Life-threatening trauma in pregnant women/girls and children

The key principles of managing major trauma are to

Treat the greatest threat to life first	and	AVOID – hypoxia; hypercapnia, hypovolaemia, hypoglycaemia and hypothermia

By following a structured approach, problems will be identified and managed in order of priority. The key steps are outlined in the primary assessment and resuscitation, enabling identification and treatment of life- threatening injuries. The secondary assessment identifies all other injuries, and provides emergency treatment for them.

Structured Approach
- Primary assessment and resuscitation
- Secondary assessment and emergency treatment
- Definitive care

Primary assessment
- **A**irway and control of haemorrhage *{and cervical spine control}*
- **B**reathing
- **C**irculation **and** continued haemorrhage control

If there is more than one injured patient, then treat patients in order of priority.

Management of Major Trauma

A team leader should be in overall charge of resuscitating a child or pregnant woman/girl suffering major trauma.

Primary Assessment and Resuscitation

During the primary assessment, assess and resuscitate in sequence, Airway, Breathing and Circulation (ABC), which, if compromised, can be an immediate threat to life.

Although the patient may have obvious severe injuries, the clinician's first task is to prevent further deterioration of the patient's condition by ensuring that vital organs, especially the heart and the brain are supplied with oxygenated blood by ensuring an open airway, adequate breathing and circulation. This is what is meant by the Primary Assessment and Resuscitation.

Although ABC management is described sequentially, if there are sufficient trained clinicians present, they can be managed at the same time. If there are limited personnel, then the approach must be A then B then C. If there is only one trained person available, then make use of untrained staff such as ward orderlies or relatives to undertake tasks under your supervision. For example, if there is visible, severe, exsanguinating haemorrhage, once you have identified and controlled it, the ward orderly can continue the pressure while you open the airway and give oxygen etc. You will need to continually watch that the untrained person's actions continue to be effective.

The first priority is establishment or maintenance of airway opening, and control of any obvious life- threatening haemorrhage.

Primary Assessment and Resuscitation: **Airway** and control of exsanguinating haemorrhage {plus cervical spine control, if appropriate}

Breathing

Circulation

Stop visible, external, exsanguinating bleeding by direct pressure. This will be from a superficial artery or large vein. Minor bleeding can be left until the vital ABC have been assessed and resuscitated. Internal bleeding will be dealt with first in "C" by replacing fluid, then, if necessary, by emergency surgery.

Open and maintain airway

We assess the airway patency by assessing its function, that is, allowing air to pass through it into the lungs. If the airway is blocked, the lungs will not receive air.

The approach is similar to that used for managing any airway, in that you must:

LOOK for chest movement

LISTEN for breath sounds

FEEL for exhaled air

Talk to the patient

If the patient is conscious, a rapid way to assess the airway is to ask them to speak "are you alright?"

A patient who can speak or, in the case of a baby, cry, must have a clear airway.
If the patient is unconscious, airway obstruction is most commonly due to obstruction by the tongue.

The signs of airway obstruction may include:
• snoring or gurgling
• stridor or abnormal breath sounds
• agitation (hypoxia)
• using the accessory muscles of ventilation/paradoxical chest movements
• cyanosis.

Cervical spine protection

In countries where there is no paramedic manned emergency ambulance service available to rescue trauma victims at the scene, the risks of an unstable cervical fracture causing permanent spinal damage and subsequent paresis occurring before the patient is brought to medical attention, is high. So any cervical fracture presenting to a medical facility after being brought in by passersby is likely to be stable.

Fortunately, unstable cervical spinal fractures are relatively uncommon. They are more likely to occur with very severe road traffic accidents and with falls from a significant height.

Protect the cervical spine with collar, sand bags and tape if the patient is likely to have an unstable cervical spine, and if definitive treatment is likely to be subsequently possible.

Again, definitive treatment requires specialist surgery and many low income countries health services may struggle to access the appropriate service for their population.

It is important to recognise that although protection of the cervical spine may occasionally be beneficial, *the opening and maintaining of a clear airway benefits every patient and is an absolute priority.*

Cervical spine immobilisation

The cervical spine can be mobilized in three ways

1. In-line stabilisation: the spine is held in the neutral position (the same as the airway position for an infant, see Section 11) by the clinician's hands on either side of the patent's head, ensuring that the ears are not covered as the patient must be able to hear to be reassured and informed. This position must be held until the collar and/or blocks are in place.
2. A cervical collar can be placed around the neck. These are manufactured in several sizes to fit different sized patients. They are measured according to the manufacturer's instruction and then gently slid under the neck at the back, the shaped part is placed under the chin at the front and the collar fastened with the "Velcro" tape fastening. It should leave the patient with a firmly held neck in a neutral position. The collar is used by itself in the combative patient, and in conjunction with blocks or sandbags in the unconscious or cooperative patient (i.e. one who will remain still).
3. Sandbags or blocks and tape are usually added after the collar has been fitted: these objects are placed on either side of the patient's head to prevent lateral movement and held in place with two tapes, one across the patient's forehead and the other across the chin part of the cervical collar.

Management of the airway

- *Head tilt/chin lift or jaw thrust* . Jaw thrust is recommended in trauma as it does not require any neck movement. However, if a jaw thrust is unsuccessful, then try chin lift with some head tilt. *A closed airway will always kill and so airway takes priority*
- *Suction / removal of blood, vomit or a foreign body* if any.
- *If there is no improvement, place an oropharyngeal airway*. Avoid nasopharyngeal airway if suspicion of base of skull injury.
- *If the airway is still obstructed, a definitive airway by intubation or surgical airway may be needed.*
- Identify the 'at risk' airway:
  - altered level of consciousness will fail to protect airway
  - vomiting with risk of aspiration, a major risk in pregnancy
  - facial trauma, including burns, will continue to worsen as tissues swell

Once the airway is open, give high flow oxygen using a mask and reservoir.

If the airway cannot be maintained and /or protected, consider need for **advanced airway management** Indications for advanced techniques for securing the airway (intubation or surgical airway) include:

- persisting airway obstruction
- conscious level of 8 or below in the Glasgow coma scale or "P" or "U"on the AVPU scale (see below for both)
- penetrating neck trauma with haematoma (expanding)
- apnoea
- hypoxia
- severe head injury
- chest trauma
- maxillofacial injury.

Intubation techniques should ideally be performed by an experienced anaesthetist. A surgical airway is best performed by an ENT surgeon but general surgeons will have been trained if not experienced in the technique. The technique of emergency cricothyrotomy can be performed by any emergency clinician (see below).

For intubation, the following sequence should be followed:

1. Pre-oxygenation with 100% oxygen, with manual lung inflation if required.
2. Administration of a carefully-judged, reduced dose of an anaesthetic induction agent.
3. Application of cricoid pressure.
4. Suxamethonium 1-2 mg/kg.
5. Intubation with a correctly-sized tracheal tube.

Confirmation of correct placement of the endotracheal tube

Signs such as chest movement and auscultation remain helpful but are occasionally misleading, especially in inexperienced hands. The most reliable evidence is to see the tube pass through the vocal cords. The correct size is a tube that can be placed easily through the cords with only a small leak. Intubation of the right main bronchus is best avoided by carefully placing the tube only 2-3 cm below the cords, and noting the length at the teeth before checking by auscultation, which is best done in the left and right lower axillae.

Indications for surgical cricothyrotomy:

- unable to open or clear the airway and patient losing consciousness due to cerebral hypoxia (that is usually cyanosed and bradycardic)
- unable to ventilate the lungs despite high level CPAP via bag valve mask system and 100% oxygen through via a reservoir attached to the bag.
- unable to intubate through larynx either because not possible or insufficient experience

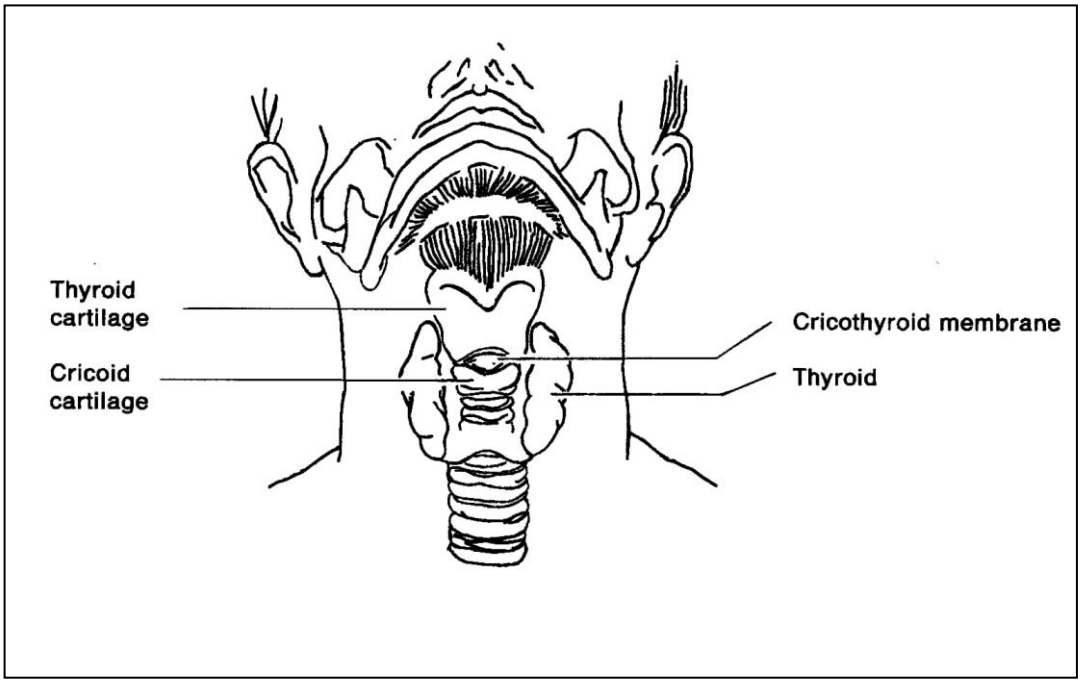
Method

1. Place the patient in a supine position.
2. If there is no risk of neck injury, consider extending the neck to improve access. Otherwise, maintain a neutral alignment.
3. Identify the cricothyroid membrane.
4. Prepare the skin, and, if the patient is conscious, infiltrate with local anaesthetic.
5. Place a hand on the neck to stabilize the cricothyroid membrane, and to protect the lateral vascular structures from injury.
6. Make a small vertical incision in the skin, and press the lateral edges of the incision outwards, to minimize bleeding.
7. Make a transverse incision through the cricothyroid membrane, being careful not to damage the cricoid cartilage.
8. Insert a tracheal spreader, or use the handle of the scalpel by inserting it through the incision and twisting it through 90 degrees to open the airway.
9. Insert an appropriately sized endotracheal or tracheostomy tube.
10. Ventilate the patient and check that this is effective.
11. Secure the tube to prevent dislodgement.

Complications of surgical cricothyroidotomy:

- asphyxia
- aspiration (for example, blood)
- laceration of the trachea
- laceration of the oesophagus
- haemorrhage or haematoma formation
- mediastinal emphysema
- subsequent glottic stenosis

- creation of a false passage into the tissues



Primary assessment and resuscitation: Breathing

After management of the airway, the patient's breathing should be assessed. The same approach is adopted as for the patient suffering a serious illness.

Assessment of breathing	Unequal breath sounds or poor oxygenation?
• **Effort** – recession, rate, added noises, accessory muscles, ala flaring • **Efficacy** – breath sounds, chest expansion; abdominal excursion; SaO2 • **Adequacy** – heart rate, skin colour (?cyanosis), mental status	• Pneumo / haemothorax • Misplaced or blocked ETT

Looking at the respiratory rate and chest expansion is essential. In addition to the signs in the box above, are any of the following present?
- penetrating injury
- presence of flail chest
- sucking chest wounds

Listen for breath sound character and equality:
- pneumothorax (decreased breath sounds on site of injury)
- detection of abnormal sounds in the chest.

Feel for:
- tracheal shift
- broken ribs
- subcutaneous emphysema

Percuss:

• percussion is useful for diagnosis of **haemothorax** (dull on affected side)and **pneumothorax** (hyperesonant on affected side).

Continue giving high flow oxygen (15 litres/min.) to all.

Careful examination of the trachea, neck veins and chest may indicate the presence of pleural collections of air or blood. Tension pneumothorax should be treated immediately with needle thoracocentesis in the second intercostal space in the mid-clavicular line.

Needle thoracocentesis
This procedure is for the rapidly deteriorating patient who has a life-threatening tension pneumothorax. If this technique is used with a patient who does not have a tension pneumothorax, there is a 10 to 20% risk of producing a pneumothorax or causing damage to the lung, or both. In such cases immediate insertion of a chest drain is mandatory.

1. Identify the second intercostal space in the midclavicular line on the side of the pneumothorax (the *opposite* side to the direction of tracheal deviation and the *same* side as the hyper-resonance).
2. Swab the chest wall with surgical prep or an alcohol swab.
3. Attach the syringe to the over needle venous cannula.
4. Insert the cannula into the chest wall, just above the rib below, aspirating all the time.
5. If air is aspirated remove the needle, leaving the plastic cannula in place.
   Alternatively, insert the over needle venous cannula without a syringe and note a "hiss" of air on relief of the tension pneumothorax when the metal stylet is removed from the plastic cannula
6. Tape the open cannula in place and proceed to chest drain insertion as soon as possible.

Complications of Needle Thoracocentesis
- Local cellulitis
- Local haematoma
- Pleural infection
- Empyema
- Pneumothorax

Provide assisted ventilation if needed to patients with breathing problems, using a bag and mask with a reservoir attached, or by intubation and intermittent positive pressure ventilation. DO NOT persist with intubation attempts without oxygenating the patient.

Look for and treat
- airway obstruction (see above)
- tension pneumothorax
- open pneumothorax
- haemothorax
- flail chest
- cardiac tamponade

see below for details

Breathing problem	Clinical signs	Treatment
Tension pneumothorax	• Decreased air entry on side of pneumothorax • Decreased chest movement on side of pneumothorax • Hyper-resonance to percussion on side of pneumothorax • Tracheal deviation away from side of pneumothorax • Hypoxic, shocked patient • Full neck veins	High flow oxygen Needle thoracocentesis Chest drain insertion
Open pneumothorax	• Penetrating chest wound with signs of pneumothorax • Sucking or blowing chest wound	High flow oxygen Chest drain Wound occlusion on 3 sides
Massive haemothorax – blood in pleural space	• Decreased chest movement • Decreased air entry • Dullness to percussion • Shock and hypoxia • Collapsed neck veins	High flow oxygen Venous access and IV volume replacement Chest drain (a haemothorax of 500–1500 ml that stops bleeding after insertion of an intercostal catheter can generally be treated by closed drainage alone. A haemothorax of greater than 1500–2000 ml, or with continued bleeding of more than 200–300 ml per hour, may be an indication for further investigation, such as thoracotomy)
Flail chest – paradoxical movement of a chest wall segment associated with underlying lung contusion	• Rare in children because they have elastic chest wall • Decreased efficiency of breathing	Oxygen and pain relief May need intubation/ventilation. Transfer if feasible.
Cardiac tamponade – blood in pericardial sac causing a decrease in cardiac output	• Shock associated with penetrating or blunt chest trauma • Faint apex beat and/or muffled heart sounds • Distended neck veins	Oxygen IV access/IV fluids Emergency needle pericardiocentesis– may need to be repeated Consider transfer if feasible

Primary assessment and resuscitation- Circulation

Assessment of circulation

Circulatory assessment includes identification of actual and potential sources of blood loss. Closed fractures and bleeding into the chest, abdomen or pelvis may make it difficult to detect how much blood has been lost. The ability to estimate the percentage blood loss is helpful in planning resuscitation. Remember that a child's circulating blood volume is only 80ml/kg so is easily compromised. Blood volume in pregnancy is 100ml/Kg, or between 5 and 7 litres.

Sign	Percentage blood loss		
	< 25	25 – 40	>40
Heart rate	slight ↑	moderate ↑	marked ↑ or bradycardia
Systolic BP	normal	normal	beginning to fall
Pulse volume	normal or ↓	↓↓	↓↓↓
Skin**	cool, pale, sweaty	cool, mottled. sweaty	cool and sweaty
Respiratory rate	slight ↑	moderate ↑	sighing respirations
Mental status	slight agitation	lethargic; unco-operative	reacts to pain

** Capillary refill time > 3sec

Note: blood pressure may be normal until up to 50% of a patient's circulatory volume has been lost. The blood pressure is initially well-maintained despite continuing bleeding in children and pregnant women/girls. As an indicator of haemorrhage, it can be falsely reassuring; a progressively worsening tachycardia may be a more revealing feature.

Resuscitation of circulation

Management is focused around avoiding hypovolaemia and controlling blood loss.

Loss of blood is the most common cause of shock in major trauma.

Concealed bleeding severe enough to cause shock can occur into the pleural cavity, abdomen, pelvis and femur. Forty percent of the circulating blood volume can be lost via an open femoral fracture wherein initial treatment should include pressure, splinting and analgesia.

1) Stop bleeding

The first priority is to stop obvious bleeding by direct pressure. Don't forget that the patient may have a wound on the back that is bleeding into the bed. To examine the back, the patient should be log-rolled, if indicated.

• Injuries to the limbs: tourniquets do not work well and may cause reperfusion syndromes and add to the primary injury. The recommended procedure of "pressure dressing" is an ill-defined entity: severe bleeding from high-energy penetrating injuries and amputation wounds can be controlled by sub-fascial gauze pack placement, plus manual compression on the proximal artery, plus a carefully- applied compressive dressing of the entire injured limb.

• Injuries to the chest: the most common source of bleeding is chest wall arteries. Immediate placement of chest tube drain plus intermittent suction plus efficient analgesia (IV Ketamine is the drug of choice, if available) expand the lung and seal off the bleeding.

Elevate the legs if shocked.

2) IV fluid resuscitation

The goal is to restore oxygen delivery to the tissues. As the usual problem is loss of blood, fluid resuscitation must be a priority.

• Adequate vascular access must be obtained. This requires the insertion of at least one, and ideally two, large-bore cannulae (14-16 G). Peripheral cut -down or intraosseous infusion may be necessary.

• Infusion fluids (crystalloids e.g. Ringer Lactate or Hartmann's solution: normal (0.9%) saline can be used if the previous fluids are unavailable, but be aware that especially in larger volumes, normal saline causes a hyperchloraemic acidosis which is detrimental to sick or injured patients) should be warmed to body temperature if possible (e.g. prewarm in bucket of warmed water). Remember hypothermia can lead to abnormal blood clotting.

• Avoid solutions containing glucose.

• Take any specimens you need for laboratory and cross- matching urgently.

Not all cases of hypovolaemia require aggressive fluid therapy. In adults, withholding fluids in penetrating trunk trauma before achieving surgical haemostasis has been associated with improved outcome. The concept is to avoid pushing up the blood pressure, which hinders clot formation and promotes further bleeding. Aggressive fluid replacement can lead to increased fluid requirements, hypothermia, dilution of clotting factors, excessive blood transfusion and its associated immunosuppression.

On the other hand, in severe head injury, cerebral perfusion is critically dependent on maintaining blood pressure. If a patient has both a severe head injury and major trunk bleeding, the apparently conflicting requirements are best managed by maintaining priorities in ABC order and achieving prompt surgical haemostasis. Beyond this strategic conflict, it should be remembered that the normal blood pressure is lower in children, hypovolaemia mimics head injury and blood pressure itself is a poor indicator of organ perfusion.

This has led to a much more cautious fluid regime, until the risk of uncontrolled bleeding has been ruled out.

As outlined above, the concept of **"hypotensive resuscitation"** is important if the cause of hypovolaemic shock is haemorrhage from penetrating injury. Here, the initial boluses of IV crystalloids required to treat shock should only be given to keep the vital organs (especially brain, heart and kidneys) perfused before emergency surgery and blood transfusion is available. Fresh blood is particularly useful to combat the coagulopathy that occurs in major blood loss if specific coagulation components such as platelets are unavailable.

Giving too much IV fluids can increase the blood pressure too far thus increasing bleeding by disrupting early clot formation. IV crystalloid also dilutes the red cells in the circulation but whether or not this could reduce oxygen carrying capacity requires further research.

Our suggestion is that when giving boluses of crystalloid or blood in shock due to bleeding in major trauma, only the amount needed to keep the blood pressure at a level sufficient to perfuse the vital organs should be given. There is no clear evidence to indicate the precise blood pressure that should be achieved in a pregnant woman or child in shock due to haemorrhage. Adequate perfusion of vital organs may best be indicated by the following: a radial pulse which can be palpated and a conscious level of A or V on the AVPU scale (i.e. the woman or child is either awake or will respond by opening his/her eyes when spoken to). During pregnancy, the adequacy of the fetal heart rate may also be helpful.

In children under 2-3 years of age, the radial pulse may be difficult to feel and the presence of a palpable brachial pulse may be the best available indicator at present.

Therefore to maintain a palpable radial pulse in pregnancy, start with IV boluses of 250 -500 mL of crystalloid or ideally blood and reassess after each.

In children to maintain a radial or brachial pulse give 10mL/kg IV boluses of crystalloid or, ideally, blood and reassess after each.

In the absence of further evidence, it is recommended that in children, start with 10 mL/kg boluses (infusions given as rapidly as possible) of Ringer-Lactate or Hartmann's or plasma expander with frequent re-assessment, rather than the full 20 mL/kg recommended in other life-threatening situations such as meningococcal sepsis or severe dehydration.

Fluid resuscitation in pregnancy starts with a 250-500 ml bolus of Ringer-Lactate or Hartmann's or plasma expander.

After repeating boluses twice (that is 10 mL/kg x 2 in a child, or 500 mL x 2 in pregnancy), the transfusion of packed red cells should be considered. The most important aspect of fluid resuscitation is the patient's response to the fluid challenge.

Improvement is indicated by:

- decrease in heart rate
- increased systolic blood pressure
- increased skin temperature
- quicker capillary refill
- improving mental state

Failure to improve should prompt an urgent search for chest, abdominal, or pelvic haemorrhage, with the immediate involvement of an experienced surgeon. Similar volumes may be repeated if there is continuing evidence of haemorrhagic shock, after re-evaluating the state of the circulation.

It is useful to delegate the initial fluid bolus to a member of the trauma team (if a team is available), who attaches the warmed fluid bag to the intravenous cannula via a three-way tap to which is attached a 20 or 50 mL syringe to give the boluses.

Early surgical involvement is essential.

3) Blood transfusion

There may be considerable difficulty in getting blood. Remember possible incompatibility, hepatitis B and HIV risks, even amongst patient's own family.

Blood transfusion must be considered when the patient has persistent haemodynamic instability despite fluid (colloid/crystalloid) infusion. If the type-specific or cross-matched blood is not available, type O negative packed red blood cells should be used. Transfusion should, however, be seriously considered if the haemoglobin level is less than 7 g/dl and if the patient is still bleeding. Blood transfusion is most important and requires blood to be taken for urgent cross match.

As described above, early surgical involvement is essential.

Vascular access is essential in all seriously injured patients. A minimum of 2 relatively large bore IV cannulae is essential. But do not waste time putting in the second until the first fluid bolus has been given.

Infusion IV line flow rates

Color Code	Gauge	Water Flow Rates (ml/min)
Brown	14	240
Gray	16	172
Yellow	17	130
Green	18	76
Pink	20	54
Blue	22	25
Lime	24	14

Peripheral veins are preferable – the inexperienced should not attempt central venous cannulation. The external jugular vein can be accessed even in shock but the cannula can become easily displaced and must be very carefully taped in place. A cut -down onto the long saphenous vein can also be used. In children an intraosseus needle can be the most rapid and efficient initial access.

Central venous cannulation can permit large volumes to be rapidly infused and also permit CVP measurements. It must be undertaken by a skilled person (for example an anaesthetist) and a Seldinger technique should be used. The femoral vein is used for a child, but not for a pregnant woman. The internal jugular or subclavian vein may be used.

Peripheral venous access can often be established once peripheral perfusion has been improved. Both femoral venous and tibial intraosseous access are best avoided if there is clinical evidence of a pelvic or abdominal injury. In such cases, it is better to secure vascular access above the diaphragm.The upper outer aspect of the humerus can be used for intraosseous access in that case.

Blood should be drawn for typing and cross-matching, haemoglobin and full blood count, glucose and electrolytes. These tests are all accurate on a marrow sample from an intraosseous approach except the full blood count.

The replacement should be warm.The physiological coagulation works best at 38.5°C, and haemostasis is difficult at core temperatures below 35°. Hypothermia in trauma patients is common during protracted improvised out-door evacuations , even in the tropics. It is easy to cool a patient but difficult to re-warm, hence prevention of hypothermia is essential. IV fluids should have a temperature of 40-42°C - using IV fluids at "room temperature" means cooling!

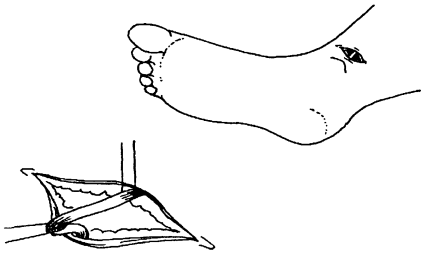
Venous cut-down

Anatomical Considerations In adults the primary site for cut-down is over the long saphenous vein above the ankle at a point approximately 2 cm anterior and 2 cm superior to the medial malleolus – but not if there is significant injury proximal to this site.

Identify the surface landmarks. These are shown below:

	Saphenous
Infant	Half a fingers breadth superior and anterior to the medial malleolus
Small Children	One fingers breadth superior and anterior to the medial malleolus
Older Children/mother	Two finger breadths superior and anterior to the medial malleolus

- Apply a venous tourniquet proximal to the intended cannulation site.
- Prepare the skin with antiseptic and sterile drapes.
- Infiltrate the area with local anaesthetic (1% lignocaine using fine 24-25G needle).
- Make a full-thickness transverse incision through the skin.
- By blunt dissection, identify and display the vein.
- Free the vein from its bed and elevate a 2 cm length.
- Ligate the distal end, leaving the suture in place for traction.
- Pass a tie around the proximal end of the vein.
- Make a small transverse venotomy and gently dilate the opening with the tip of a closed haemostat.
- Introduce the plastic cannula (without trochar) through the venotomy and secure it in place by tying the proximal ligature.
- Attach the giving set and commence flow at the required rate.
- If possible, close the incision, otherwise apply a sterile dressing and secure giving set tubing in place.



Complications
Haemorrhage or haematoma.
Perforation of the posterior wall of the vein.
Nerve transection.
Phlebitis.
Venous thrombosis.

External jugular venous cannulation

Place the patient in a head-down position to dilate the vein and reduce the risk of air embolus.

1. Place patient in a 15–30º head-down position (or with padding under the shoulders so that the head hangs lower than the shoulders).
2. Turn the head away from the site of puncture.
3. Clean the skin over the appropriate side of the neck.
4. Identify the external jugular vein, which can be seen passing over the sternocleidomastoid muscle at the junction of its middle and lower thirds.
5. Have an assistant place his or her finger at the lower end of the visible part of the vein just above the clavicle. This stabilises it and compresses it so that it remains distended.
6. Puncture the skin and enter the vein.
7. When free flow of blood is obtained, ensure no air bubbles are present in the tubing and then attach a giving set.
8. Tape the cannula securely in position.

Other less common causes of shock in major trauma

Cardiogenic shock

Inadequate heart function may result from
- myocardial contusion (bruising)
- cardiac tamponade
- tension pneumothorax (preventing blood returning to heart)
- penetrating wound of the heart
- myocardial infarction.

Assessment of the jugular venous pressure is essential in these circumstances .Iit will be elevated compared with Hypovolaemic shock, where it may not be visible.
An ECG should be recorded, if available.

Neurogenic shock
This is due to the loss of sympathetic tone, usually resulting from spinal cord injury, with the classical presentation of hypotension without reflex tachycardia or skin vasoconstriction.

Tension pneumothorax
See under breathing section above. This can present with shock as well as breathing impairment.

Management of circulation

- Peripheral or IO access (see procedures)
- Direct pressure on bleeding sites
- Elevate the legs
- External jugular or femoral venous access
- Saphenous or cephalic cut down
- Fluid resuscitation if any evidence of shock
- Monitor response and only continue with fluids if needed
- **Do not give excess fluids – especially to patients with head or chest injuries, or malnutrition**

If possible take blood for

- Cross matching
- Hb and full blood count
- Glucose
- Electrolytes

Fluid Resuscitation

Crystalloid / colloid 10 ml /Kg in child or 500ml-1litre in mother

monitor response
If no change or worse

Repeat above bolus

monitor response: no change/ worse

Blood 10 ml/kg in child or 500ml in a mother

The most important aspect of fluid resuscitation is the response to a fluid challenge.
Improvement is indicated by

- Decreased heart rate
- Increased skin temp
- Faster capillary refill
- Improved mental state
- Increased systolic BP
- Improved urinary output

If the patient fails to improve, look for chest, abdominal or pelvic blood loss and consider surgical intervention

Warnings	**Cardio-respiratory arrest despite secure airway and adequate oxygenation:** ○ Tension pneumothorax **needs** emergency thoracocentesis and insertion of intercostal drain(s) ○ Exsanguination **needs** large fluid boluses and blood transfusion ○ Pericardial tamponade **needs** pericardiocentesis

Primary assessment: neurological failure

Head Injury is the major cause of death in trauma

Rapid assessment of the central nervous system for evidence of failure includes**:**

Applying the AVPU score:

- with a score of 'P' or 'U', intubation should take place in order to maintain and protect the airway. If there is no-one skilled in intubation, the patient should be placed in the recovery position.
- remember to check for a pain response above the level of the clavicle, as a patient with a spinal injury may not be able to respond by moving their limbs.

- Look for signs indicative of injury e. g., bruises, lacerations or haematoma, in the head and neck area,
- Examine the pupils for size, equality and reaction to light. Look for other lateralizing signs, such as limb weakness or focal seizures.

At this stage, the brain is best cared for by close attention to managing A B and C, and by correction of any hypoglycaemia.

If there is evidence of raised intra-cranial pressure (RICP):

- intubate and ventilate to maintain oxygenation, and if measurable a normal arterial PCO2 level
- maintain systolic BP;
- nurse the patient 30° head up;
- contact a neurosurgeon, if available.

Mannitol 200mg/kg (maximum dose 12.5 grams) should be administered after first excluding intracranial haematoma. If this is not excluded, there will be temporary improvement because of relief of cerebral oedema, but there may be sudden worsening a little while later due to rapid expansion of the haematoma.

Low blood glucose is common in child trauma victims, and can cause brain damage.. Always check the blood glucose where possible; if it is not possible to check it, treat immediately any baby or small child with 5ml/kg of 10% glucose IV.

Analgesia in major trauma (see Section 4 on pain control)

Pain increases fear and distress, makes the patient less able to co-operate, and raises intracranial pressure. If the patient is fully conscious and in severe pain, then control of pain is required.

Pain relief takes several different forms

- Reassurance
- Splinting of fractures
- Covering wounds – especially burns
- Drugs
  - There is no place for oral or IM medication in a major trauma situation
  - There are two alternatives in severe trauma:

Ketamine

Its positive inotropic effects, and the fact that it does not affect the gag reflex, make this a very helpful analgesic, especially where there is, or has been, shock. Repeated IV doses of 200micrograms/kg followed by careful reassessment are usually effective, especially during transfer to a more specialized hospital (if available and relevant).

Morphine

100-200 micrograms/kg morphine IV in a child, or 5-10mg in the mother, is the drug of choice in major trauma, followed by careful reassessment. If the conscious level falls, the effect can be

reversed with Naloxone, showing whether the effect is caused by the morphine or by a worsening brain injury. If there is respiratory depression, first ventilate with bag/valve /mask before giving naloxone.

Entonox

Entonox (50/50 O2/N2O) is useful, especially for limb injuries while splints are being applied. Do not use in the presence of head, chest or abdominal trauma.

A head injury is NOT a contra-indication for giving morphine unless there is depressed consciousness when great care is needed.

Summary of primary assessment and resuscitation

The injured patient should have

- A team approach with urgent call for surgical and anaesthetic availability.
- Clear airway and 100% oxygen for breathing
- Adequate respiration, achieved by manual or mechanical ventilation and chest decompression when indicated
- Venous access and an initial fluid challenge, if indicated on circulatory assessment
- Blood sent for typing and cross matching
- Identification of the need for life saving surgery and preparation underway
- Identification of any serious head injury and attention paid to maximising A B and C
- Cervical spine immobilisation: where appropriate

Is part of the chart above missing?

Life threatening injuries identified and treated

Injury	Treatment
Airway obstruction	Head tilt, chin lift and jaw thrust, oropharyngeal airway, intubation or surgical airway
Tension pneumothorax	Needle thoracocentesis and chest drain
Open pneumothorax	3 sided dressing, then chest drain
Massive haemothorax	IV access, chest drain and blood transfusion
Flail chest	Intubation if needed
Cardiac tamponade	Pericardiocentesis Spinal needle ideal UBL (Upwards, Backwards, Left)

Before the secondary assessment begins, it should be remembered that:

the **ABC and neurological failure components of the primary assessment and resuscitation require constant re-evalulation, as deterioration can be rapid.**

Emergency operative treatment to control life-threatening haemorrhage should be performed promptly, without waiting for non-urgent examination and imaging.

Identifying all anatomical injuries remains an important goal, but may be overridden by pressing physiological requirements to ensure that oxygenated blood reaches vital organs in sufficient degree: this may require emergency surgery before all nonlife-threatening injures have been identified.

Secondary assessment and emergency treatment

Secondary assessment and emergency treatment are undertaken only when the patient's ABC's are stable.

If any deterioration occurs during this phase, then secondary assessment must be interrupted by another primary assessment and resuscitation

Documentation is required for all procedures undertaken. This involves careful examination from head-to-toe in a systematic way, including a *controlled examination of the back, avoiding spinal movement (by log-rolling).* Clear documentation of all injuries should be noted, to serve as the basis of the subsequent management strategy.

Shortly after the primary assessment and resuscitation, various adjuncts help with protecting the patient and monitoring progress

Secondary assessment – Adjuncts
- Monitoring ECG, SaO2 and BP
- Urinary and gastric catheters
- Portable X-rays of chest and pelvis
- Ultrasound of abdomen if available
- Adequate pain control (see below)
- Base line blood tests (especially Hb, cross match, biochemistry and clotting

History
- Events before and after incident
- First aid given at scene
- Past medical history
- Medications and allergies
- Immunisation status
- Last food and drink

Adjuncts to the secondary assessment and emergency treatment include:
- ECG/Oxygen saturation/blood pressure monitoring (should also be used in primary assessment and resuscitation)
- Gastric and urinary catheters
- Portable X-rays of the chest and pelvis

Head examination
- scalp and ocular abnormalities
- external ear and tympanic membrane
- periorbital soft tissue injuries

Head injury patients are suspected to have cervical spine injury until *demonstrated* otherwise

Neck examination
- penetrating wounds
- subcutaneous emphysema
- tracheal deviation
- neck vein appearance (JVP)

Neurological examination
- brain function assessment using the AVPU or Glasgow Coma Scale (GCS)
- spinal cord motor activity
- sensation and reflex

Chest examination
- clavicles and all ribs
- breath sounds and heart sounds
- ECG monitoring,if available

Abdominal examination

- penetrating wound of abdomen requiring surgical exploration
- blunt trauma ; a nasogastric tube is inserted. (Not in the presence of facial trauma)
- rectal examination
- insert urinary catheter except in children. (Check for meatal blood before insertion)

Pelvis and limbs

X-rays (if possible and where indicated)

- chest X-ray and cervical spine films (important to see all 7 vertebrae)
- pelvic and long bone X-rays
- skull X-rays may be useful to search for fractures when head injury is present without focal neurologic deficit
- CT scans of the brain and abdomen, if available

Head injury

This remains the commonest cause of death and disability in severe trauma in children. The scalp and face are examined for bruising, abrasions, lacerations and evidence of fracture.

Basal skull fracture is manifest by signs such as:

- racoon eyes (bilateral peri-orbital haematoma), bleeding from the ears or a visible haemotympanum,
- Battle's sign (bruising over the mastoid process, which is a relatively late sign),
- cerebrospinal fluid leakage from the nose, mouth or ears.

The AVPU or Glasgow Coma Score is again evaluated allowing a dynamic comparison with the primary assessment estimation, unless the child is now intubated and sedated.

As infants and small children are prone to hypoglycaemia, it is important to consider this as a potential cause of altered consciousness.

Delay in the early assessment of head-injured patients can have devastating consequence in terms of survival and patient outcome. Hypoxia and hypotension double the mortality of head-injured patients.

The following conditions are potentially life-threatening but difficult to treat in district hospitals. It is important to treat what you can with your expertise and resources, and to triage casualties carefully.

Immediate recognition and early management must be made of the following conditions:

Acute extradural haemorrhage:

classical signs consist of:

- loss of consciousness following a lucid interval, with rapid deterioration;
- rapid rise in intracranial pressure, due to bleeding from the middle meningeal artery;
- development of hemiparesis on the opposite side, with a fixed pupil on the same side as the impact area.

The management is surgical, and every effort should be made to do burr-hole decompressions.

Acute subdural haematoma

Bleeding with clotted blood in the subdural space, accompanied by severe contusion of the underlying brain. It occurs from tearing of bridging veins between the cortex and the dura. Again, surgery is needed but requires a neuro-surgeon, not burr holes alone.

The conditions below should be treated with more conservative medical management, as neurosurgery usually does not improve outcome:

- Base-of-skull fractures
- Cerebral concussion ,with temporary altered consciousness
- Depressed skull fracture;an impaction of fragmented skull that may result in penetration of the underlying dura and brain.
- Intracerebral haematoma;may result from acute injury or progressive damage secondary to contusion.
- In children, bleeding is a less frequent problem than global brain swelling: again this is managed medically but apart from ventilation and general supportive therapy, recovery is dependent on the severity of the injury and the effect of the initial physiological support of ABC.

NB: Alteration of consciousness is the hallmark of brain injury

The most common errors in head injury evaluation and resuscitation are:

- failure to perform ABC and prioritise management;
- failure to look beyond the obvious head injury;
- failure to assess the baseline neurological examination;
- failure to re-evaluate the patient who deteriorates.

Management of Head Trauma

The Airway, Breathing and Circulation are stabilised (and the C-spine immobilised, if possible). Vital signs are important indicators of the patient's neurological status, and must be monitored and recorded frequently.

Glasgow coma score (GCS):

- severe head injury is when GCS is 8 or less;
- moderate head injury is when GCS is between 9 and 12;
- minor head injury is when GCS is between 13 and 15.

Remember:

- deterioration may occur due to bleeding
- unequal or dilated pupils may reflect an increase in intracranial pressure
- head or brain injury is never the cause of hypotension in the adult trauma patient
- sedation should be avoided as it decreases the level of consciousness, and promotes hypercarbia due to slow breathing with retention of CO2
- the Cushing response is a late sign, reflecting a lethal rise in intracranial pressure, associated with a poor prognosis. The hallmarks are:

- bradycardia
- hypertension
- decreased respiratory rate

Basic medical management for severe head injuries includes:

• intubation and ventilation, producing moderate normocapnia (pCO2 to 4.5-5 Kpa, if possible to monitor). This will reduce both intracranial blood volume and intracranial pressure temporarily
• sedation with possible paralysis (this needs clarification, as it is stated above that sedation should be avoided)
• moderate IV fluid input with diuresis;do not overload
• nursing with head up at an angle of 20 degrees
• prevention of hyperthermia

Chest trauma

The majority of chest injuries result from blunt trauma, and are usually associated with injuries in other organ systems.

Approximately a quarter of deaths due to trauma are attributed to chest injury. Immediate deaths are essentially due to major disruption of the heart or of the great vessels. Early deaths due to chest trauma include airway obstruction, cardiac tamponade or aspiration.

The majority of patients with thoracic trauma can be managed by simple manoeuvres and do not require surgical treatment.

Respiratory distress may be caused by:
• rib fractures/flail chest
• pneumothorax
• tension pneumothorax
• haemothorax
• pulmonary contusion (bruising)
• open pneumothorax
• aspiration.

Haemorrhagic shock may be due to:
• haemothorax
• haemomediastinum.

The increased compliance of the chest wall in the child is protective, but can make interpretation of the severity of injury difficult. Rib fractures are uncommon in the infant or child, but indicate that significant blunt force has been applied. Moreover, serious chest injury can occur without obvious external signs of trauma. The energy that is not dissipated in breaking the elastic ribs may be transferred to the lungs to be manifest as pulmonary contusion. Respiratory failure can occur quickly in infants and young children with chest trauma, yet the majority of chest injuries require no more than the insertion of an intercostal drain.

- Thorough re-examination of the chest front and back, using the classical *inspection-palpation-percussion-auscultation approach,* is combined with a chest *X* ray.
- Particular attention is directed to the symmetry of chest movement and breath sounds, the presence of surgical emphysema and pain or instability on compressing the chest.
- Tracheal deviation and altered heart sounds are noted.

- On log-rolling the child**,** *it is important to reconsider flail chest***,** as a posterior floating segment is often poorly tolerated in children.

Rib fractures

Fractured ribs may occur at the point of impact and damage to the underlying lung may produce lung bruising or puncture. The ribs usually become fairly stable within 10 days to two weeks. Firm healing with callus formation is seen after about six weeks.

Flail chest

The unstable segment moves separately and in an opposite direction from the rest of the thoracic cage during the respiration cycle. Severe respiratory distress may ensue.

Pneumothorax

- A *tension pneumothorax* develops when air enters the pleural space but cannot leave. The consequence is progressively increasing intra-thoracic pressure in the affected side resulting in mediastinal shift. The trachea may be displaced (late sign) and is pushed away from the midline by the air under tension.The patient will become short of breath and hypoxic. Urgent needle decompression (thoracocentesis) is required prior to the insertion of an intercostal drain.
- A *simple pneumothorax* can be diagnosed by Xray or ultrasound scanning and, though not life-threatening, may be associated with significant underlying lung injury. All traumatic pneumothoraces *require close observation***.** Small ones often absorb spontaneously but larger ones frequently require chest drainage.
- *Open pneumothoraces*, or sucking chest wounds, allow bidirectional flow of air through a chest wall defect. The lung on the affected side is exposed to atmospheric pressure with lung collapse and a shift of the mediastinum to the uninvolved side. This must be treated rapidly. In compromised patients, intercostal drains, intubation and positive pressure ventilation is often required. Alternatively they can be treated by applying an occlusive dressing, taped on three sides to serve as a flap valve, followed by inserting a chest drain remote from the site of injury. A better dressing is the customised Asherman chest seal, which consists of an adhesive ring, similar to that on a colostomy stoma bag, which projects into a pipe-shaped flap valve, resembling that in a Heimlich valve. **Beware of the possibility of a tension pneumothorax developing when one of these is used.**

Pulmonary contusion

This is usually caused by blunt trauma, and may occur in association with rib fractures plus/minus a flail segment. It is common after chest trauma. It is a potentially life-threatening condition. The onset of symptoms may be slow and progress over 24 hours post -injury. It is likely to occur in cases of high-speed accidents, falls from great heights, and injuries by high-velocity bullets.

Symptoms and signs include:

- dyspnoea
- cyanosis.
- sparse or absent breath sounds
- hypoxaemia
- tachycardia

Treatment involves supplemental oxygen, careful fluid management and particular attention to pain relief. Endotracheal intubation may be necessary in severe cases.

Traumatic haemothorax

This is more common in penetrating than in non-penetrating injures to the chest. If the haemorrhage is severe, hypovolaemic shock will occur, and also respiratory distress due to compression of the lung on the involved side.

Optimal therapy consists of the placement of a large chest tube.

• A haemothorax of 500-1500 ml in pregnancy, or 10-30ml/Kg in a child, that stops bleeding after insertion of an intercostal catheter, can generally be treated by closed drainage alone

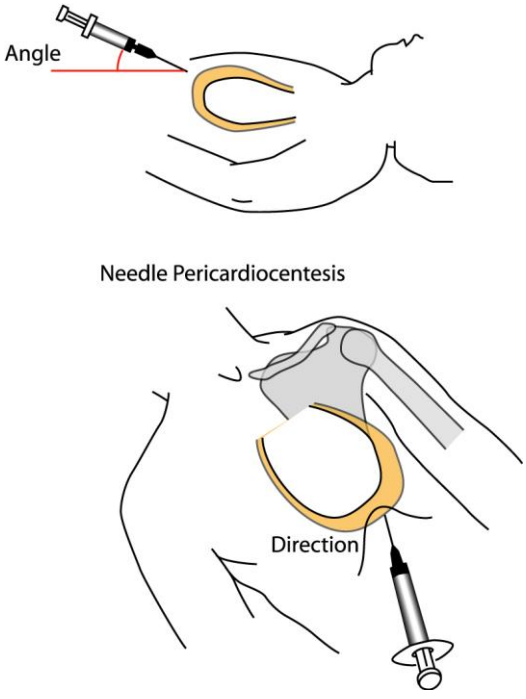
• A haemothorax of greater than 1500-2000 ml in pregnancy, or > 30ml/Kg in a child, with continued bleeding of more than 200-300 ml per hour in pregnancy or > 5 ml/Kg per hour in a child, is an indication for further investigation e.g. thoracotomy.

The injuries listed below are also possible in severe trauma, but carry a high mortality even in regional centres.

1) *Myocardial contusion* is associated, in chest blunt trauma, with fractures of the sternum or ribs. The diagnosis is supported by abnormalities on ECG and elevation of serial cardiac enzymes if these are available. Cardiac contusion can simulate a myocardial infarction. The patient must be closely observed, with cardiac monitoring if available. This type of injury is more common than we think, and may be a cause of sudden death some time after the accident.
2) *Pericardial tamponade*: Penetrating cardiac injuries are a leading cause of death in young men in some notorious urban areas but rare in other settings. It is rare to have pericardial tamponade with blunt trauma. Pericardiocentesis (see below) must be undertaken early if this injury is considered likely. Look for pericardial tamponade in patients with:
    - shock
    - distended neck veins
    - no pneumothorax
    - muffled heart sounds.

Pericardiocentesis (IMEESC 13.2) Indication – in the trauma situation this is performed when cardiac tamponade is suspected. This is usually, but not always caused by a penetrating injury between the nipple line, or the shoulder blades. The clinical findings are shock, muffled heart sounds (although this is a difficult sign to elicit with confidence) and distended neck veins. It is important to differentiate between this and tension pneumothorax, in which the trachea is deviated and air entry reduced on the affected side.

Ideally this procedure should be carried out under ECG control, but if that is not available, extra care must be taken.



Procedure

- Lie child on the back and attach ECG
- Prepare yourself and patient; this is a sterile procedure
- If conscious, infiltrate local anaesthetic at the costal margin just below the xiphisternum
- Attach cannula to syringe and insert cannula just below and left of the xiphisternum
- Angle at 45° and advance towards the tip of the scapula
- Aspirate continuously whilst advancing and watch the ECG
- Blood will flow into the syringe when the pericardial sac is entered
- Watch the ECG for arrhythmias, ectopic beats or injury pattern – all signs that the myocardium has been touched
- If bright red blood flows in large amounts, the heart has been entered, and the cannula should be withdrawn
- If successful, cardiac function should improve immediately

Pericardiocentesis is a temporary procedure. If repeat aspiration is needed, it is likely that a pericardiotomy will be needed. Always try to discuss the case with a cardiothoracic surgeon.

3) *Thoracic great vessel injuries*: Injury to the pulmonary veins and arteries is often fatal, and is one of the major causes of on-site death.

4) *Rupture of trachea or major bronchi***:** Rupture of the trachea or major bronchi is a serious injury with an overall estimated mortality of at least 50%. The majority (80%) of the ruptures of bronchi are within 2.5 cm of the carina.

The usual signs of tracheobronchial disruption are:
- haemoptysis
- dyspnoea
- subcutaneous and mediastinal emphysema
- occasionally cyanosis.

Trauma to the oesophagus

This is rare in patients with blunt trauma, and more frequent in association with penetrating injury.. It is lethal if unrecognised, because of mediastinitis. Patients often complain of sudden sharp pain in the epigastrium and chest with radiation to the back. Dyspnoea, cyanosis and shock occur but these may be late features. Urgent IV broad spectrum antibiotics covering both aerobic and anaerobic organisms, as well as nil by mouth nursing are required.

Diaphragmatic injuries

These may occur in association with either blunt or penetrating chest trauma, paralleling the rise in frequency of car accidents. The diagnosis is often missed.

Diaphragmatic injuries should be suspected in any penetrating thoracic wound which is:
- below 4th intercostal space anteriorly
- 6th interspace laterally
- 8th interspace posteriorly

They are more commonly seen on the left side.

Thoracic aorta rupture

This occurs in patients with severe decelerating forces such as high speed car accidents or a fall from a great height. It has a very high mortality due to rapid exsanguination; the total adult blood volume of 5 litres may be lost in the first minute following injury.

Abdominal trauma

Abdominal injuries are common and, if unrecognised, may prove fatal. Any patient involved in any serious accident should be considered to have an abdominal injury until it has been ruled out.

Severe visceral injuries occur more frequently in children than in adults. Unexplained blood loss evident during the primary assessment may be due to intra-abdominal haemorrhage.

The abdomen is a classical silent area after trauma. It has to be actively cleared of injury rather than simply noted to be soft and non-tender, especially in the face of altered consciousness.

Cardiovascular decompensation may occur late and precipitously.

The organ most commonly injured in penetrating trauma is the liver, and in blunt trauma the spleen is often torn and ruptured. This is especially the case in children where these organs are poorly protected by ribs and muscles and especially where chronic illness may cause enlargement and fragility of the liver and spleen.

Thorough history-taking and a careful examination of the abdomen may give clues to as the origin of bleeding or perforation.

Gastric distension may cause respiratory embarrassment, and a gastric tube should be placed.

In order to gain cooperation in a frightened child, placing the examiner's hand over the mother's hand to undertake palpation.

There are two basic categories of abdominal trauma:
1.*penetrating trauma* where surgical consultation is urgent:
For example**:**
- gunshot
- stabbing

2. *non-penetrating trauma*
- compression
- crush
- seat belt
- acceleration/deceleration injuries

About 20% of trauma patients with acute haemoperitoneum have no signs of peritoneal irritation at the first examination, and *repeated primary assessment* must be undertaken.

Blunt trauma can be very difficult to evaluate, especially in the unconscious patient. These patients may need a peritoneal lavage. However, an exploratory laparotomy may be the best definitive procedure if abdominal injury needs to be excluded.

Complete physical examination of the abdomen includes rectal examination (although this should be avoided in children as a routine and only performed if clinically indicated), assessing:

- sphincter tone
- integrity of rectal wall
- blood in the rectum

Remember to check for blood at the external urethral meatus.

Women should be considered pregnant until pregnancy is excluded. The fetus may be salvageable, and the best treatment of the fetus is resuscitation of the mother. A pregnant mother at term, however, can usually be resuscitated properly only after delivery of the baby. This difficult situation must be assessed at the time.

The diagnostic peritoneal lavage (DPL) may be helpful in determining the presence of blood or enteric fluid due to intra-abdominal injury. The results can be highly suggestive, but it is overstated as an important diagnostic tool. If there is any doubt, a laparotomy is still the gold standard.
The indications for DPL include:
- unexplained abdominal pain
- trauma of the lower part of the chest
- hypotension, hematocrit fall with no obvious explanation
- any patient suffering abdominal trauma and who has an altered mental state
- patient with abdominal trauma and spinal cord injuries
- pelvic fractures.

The relative contraindications to DPL are:
- pregnancy
- previous abdominal surgery
- operator inexperience
- if the result would not change your management, for example if laparotomy is planned.

Other specific issues with abdominal trauma:
- *Pelvic fractures* are often complicated by massive haemorrhage and urological injury.
- It is important to examine the rectum for the presence of blood and for evidence of rectal or perineal laceration (see above for approach in children).
- X-ray of the pelvis may be valuable, if clinical diagnosis is difficult.

The management of pelvic fractures includes:
- resuscitation (ABC)
- transfusion
- immobilisation and assessment for surgery
- analgesia.

In a severely injured child, a urinary catheter should be inserted. This may be omitted in small babies and in less severely injured children. Small boys are particularly prone to urethral stricture after catheterisation. If the mechanism of injury is of concern, it is important to exclude renal tract injury, by examining the first urine for red blood cells.

Management of severe abdominal injury

Abdominal ultrasound (and computed tomography scanning, if available), have become invaluable adjuncts to the secondary assessment, not only for diagnosing intra-abdominal injury, but also for monitoring progress when a defined injury is being managed conservatively.
Bleeding from solid organs may not show up immediately in the resuscitation room, and evidence of hollow-organ rupture may take 24 hours or more to show as free fluid on ultrasound. This commits the trauma team to a high index of suspicion well beyond the classical "golden hour". This phrase indicates the importance of prompt identification and resuscitation of Airway, Breathing or Circulation problems that, without intervention, would lead to further damage from hypoxia and hypovolaemia being suffered by the injured patient.

Patients with refractory shock, penetrating injuries or signs of perforation require laparotomy.

Other injuries may be managed conservatively. After initial fluid transfusion, an experienced surgeon may decide that bleeding from an injured spleen, liver or kidney does not require immediate operative intervention. Computed tomography (CT) scanning, if available, is an invaluable aid to decision-making.

Splenic injury is relatively common, and can occur after relatively minor trauma, especially if the spleen is enlarged following an inflammatory process or infection, notably malaria. Signs include left upper quadrant pain and tenderness, with referred pain to the shoulder tip. Non-operative management is used frequently in many centres, but long-term problems of splenectomy are insignificant in comparison to the potential consequences of inadequate supervision of conservative management.

Increasingly, *liver injuries* are also being managed conservatively. Unlike the relatively straightforward operation of splenectomy, operative liver repair or resection is hazardous, and packing plays a major role in the operative management of uncontrolled hepatic bleeding.

Injuries to the retroperitoneal organs, such as the kidneys or pancreas, may present with vague or atypical signs, again requiring a high index of suspicion. A significant kidney injury does not always cause demonstrable haematuria.

Ultrasound studies and dynamic contrast CT scans (if available) may provide valuable information on renal structure and function, but false negatives commonly occur. Intravenous urography remains useful for demonstrating the details of renal and ureteric injury, especially in centres without a CT scanner. Pancreatic injury may occur with a normal amylase level, and the amylase may be raised in the absence of pancreatic damage.

Spinal trauma

Managing spinal cord injuries is particularly difficult in low -income settings, where spinal surgery may not be available within the country. Usually patients in these settings have not been handled carefully in transport from the site of injury to the hospital. Decisions have to be made as to whether or not cervical spinal immobilisation is appropriate, especially if it could interfere with airway resuscitation.

Spinal injury should be ruled out in any patient who has been subject to a mechanism of injury capable of damaging the spine

This seemingly obvious statement draws attention to the fact that it is often surprisingly difficult to ascertain whether there has been an injury to the spine or not, particularly in the face of a concomitant head injury, or in a child who is too young to communicate.

Even in an alert older child, distracting pain from a limb injury may lead the patient to ignore and deny neck pain, even when a spinal fracture exists. Radiological clearance in children is further complicated by the difficulty of interpreting *X* rays of immature bones, and by the relative laxity of ligaments, which gives rise to pseudo-subluxation.

Spinal cord injury without radiological abnormality (SCIWORA) has been recognised as a problem in children.
Be aware of the significant incidence of Spinal Cord Injury Without Radiological Abnormalities (SCIWORA) in children.

Spinal injury is less common in children than in adults, partly because of the elasticity of the bones and ligaments. This same elasticity contributes to the different patterns of spinal injury seen. In the cervical spine, for example, injuries tend to occur at a higher level than in adults, and often span several segments rather than dissipating energy in fracturing a single vertebra.

Examination of potentially spine-injured patients must be carried out with the patient in the neutral position (i.e. without flexion, extension or rotation), and without any movement of the spine.
The patient should be:

- log-rolled;
- properly immobilised (in-line immobilisation, stiff neck cervical collar or sandbags);
- transported in the neutral position.

With vertebral injury (which may overlie spinal cord injury), look for:

- local tenderness;

- deformities, as well as for a posterior “step-off ” injury,
- oedema. .

Clinical findings pointing to injury of the cervical spine include:

- difficulties in respiration (diaphragmatic breathing - check for paradoxical breathing);
- flaccidity, with no reflexes (check rectal sphincter);
- hypotension with bradycardia (without hypovolaemia).

The entire spine should be palpated during a log-roll, when the patient is turned on to the side in a controlled way, keeping the spine in-line. The presence of palpable steps, bogginess or tenderness is noted. The limbs are examined for sensory and motor signs of focal or segmental deficit.

Neurological assessment

Assessment of the level of injury must be undertaken. If the patient is conscious, ask the patient questions relevant to his/her sensation, and ask him/her to try to make minor movements, to be able to assess motor function of the upper and lower extremities.
The following summarises key reflex assessment to determine level of lesion:

Motor response

- Diaphragm intact level C3, C4, C5
- Shoulder shrug C4
- Elbow flexion (biceps) C5
- Wrist extension C6
- Elbow extension C7
- Wrist flexion C7
- Abduction of fingers C8
- Active chest expansion Tl-T12
- Hip flexion L2
- Knee extension L3-L4
- Ankle dorsiflexion L5-S 1
- Ankle plantarflexion S1-S2

Sensory response

- Anterior thigh L2
- Anterior knee L3
- Anterolateral ankle L4
- Dorsum great and 2nd toe L5
- Lateral side of foot Sl
- Posterior calf S2
- Peri-anal and perineal sensation S2-S5

NB if no sensory or motor function is exhibited, with a complete spinal cord lesion, the chance of recovery is small.

A diaphragmatic breathing pattern, bradycardia, hypotension, peripheral vasodilatation and priapism suggest spinal cord injury.

Throughout the primary and secondary assessments, precautions for spinal protection should ideally be maintained, using a hard collar and side-supports (blocks and straps or sandbags and tape), except for airway procedures and local examination, when manual in-line immobilisation is reinstituted.

If the patient is alert, able to communicate clearly and has no distracting pain from another injury, the spine can be cleared clinically without resorting to Xrays.
Otherwise, ideally spinal precautions are maintained until radiological clearance is achieved and the patient is re-examined.

If possible, three Xrays of the cervical spine are required: cross-table lateral view with arm traction to reveal the C7-T1 interface; antero-posterior view and transoral odontoid peg view. These must be assessed by an experienced professional (if available), paying particular attention to the soft tissues as well as the bony structures.

If the mechanism of injury warrants it, thoracic and lumbar views are also required.

If the lower cervical spine is not adequately visualised on the lateral view, oblique views are requested. If the *X* rays are inadequate or show suspicious areas, CT scanning, if available, is recommended to confirm or exclude a fracture.

Other neurological injuries include damaged nerves to fingers and the brachial plexus.

Pelvic trauma

Pelvic injury remains a potentially life-threatening injury, especially if it is associated with a large retroperitoneal haematoma, or if the fracture site communicates with the rectum. External fixation of the pelvis may be valuable in controlling major venous haemorrhage.

It may be difficult to distinguish retroperitoneal haemorrhage from intraperitoneal haemorrhage, the latter requiring laparotomy.

Not all pelvic trauma is serious. Some pubic rami fractures are minor injuries, with little intervention required. Nevertheless, the pelvis is a ring structure that tends to break in two places. On inspecting the pelvic *X* ray, careful attention should be paid to the sacroiliac joints and sacral foramina, to seek subtle evidence of a second break in the ring.

Limb Trauma

In general, limb fractures in children are more likely to be managed conservatively than in adults, reflecting the child's capacity to heal, and the risk of interfering with growth plates. An understanding of the Salter-Harris classification of epiphyseal fractures is essential, and access to a radiological atlas of developmental stages is helpful.
Examination must include:

- skin colour and temperature
- distal pulse assessment
- grazes and bleeding sites
- limb’s alignment and deformities
- active and passive movements
- unusual movements and crepitation
- severity of pain caused by injury.

Management of extremity injuries

Aim to:
- keep blood flowing to peripheral tissues
- prevent infection and skin necrosis
- prevent damage to peripheral nerves.

Special issues relating to limb trauma:
- Stop active bleeding by direct pressure, rather than by tourniquet, as it can be left on by mistake, and this can result in ischaemic damage.

Open fractures:
Any wound situated in the neighbourhood of a fracture mustbe considered as a communicating one.

Principles of the treatment include:
- stop external bleeding;
- immobilise and relieve pain.

Early Fasciotomy

Compartment syndrome is fairly common, and often underestimated. This condition is caused by an increase in the internal pressure of fascial compartments, which may result from crush injuries, fractures, intramuscular haematomas or amputations. This causes compression of vessels, with resultant hypoperfusion and hypoxia of tissues, including peripheral nerves.

Compartment syndrome is rescognised by the following signs in a fractured or otherwise injured limb:
- pain, accentuated by passive stretching of the involved muscles
- decreased sensation
- swelling
- limb pallor
- limb paralysis
- absence of limb pulse

The final result of this compartment sundrome is ischaemic, or even necrotic, muscles with restricted function.

Fasciotomy involves cutting the fascial bands around the affected muscle to release the pressure within the compartment, allowing the tissues to re-perfuse. The procedure requires a good knowledge of the relevant anatomy and is usually performed by an orthopaedic surgeon.

Special issues regarding major trauma in pregnancy

Road traffic accidents are the most common cause. Intimate partner violence starts or increases in pregnancy, and 40% of women who are murdered are killed by a current or ex-partner.

Physiological changes of pregnancy which affect the management of trauma

Anatomical and physiological changes occur in pregnancy, which are extremely important in the assessment and resuscitation of the pregnant trauma patient.

Anatomical changes

- As the uterus increases in size during pregnancy, it becomes more vulnerable to damage by both blunt and penetrating injury. Before 12 weeks' gestation, it is protected by the bony

pelvis, but thereafter it is an abdominal organ. The uterine fundus reaches the umbilicus at 20 weeks, and the xiphisternum at 36 weeks.

- In the first trimester, the fetus is well- protected by the thick walled uterus and relatively large amounts of amniotic fluid. As pregnancy progresses, the uterine wall becomes thinner, providing less protection to the fetus.

- In late pregnancy, the uterus and its contents shield the maternal abdominal contents, providing a degree of protection to the maternal viscera, at the expense of fetal wellbeing.

Physiological changes in pregnancy

- increased tidal volume
- blood volume increased by 40% to 100ml/Kg
- increased basal heart rate to 85-90bpm
- 30% increased cardiac output
- fall in blood pressure of 5-15 mmHg
- aorto-caval compression as uterus increases in size from 20 weeks gestation ,with potential for reduced cardiac output
- upward displacement of diaphragm as uterus increases in size, with impact on lung volume, and predisposing to gastro-oesophageal reflux

Special issues in the traumatised pregnant woman/girl

Blunt trauma may lead to;

- haemorrhage from abdominal organs, notably spleen and liver;
- uterine irritability and premature labour;
- partial or complete uterine rupture;
- partial or complete placental separation (up to 48 hours after trauma);
- fetal death
- fetal distress

Pelvic fractures maybe associated with severe blood loss..

What are the priorities?

• assessment and resuscitation according to the ABC and neurological failure structured approach;
• resuscitation in the left lateral position after 20 weeks gestation to avoid aorto-caval compression: remember *left lateral tilt;*
• assessment of fundal height and tenderness, and fetal heart rate monitoring as appropriate.
• vaginal examination or speculum examination to assess vaginal bleeding,cervical dilatation and rupture of membranes;

If placenta praevia is known or suspected, digital vaginal examination should NOT be performed, as major haemorrhage may occur. Careful speculum examination is acceptable.

It is important to be alert to signs of hypovolaemia, which are delayed in pregnancy as the mother has a higher circulating volume. Hypovolaemia may compromise the fetus before the mother's vital signs become abnormal. A fall in maternal blood pressure is a late and ominous sign.

Resuscitation of the mother may save the baby also. There are times when the mother's life is at risk and the fetus may need to be delivered in order to save the mother.

Action plan

1. Call for the most senior help available.
2. Perform standard primary assessment and resuscitation.
3. In addition:

- Assess fetal wellbeing. Use ultrasound to detect fetal heart rate and to identify any retro-placental or intra-abdominal bleeding. Ultrasound is also useful in ascertaining the presentation of the fetus; transverse lie may suggest rupture of the uterus.
- Consider whether Caesarean section is indicated maternal or fetal reasons

Indications for Caesarean section (if safely available):

- cardiac arrest
- uterine rupture
- inadequate exposure during laparotomy for other abdominal trauma
- placental abruption
- an unstable pelvic or lumbo-sacral fracture with the patient in labour
- fetal distress with a viable fetus

Peri-mortem Caesarean section

This should be undertaken when maternal cardiac output has not been restored by cardiopulmonary resuscitation (CPR). Delivery should ideally be accomplished within 5 minutes of cardiac arrest.

The rationale behind Peri-mortem Caesarean section is as follows:

- Improvement in maternal cardiac output due to relief of aorto-caval compression;
- Improvement in maternal oxygenation;
- Greater efficacy of CPR due to better access.

Peri-mortem Caesarean section should be undertaken with a left lateral tilt of 15 to 30 degrees or, preferable with manual displacement of the uterus. CPR should continue throughout, until cardiac output is restored. The operation should take place at the scene of cardiac arrest, rather than moving the patient to the operating theatre, which wastes precious time. Blood loss is minimal until cardiac output resumes. The woman can be moved to the operating theatre once cardiac output is restored. The fetus may survive, but this is a secondary consideration; the aim of Peri-mortem Caesarean section is to save the mother's life as resuscitation is more likely to be effective if the gravid uterus is emptied.

Secondary assessment

Left lateral tilt should be maintained throughout the assessment, in order to minimise aort-caval compression. When spinal injury is suspected, manual displacement of the uterus should be undertaken instead.

Specific types of trauma

Blunt trauma
The three commonest causes are motor vehicle accidents, falls and intimate partner violence.

Uterine rupture due to blunt trauma is relatively rare.

Blunt trauma to the abdomen may cause placental abruption. Kleihauer testing, if available, is useful in detecting feto-maternal haemorrhage as an indicator of placental damage.. Detection of intra abdominal haemorrhage may be difficult in pregnancy, so laparotomy should be considered..

Remember that the mother may lose a third of her blood volume before the vital signs become abnormal.

Penetrating Abdominal Wounds

Knife and gunshot wounds are the most common. Penetrating injuries can cause uterine injury at any stage of pregnancy. The uterus, fetus and amniotic fluid reduce injury to the mother by absorbing energy and displacing bowel upwards and to the side. Penetrating injuries above the uterus may cause extensive gastrointestinal and vascular damage. Exploratory laparotomy is usually required in the management of penetrating abdominal wounds, in pregnancy as in the non-pregnant.

Thoracic trauma

Injury to major thoracic structures is particularly dangerous in pregnancy, due to the combination of pre-existing relative aorto-caval compression, reduced respiratory excursion and increased oxygen requirement. However, most injuries can be identified by careful assessment, and managed with simple measures, including left lateral tilt and facial oxygen.

Pathway of Care: Trauma in Pregnancy

Primary assessment and Resuscitation	**Airway**: increased risk of aspiration – early nasogastric tube **Breathing**: if chest drain needed, place at higher level (3rd or 4th intercostal space). **Circulation**: left lateral tilt. Abnormalities in pulse rate, BP and capillary refill are late because of increased blood volume of pregnancy. Significant hypovolaemia compromises fetus; therefore treatment with IV boluses of Ringer-Lactate or Hartmann's, and then blood (if due to haemorrhage) as soon as possible. **Avoid hypotension.** **Neurological failure**: convulsions may be due to eclampsia as well as head injury

Secondary assessment and emergency treatment:

Assess for:

- Ruptured uterus and placental abruption after blunt trauma to abdomen (including seatbelt injury). (Uterine tenderness, vaginal bleeding, shock). They may be indistinguishable clinically. Scan may show fetal death or intra-abdominal fluid (blood).
- Rupture of membranes (by speculum)
- Fetal distress

Evidence of intra-abdominal bleeding or injury to abdominal organs

Consider bowel injury (compressed by uterus and therefore more vulnerable to blunt trauma or penetrating injuries)

Ensure anti-tetanus measures.
X rays as needed.
On discharge from hospital, patient to report abdominal pain, decreased fetal movements, vaginal bleeding or fluid leakage.

Special issues regarding major trauma in children

Trauma is a leading cause of death for all children, with a higher incidence in boys. The survival of children who sustain major trauma depends on the severity of the trauma, effective pre-hospital care and early resuscitation.

The initial assessment of the paediatric trauma patients is identical to that for the adult. The first priority is the Airway, Breathing, then Circulation, early neurological assessment, and finally exposing the child for full examination, without losing heat.

Paediatric 'NORMAL' values are helpful as follows:

Variable	**< 1 year**	**1-2 years**	**2-5 years**	**5 -12 years**	**>12 years**
Respiratory rate (breaths/minute)	30-40	25-35	25-30	20-25	15-20
Heart rate (beats/minute)	110-160	100-150	95-145	80-120	60-100
Systolic BP mm hg	70-90	80-95	80-100	90-110	100-120

Specific resuscitation and intubation issues in the child:

- the head, tongue and nasal airway are relatively large;
- the angle of the jaw is greater, the larynx is higher and the epiglottis is proportionally bigger and more "U"-shaped;
- the cricoid is the narrowest part of the larynx, which limits the size of the ETT. By adult life, the larynx has grown and the narrowest part is at the cords;
- obligatory nose breathing occurs in small babies;
- the trachea in the full-term new-born is about 4 cm long, and will admit a 2.5 or 3.0 mm diameter ETT. (The adult trachea is about 12 cm long);
- gastric distension is common following resuscitation, and a naso-gastric tube is useful to decompress the stomach.

If tracheal intubation is required, avoid cuffed tubes in children less than 10 yrs., so as to minimise subglottic swelling and ulceration. Oral intubation is easier than nasal for infants and young children.

Shock in the paediatric patient:

The femoral artery in the groin and the brachial artery in the antecubital fossa are the best sites to palpate pulses in the child. If the child is pulseless, cardiopulmonary resuscitation should be commenced.

Signs of shock in paediatric patients include:

- tachycardia
- weak or absent peripheral pulses
- capillary refill time > 3 seconds
- tachypnoea
- agitation

- drowsiness
- poor urine output.

Hypotension is a late sign, even in the presence of severe shock.

A normal urine output is 1-2 ml/kg/hour for the infant, and 0.5-1 ml/kg/hour in the older child.

Hypothermia is a major problem in children because of their relatively large surface area. They lose proportionally more heat through the head. All fluids should be warmed. Exposure of the child is necessary for assessment, but consider covering as soon as possible.

Continuing care for patients who have suffered major trauma

Transfer

Not every hospital has the resources and expertise to safely care for injured pregnant women/girls and children. Ideally, children with serious injuries should be transported directly from the scene of the accident to a centre with such capability (if one exists in the country). Even then, geographical constraints may render transfer unsafe.

Patients should be transported only if they are going to a facility that can provide a higher level of care.

Even when the transfer is urgent, it is essential to achieve physiological stability before embarking on a hazardous journey in the isolated environment of the ambulance. Thorough assessment should take place prior to transfer, to exclude co-existing life-threatening conditions which may be amenable to treatment on site. For example a child with a head injury should not be transferred in a hypotensive condition from unrecognised and untreated intra-abdominal bleeding.

Effective communication is essential, with:

- the receiving centre;
- the transport service;
- escorting personnel;
- the patient and relatives.

Communication between the referring and the admitting clinicians is necessary, not only to agree that transfer is indicated, but also to establish guidelines for care in transit, and to warn the receiving centre when the patient is expected to arrive.

Effective stabilisation necessitates:
- prompt initial resuscitation;;
- control of haemorrhage and maintenance of the circulation;
- immobilisation of fractures;
- analgesia.

Remember: if the patient deteriorates, re-evaluate the patient by using the primary assessment, checking and treating life-threatening conditions, then make a careful assessment focussing on the injures area.

Inter-hospital transfer requires careful planning, to provide:

- . trained medical and nursing escorts;

- . simple, compact, robust equipment;
- . drugs for resuscitation, sedation, pain relief and muscle relaxation;
- . fluids and blood products if indicated;
- . a suitable vehicle and ambulance staff.

In trauma care, some transfers are time-limited, for example to evacuate an extradural haematoma. In such cases, the extra time taken for a retrieval team to reach the referring hospital may offset the benefit of their specialised skills.

Perioperative care in major trauma

In the operating theatre, definitive anatomical reduction, repair or resection of individual injuries takes place. While the surgical team focuses on anatomical correction, the anaesthetic team maintains physiological system control. The impetus and sense of urgency evident in the Emergency Department should be maintained, without losing the thoroughness necessary to manage all aspects of care.

If the patient has a significant head injury, the anaesthetic agents should be chosen to avoid increasing intracranial pressure or cerebral blood flow. In general, this means avoiding high doses of volatile agents such as Halothane or Isoflurane. Ketamine has long been considered to be contraindicated in head injury, although there is recent evidence that challenges this view. It may be the only anaesthetic available.

If the child is undergoing lengthy extra-cranial surgery in the face of a severe head injury, it is wise to observe the pupils at frequent intervals.

Maintaining the child's core temperature is a key aim during prolonged surgery. Hypothermia impairs platelet function and increases the risk of infection, though it has been claimed to help preserve brain function in severe head injury. The ambient temperature should be adjusted, without sacrificing acceptable operating conditions for the surgical and anaesthetic teams.

High dependency care

In the immediate management of the injured patient, the focus was on physiological assessment and intervention using an ABC structured approach, followed by anatomical assessment and definitive care.

When high dependency care is instituted, physiological stabilisation again becomes the main concern, though it is important to remain alert to recognise any further injuries not evident in the secondary assessment. Detailed physiological control is facilitated by monitoring and good nursing.

Step-down care and rehabilitation

High-dependency care, acute ward care and rehabilitation serve to minimise disability, rather than influence mortality, which is already largely determined by this time. The emphasis shifts towards integration back into normal life, physically and psychologically, though the course may be interrupted by further reconstructive surgery.

Section 13 Quiz 1.

In the management of the seriously injured which of the following statements are true?

a) Cervical spine control should be maintained while assessing the airway providing this does not prevent airway opening which has priority
b) Jaw thrust should be avoided if there is a possibility of a cervical spine injury
c) Facial burns may be an indication that early intubation is desirable
d) If a massive haemothorax is suspected in the primary survey, it should be drained prior to gaining IV access
e) High flow O_2 is only needed if low oxygen saturations are shown by pulse oximetry

Section 13 Quiz 2. When assessing circulation in the seriously injured which of the following statements are true?

a) A raised HR alone is a good sign of blood loss
b) Blood pressure may be normal despite loss of more than a 1/3 of blood volume
c) The intraosseous route as an alternative to IV access should be considered early in the resuscitation of children.
d) Capillary refill time is more reliable if assessed on the hand than over the sternum?

Section 13 Quiz 3. During the primary survey which of the following statements are true?

a) Part of assessment of the CNS includes checking blood glucose early
b) Close attention to airway, breathing and circulation is the best management for any brain injury
c) The treatment for a flail chest airway involves intubation
d) Suspected bleeding from an intra-abdominal injury always requires surgery

Section 13 Quiz 4. When evaluating major trauma which of the following statements are true?

a) An AP CXR and pelvic x-ray are indicated early in management
b) If no fractures are seen on a child's CXR severe underlying damage is unlikely to be present
c) The lateral cervical spine x-ray will identify 95% of fractures
d) The skull x-ray is more useful than repeated neurological examination for detecting intracranial injury
e) Morphine when indicated, should be given intravenously

ANSWERS:

1. ac 2. abc 3. abc 4. ae

Section 13 Quiz 5.

In which of the following circumstances should Spinal injuries be suspected?

a) in multiply injured patients
b) if there are injuries above the clavicle
c) if the injured is a pedestrian hit by a vehicle

Section 13 Quiz 6.

When treating trauma patients which of the following statements are true?

a) The frightened, uncooperative child and hypoxic older patient will not benefit from aggressive effort to immobilize the neck
b) All patients with major trauma should have full spinal stabilisation and be treated as if they have a cervical spine injury until proven otherwise
c) Examining the back by logrolling a mother or older child requires 4 people
d) When cardiac tamponade is treated, aspiration of blood from the pericardium leads to a permanent improvement in cardiac function
e) Anti tetanus prophylaxis should be given

Section 13 Quiz 7.

What are the 6 life threatening chest injuries to diagnose and treat in the primary survey?

ANSWERS:

5. abc 6. abce 7. airway obstruction, tension pneumothorax, open pneumothorax, massive haemothorax, flail chest, cardiac tamponade

Section 13 Quiz 8.

Which of the following physiological changes of pregnancy are correct and affect the management of trauma?

a) Basal heart rate decreased
b) Fall in blood pressure
c) Increased blood volume
d) Vena caval compression with increasing uterine size
e) Upward displacement of diaphragm compromising respiratory function

Section 13 Quiz 9.

The primary survey of the injured pregnant patient must include which of the following?

a) Airway assessment and protection
b) Providing lateral tilt or manual displacement of the uterus after 20 weeks gestation
c) Aggressive volume replacement
d) USS to assess fetal wellbeing

Section 13 Quiz 10.

Which of the following are indications for Caesarean section in the management of major trauma in pregnancy?

a) Cardiac arrest, primarily for fetal survival
b) Uterine rupture
c) Bleeding from a pelvic fracture which cannot be stabilised
d) Other abdominal trauma, if there is inadequate exposure at laparotomy

Section 13 Quiz 11.

In major trauma what are the 4 areas where blood loss can be concealed?

Section 13 Quiz 12.

Concerning trauma occurring in pregnancy which of the following statements are true?

a) Domestic violence often starts or increases during pregnancy
b) Risk of placental abruption is not uncommon with blunt abdominal trauma
c) Intra abdominal haemorrhage is relatively easy to detect clinically
d) Penetrating injuries above the uterus are an indication for early laparotomy
e) Burns to face and neck warrants early consideration of endotracheal intubation

ANSWERS:

8. bcde 9. abc 10. bcd 11. chest, abdomen, pelvis, femur 12. abde

The child with burns (IMEESC 5.3 and Best Practice Protocol)

The commonest cause of death within the first hour after burns is smoke inhalation. Thus attention to the airway and breathing is of prime importance.

Pathway of Care: burns in a child

Primary Survey:	Airway –	look for inhalation injury – deposits round mouth - carbon in sputum - burns to face
	Breathing –	look for lung injury circumferential burns to chest Carbon monoxide poisoning?
	Circulation –	shock is late in burns
	Disability –	AVPU, pupils, posture
	Exposure	

Emergency treatment:	Airway -	protect
	Breathing -	high flow oxygen
	Circulation -	IV access, bloods for FBC, X match
	Disability -	if PU on AVPU support airway and breathing

Secondary survey:	Exclude other injuries
	Assess burn - surface area depth – superficial, partial thickness, full thickness? Special areas involved? – mouth, hands, perineum

Treatment:	Analgesia – oral codeine, entonox, IV morphine Consider ranitidine for stress ulceration (refer to paediatric formulary for dosage at different ages) 100% O_2 if CO poisoning
IV Fluid therapy -	burns >10% Fluid (crystalloids) additional to maintenance ml/day = % burn x wt (Kg) x 4 Give half of additional fluid in first 8 hours – colloids may be better but are not calculated according to this formula. The quantity of fluid given in the first 8 hours must include any fluids given as a resuscitation bolus. Keep urine output >1ml/kg/hr
Wound care -	cover burns with sterile dressings leave blisters prevent contractures
	High protein diet + multivitamins Monitor Hb Mobilise Splint joints in position of function

Primary assessment

Remember other injuries may exist. Follow a structured approach

Emergency treatment

Follow a structured approach

Secondary assessment

Other injuries may occur from a blast, falling objects, or while trying to escape. Follow a structured approach

Assessing the burn:

Surface area

- estimate using burns charts
- or with the patient's palm and adducted fingers (1% body surface area)
- do not use rule of nines <14 years old, but acceptable for mother

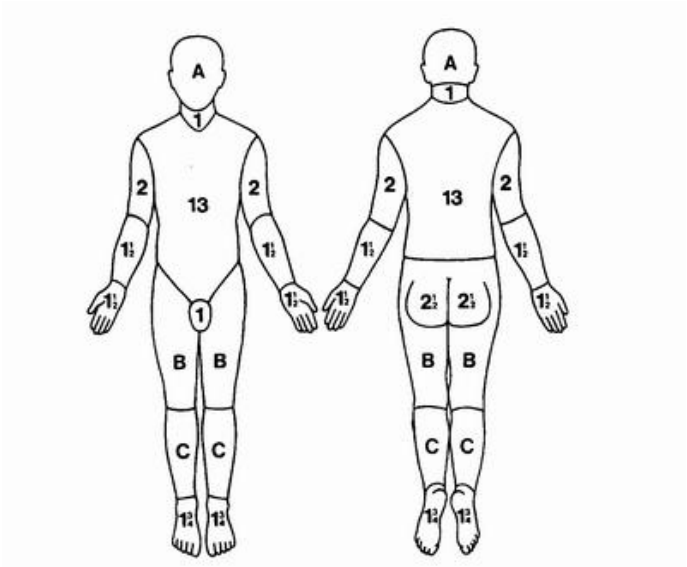
Depth

- superficial - injury only to the epidermis; skin is red with no blister formation
- partial thickness - some damage to the dermis; blistering is usually seen and the skin is pink or mottled
- full thickness - damage to epidermis, dermis and below; the skin looks white or charred, and is painless and leathery to touch.

Special areas

- face and mouth - risk of inhalational injury
- hand - can cause severe functional loss if scarring occurs
- perineal burns - prone to infection and are difficult to manage

Area indicated	Surface area (%) at				
	0	**1 year**	**5 years**	**10 years**	**15 years**
A	9.5	8.5	6.5	5.5	4.5
B	2.75	3.25	4.0	4.5	4.5
C	2.5	2.5	2.75	3.0	3.25



Specific treatment

Analgesia

- IV morphine 100 micrograms/kg early in burn if severe pain is present: later use WHO ladder
- Ketamine 5 to 10mg/Kg in a child can be given orally, PR or IM for dressing changes. If given IV, use lower dose of 500 micrograms to 1mg/Kg. **Person administering this drug must be capable of managing the airway and breathing.** In children give atropine 20 micrograms/Kg IM before the ketamine.
- Consider ranitidine oral or IV (refer to paediatric formulary for dosage) twice daily to reduce stress ulceration

Inhalation of toxic fumes

- toxic gases include carbon monoxide and hydrogen cyanide
- give 100% oxygen

Fluid therapy

- with burns of >10% give IV fluids **additional to maintenance**.
- calculate as fluid (ml of crystalloid) / day = percentage burn (%) x weight (kg) x 4 give half this in the first 8 hours (calculate from the actual time of burn) after the burn - (Ringer-Lactate or Hartmann's). *The quantity of fluid given in the first 8 hours must include any fluids given as a resuscitation bolus.*

Assessment of the size and extent of the burn is difficult. This formula is only a rough guide and it is essential to reassess the fluid state of the patient regularly.

- keep urine output at >1ml/kg/hour
- consider bladder catheterisation if shocked

Wound care

Started early, this will reduce infection and provide analgesia

- Cover burns with sterile towels / cling film (not circumferentially)
- Leave blisters intact
- Avoid unnecessary examination
- Prevent contractures: escharotomies if burn constricts limb blood supply

BURNS IN THE PREGNANT MOTHER (IMEESC 5.3 and Best Practice Protocol)

These may be flame burns, scalds, chemical or electrical burns. Any burn affecting more than 20% total body surface area (TBSA) is a serious risk to the mother and fetus. In a mother with a burn > 70-80% of the TBSA mortality is 50-90%. If the burn affects < 30% TBSA the prognosis is good for both fetus and mother and depends on the management of complications such as hypoxia, hypotension and sepsis. If the pregnancy has reached more than 36 weeks, delivery maybe advisable before complications set in.

Immediate first aid involves extinguishing the flames by wrapping the patient in a blanket or equivalent. Small burns can be cooled with clean cold water but if the burns are extensive, cold water may cause hypothermia.

Fluid loss is greatest in the first 12 hours, causing disturbances in fluid and electrolyte composition.

Primary Survey

Airway and breathing

Airway burns may cause immediate **or delayed** airway compromise so **consider early intubation** as severe swelling of the airway can lead to obstruction. Chemical damage may occur from highly irritant gases, which can lead to progressive respiratory failure. Many plastics and modern materials give off cyanide, which may be absorbed into the blood stream. Many plastics and modern materials give off cyanide, which may be absorbed into the blood stream. Carbon monoxide is the most common poison produced in fires.

Circulation

Assess the amount of body surface area burned

The rule of nines is used to assess the body surface area burned:

Head and neck 9%

Each upper limb 9%

Front of trunk 18% (the pregnant abdomen would represent a larger proportion of the total body surface area)

Back of trunk 18%

Each lower limb 18%

Perineum 1%

The area of the patient's palm represents about 1% of the body surface area

Assess the depth of the burn

In partial thickness burns sensation to pinprick and pain, sweat glands and hair follicles are preserved.

In full thickness burns the area is insensitive to pain and may appear dirty or white (the eschar).

A simple test to distinguish between partial and full thickness burns is to pull a hair out: if it comes out easily the burn is full thickness

IMEESC The following principles can be used as a guide to detect and manage respiratory injury in the burn patient:

- Burns around the mouth
- Facial burns or singed facial or nasal hair
- Hoarseness, rasping cough
- Evidence of glottic oedema
- Circumferential, full-thickness burns of chest or neck.

Assess the circulatory status.

- Secure IV access and replace fluids with warmed Ringer-Lactate or Hartmann's each containing 5 or 10% glucose (see appendix). A pregnant mother requires 2 to 4mls per kg per % of body surface area burnt to be given over the first 24 hours in addition to baseline maintenance fluids. Half of this volume is given in the first 8 hours, half in the next 16hours. *The quantity of fluid given in the first 8 hours must include any fluids given as a resuscitation bolus.*
- Monitor urinary output (should be > 30 ml per hour).
- **Assess the need to deliver the fetus. Fetal survival is poor in burns affecting > 50% TBSA. In view of the high perinatal mortality in mothers with extensive burns, those who are extensively burned and more than 32 weeks gestation should be delivered soon after admission. Abortion is common in patients with burns > 33% TBSA, especially during the second trimester. Fetal loss during the third trimester can be expected with extensive burns unless delivery occurs within 5days.** If the pregnancy has reached more than 36 weeks, delivery maybe advisable before complications set in.
- Consider the need for escharotomy, as burnt tissue may constrict the blood supply to the limbs.

The pregnant woman or girl or child with electrical injuries

Primary assessment and resuscitation
Call for help and **disconnect the electricity in a safe manner**

Be aware that high voltage sources can discharge through several centimetres of air.

Airway
The upper airway should be opened and secured especially if this is compromised by facial or other injuries. The cervical spine should be immobilised if there is a strong possibility of an unstable fracture.

Breathing
If the patient is not breathing give rescue breaths using a mouth to mouth technique if no equipment is available (e.g. in the home) and, if available, a bag and mask with high flow oxygen through an attached reservoir. If breathing but cyanosed or low oxygen saturation is present give inspired oxygen to keep SaO2 if pulse oximeter is available between 94 and 98%

Circulation
If the patient appears lifeless despite the rescue breaths, commence chest compressions and continue CPR as described in chapter 1.12 until help arrives. In the resuscitated or non-arrested patient brought to hospital, after ABC assessment and management, the entry and exit point of the current should be sought in order to determine a picture of the sort of possible internal injuries that could have occurred. Children with significant internal injuries have a greater fluid requirement than one would suspect on the basis of the area of the external electric burn.

Secondary assessment and emergency treatment
Other injuries should be treated in an appropriate and structured manner.
Associated injuries are common in electrocution. Almost all possible injuries can occur as a result of falls or being thrown from the source. Burns are particularly common and are caused either by the current itself or by burning clothing. Tetanic contraction of muscles can cause fractures, subluxations or muscle tearing.

Other problems
Burns cause oedema and fluid loss. Myoglobinuria occurs after significant muscle damage and acute renal failure is a possibility. In this case, it is important to maintain a urine production of more than 2 mL/kg/hour in a child or 60mL/kg/hour in pregnancy with the judicious use of diuretics such as mannitol and appropriate fluid loading. Alkalisation of the urine with sodium bicarbonate (1 mmol/kg in a child (1 mL/kg of 8.4% or 2 mL/kg of 4.2% solution) or 50 mmol in pregnancy increases the excretion of myoglobin.

Arrhythmias can occur up to a considerable time after the electrocution, and continuous ECG monitoring is helpful, if available.

Drowning in the pregnant woman or girl or child

Emergency treatment

- assess ABC and cervical spine
- assume neck injury in all cases, especially after diving
- ensure adequate oxygenation
- remove all wet clothes
- external re-warming if core temperature > 32 degrees C (radiant heaters, warmed dry blankets)

- core re-warming if core temperature < 32 degree C (warmed IV fluid (39 degree C) or gastric/lavage with warmed crystalloid at 42 degree C and heated humidified oxygen at 42 degree C)
- assume the stomach is full of water
  - aim for early nasogastric drainage and intubation (if possible)
- anticipate and treat hypothermia (measure with low reading thermometer in rectum)
- beware of shock after warming from vasodilatation (prevent core temperature exceeding 37 degree C). Treat with IV fluids.
- check for electrolyte abnormalities especially hyponatraemia - this will increase the risk of cerebral oedema
- keep blood glucose normal
- Prophylactic antibiotics are often given after immersion in severely contaminated water. Fever is common during the first 24 hours but is not necessarily a sign of infection. Gram-negative organisms, especially Pseudomonas aeruginosa, are common and Aspergillus species have been reported. When an infection is suspected broad-spectrum intravenous antibiotic therapy (such as cefotaxime) should be started after blood and sputum cultures (when possible).

Do not discontinue resuscitation until core temperature is at least 32 degree C or cannot be raised.

Failure to restore an adequate circulation after 30 minutes of resuscitation after re-warming to 32-35 degree C makes further efforts unlikely to be successful.

Section 13 Quiz 13.

When considering burns which of the following statements are true?

a) The rule of nines is used to assess the body surface area burned in pregnancy
b) Inhalation of Carbon monoxide is a serious complication of fires
c) If the burn has affected less than 30% of the body surface area of a pregnant mother, the prognosis is good for mother and fetus
d) Complications include hypotension, hypoxia and sepsis
e) Cooling extensive burns with cold water is always indicated as a first aid measure

Section 13 Quiz 14.

When assessing and treating major burns which of the following statements are true?

a) Full thickness burns are very painful
b) Partial thickness burns have hair follicles preserved
c) If a pregnant mother is more than 30/40 gestation, delivery may be advisable
d) Fluid loss via burnt skin may be extensive and is initially treated with IV crystalloid or colloid in addition to maintenance fluids
e) Subsequent IV fluids should be guided by urine output and measurement of plasma electrolytes.

Section 13 Quiz 15.

When considering burns in children which of the following statements are true?

a) The rule of nines is an effective way to assess surface area of burn
b) The patient's palm and outstretched fingers can be used to estimate every 1% body surface area of burn
c) It is important to exclude other injuries
d) Inhalation of a significant amount of carbon monoxide will cause central cyanosis
e) Blisters should be left intact

Section 13 Quiz 16.

When there has been near drowning, which of the following statements are true?

a) A neck injury should be assumed
b) A low reading rectal thermometer may be needed to measure body temperature
c) Core re-warming is needed if core temperature is < 32°C
d) Resuscitation should not be discontinued until the core temperature is at least 32°C or cannot be raised
e) Hypovolaemic shock may occur after re-warming

ANSWERS:

13. abcd 14. bcde 15. bce 16. abcde

The pregnant woman or girl or child suffering envenomation

Diagnosis and Initial Assessment

- assess ABCD: shock is common in viper bites
- endotracheal intubation and assisted ventilation if available and sustainable are indicated for bulbar palsy and paralysis of intercostal muscles and diaphragm (alternatively prolonged bag/mask ventilation – possibly in rotation by family members)
- look for signs of bleeding
- look for early signs of neurotoxicity: ptosis, limb weakness, or difficulties in talking, swallowing or breathing
- check for muscle tenderness and myoglobinuria in sea-snake bites
- take blood for Hb, WCC and platelet count; prothrombin time, APTT and fibrinogen levels (if available); urea and creatinine; creatine phosphokinase (if available)
- if sophisticated clotting studies are unavailable, perform the 20 minute whole blood clotting test (WBCT20):

- place a few ml of freshly sampled blood in a new, clean, dry glass tube or bottle - leave undisturbed for 20 minutes at ambient temperature - tip vessel once - If blood is still liquid (unclotted) and runs out, patient has hypofibrinogenaemia ('incoagulable blood') as a result of venom-induced consumption coagulopathy - perform on admission and repeat 6 hours later

Further Management

- observe in hospital for at least 24 hours - envenoming can develop rapidly after latent period
- give antivenom if there are signs of envenoming; ideally type specific and have adrenaline available for possible anaphylaxis. Children require exactly the same dose as adults (dose is dependent upon amount of venom injected, not bodyweight). Dilute antivenom in two to three volumes of 5% glucose or Ringer Lactate or Hartmann's solution or 0.9% saline and infuse over 45 min to an hour. Infusion rate should be slow initially and gradually increased. Note: doses of antivenom vary considerably, follow instructions enclosed with the antivenom.
- fasciotomy is needed if there is clinical evidence of raised intra-compartmental pressure
- correct any coagulopathy as soon as possible using fresh blood if available and vitamin K 300 micrograms/kg IV
- if venom has been spat in the eyes, eg cobras, irrigate rapidly with water; adrenaline 0.5% drops may help reduce pain and inflammation
- avoid IM injections and invasive procedures in patients with incoagulable blood
- give tetanus prophylaxis
- excise any necrotic tissue

In *scorpion stings*

Control pain with infiltration of 1% lignocaine around wound or systemic morphine. Prazosin is effective for treating hypertension and cardiac failure (5-15 micrograms/kg two to four times a day increasing to control blood pressure to a maximum of 500 micrograms/kg/day for under 12 years and 20 mg/kg/day over 12 years). The patient should be lying down for the first four to six hours of treatment in case of a sudden fall in blood pressure.

The mother or child who has ingested drugs or poisons

- in poor countries the most commonly ingested poisons are kerosene and caustic solutions
- self-harm is a major cause in adolescents and in mothers
- most accidental ingestions are non-toxic and deaths are uncommon
- accidental poisoning is most common aged 18-36 months: ask specifically about access to prescribed drugs, household substances etc.
- many die from inhalation of carbon monoxide and other gases in household fires
- traditional remedies can sometimes be highly toxic
- alcohol and solvent abuse are common
- occasionally an adult will deliberately poison a child. It is necessary to have a high index of suspicion in such cases as the history of poisoning will not be given
- some drugs are particularly dangerous in overdose e.g. quinine, diphenoxylate with atropine and tricyclic anti-depressants

Pathway of Care Poisoning in a child

Safe approach – remove from inhaled poison
care with chemicals such as organophosphates (external decontamination)

Airway	- if consciousness depressed GCS <8 or P or U (AVPU) assume compromised protect airway by recovery position and intubation if possible
Breathing	- consider high concentration of oxygen (especially CO poisoning even if pink) give rescue breaths if necessary
Circulation	- treat shock and arrhythmias
Disability	- check blood glucose/give IV/NG glucose (5ml/Kg 10% glucose) check pupils – dilated suggests amphetamines, atropine, tricyclic antidepressants, constricted suggests opiates or organophosphates
Posture	- hypertonia suggests amphetamines, ecstasy or tricyclic antidepressant poisoining
Convulsions	- suggests hypoglycaemia (alcohol), tricyclic antidepressants or some insecticides
Exposure	-look for injection sites core temperature

Emergency treatment
– drink milk or water urgently after caustic substances
- naloxone if opiate suspected (10micrograms/Kg IV repeated every 2-3 minutes to maximum dose of 2mg)
- consider phenytoin if tricyclic antidepressant poisoning (15-20mg/Kg IV infusion over 30 minutes then 2.5 to 7.5mg/Kg 12 hourly
- consider sodium bicarbonate 1 mmol/kg in tricyclic poisoning

Drug elimination
- activated charcoal 1g/Kg urgent (not useful alcohol or iron) and repeat after 4 hours

-gastric lavage (for high lethality ingestions) 10 – 20 ml/kg 0.9% saline aliquots
NOT after corrosives or petroleum products
If charcoal is not available and a potentially life-threatening dose of poison has been taken (particularly of iron), give paediatric ipecacuanha (10 mL for those aged six months to two years and 15 mL for over two years plus a glass of water) to induce vomiting. Do not give ipecacuanha if the child has a decreasing level of, or impaired, consciousness. Do NOT give if corrosive solutions have been ingested or if kerosene, turpentine or petrol have been ingested as they could be inhaled following vomiting resulting in lipoid pneumonia.

Pathway of Care Poisoning in pregnancy

Assess: Safe approach – remove from inhaled poison
care with chemicals such as organophosphates (external decontamination)

Airway	- if consciousness depressed GCS <8 or P or U (AVPU) assume compromised protect airway by recovery position and intubation if available
Breathing	- consider high concentration of oxygen (especially CO poisoning even if pink) give rescue breaths if necessary
Circulation	- treat shock and arrhythmias
Disability	- check blood glucose/give IV/NG glucose (5ml 50% glucose) check pupils – dilated suggests amphetamines, atropine, tricyclic antidepressants, constricted suggests opiates or organophosphates
Posture	- hypertonia suggests amphetamines, ecstasy or tricyclic antidepressant poisoining
Convulsions	- suggests hypoglycaemia (alcohol), tricyclic antidepressants or some insecticides
Exposure	- look for injection sites -measure core temperature

Emergency treatment
– drink milk or water urgently after caustic substances
- naloxone if opiate suspected (0.8-2mg IV repeated every 2-3 minutes to maximum dose of 10mg)
- consider phenytoin if tricyclic antidepressant poisoning (15-20mg/Kg IV infusion over 30 minutes-not exceeding a dose rate of 50mg/minute then 2.5 to 7.5mg/Kg 12 hourly

Drug elimination – activated charcoal 50 grams urgent (not useful in alcohol or iron poisoning) repeat after 4 hours

OR

Gastric lavage (for high lethality ingestions such as iron) 250ml 0.9% Saline aliquots NOT after corrosives or petroleum products

Airway protection essential if impaired consciousness

Domestic violence (IMEESC 9.3)

Domestic Violence and Pregnancy

Domestic violence (partner violence) is reported in up to 1 in 5 pregnancies, often beginning or getting worse at this time. The risk of moderate-to-severe violence appears to be greatest in the post partum period. Battered women are at increased risk for miscarriage, premature labour, placental abruption, low birth weight infants, fetal injury and intra-uterine fetal death. As a result of violence, women are 5 times more likely to attempt suicide.

Injuries to the abdomen, genitals and breasts are most frequent in pregnancy but can be multiple affecting any part of the woman's body.

Recognising Domestic Violence in Pregnancy

Women who are being abused may be late and poor attendees at AN Clinics. They may attend repeatedly with trivial symptoms and appear reluctant to be discharged home. The partner may be constantly present not allowing for private discussion. The woman may seem reluctant to speak in front of or contradict her partner.

Any signs of violence on the woman's body will be minimised. As with child abuse, the mechanism of injury often does not fit with the apparent injury. There may be untended injuries of different ages or the late presentation of injuries. A history of behavioral problems or abuse in children in the family may be indicative.

Diagnosing Domestic Violence

Routinely ask mothers if they have been subject to violence. Questions such as the following may allow the woman to disclose that she is subject to violence:

- I have noticed you have a number of bruises. Did someone hit you?
- You seemed frightened by your partner. Has he ever hurt you?
- You mention that your partner loses his temper with the children. Does he ever with you?
- How does your partner act when drinking or on drugs?

Other strategies such as questionnaires in the Ladies' toilets may help those women whose husbands are constantly by their sides. Community midwives and TBAs visiting women at home may have the privacy to discuss such sensitive issues. The provision of interpreters is essential. Family members should not act as interpreters in this situation as free dialogue will probably not occur.

A system for caring for and protecting mothers subject to violence should be advocated for by all health professionals undertaking maternal and child healthcare.

Life threatening child abuse (IMEESC 5.2)

Introduction

The following injuries/apparent illnesses may occur as part of child abuse and can result in life-threatening emergencies.

Directly:	asphyxial event: suffocation, hanging, strangulation subdural haemorrhage poisoning and other induced illness (eg septicaemia) ruptured abdominal viscus cervical spine injury rib cage and long bone fractures drowning burns
Indirectly:	sexual abuse and severe emotional abuse (through later self poisoning or other suicidal acts

Suffocation

Suffocation can result in death or life threatening events with hypoxic ischaemic injury after prolonged episodes

Features suggesting that an Apparent Life Threatening Event (ALTE) is due to suffocation include:

- bleeding from the nose and/or mouth at the time of the ALTE (highly specific)
- petechial haemorrhages around the face
- strangulation marks
- recurrent severe apnoeic or cyanotic episodes with their onset always in the presence of one person
- events in infants over 6 months post term age
- Some of the following features (usually not known at time of presentation) in the possible perpetrator may indicate a predisposition to induce such an illness in their child:
    - Fabrication or induction of illness in themselves
    - History of false allegations of physical or sexual assault
    - Previous self-harm
    - Severely disrupted care in own childhood
    - Antisocial acts such as arson, domestic violence, violent crime, abuse of pets

Non-accidental brain injury

Presentation:	○ sudden onset of impaired consciousness in an infant ○ sudden fits in an infant ○ Apnoeic or cyanotic episode ○ Intractable vomiting ○ Unexplained anaemia
On examination:	○ Obvious head injury (unusual - suggests impact injury as well as shaking) ○ impaired consciousness ○ meningitic picture ○ bulging fontanellele ○ retinal haemorrhages

Ruptured abdominal viscus

Presentation:	○ shock ○ severe abdominal or chest/shoulder pain ○ vomiting
On examination:	○ shock ○ peritonism ○ abdominal bruising (uncommon) ○ haematuria ○ rectal bleeding

Indicators of abuse which although themselves are not life threatening indicate the possibility of future life threatening abuse

- torn frenulum
- extreme passivity and frozen watchfulness
- bruises indicating abusive behaviour by a carer (particularly in an infant)
- fractures particularly in an infant with X ray changes of multiple fractures of different ages
- cigarette burns
- genital injuries

Management of life threatening child abuse

1. ABCD depending on systems affected
2. Think of the possibility of abuse

3. Think of possibility of poisoning
4. Make diagnosis (good quality history, carefully recorded notes of history and examination, careful collection and labelling of forensic specimens, photographs of injuries, and x-rays, consider additional investigations such as covert video surveillance)
5. Check child protection register (if one exists)
6. Refer to child protection team (doctor, social services, police) if one exists; if not, advocate for Government to establish one

Section 13 Quiz 16

Which of the following statements are true concerning a child who has been poisoned?

a) Always inducing vomiting
b) Airway protection must be provided if there is decreased conscious level
c) Check the blood glucose
d) Give Naloxone if opiate ingestion
e) Phenytoin and Sodium bicarbonate are helpful if tricyclic antidepressant poisoning

Section 13 Quiz 17

Which of the following statements are true concerning Life threatening abuse?

a) In pregnancy leads to an increased risk of miscarriage, placental abruption and intrauterine fetal death
b) Questions should be routinely asked of pregnant women when they are alone
c) In children a bruise over the abdomen may indicate a dangerous intra-abdominal injury
d) In children should be suspected if the history does not fit with findings on examination
e) In infants may be suspected if there are x-ray changes of fractures of different ages

ANSWERS

16. bcde 17. abcde