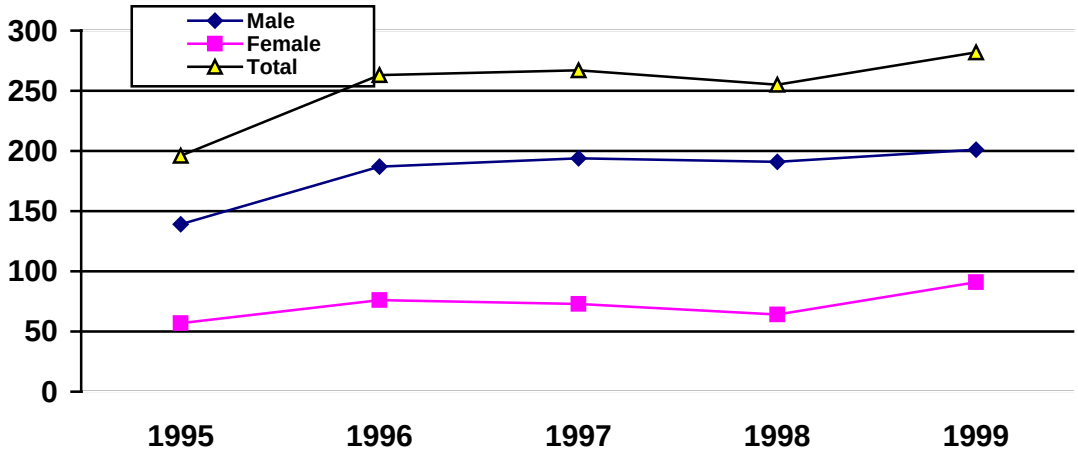
CHEST INJURY

1273 patients were admitted to Liverpool Hospital during 1995-1999 with the diagnosis of chest injury. 912 (71.6%) of these patients were male, and 361 (28.4%) were female. The average age was 41 years, however they ranged from one up to 99 years.

The graph below represents the number of patients admitted to Liverpool hospital with a chest injury. The graph is broken down into male and female patients, and the years that they were admitted. The number of men injured more than double the women. There is also a small upward trend in the number of patients with a chest injury that have been admitted to Liverpool Hospital over the recent years.

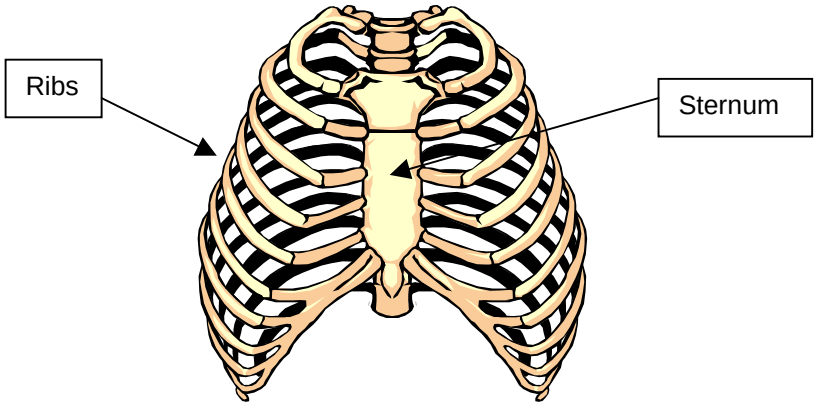


What is a chest injury?

A chest injury is any injury to the chest wall or any of the organs inside the chest. It can arise from blunt trauma (e.g. car crash, fall) or penetrating trauma (e.g. gunshot or stabbing). The chest, or thorax, contains many important organs and, despite the protective rib cage, chest injuries can be some of the most serious and life threatening in trauma. In this booklet chest injury is divided into sections, with information on the parts and organs of the chest, how they work and what happens if they are injured. Although each part is dealt with separately, organs are rarely damaged individually. Combinations of injuries are common and the patient must be treated as a whole.

THE BONES OF THE CHEST

These are the ribs, the sternum (breast-bone), the clavicle (collar-bone) and the scapula (shoulder-blade). The spinal column in the chest region is also part of the bones of the chest and is covered in the spinal booklet. The bones and muscles between the ribs make up the chest wall, which protects the vital organs in the chest and upper abdomen.



RIBS

The ribs provide the skeletal framework of the chest wall. Ribs can be broken in more than one place, and more than one rib may be broken depending on the force involved. Even a single broken rib can be very painful and cause difficulty in breathing, especially for the elderly. In severe cases three or more neighbouring ribs are broken in two places, and a whole section of the chest wall is only attached by the muscles that are above and below it. The section is called a **flail segment** and can move independently of the rest of the chest wall, reducing breathing capacity. This is also a dangerous injury because the lung underneath the ribs will be heavily bruised.
The top two pairs of ribs are protected by the collar-bone and shoulder and are hardest to break. If they are broken it is a sign that the patient is likely to have severe injuries inside the chest, even if these are not immediately apparent.
Children rarely break ribs as the ribs are still growing and remain springy, however the lung underneath can be bruised without a rib fracturing. The elderly are more likely to break ribs in an accident as their bones are more brittle.

Causes of injury - Ribs can be broken by blunt trauma. This includes motor vehicle crashes, falls, assault with boot or baseball bat and sporting injuries. The most common cause seen at Liverpool is motor vehicle crashes.

Diagnosis - This is made by clinical assessment and chest x-ray. Not all fractured ribs will show up on chest x-ray but this is not important. Bruised ribs are just as painful as broken ones and the treatment is the same. The important issue is to make sure that breathing is adequate and that there are no further injuries.

Treatment - this is pain relief, physiotherapy and assistance with breathing if necessary. The ribs will heal well without any other treatment as they are held in place by strong muscles. Treatment of other injuries, especially of the lung, is more important. At Liverpool patients are often admitted to Intensive Care for a short period to ensure the pain is controlled and physiotherapy started. These measures are all taken to try to prevent pneumonia, which is a risk when deep breaths can not be taken, especially in smokers. Patients with flail

segments will all need time on the Intensive Care Unit and often need help from a machine to breathe. The machine is called a ventilator, and is used because of the extensive bruising to the lung found under a flail segment.

Outcome - for simple rib fractures, once the patient has adequate pain relief from tablets and can breath deeply, cough and move around they can be discharged home. Young patients with a single rib fracture may not even require admission to the hospital. Patients who have considerable pain or a more complicated injury may require admission to hospital for several days. A patient, who has broken ribs as a result of a preventable fall, may need to stay longer to ensure that resources have been put in place to reduce the risk of a repeat fall.

Sternum

Also known as the breast-bone, the sternum joins the two sets of ribs at the front. It is a flat bone, about 15cm in length. The first to seventh ribs join onto to it directly, and the eighth to tenth ribs indirectly. Place your finger on your chin and move it straight down over your throat to the top of your chest. Alternatively slide your finger along your collar-bone to your middle. There is a dip in the bone called the suprasternal notch. This is the top of the sternum. Put your fingers under your ribs on both sides and bring your fingers up to the middle where they meet. This is the bottom of the sternum.

Causes of injury - Once again, the motor vehicle crash is a common cause when it comes to chest injury. In the case of sternal injury, it is usually a blow to the middle of the chest that creates the injury. Other causes are consistent with that of fractured ribs (above).

Diagnosis – Sternal fractures are not visible on a chest x-ray. If the doctor suspects a fracture after examination a separate x-ray of the sternum can be taken. Like rib fractures, a break indicates that significant force was present at the time of injury and underlying organs may be damaged. The heart may be bruised (major injury to the heart is usually immediately fatal). To rule this out an ECG and blood tests will be needed.

Treatment - pain relief and physiotherapy. If there is a heart injury, the patient will be monitored for changes in the heart's electrical activity. Like rib fractures pneumonia is a risk as a sternal fracture breaks taking deep breaths painful.

Outcome – this is usually good. Once the patient has their pain controlled by tablets and is mobile and able to cope at home, they can be discharged, usually within a week. Once over the initial period a full recovery is likely.

Clavicle (collar-bone)

The collar-bones can be felt on either side at the top of the chest. One end attaches to the sternum and the other joins the shoulder. The clavicle helps stabilise the shoulder and support the arm. Rarely the clavicle may not break but become dislocated at either end.

Causes of injury - Clavicle fractures are common especially in childhood, when the cause is usually a fall. Other forms of blunt trauma can break the collar-bone especially when the force is exerted from the side.

Diagnosis – this can often be made clinically as the collar-bone lies just under the skin and can be felt easily in most people. An x-ray will confirm the fracture.

Treatment – treatment is almost always a sling to support the arm whilst the break heals. In a very few fractures an operation may be needed to put the pieces back together but this is very rare.

Outcome - the clavicle heals extremely well and patients are usually back to normal activity within 4-6 weeks, faster in children. A small bump may be seen and felt at the fracture site where the bone has mended. In children this may gradually disappear as they grow.

Scapula (shoulder blade)

These bones form the shoulder joints and help move and support the arm. As a result they are mainly covered and protected by muscles and not often injured. The scapula joins the collar-bone at the shoulder, and can be felt on the outside and back of the shoulder. It extends a little way down the back as a triangular shape, and can be easily seen in thin people if they raise and lower their arms.

Causes of injury - A break in a scapula indicates significant and direct blunt force and possible underlying injuries. Blunt trauma from the back or side is most likely to cause a fracture.

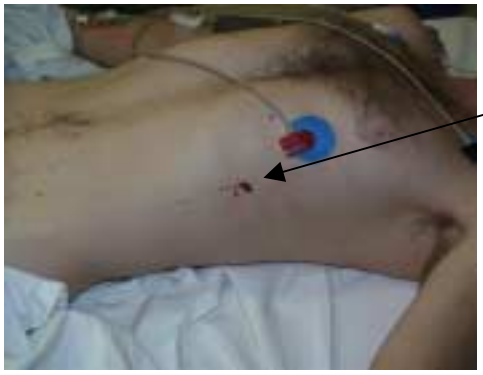
Diagnosis - this is made on examination by feeling the bone and testing movement of the shoulder. Sometimes a fracture can be seen on the chest x-ray but separate x-rays are needed to confirm the diagnosis.

Treatment - pain relief, physiotherapy and a sling are almost always all that is required, other than treating any other injuries.

Outcome - most fractures heal well, and though the shoulder may be sore and stiff for a several weeks a full recovery can be expected.

LUNG INJURY

The two lungs take up most of the chest cavity. The upper limit is above the clavicles and the lower the diaphragm. This is about the nipple line at the front and half way down the back but this rises and falls with breathing. Linings called the pleura cover the lungs and the inside of the chest wall. The pleura allow the lungs and chest wall to slide easily over each other during breathing as the lungs inflate and deflate. If the pleura become inflamed as a result of infection or injury, breathing becomes painful – hence pleurisy. There is normally no space between the pleura, however following injury one may be formed, and is called the pleural cavity.
The heart lies between the lungs along with the aorta, other major blood vessels, the trachea and the oesophagus or gullet. This area between the lungs is called the mediastinum.
The lungs' function is gas exchange – the body uses oxygen and produces carbon dioxide as waste. Blood carries the carbon dioxide to the lungs where it is exhaled and more oxygen taken on. The trachea carries air from the throat to the chest where it splits into two – a bronchus for each lung. Each bronchus divides and subdivides many times until a tiny bubble-like structure called an alveolus is reached. Here the gas exchange takes place and each lung has millions of alveoli, which give the lung a spongy texture.



This may look like a small wound that won't amount to any serious injury. However, in most knife wounds, we do not know how long the knife was, or how far the knife went through the skin. This injury may result in significant and life threatening injuries to both the chest and the abdomen.

Causes of injury – The lungs are vulnerable to blunt and penetrating trauma. The latter will cause damage along the path of the knife or bullet and may cause the lung to collapse. Blunt trauma creates direct damage by bruising, or indirect as shock waves are created which make the lung collapse.

Pneumothorax (*new-mow-thor-ax*) **–** this is a partial or complete collapse of the lung. Air escapes from the lung and collects between the pleura, creating a space. This is usually the result of trauma but very rarely can happen out of the blue. The collapsed part of the lung is unable to help with breathing so large or complete pneumothoraces are serious injuries.

Simple Pneumothorax - air escapes from the lung but there is little or no further leak as the injury site seals itself. Simple pneumothoraces may grow slowly and will affect breathing if large enough.

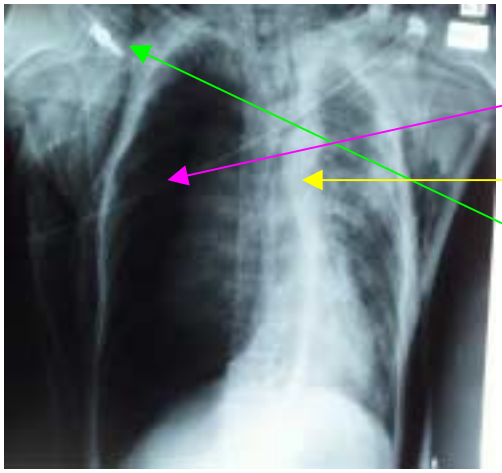
Tension Pneumothorax – the damaged area allows air to escape from the lung and fails to seal but acts as a valve. With each breath, more air escapes between the pleura but cannot get back into the lungs or go anywhere else so the pneumothorax grows. As it grows it pushes on the lungs, heart and major blood vessels. This affects breathing and blood circulation and without immediate treatment will kill the patient.

Open Pneumothorax – penetrating trauma leaves a hole in the side of the chest. If the hole is large enough, with each breath air will enter the chest through the hole as well as through the trachea. This air will not leave on breathing out and will grow making the lung on that side collapse. Since air is heard being sucked into the chest this is also known as a sucking chest wound.

Haemothorax (*hee-mow-thor-ax*) **–** this is a collection of blood in the pleural cavity. The bleeding may be from the chest wall or the lungs. To be seen at chest x-ray least 200 ml of blood must be present. If there is heavy bleeding and more than 1500 ml accumulates it becomes a massive haemothorax. This is a very serious injury as there is plenty of room to bleed to death within the chest.
Both air and blood may accumulate in the pleural cavity – this is called a haemo-pneumo-thorax.

Diagnosis – these conditions are diagnosed on examination and by chest x-ray. The doctor looks for rapid, shallow, painful breathing, a change in the patients colour, pulse or blood pressure as well as wounds or bruises. The doctor will then feel the chest for tenderness, broken ribs and air under the skin. This is called subcutaneous emphysema. Finally the doctor listens to the chest with a stethoscope checking that air is moving in and out normally.

Treatment – all trauma patients should receive oxygen via a mask. The size and the condition of the patient will determine the treatment of a simple pneumothorax. All but the smallest ones, which are causing minimal symptoms, will need the insertion of a chest drain (see below). The patient will also receive pain relief, antibiotics and physiotherapy.
A tension pneumothorax is a life-threatening diagnosis. The doctor will insert a needle into the pleural space at the top of the chest. This will allow the air there to escape and the lung to re-expand. This brings only temporary relief so the medical team will then put a chest drain in.
Treatment for the open pneumothorax is also a chest drain. Prior to this, a dressing called a chest seal is used over the wound. This acts as a valve and will allow air out of the chest but not in. A specialised seal is used or an air tight dressing taped down on three sides with the fourth left free.
A haemothorax also needs a chest drain as blood in the chest cavity will squash the lung making breathing difficult. If the blood is left it may also become infected and cause other problems later. A massive haemothorax is life-threatening and requires an immediate operation on the chest to stop the bleeding – this is called a thoracotomy.



This is an x-ray of a tension pneumothorax. Look at the side on your left. It is black. This area is a massive tension pneumothorax. It has pushed the mediastinum over to the other side.
There is a small needle in the upper chest - this is a needle thoracentesis.

Chest Drain – Also known as an intercostal drain/catheter. This is a tube placed into the pleural cavity through the chest wall between the ribs, and connected to a plastic bottle. The tube drains air and blood from the chest - either freely or under suction - so that the lung can re-expand to its proper size. To put the drain in, a doctor will use local anaesthetic before making a small cut (3-4 cm) in the side of the chest below the armpit. This will leave a small scar. The drain is left in place until the air and blood has been removed and the lung expanded again. Whilst the chest drain is in place the patient receives oxygen, pain relief and physiotherapy.

This is one of the types of chest drains available. The chamber on the left side is what collects the blood and air from the pleural space (in this case haemothorax), and the chambers on the right side apply the suction.

Outcome - The patient with only a simple pneumothorax or small haemothorax generally does well. The chest drain will be in place for two to three days, with discharge home following soon after removal. The other conditions discussed in this section are usually accompanied by other serious injuries, which will limit the speed of recovery.

Lung contusion

A pneumothorax or haemothorax are not direct lung injuries – they are injuries that have made the lung to collapse or become compressed. A lung contusion is different - it is a bruise to the lung tissue itself. Bruised lung tissue does not function normally reducing the patient's ability to exchange oxygen and carbon dioxide. Added to this, a bruised lung means a bruised chest wall, which will make breathing painful and difficult.

Causes of injury - blunt trauma exerts force to the chest wall, which is transmitted through to the lung causing the contusion. This can be the result

of the chest hitting the steering wheel in a car crash or a kick to the chest during an assault. There may be rib fractures over the contusion but this is not always so, especially in children whose bones are more flexible. Similarly rib fractures do not always have lung contusions under them. Flail segments (see rib injuries) are whole sections of the chest wall that have been driven into the lung, and always have bad lung contusions associated with them.

Diagnosis - Lung contusion may not be readily apparent on presentation to hospital. Like other bruises they take time to develop. The patient usually has other injuries besides the bruised lung, and is treated for those other injuries as the lung contusion develops. The diagnosis is made on a chest x-ray or CT scan, either at admission or a day later but may be suspected from other tests.

Treatment - The size of the bruise and previous health determines the symptoms of the patient. Even small contusions will have a stay in hospital with intensive physiotherapy and pain management. Patients with severe lung contusions will need treatment on the Intensive Care Unit, and will often have to have their breathing taken over by a machine whilst the lung and chest wall recover. The elderly and those with long-term lung disease may need this treatment with small contusions.

Outcome – This is strongly related to the degree of injury and the patient's other injuries and previous health. Young, fit patients that have small lung contusions usually have a good outcome. Those who are older, less fit, or have a more significant injury have a much longer stay with the potential for greater complications, such as pneumonia.

MEDIASTINAL INJURY

The area between the lungs is called the mediastinum. The mediastinum contains many important structures, such as the heart, the oesophagus (food pipe), the trachea (windpipe), nerves and parts of the biggest blood vessels in the body.

The coloured areas are the structures within the mediastinum.

1,2,3 – Inferior and superior vena cavae (veins)
4,5 - Right and left ventricles of the heart
6 - Aorta
7 - Pulmonary blood vessels (supply the lungs)

Cardiac Injury

Cardiac refers to the heart. The heart has been likened to a pendulum of a clock – it is suspended within the mediastinum, by the major blood vessels. These vessels bring blood from the body to the heart, which pumps it to the lungs, where oxygen and carbon dioxide are exchanged. From the lungs blood returns to the heart which send it round the body again. As a result injuries to the heart are very serious.

Pericardial tamponade – the pericardium is a sac surrounding the heart, which moves with the heart to make reduce friction with the other chest contents. If the heart is injured blood can collect in the pericardium, which is not elastic. As the amount of blood increases, it restricts the heart from beating to its full potential. This is cardiac tamponade and it may become so tight that it restricts the heart from beating effectively altogether.

Common Causes - The most common mechanism creating pericardial tamponade is penetrating trauma. Knives, bullets, and other sharp instruments are usually responsible for the bleeding that leads to the tamponade. It is rare for tamponade to result from a blunt mechanism of injury.

Diagnosis - this is made from the patient's signs and symptoms. The heart's ability to pump blood is increasingly restricted. This leads to a faster pulse and a lower blood pressure. The patient becomes short of breath and confused. The neck veins stand out and the heart sounds muffled when the doctor listens to the chest.

Treatment - this injury is life threatening and requires immediate intervention to save the patient by removing the blood from inside the sac. Initially a large needle can be put into the pericardium, and the blood removed with a syringe. An operation on the heart is required in all cases to stop the bleeding and repair any other damage.

Outcome – this depends on the patient's previous state of health, the exact damage to the heart and how quickly they arrived at hospital and were treated. Some patients may make a full recovery. Others will only make a partial one or die.

Myocardial Contusion – this is a bruise to the heart from blunt trauma. The most common cause is the steering wheel hitting the chest in a car crash and the force being transmitted through the breast bone to the heart. The diagnosis is made on an ECG. The contusion affects the heart's capacity to pump blood and treatment and outcome depend on the size of the bruise. A small contusion requires no treatment and will make a full recovery. Large contusions may require drugs to improve the efficiency of the heart, and the cardiac muscle may be permanently damaged. This is similar in effect to a heart attack and may restrict the future activity of the patient.

Aortic Injury

The aorta is the major blood vessel of the body. It comes off the top of the heart and turns backwards and down in the chest moving towards the abdomen. As it travels the major arteries split off taking blood to the arms, head and other major body sections. The aorta may be punctured by penetrating injury or torn by blunt injury, especially mechanisms where the body has been subjected to extreme acceleration or deceleration (high speed car crashes, falls from height). Most such injuries cause catastrophic bleeding and immediate death. In a few cases the other organs in the chest will contain the bleeding, at least temporarily. The diagnosis is made on chest x-ray, CT and aortogram. Treatment is an immediate operation to repair the damage before the bleeding restarts with fatal effects.

DIAPHRAGM

The diaphragm separates the thorax (chest) from the abdomen. It is shaped like a dome, and is a thin sheet of muscle. Besides separating the chest from the abdomen, the diaphragm also is the most important muscle of breathing. The diaphragm can move 10cm during a breath. It contracts and flattens out during inspiration, thereby providing a larger volume for the air to rush in to the lungs.

Injury to the Diaphragm

Common Causes - The diaphragm can be injured by blunt and penetrating trauma. Any part of the diaphragm may be damaged, but the left side is more commonly injured because the liver protects the diaphragm on the right side. Most tears in the diaphragm are about 5 – 10 cm in length, but large tears are more common in blunt trauma.

Following an injury, the ability to keep the contents of chest and abdomen separate decreases. Even with small tears, the abdominal contents (usually the bowel) may protrude into the chest cavity creating a hernia. This is rare, but dangerous if the blood supply to the hernia is cut off or breathing is compromised.

Diagnosis - Diaphragmatic injury may be difficult to diagnose unless suspected clinically. Chest x-ray is unlikely to show anything unless there is a hernia. A CT scan may pick up a tear, especially if it is large. Diagnosis may also be made at operation by looking at the diaphragm, either directly by opening the abdomen (laparotomy) or via key-hole surgery using a telescope (laparoscopy).

Treatment - Tears in the diaphragm require an operation in which the abdomen or chest is opened and the hole closed. If the tear has allowed the abdominal contents to move into the chest, the operation may be needed urgently.

Outcome - There are usually no long-term problems associated with injury to the diaphragm once it is repaired. If a tear is not suspected and missed, a hernia may occur several years after the injury.

TESTS PERFORMED ON PATIENTS WITH CHEST TRAUMA

Electrocardiograph(ECG) - This is common test, used in many doctor's surgeries. The investigation studies the electrical conduction system of the heart, and may indicate abnormalities in heart rhythm or activity that may be caused by an injury. It is a quick, non-painful procedure and involves the application of sticky electrodes to specific areas of the body, which are connected to the leads of the machine. Once this is done the patient is asked to lie very still for a few second so that the reading can be taken.

This is one of our ICU doctors reviewing an ECG.

Echocardiography – Echo is a specialist form of ultrasound, which is the investigation used in pregnant women to look at the baby. Echo produces a picture of the heart as it contracts, and assesses the effectiveness of the contractions and the function of the heart muscle and valves. It is particularly useful in examining the heart structure and can establish if there is blood around the heart that may result in pericardial tamponade.

This is a photo of a specialist doing an Echo. The probe is placed over the patient's heart.

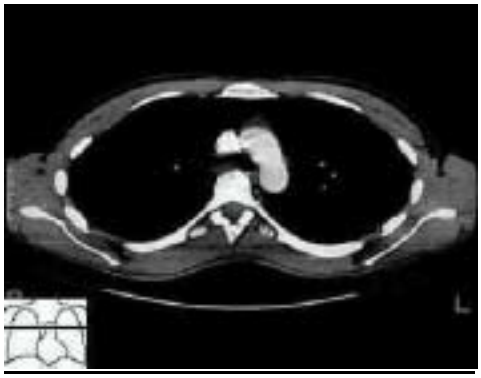
Aortogram – this investigation produces an image of the aorta to see if there are any leaks following trauma. The doctor puts a needle into the artery at the groin. A tube is fed backwards up the artery and then the aorta whilst x-rays are taken to ensure correct positioning. At the point where the aorta leaves

the heart dye is injected and x-rays taken. As the dye moves through the aorta, it shows up on the x-rays and shows if there are any leaks.

This is a picture from an angiogram. The big arch is the aorta.

Computerised Tomography (CT scan) – This test is especially good at identifying injuries solid abdominal organs such as the liver or spleen. The computer uses x-rays to produce cross-sections or slices of the body. However, the chest x-ray provides us with so much information, that most of the time a chest CT scan is not that useful, and does not greatly change our management of the patient. A CT can be helpful in diagnosing major vessel injury, or extensive lung injury that may not have shown up as clearly on the chest x-ray.

This is a photo of one of the CT scanners at Liverpool Hospital.
The patient is put on the table and it moves in and out depending on what needs to be scanned. Any part of the body can be scanned.



This is a CT scan of the chest.

Chest x-ray - x-rays of the chest, pelvis and neck are standard in all trauma patients. The chest x-ray is particularly useful as it can show bony injury, lung

injury and great vessel injuries as well as if there is a breach in the diaphragm.

COMMON QUESTIONS

What is a thoracotomy?

A thoracotomy is an operation on the chest. It involves opening the chest to expose, inspect and repair the organs inside. These operations are mostly performed in the operating theatre, but in extreme emergencies, are done in the Emergency Department.

What does intubated and ventilated mean?

If breathing is difficult due to pain or physical injury, a patient may be intubated and ventilated. Intubation is the process of putting the patient to sleep and putting a tube past their throat into their windpipe (trachea), securing passage to the lungs. Since the patient is often paralysed to stop choking as this is done, their breathing must be done for them as well. This is ventilation. Once the lungs or the chest wall injury have improved the tube and ventilator can be removed, and the patient can begin to breathe normally again.

What does “fractured” mean?

Fractured is another word for broken. If you have broken ribs, then they are fractured.

What is “shock”?

Shock is not being frightened by an event and is not treated with a cup of tea or counselling. Shock is a failure to deliver sufficient oxygen to the cells in the body’s tissues and organs. There are many different causes of shock. The most common one in trauma is due to loss of blood and is called hypovolaemic shock. When a patient bleeds it may be internal or external. External bleeding is obvious and can be seen on the floor or the patient. Internal bleeding may be in the chest, the abdomen, the pelvis, or the long bones of the arm or leg. The treatment of shock is to locate the source of bleeding and control it with pressure, splinting or operation. The blood loss is then replaced initially by sterile fluids and then donated blood.

If the seat belt causes injuries, is it better not to wear it?

Definitely NOT! In Australia, we are required by law to wear seatbelts in the front and the back. Regardless of this, there are several important reasons why we should wear seatbelts. The seatbelt acts as a restraint in the event of a crash. If a person is not restrained in a crash, especially at speed, they are likely to be thrown about inside the car. As a result they will sustain increased injuries and may collide with other occupants also injuring them. Unrestrained car occupants may also be ejected from the vehicle through the windscreen or windows and receive further injuries on striking the ground. Ejection from a vehicle carries a very high risk of death or very serious injury. Seatbelts do cause some injuries but prevent many more and worse ones. If worn correctly seat belts are safe. The correct position for a seat belt is across the chest and lap, not across the lower neck and abdomen. This is especially important for children.

BETTER PRACTICE GUIDELINES

Better Practice Guidelines are available on a number of health related issues. These guidelines are compiled with the assistance of expert advice and research on the topics under scrutiny.

There is a collection of practice guidelines from various international sources of chest injury. One such guideline is from Eastern Association for the Surgery of Trauma (EAST) in the USA and refers to the investigation of the aorta.

FACILITIES AT LIVERPOOL HOSPITAL

Intensive Care

The Intensive Care Unit consists of 22 beds. Seriously ill patients receive one-to-one nursing. Specialist doctors with expertise in caring for ill patients with complex needs provide the medical care. Patients who have suffered major abdominal trauma may be admitted to this unit for further treatment and monitoring before or after operation.

Ward

The Trauma, Orthopaedics and Plastics ward where most of the patients with abdominal injuries are admitted is on the third floor of the clinical building. The ward has 40 beds, with a staff ratio of one nurse to five patients. The phone number for the ward is (02) 98283103.

Social Worker

Liverpool Hospital has social worker facilities provided throughout the duration of hospital stay. A social worker is alerted to the arrival of a trauma patient in the Emergency Department, and will provide any necessary assistance.

For the rest of the hospital stay, social work cover and help is available in Intensive Care, the ward and the Brain Injury Unit. Social workers will also assist in the completion of Workcover and sick entitlement forms.

OTHER INFORMATION

Health at Yahoo

Health at Yahoo provides a dictionary of medical terms with easy to understand answers.
www.health.yahoo.com