

## ABC of emergency radiology

### Major trauma

Otto Chan, Alistair Wilson, Michael Walsh

Advanced trauma life support is the standard method for the initial management of severely injured patients. The principle is simple—treat the greatest threat to life first. Loss of airway will kill before inability to breathe, and inability to breathe will kill before bleeding and loss of circulation. A definitive diagnosis is not necessary to treat the patient initially. The most important point to remember is that no harm should be done to the patient during treatment. The management of severely injured patients is divided into the primary and secondary survey. This article deals with the imaging during the primary survey.

### Primary survey

The primary survey comprises a rapid evaluation of the patient, resuscitation, and institution of life preserving treatment. This process is called the ABCDE of trauma. Adjuncts to the primary survey include relevant imaging during resuscitation and re-evaluation.

In practice, most of the steps of the ABCDE are carried out simultaneously by a trauma team. Anaesthetists will usually deal with the airway and intravenous access while the surgeon evaluates the chest, abdomen, and pelvis for potential life threatening injuries.

Imaging is requested as part of the primary survey while the patient is assessed, life threatening injuries are dealt with, and resuscitation procedures instituted. Imaging should not be performed if it interferes with the rest of the primary survey or definitive care, and only investigations that may have a direct effect on the patient's initial problems should be done.

Examples of imaging done as part of the primary survey include radiographs of the supine anteroposterior chest, supine pelvis, and lateral cervical spine (although this can be delayed if necessary); and limited ultrasonography (also known as FAST, focused assessment with sonography for trauma)

#### Airways and cervical spine control

The airway should be assessed for patency. Foreign bodies and vomit should be removed and facial, mandibular, tracheal, and laryngeal injuries should be excluded clinically.

If the patient is conscious and talking, there is usually no immediate need for airway intervention. If the patient is unconscious and breathing spontaneously, an oropharyngeal airway may suffice as a temporary measure. Any patient who has a head injury and a score on the Glasgow coma scale of 8 or less should be intubated. However, intubation may be required for optimal control of airways in patients with higher scores.

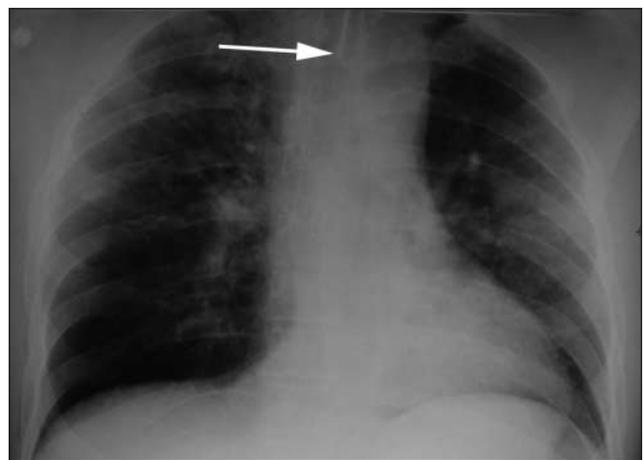
If the patient has been intubated, a chest radiograph should be taken to check the position of the endotracheal tube. The tip of the tube should not lie below the level of the aortic arch in a supine chest radiograph and a minimum of 3.5 cm (and preferably 5 cm) above the carina.

Care should be taken to avoid worsening a potential cervical spine injury while establishing and safeguarding an airway. If the airway has been secured and the neck immobilised the cervical spine radiograph can be delayed. The cervical spine should be immobilised with a cervical collar, sandbag, and tape. Should the collar need to be removed, an experienced member

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#### ABCDE of trauma

- Airway and cervical spine control
- Breathing and ventilation
- Circulation and haemorrhage control
- Disability and neurological status
- Exposure and environment



Supine radiograph showing endotracheal tube 5 cm above carina (arrow)



Radiograph of supine pelvis may be requested for the primary survey. This radiograph shows no abnormality

of the trauma team should carry out in-line manual immobilisation of the head and neck.

### Breathing and ventilation

A patent airway does not guarantee adequate ventilation. The lungs, chest wall, and diaphragm must be assessed for potential injuries that could compromise ventilation acutely. These injuries include tension pneumothorax, tension haemothorax, flail chest, and open pneumothorax. It can be difficult to exclude these injuries in a patient with multiple trauma. A chest radiograph must be taken as soon as possible. If the patient is subsequently intubated or ventilated, a second radiograph should be taken to confirm that the endotracheal tube is in a satisfactory position and that life threatening injuries have not been made worse. Ventilation can cause a simple pneumothorax to become a tension pneumothorax.

### Circulation and haemorrhage control

The patient's haemodynamic state must be assessed quickly and accurately because bleeding is a major cause of preventable death. Clinical evaluation is essential, in particular, the level of consciousness, skin colour, and pulse. Any external source of bleeding should be identified and dealt with immediately using manual pressure. When the examination or history suggests internal injury, a pelvic radiograph should be taken and limited ultrasonography (FAST) done to exclude hidden blood loss.

FAST can be performed by a physician, surgeon, or radiologist and has been shown to be valuable in the assessment of blunt trauma patients in the emergency room, especially in unstable patients with multiple injuries. Ultrasonography should be performed in five areas. These areas are the 5 Ps—perihepatic, perisplenic, and pelvis in the abdomen, and pericardial (to exclude a pericardial tamponade) and pleural (to detect fluid or a pneumothorax or consolidated lung) in the chest. The presence of a pelvic fracture or free fluid on ultrasonography mandates a specialist opinion.

### Disability (neurological examination)

The patient's neurological state is assessed with the Glasgow coma scale. It is easy and quick to use and is a determinant of patient outcome and possible further management.

All patients with a head injury should have computed tomography of the head, especially if they have lost consciousness, have amnesia, or severe headaches. Up to 18% of patients with mild head injuries (Glasgow coma scale 14-15) have abnormalities on computed tomography, and 5% of these patients may require surgery.



Opaque left haemothorax with evidence of contralateral shift of the mediastinum

### Main causes of hidden blood loss

- Chest, abdomen, and retroperitoneal injuries
- Pelvic fractures
- Multiple long bone fractures

### Glasgow coma scale score

#### Eye opening (graded 1-4)

- Spontaneous—4
- To speech—3
- To pain—2
- None—1

#### Best motor response (graded 1-6)

- Obeys command—6
- Localises pain—5
- Normal flexion—4
- Abnormal flexion—3
- Extension (decerebrate)—2
- None—1

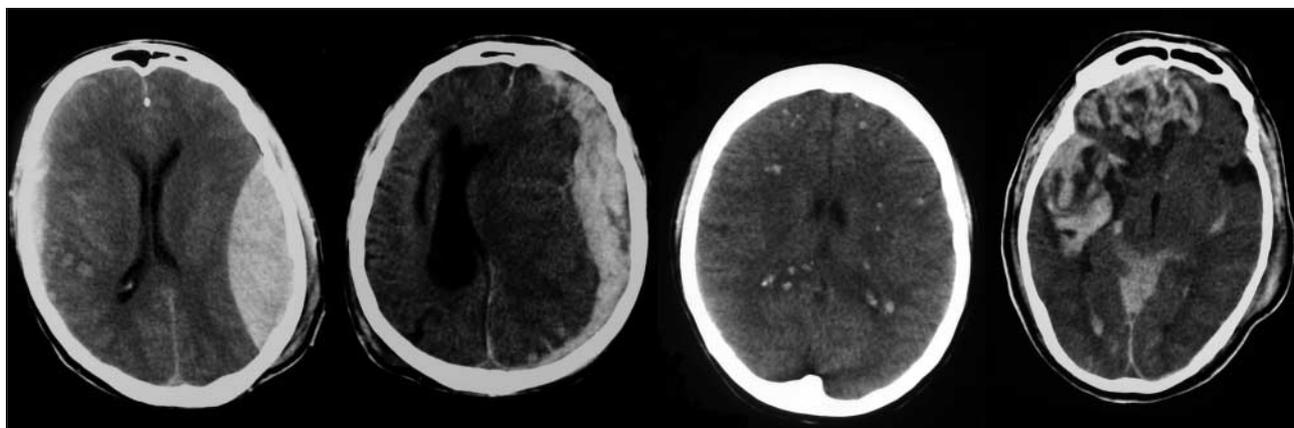
#### Verbal response (graded 1-5)

- Orientated—5
- Confused conversation—4
- Inappropriate words—3
- Incomprehensible sounds—2
- None—1

Maximum score 15,  
minimum score 3

- Mild injury 14-15
- Moderate injury 9-13
- Severe injury 3-8
- Coma  $\leq$  8

**If the patient has a head, scan it—missing a serious head injury may have catastrophic consequences**



Extradural haematoma and a subtle subdural haematoma (left), subdural haematoma (middle left), diffuse axonal injury (middle right), and combination injuries (right)

Computed tomography should be done as soon as possible because morbidity and mortality rises substantially if surgery is delayed. The intracranial findings of computed tomography may include no abnormality, extradural haematoma, subdural haematoma, contusions and intracerebral haematomas, subarachnoid blood, diffuse axonal injury, and combination injuries.

The National Institute of Clinical Excellence (NICE) introduced UK guidelines for management of head injury in 2003 that support the advanced trauma life support guidelines. They emphasise that computed tomography must be done within an hour of the patient arriving at the hospital.

**Exposure and environment**

The patient should be fully exposed (by cutting off all clothes) to allow a full examination. It is, however, critical to keep the patient warm with blankets and a heated emergency room. Large volumes of fluids may be infused, and these intravenous fluids should be warmed.

**Adjuncts to primary survey and resuscitation**

As a minimum, patients should have electrocardiography, their blood pressure monitored, pulse oximetry, a nasogastric tube, and a urinary catheter. Blood gases should also be monitored. If a fracture at the base of the skull is suspected, the nasogastric tube can be inserted after computed tomography of the head or an orogastric tube placed.

**Interpreting primary survey images**

All imaging must be supervised and done without fuss or undue delay and with meticulous technique. Attention to detail is essential. In particular, the film must be labelled (including the patient's name and a side marker).

The supine chest radiograph should be taken as soon as possible after the patient has been exposed and centred correctly. Attention must be paid to stop patients being rotated and keeping them in the middle of the trolley.

**ABCs interpretation of pelvic radiographs**

**Alignment**

- Check the pubic symphysis is symmetrical and not widened
- Carefully check that the sacroiliac joints are intact

**Bones**

- Check that all three pelvic rings are intact
- Use a bright light to check iliac crests and hips
- Look at the lumbar spine and hip joints separately

**Cartilage**

- Check the distance of the pubic symphysis
- Again check the sacroiliac joints
- Check both hips

**Soft tissues**

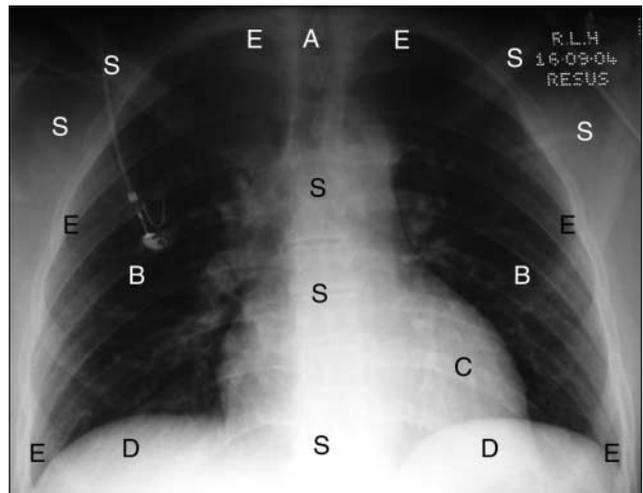
- Check the soft tissue planes are symmetrical
- Look for obturator internus
- Carefully delineate the perivesical fat plane
- Make sure the gluteus medius and psoas fat planes are intact

Alistair Wilson is consultant in accident and emergency medicine and Michael Walsh is consultant surgeon at Royal London Hospital, London.

The *ABC of Emergency Radiology* is edited by Otto Chan, consultant radiologist, Royal London Hospital, London (zaideotto@blueyonder.co.uk).

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Supine anteroposterior radiograph of normal chest with ABCDEs interpretation

**Interpretation of the supine chest radiograph (ABCDEs)**

**Airways**

- Check trachea is clear and central
- Is airway patent?
- Check position of endotracheal tube
- Are there any teeth or foreign bodies?
- Check all lines and tubes

**Breathing**

- Exclude tension pneumothorax and haemothorax
- Check there is no radiological flail segment
- Exclude rib fractures
- Check lungs are clear

**Circulation**

- Check heart size and mediastinal contours are normal
- Make sure that the aortic arch is clearly seen
- Check the hila and vascular markings are normal

**Diaphragm**

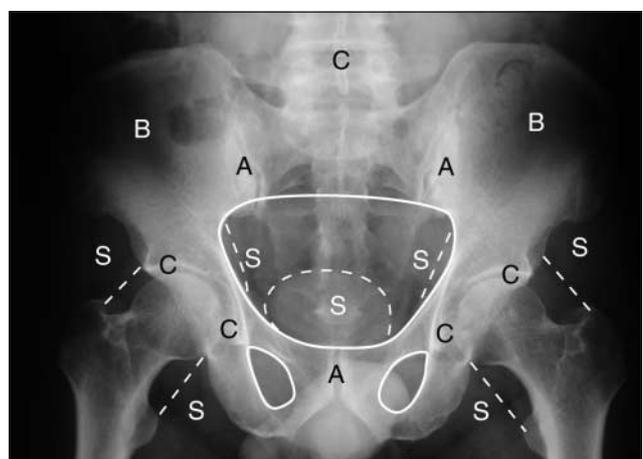
- Check that diaphragms appear normal (size, shape, and position)
- Can both diaphragms be clearly seen?
- Check under each diaphragm

**Edges**

- Check the pleura and costophrenic recesses
- Exclude a subtle pneumothorax or effusion

**Soft tissues and skeleton**

- Look for surgical emphysema
- Check clavicles and shoulders and exclude rib fractures
- Look at the paraspinous lines and check the spine



Radiograph of supine pelvis showing ABCDEs interpretation