

Primary Trauma Care Manual

Standard Edition

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A Manual for Trauma Management in District and Remote Locations

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Introduction

Trauma transcends all national boundaries. Many less affluent countries have a significant proportion of road and industrial trauma in a generally young population. Morbidity and mortality associated with such trauma can be reduced by early and effective medical intervention.

This Primary Trauma Care course is intended to provide basic knowledge and skills necessary to identify and treat those traumatised patients who require rapid assessment, resuscitation and stabilisation of their injuries. This course will particularly highlight the need for early recognition and timely intervention in specific life-threatening conditions.

This course is intended to provide material by lectures and practical skill stations that represents an acceptable method of management for trauma. It provides a very basic foundation on which doctors and health workers can build the necessary knowledge and skills for trauma management with minimal equipment and without sophisticated technological requirements.

There are several very successful and well organised trauma courses and manuals available, including the American College of Surgeons ATLS™ course and the EMST Australian course. These courses are directed to medical personnel in well equipped hospitals with oxygen, communication and transport etc. and offer a comprehensive syllabus. The Primary Trauma Care is not a substitute for these courses, but uses similar basic principles and emphasises basic trauma care with minimal resources.

The Objectives

At the completion of this course you should:

1. Understand the priorities of trauma management
2. Be able to rapidly and accurately assess trauma patients needs
3. Be able to resuscitate and stabilise trauma patients
4. Know how to organise basic trauma care in your hospital.

Trauma in Perspective

Most countries of the world are experiencing an epidemic of trauma, but the most spectacular increase has been in the developing countries. Proliferation of roads and use of vehicles has led to a rapid increase in injuries and deaths and many peripheral medical facilities find themselves faced with multiple casualties from bus crashes or other disasters. Severe burns are also common in both urban and rural areas.

A number of important differences between high and low-income countries make development of a specifically designed Primary Trauma Care Course beneficial. They include:

- the great distances over which casualties may have to be transported to reach a medical facility
- the time taken for patients to reach medical care
- the absence of high-tech equipment and supplies
- the absence of skilled people to operate and service it.

PREVENTION of trauma is by far the cheapest and safest mode to manage trauma. This depends on the location's resources and factors such as:

- culture
- manpower
- politics
- health budget
- training.

Every effort should be made by the medical trauma teams to address the above factors in the prevention of trauma. Much of this lies beyond the scope of this manual, but time will be spent on the course looking at local circumstances and prevention possibilities.

ABCDE of Trauma

The management of severe multiple injury requires clear recognition of management priorities and the goal is to determine in the initial assessment those injuries that threaten the patient's life. This first survey, the 'primary' survey, if done correctly should identify such life-threatening injuries such as:

- airway obstruction
- chest injuries with breathing difficulties
- severe external or internal haemorrhage
- abdominal injuries.

If there is more than one injured patient then treat patients in order of priority (Triage). This depends on experience and resources (Discussed in the practical sessions).

Apply monitoring equipment as soon as practicable and available. Ideally: ECG, blood pressure, oxymetry, and some method of measuring CO₂.

The ABCDE survey (Airway, Breathing, Circulation, Disability and Exposure) is undertaken. This primary survey must be performed in no more than 2-5 minutes. Simultaneous treatment of injuries can occur when more than one life-threatening state exists. It includes:

• **Airway**

Assess the airway. Can patient talk and breathe freely? If obstructed, the steps to be considered are:

- chin lift/jaw thrust (tongue is attached to the jaw)
- suction (if available)
- guedel airway/nasopharyngeal airway
- intubation. NB keep the neck immobilised in neutral position.

• **Breathing**

Breathing is assessed as airway patency and breathing adequacy are re-checked. If inadequate, the steps to be considered are:

- decompression and drainage of tension pneumothorax/haemothorax
- closure of open chest injury
- artificial ventilation.

Give oxygen if available.

Reassessment of ABC's must be undertaken if patient is unstable

- **Circulation**

Assess circulation, as oxygen supply, airway patency and breathing adequacy are re-checked. If inadequate, the steps to be considered are:

- stop external haemorrhage
- establish 2 large-bore IV lines (14 or 16 G) if possible
- administer fluid if available.

- **Disability**

Rapid neurological assessment (is patient awake, vocally responsive to pain or unconscious). There is no time to do the Glasgow Coma Scale so a

- awake A
- verbal response V
- painful response P
- unresponsive U

system at this stage is clear and quick.

- **Exposure**

Undress patient and look for injury. If the patient is suspected of having a neck or spinal injury, in-line immobilization is important. This will be discussed in the practical sessions.

NOTES... ☹

Airway Management

The first priority is establishment or maintenance of airway patency.

- **Talk to the patient**

A patient who can speak clearly must have a clear airway. The unconscious patient may require airway and ventilatory assistance. The cervical spine must be protected during endotracheal intubation if a head, neck or chest injury is suspected. Airway obstruction is most commonly due to obstruction by the tongue in the unconscious patient.

- **Give oxygen (if available, via self-inflating bag or mask)**

- **Assess airway**

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.

Be alert for foreign bodies. The techniques used to establish a patent airway are outlined in Appendix1 and will be reviewed in the practical sessions. Intravenous sedation is absolutely contraindicated in this situation.

- **Consider need for advanced airway management**

Indications for advanced airway management techniques for securing the airway include:

- persisting airway obstruction
- penetrating neck trauma with haematoma (expanding)
- apnoea
- hypoxia
- severe head injury
- chest trauma
- maxillofacial injury.

Airway obstruction requires URGENT treatment

Ventilation (Breathing) Management

The second priority is the establishment of adequate ventilation.

- **Inspection (LOOK) of respiratory rate is essential. Are any of the following present**
 - cyanosis
 - penetrating injury
 - presence of flail chest
 - sucking chest wounds
 - use of accessory muscles?
- **Palpation (FEEL) for**
 - tracheal shift
 - broken ribs
 - subcutaneous emphysema
 - percussion is useful for diagnosis of haemothorax and pneumothorax.
- **Auscultation (LISTEN) for**
 - pneumothorax (decreased breath sounds on site of injury)
 - detection of abnormal sounds in the chest.

Resuscitation action

This is covered in lecture and in practical sessions: see Appendix 5

- the chest pleura is drained of air and blood by insertion of an intercostal drainage tube as a matter of priority and before chest X-ray if respiratory distress exists
- when indications for intubation exist but the trachea cannot be intubated, direct access via a cricothyroidotomy may be achieved. See Appendix 1.

Special notes

- If available, maintain the patient on oxygen until complete stabilisation is achieved.
- If a tension pneumothorax is suspected then one large-bore needle should be introduced into the pleural cavity through the second intercostal space, mid clavicular line to decompress the tension and allow time for the placement of an intercostal tube.
- If intubation in one or two attempts is not possible a cricothyroidotomy should be considered priority. This depends on experienced medical personnel being available, with appropriate equipment, and may not be possible in many places.

DO NOT persist with intubation attempts without ventilating the patient

Circulatory Management

The third priority is establishment of adequate circulation.

‘Shock’ is defined as inadequate organ perfusion and tissue oxygenation. In the trauma patient it is most often due to hypovolaemia.

The diagnosis of shock is based on clinical findings: hypotension, tachycardia, tachypnoea, as well as hypothermia, pallor, cool extremities, decreased capillary refill, and decreased urine production. See Appendix 3.

There are different types of shock including:

Haemorrhagic (hypovolaemic) shock: Due to acute loss of blood or fluids. The amount of blood loss after trauma is often poorly assessed and in blunt trauma is usually underestimated. Remember

- large volumes of blood may be hidden in the abdominal and pleural cavity
- femoral shaft fracture may lose up to 2 litres of blood
- pelvic fracture often lose in excess of 2 litres of blood.

Cardiogenic shock: Due to inadequate heart function. This may be 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 and an ECG should be recorded if available.

Neurogenic shock: 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.

Septic shock: Rare in the early phase of trauma but is a common cause of late death (via multi-organ failure) in the weeks following injury. It is most commonly seen in penetrating abdominal injury and burns patients.

*Hypovolaemia is a life-threatening emergency
and must be recognised and treated aggressively*

Circulatory Resuscitation Measures (See Appendix 5)

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 two large-bore cannulas (14-16 G). Peripheral cut down may be necessary.
- Infusion fluids (crystalloids e.g. N/Saline as first line) 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.

Urine

Measure urine output as an indicator of circulation reserve. Output should be more than 0.5 ml/kg/hr. Unconscious patients may need a urinary catheter, if they are persistently shocked.

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.

First priority: stop bleeding

- Injuries to the limbs: Tourniquets do not work. Besides, tourniquets 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 subfascial 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 in-field placement of chest tube drain *plus* intermittent suction *plus* efficient analgesia (IV ketamine is the drug of choice) expand

Loss of blood is the main cause of shock in trauma patients

the lung and seal off the bleeding.

- Injuries to the abdomen: “Damage control laparotomy” should be done as soon as possible on cases where fluid resuscitation cannot maintain a systolic BP at 80-90 mm. The sole objective of DC laparotomy is to gauze pack the bleeding abdominal quadrants, whereafter the mid-line incision is temporarily closed within 30 minutes with towel clamps. DC laparotomy is not surgery, but a resuscitative procedure that should be done under ketamine anesthesia by any trained doctor or nurse at district level. This technique is something that needs to be observed before doing it, but done properly, can save lives.

Second priority: Volume replacement, warming, and ketamine analgesia

- The replacement should be warm: The physiological coagulation works best at 38.5°C, 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. Per oral and IV fluids should have a temperature at 40-42°C - using IV fluids at “room temperature” means cooling!
- Hypotensive fluid resuscitation: In cases where the haemostasis is insecure or not definitive, volumes should be controlled to maintain systolic BP at 80-90 mm during the evacuation.
- Colloid solutions out - electrolyte solutions in! Recent careful reviews of controlled clinical studies show slight negative effects of colloids compared to electrolytes in resuscitation after blood loss.
- Per-oral resuscitation is safe and efficient in patients with positive gag reflex without abdominal injury: Oral fluids should be low in sugar and salts; concentrated solutions can cause an osmotic pull over the intestinal mucosa, and the effect will be negative. Diluted cereal porridges based on local foodstuffs are recommended.
- The analgesic choice: The positive inotropic effects, and the fact that it does not affect the gag reflex, makes us recommend ketamine in repeated IV doses of 0.2 mg/kg during evacuation of all severe trauma cases.

Secondary Survey

Secondary survey is only undertaken when the patient's ABC'S are stable.

If any deterioration occurs during this phase then this must be interrupted by another PRIMARY SURVEY. Documentation is required for all procedures undertaken. This will be covered in the Forum.

The head-to-toe examination is now undertaken, noting particularly:

Head examination

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

Neck examination

- penetrating wounds
- subcutaneous emphysema
- tracheal deviation
- neck vein appearance.

Neurological examination

- brain function assessment using the Glasgow Coma Scale (GCS) (see Appendix 4)
- spinal cord motor activity
- sensation and reflex.

Chest examination

- clavicles and all ribs
- breath sounds and heart tones
- 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 (check for meatal blood before insertion).

Head injury patients are suspected to have cervical spine injury until proven otherwise

Pelvis and limbs

- fractures
- peripheral pulses
- cuts, bruises and other minor injuries.

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
- order others selectively. NB chest and pelvis X-rays may be needed during primary survey.

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Chest Trauma

Approximately a quarter of deaths due to trauma are attributed to thoracic injury. Immediate deaths are essentially due to major disruption of the heart or of great vessels. Early deaths due to thoracic 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 due to:

- haemothorax
- haemomediastinum.

Rib fractures: Fractured ribs may occur at the point of impact and damage to the underlying lung may produce lung bruising or puncture. In the elderly patient fractured ribs may result from simple trauma. 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.

Tension pneumothorax: Develops when air enters the pleural space but cannot leave. The consequence is progressively increasing intrathoracic pressure in the affected side resulting in mediastinal shift. The patient will become short of breath and hypoxic. Urgent needle decompression is required prior to the insertion of an intercostal drain. The trachea may be displaced (late sign) and is pushed away from the midline by the air under tension.

Haemothorax: More common in penetrating than in non-penetrating injuries 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.

*The extent of internal injuries cannot be judged
by the appearance of a skin wound*

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

- 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 is an indication for further investigation e.g. thoracotomy.

Pulmonary contusion: is common after chest trauma. It is a potentially life-threatening condition. The onset of symptoms may be slow and progress over 24 hrs 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 (short of breath)
- hypoxaemia
- tachycardia
- rare or absent breath sounds
- rib fractures
- cyanosis.

Open or “sucking” chest wounds of the chest wall. In these 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. A seal e.g. a plastic packet is sufficient to stop the sucking, and can be applied until reaching hospital. In compromised patients intercostal drains, intubation and positive pressure ventilation is often required.

The injuries listed below are also possible in trauma, but carry a high mortality even in regional centres. They are mentioned for educational purposes.

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. Patient must be submitted to observation with cardiac monitoring if available. This type of injury is more common than we think and may be a cause of sudden death well after the accident.

Pericardial tamponade: Penetrating cardiac injuries are a leading cause of death in urban areas. It is rare to have pericardial tamponade with blunt trauma. Pericardiocentesis must be undertaken early if this injury is considered likely. Look for it in patients with:

- shock
- distended neck veins
- cool extremities and no pneumothorax
- muffled heart sounds.

Beware pulmonary contusion and delay in deterioration of respiratory state

Pericardiocentesis is the first therapy and this will be discussed in the practical session.

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.

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 the followings:

- haemoptysis
- dyspnoea
- subcutaneous and mediastinal emphysema
- occasionally cyanosis.

Trauma to oesophagus: In patients with blunt trauma this is rare. More frequent is the perforation of the oesophagus by 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 symptoms.

Diaphragmatic injuries: Occur more frequently in blunt 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:

- below 4th intercostal space anteriorly
- 6th interspace laterally
- 8th interspace posteriorly
- usually the left side.

Thoracic aorta rupture: Occurs in patients with severe decelerating forces such as high speed car accidents or a fall from a great height. They have high mortality as the cardiac output is 5 l/min and the total blood volume in an adult is 5 litres.

Beware pericardial tamponade in penetrating chest trauma

Abdominal Trauma

The abdomen is commonly injured in multiple trauma. The commonest organ injured in penetrating trauma is the liver and in blunt trauma the spleen is often torn and ruptured.

The initial evaluation of the abdominal trauma patient must include the A (airway and C-Spine), B (breathing), C (circulation), and D (disability and neurological assessment) and E (exposure).

Any patient involved in any serious accident should be considered to have an abdominal injury until proved otherwise. Unrecognised abdominal injury remains a frequent cause of preventable death after trauma.

There are two basic categories of abdominal trauma:

- penetrating trauma where surgical consultation is important e.g.
 - gunshot
 - stabbing.
- non-penetrating trauma e.g.
 - compression
 - crush
 - seat belt
 - acceleration/deceleration injuries.

About 20% of trauma patients with acute haemoperitoneum (blood in abdomen) have no signs of peritoneal irritation at the first examination and the value of REPEATED PRIMARY SURVEY cannot be overstated.

Blunt trauma can be very difficult to evaluate, especially in the unconscious patient. These patients may need a peritoneal lavage. (Discussed in session.) 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, assessing:

- sphincter tone
- integrity of rectal wall
- blood in the rectum
- prostate position.

Remember to check for blood at the external urethral meatus.

Women should be considered pregnant until proven otherwise. The foetus may be

Blood catheterisation (with caution in pelvic injury) is important

salvageable and the best treatment of the foetus is resuscitation of the mother. A pregnant mother at term, however, can usually only be resuscitated properly 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 lavage 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 (drugs alcohol, brain injury)
- patient with abdominal trauma and spinal cord injuries
- pelvic fractures.

The relative contraindications for the DPL are:

- pregnancy
- previous abdominal surgery
- operator inexperience
- if the result does not change your management.

Other specific issues with abdominal trauma:

Pelvic fractures are often complicated by massive haemorrhage and urology injury.

- examining the rectum for the position of the prostate and for the presence of blood or rectal or perineal laceration is essential
- X-ray of the pelvis (if clinical diagnosis difficult).

The management of pelvic fractures includes:

- resuscitation (ABC)
- transfusion
- immobilisation and assessment for surgery
- analgesia.

Pelvic fractures often cause massive blood loss

Head Trauma

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 triage casualties carefully.

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

- **Acute extradural** - classically the signs consist of:
 - loss of consciousness following an lucid interval, with rapid deterioration
 - middle meningeal artery bleeding with rapid raising of intracranial pressure
 - the development of hemiparesis on the opposite side with a fixed pupil on the same side as the impact area.
- **Acute subdural haematoma** - with clotted blood in the subdural space, accompanied by severe contusion of the underlying brain. It occurs from tearing of bridging vein between the cortex and the dura.

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

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

- **Base-of-skull fractures** - bruising of the eyelids (Raccoon eyes) or over the mastoid process (Battle's sign), cerebrospinal fluid (CSF) leak from ears and/or nose
- **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.

Alteration of consciousness is the hallmark of brain injury

The most common error 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 patient who deteriorates.

Management of Head Trauma

The Airway, Breathing and Circulation are stabilised (and the C-spine immobilised, if possible). Vital signs of important indicators in the patients neurological status must be monitored and recorded frequently. Glasgow Coma Score (GCS) evaluation is undertaken: see Appendix 4.

Remember:

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

Deterioration may occur due to bleeding

- unequal or dilated pupils may indicate 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 not only interferes with the status of consciousness but will promote hypercarbia (slow breathing with retention of CO₂)
- the Cushing response is a specific response to a lethal rise in intracranial pressure. This is a late and poor prognostic sign. The hallmarks are:
 - bradycardia
 - hypertension
 - decreased respiratory rate.

Basic medical management for severe head injuries includes:

- intubation and hyperventilation, producing moderate hypocapnia (PCO₂ to 4.5-5 Kpa). This will reduce both intracranial blood volume and intracranial pressure temporarily
- sedation with possible paralysis
- moderate IV fluid input with diuresis i.e. do not overload
- nurse head up 20%
- prevent hyperthermia.

Never assume that alcohol is the cause of drowsiness in a confused patient

Spinal Trauma

The incidence of nerve injury in multiple trauma is higher than expected. The most common injuries include damaged nerves to fingers, brachial plexus and central spinal cord.

The first priority is to undertake the primary survey with evaluation of ABCDEscheme:

- A Airway maintenance with care and control of a possible injury to the cervical spine
- B Breathing control or support
- C Circulation control and blood pressure monitoring
- D Disability means the observation of neurological damage and status of consciousness
- E Exposure of the patient to assess skin injuries and peripheral limb damage.

Examination of 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 his spine. The patient should be:

- log-rolled (discussed in practical session)
- properly immobilised (in-line immobilisation, stiff neck cervical collar or sandbags). This will be discussed in the practical sessions
- transported in a 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 (swelling).

Clinical findings indicating injury of the cervical spine include:

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

C-Spine: (if available) In addition to the initial X-rays, all patients with a suspicion of cervical spine injury should include an AP and a lateral X-ray with a view of the atlas-axis joint. All seven cervical vertebrae must be seen on the AP and lateral.

Caution: Never transport a patient with a suspected injury of cervical spine in the sitting or prone position. Always make sure the patient is stabilised before transferring

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 try to ask him/her to do minor movements to be able to find motor function of the upper and lower extremities.

The following summarizes key reflex assessment to determine level of lesion:

Motor response

- Diaphragm intact level C3, C4, C5
- Shrug shoulders C4
- Biceps (flex elbows) C5
- Extension of wrist C6
- Extension of elbow C7
- Flexion of wrist C7
- Abduction of fingers C8
- Active chest expansion T1-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 S1
- Posterior calf S2
- Peri-anal sensation (perineum) S2-S5

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

*Loss of autonomic function with spinal cord injury
may occur rapidly and resolve slowly*

Limb Trauma

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
- level of pain caused injury.

Management of extremity injuries should 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 must be considered as a communicating one. Principles of the treatment include:
 - stop external bleeding
 - immobilise and relieve pain.
- Compartment syndrome is caused by an increase the internal pressure of fascial compartments; this pressure results in a compression of vessels and peripheral nerves situated in these regions. Perfusion is limited, peripheral nerves damaged and the final result of this condition is ischaemic or even necrotic muscles with restricted function.
- Amputated parts of extremities should be covered with sterile gauze towels which are moistened with saline and put into a sterile plastic bag. A non-cooled amputated part may be used within 6 hours after the injury, a cooled one as late as after 18 to 20 hours.

Deep penetrating foreign bodies should remain in situ until theatre exploration

Limb Support: Early Fasciotomy

The problem with compartment syndromes are often underestimated:

- Tissue damage due to hypoxemia: Compartment syndromes with increased intra muscular (IM) pressures and local circulatory collapse are common in injuries with intramuscular hematomas, crush injuries, fractures or amputations. If the perfusion pressure (systolic BP) is low, even a slight rise in IM pressure causes local hypoperfusion. With normal body temperature peripheral limb circulation starts to decrease at a systolic BP around 80 mmHg.
- The damage on reperfusion is often serious: If there is local hypoxemia (high IM pressure, low BP) for more than 2 hours, the reperfusion can cause extensive vascular damage. That is why decompression should be done early. In particular the forearm and lower leg compartments are at risk.

When the bleeding source is controlled, we recommend in-field fasciotomy of forearm and lower leg compartments if the evacuation time is 4 hours or more. Fasciotomy should be done by any trained doctor or nurse under ketamine anaesthesia at the district location.

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Special Trauma Cases

Paediatrics

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 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, without losing heat.

Paediatric 'NORMAL' values are included in Appendix 2.

Specific resuscitation and intubation issues in the young include:

- the relatively larger head and larger nasal airway and tongue
- nose breathing in small babies
- angle of the jaw is greater, larynx is higher and epiglottis is proportionally bigger and more "U"-shaped
- 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
- 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: (Refer Appendix 2).

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 > 2 seconds
- tachypnoea
- agitation

*The principles in managing paediatric trauma patients
are the same as for the adult*

- drowsiness
- poor urine output.

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

Vascular access should be obtained. Two large bore intravenous cannulae should be inserted. Attempt peripheral veins first and avoid central venous catheters. Good sites are the long saphenous vein at the ankle and the femoral vein in the groin.

Intraosseous access is relatively safe and a very effective method of fluid administration. If an intraosseous needle is unavailable then a spinal needle can be used. The best site is on the anteromedial aspect of the tibia below the tibial tuberosity. The epiphyseal growth plate must be avoided.

Fluid replacement should be aimed to produce a urine output of 1-2 ml/kg/hour for the infant, and 0.5-1 ml/kg/hour in the adolescent. An initial bolus of 20 ml per kilogram of the body weight of Normal Saline should be given. If no response is obtained after a second bolus then 20 ml/kg type specific blood or O Rh negative packed red blood cells (10 ml/kg) should be administered if available.

Hypothermia is a major problem in children. They lose proportionally more heat through the head. All fluids should be warmed. Because of the child's relatively large surface area to volume ratio, hypothermia is a potential problem. Exposure of the child is necessary for assessment but consider covering as soon as possible.

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The child should be kept warm and close to family if at all possible

Pregnancy

The ABCDE priorities of trauma management in pregnant patients is the same as those in non-pregnant patients.

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

Anatomical changes

- size of the uterus gradually increases and becomes more vulnerable to damage both by blunt and penetrating injury
 - at 12 weeks of gestation the fundus is at the symphysis pubis
 - at 20 weeks it is at the umbilicus and
 - at 36 weeks the xiphoid.
- the foetus at first is well protected by the thick walled uterus and large amounts of amniotic fluid.

Physiological changes

- increased tidal volume and respiratory alkalosis
- increased heart rate
- 30% increased cardiac output
- blood pressure is usually 15 mmHg lower
- aortocaval compression in the third trimester with hypotension.

Special issues in the traumatised pregnant female

- blunt trauma may lead to
 - uterine irritability and premature labour
 - partial or complete rupture of the uterus
 - partial or complete placental separation (up to 48 hours after trauma)
 - With pelvic fracture be aware of severe blood loss potential.

What are the priorities?

- assessment of the mother according to the ABCDE
- resuscitate in left lateral position to avoid aortocaval compression
- vaginal examination (speculum) for vaginal bleeding and cervical dilatation
- mark fundal height and tenderness and foetal heart rate monitoring as appropriate.

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

Aortocaval compression must be prevented in resuscitation of the traumatised pregnant woman. Remember left lateral tilt

Burns

The burn patient has the same priorities as all other trauma patients.

Assessment : Airway , Breathing (beware of inhalation and rapid airway compromise), Circulation (fluid replacement), Disability (compartment syndrome) Exposure (% burn).

The source of burn is important e.g. fire, hot water, paraffin, kerosene etc. Electrical burns are often more serious than they appear. Remember damaged skin and muscle can results in acute renal failure.

Essential management points:

- stop the burning
- ABCDE then determine the percentage area of burn (Rule of 9's)
- good IV access and early fluid replacement.

Specific issues for burns patients

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.

Nasotracheal or endotracheal intubation is indicated especially if patient has severe increasing hoarseness, difficulty swallowing secretions, or increased respiratory rate with history of inhalation injury.

The burn patient requires at least 2-4 ml of crystalloid solution per kg body weight per percent body surface burn in the first 24 hours to maintain an adequate circulating blood volume and provide adequate renal output. The estimated fluid volume is then proportioned in the following manner:

- one half of the total estimated fluid is provided in the first 8 hours post burn
- the remaining one half is administered in the next 24 hours, to maintain an average urinary output of 0.5-1.0 ml/kg/hr.

Undertake the following (if possible):

- pain relief
- bladder catheterisation if burn > 20%
- nasogastric drainage
- tetanus prophylaxis

Clinical manifestations of inhalation injury may not appear for the first 24 hours

Transport of Critically Ill Patients

Transporting patients has risk. It requires good communication, planning and appropriate staffing. Any patient who requires transportation must be effectively stabilised before departure. As a general principle, patients should be transported only if they are going to a facility that can provide a higher level of care.

Planning and preparation include consideration of:

- the type of transport (car, landrover, boat etc)
- the personnel to accompany the patient
- the equipment and supplies required en route for routine and emergency treatment
- potential complications
- the monitoring and final packaging of the patient.

Effective communication is essential with:

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

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 survey, checking and treating life-threatening conditions, then make a careful assessment focussing on the affected system.

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*Be prepared. If anything can go wrong, it will,
and at the worst possible time*

Appendix 1 - Airway Management Techniques

Basic techniques

- **Chin lift and jaw thrust**

The chin lift manoeuvre can be performed by placing two fingers under the mandible and gently lifting upward to bring the chin anterior. During this manoeuvre the neck should not be hyper extended. (Demonstrated in the Practical session)

The jaw thrust is performed by manually elevating the angles of the mandible to obtain the same effect. (Demonstrated in the Practical session) Remember these are not definitive procedures and obstruction may occur at any time.

- **Oropharyngeal airway**

The oral airway must be inserted into the mouth behind the tongue and is usually inserted upside down until the palate is encountered and is then rotated 180 degrees. Care should be taken in children because of the possibility of soft tissue damage.

- **Nasopharyngeal airway**

This is inserted via a nostril (well lubricated) and passed into the posterior oropharynx. It is well tolerated.

Advanced techniques

- **Laryngeal Mask Airway (LMA)**

LMA is the supraglottic airway which consists of a mask and an airway tube. It may improve ventilation in the circumstances which bag mask ventilation is not adequate or even impossible, with/without an oropharyngeal / nasopharyngeal airway in place. The most common choice would be Classic LMA, Size 4 or 5 is used for adult male and size 3 or 4 for adult female, size 2 or less for paediatric use. It is contraindicated when the patient is at risk of regurgitation and aspiration. However it may be an emergency life-saving approach for those patients who could not be intubated promptly with compromising airway. LMAs, such as the ProSeal LMA, which is integrated with a drainage tube, may be a proper choice in these scenarios.

Remember: patients with trauma of the face and neck are at risk for airway obstruction

- **Orotracheal intubation**

If uncontrolled, this procedure may produce cervical hyper-extension. It is essential to maintain in line immobilisation (by an assistant). (Demonstrated in the Practical session) Cricoid pressure may be necessary if a full stomach is suspected. The cuff must be inflated and correct placement of the tube checked by verifying normal bilateral breath sounds.

Tracheal intubation must be considered when there is a need to

- establish a patent airway and prevent aspiration
- deliver oxygen while not being able to use mask and airway
- provide ventilation and prevent hypercarbia.

This should be performed in no more than 30 seconds: if unable to intubate then ventilation of the patient must continue. Remember: patients die from lack of oxygen, not lack of an endo-tracheal tube.

- **Surgical cricothyroidotomy**

This is indicated in any patient where intubation has been attempted and failed and the patient cannot be ventilated. The cricothyroid membrane is identified by palpation; a skin incision that extends through the cricothyroid membrane is made. An artery forceps is inserted to dilate the incision. A size 4-6 endotracheal tube (or small tracheostomy tube) is inserted.

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Appendix 2: Paediatric Physiological Values

Variable	Newborn	6 months	12 months	5 years	Adult
Respiratory rate (b/min)	50 ± 10	30 ± 5	24 ± 6	23 ± 5	12 ± 3
Tidal volume (ml)	21	45	78	270	575
Minute ventilation (L/min)	1.05	1.35	1.78	5.5	6.4
Hematocrit	55 ± 7	37 ± 3	35 ± 2.5	40 ± 2	43-48
Arterial pH	7.3-7.4		7.35-7.45		7.35-7.45

Age	Heart rate range	Systolic blood pressure (beats per minute)
		(mmHg)
0-1 year	100-160	60-90
1 year	100-170	70-90
2 years	90-150	80-100
6 years	70-120	85-110
10 years	70-110	90-110
14 years	60-100	90-110
Adult	60-100	90-120

Respiratory Parameters and Endotracheal Tube Size and Placement					
Age	Weight (kg)	Respiratory Rate (b/min)	ETT size	ETT at Lip (cm)	ETT at Nose (cm)
Newborn	1.0-3.0	40-50	3.0	5.5-8.5	7-10.5
Newborn	3.5	40-50	3.5	9	11
3 months	6.0	30-50	3.5	10	12
1 year	10	20-30	4.0	11	14
2 years	12	20-30	4.5	12	15
3 years	14	20-30	4.5	13	16
4 years	16	15-25	5.0	14	17
6 years	20	15-25	5.5	15	19
8 years	24	10-20	6.0	16	20
10 years	30	10-20	6.5	17	21
12 years	38	10-20	7.0	18	22

Appendix 3: Cardiovascular Parameters

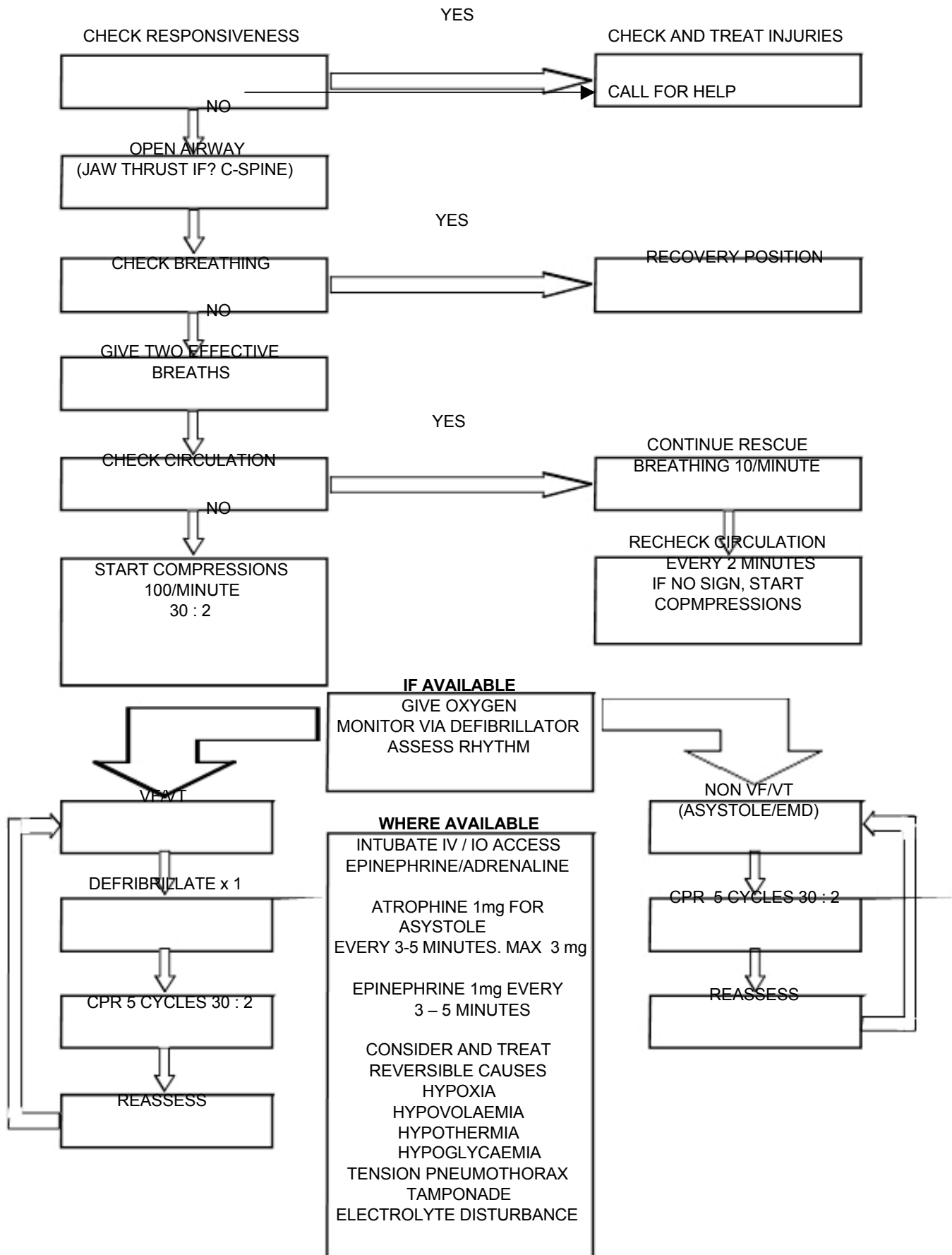
Blood loss	Heart rate	Blood pressure	Capill refill	Resp Rate	Urine volume	Mental state
Up to 750 ml	< 100	normal	normal	normal	> 30 mls/hr	normal
750–1500 ml	> 100	systolic normal	positive	20–30	20–30	mild concern
1500–2000 ml	> 120	decreased	positive	30–40	5–15	anxious/confused
more than 2000 ml	> 140	decreased	positive	> 40	< 10	confused/coma

Appendix 4: Glasgow Coma Scale

Eyes (4)	Open spontaneously	4
	Open to command	3
	Open to pain	2
	None	1
Verbal (5)	Normal	5
	Confused talk	4
	Inappropriate words	3
	Inappropriate sounds	2
Motor (6)	None	1
	Obeys command	6
	Localises pain	5
	Flexes limbs normally to pain	4
	Flexes limbs abnormally to pain	3
	Extends limbs to pain	2
	None	1

Appendix 5: Cardiac Life Support

Ensure safety of patient and



Appendix 6: Trauma Response

Long before any trauma patient arrives in your medical care, roles must be identified and allocated to each member of the trauma 'team'

Team members (depends on availability)

Ideally:

- On-duty emergency doctor or experienced health worker (team leader)

Trauma Team roles	
Team leader (Doctor)	(Nurse)
1. Co-ordinate ABC's	1. Help co-ordinate early resuscitation
2. History - patient or family	2. Liaise with relatives
3. Request X rays (if possible)	3. Check documentation including:
4. Perform secondary survey	- allergies
5. Consider tetanus prophylaxis and antibiotics	- medications
6. Reassess patient	- past history
7. Prepare patient for transfer	- last meal
8. Complete documentation	- events leading to injury
	4. Notify nursing staff in other areas

- On-duty emergency nurse
- 1 or 2 additional helpers

When the patient actually arrives, a rapid overview is necessary.

This is known as TRIAGE.

This rapid overview prioritises patient management according to:

- manpower
- resources.

This will be discussed at length during the course

Appendix 7: Activation Plan for Trauma Team

Criteria

The following patients should undergo full trauma assessment:

History

- fall >3 metres
- MVA: net speed >30 km/hr
- thrown from vehicle/trapped in vehicle
- death of a person in accident
- pedestrian vs car/cyclist vs car/ unrestrained occupant.

Examination

- airway or respiratory distress
- BP >100mmHg
- GCS <13/15
- >1 area injured
- penetrating injury

Disaster management

Disasters do occur and disaster planning is an essential part to any trauma service. A disaster is any event that exceeds the ability of local resources to cope with the situation.

A simple disaster plan must include:

- disaster scenarios practice
- disaster management protocols including:
 - on-scene management
 - key personnel identification
 - trauma triage
- medical team allocations from your hospital
- agree in advance who will be involved in the event of a disaster
 - ambulance
 - police/army
 - national/international authorities
 - aid and relief agencies.
- evacuation priorities
- evacuation facilities
- modes of transport: road/air (helicopter/fixed wing)/sea
 - work out different communications strategies.

This will be discussed more in the Practical session.

