a normal hemithorax with a pneumothorax on the opposite side!)

Appendix 3

Hemo-pneumothorax:



This CXR shows a patient with a right sided hemo-pneumothorax. In these situations the pleural fluid will have a sharply demarcated flat horizontal upper level, as opposed to the typical curved meniscus when there is no pneumothorax.

References

1. Haemothorax in Trauma.org Website, Accessed June 2015.

    - www.trauma.org/

2. Fitzgerald M, Gocentas R, Stevens J. Chest Trauma in Cameron et al, Textbook of Adult Emergency Medicine 4th ed 2015.

3. Joseph A.P, Harris R, Dimmick S, Radiology in Major Trauma in Cameron et al, Textbook of Adult Emergency Medicine 4th ed 2015.

4. ATLS 10th ed. 2017.

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