

PRIMARY TRAUMA CARE COURSE MANUAL

for Trauma Management
in
Locations with Limited Resources

2018 Edition

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PTC



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Introduction to the 2015 Updated Edition

The mission of Primary Trauma Care is *“To promote and enable the training of medical professionals to manage and treat severely injured patients in low & middle income countries. The desired outcome is that lives are saved and disabilities are avoided”*

Our original PTC Manual stated *“most countries of the world are experiencing an epidemic of trauma”*. The Primary Trauma Care course was developed to provide the principles of the priorities of trauma management and skills needed to accurately assess and manage trauma patients' needs. Since the start in 1996, PTC courses have been introduced in more than 75 countries.

What is the trauma burden and has it changed since 1996?

Disease burden is defined by the WHO as *“the impact of a health problem on an area measured by financial cost, mortality, morbidity or other indicators”*.

Low and Middle Income Countries have particular difficulties with management of trauma: patients often need to be transferred for great distances, and arrive late after injury. There may be no high-tech equipment (and sometimes not even electricity, oxygen & running water) and small numbers of health professionals with training.

It is difficult to make reliable accurate estimates of the incidence and burden of trauma in low and middle income countries. Population-based injury surveillance systems are obviously the best source but unlikely to be established in these regions for several decades.

In many regions a reasonable estimate of this burden comes from the existing medical sources, including hospital records, police reports, health surveys and death registers. Many hospitals need trauma registries.

Accurate trauma data is needed to inform policy-makers and health officials about the true magnitude and ranking of trauma as a major burden of disease in individual countries.

In 2000 – 2015 the WHO Global Burden of Disease (GBD) project aided informed decision-making and increased attention on this significant public health problem.

The WHO GBD programme currently indicates that nearly 3,500 people die on the world's roads every day. Tens of millions of people are injured or disabled every year with a huge burden of disability. Children, pedestrians, motor-cyclists and the elderly are among the most vulnerable of road users.

We now have a better understanding of the leading causes of death/burden of disease in relation to geographical region, income levels, by age and sex. This can allow rational cost effective decisions to be made to improve patient outcome from trauma intervention programmes.

PTC provides a great opportunity to introduce a trauma management system into patient management and improve patient outcome. Trauma training needs to be done in a cost effective, clinically effective and outcome effective way so as to make the most of resources.

We regularly update the Primary Trauma Care Manual. The manual's robustness since 1996 has been due to its simplicity, its clarity and its ability to be used in all regional areas without the need for high technological support.

The Primary Trauma Care Manual is not a substitute for advanced trauma management programmes such as ATLS™ and other similar courses. It is a method that has proved successful in training health care professionals in one method of trauma management in low and middle income countries (LMICs).

The objectives of the Primary Trauma Care course remain the same:

For the candidate to understand the clinical priorities in trauma management and be competent to undertake a rapid systematic assessment and to resuscitate and stabilise trauma patients in environments of limited resource.

Primary Survey: The ABCDE of Trauma

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

- Airway obstruction
- Breathing difficulties with chest injuries
- Circulation problems due to severe external or internal haemorrhage
- Disabilities: head and spinal injuries.

If there is more than one injured patient then treat patients in order of priority (Triage). This depends on experience and resources; we will cover this in the practical sessions. Apply oxygen and monitoring equipment as soon as available. Ideally monitoring should include ECG, blood pressure, pulse oximetry, and some method of assessing CO₂.

The Primary survey is **A**irway, **B**reathing, **C**irculation, **D**isability and **E**xposure. It must be performed in no more than 5 minutes and it involves assessment and *immediate* treatment of any life threatening injuries. Simultaneous treatment can occur when more than one life-threatening injury exists in a trauma victim.

Airway

Assess the airway and protect the Cervical Spine.

Can the patient talk and breathe freely? Give Oxygen.

If obstructed, further steps need to be considered.

Breathing

Is the patient breathing normally? Give oxygen.

Is the chest moving equally on both sides?

If abnormal, further steps need to be considered.

Circulation

Assess circulation: colour, perfusion, pulse, blood pressure.

If abnormal, further steps need to be considered.

Disability

Assess the patient for neurological disability from brain or spine injury.

Is the patient

Awake?	A
Opening eyes to Voice?	V
Opening eyes to Pain?	P
Unresponsive?	U

If abnormal, further steps need to be considered

Exposure

Undress the patient and look for hidden injury. Keep their temperature stable.

(See Appendix 1 – Primary Survey flow Chart)

Airway

The first priority is establishment or maintenance of an open airway.

Talk to the patient!

A patient who can speak clearly must have a clear airway. The unconscious patient may require airway and breathing assistance. The most common cause of airway obstruction in an unconscious patient is the tongue falling back to block the airway.

If the patient can speak with a normal voice, then their airway is clear. If they can talk in full sentences, then their breathing is probably normal.

Protect the cervical spine!

Airway assessment and management must include care of the neck. If there is any suggestion of head or neck injury or suspicion from the mechanism of injury, then the cervical spine should be stabilised and protected.

Give Oxygen (via mask or self-inflating bag)

Assess Airway (look, listen and feel)

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

A completely obstructed airway is silent. Use a pulse oximeter, if one is available, to detect hypoxia.

Look for foreign bodies; the techniques used to establish an open airway are outlined in Appendices 2 and 4.

Basic airway management

- Remove foreign bodies
- Suction
- Basic airway opening techniques (jaw thrust, chin lift, simple airway insertion)
- Assisted ventilation with Bag-Valve-Mask (BVM)

Consider the need for advanced airway management

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

- Apnoea
- Hypoxia
- Persisting airway obstruction
- Severe head injury
- Maxillofacial injury
- Penetrating neck trauma with haematoma (expanding)
- Chest trauma

(Airway Management Techniques are discussed further in Appendix 2)

Breathing (Ventilation)

The second priority is the establishment of effective breathing.

Assessment

LOOK

Count the respiratory rate.

Are any of the following present:

- Cyanosis?
- Penetrating injury?
- Presence of flail chest?
- Sucking chest wounds?
- Use of accessory muscles?

FEEL for

- Tracheal shift
- Broken ribs
- Chest wall expansion on both sides of the chest
- Subcutaneous emphysema.

Percussion is useful for diagnosis of haemothorax and pneumothorax.

LISTEN with a stethoscope for:

- Pneumothorax (decreased breath sounds on site of injury)
- Detection of abnormal sounds in the chest.

Management

- Give oxygen
- Assisted ventilation with BVM
- Immediately decompress tension pneumothorax.
- Drain haemothorax or pneumothorax

(Breathing management is covered in detail in Appendix 2)

Circulation

The third priority is to establish good circulation.

Haemorrhage is responsible for about one third of in-hospital deaths due to trauma and is an important contributory factor for other causes of death, particularly head injury and multi organ failure.

'Shock' is defined as inadequate organ perfusion and tissue oxygenation. Shock is a clinical diagnosis and it is most important to identify the cause. In the trauma patient shock is most often due to haemorrhage and hypovolaemia. The diagnosis and treatment of shock should occur almost simultaneously.

The diagnosis of shock is based on assessment of the clinical findings of:

- Tachycardia
- Decreased capillary refill time
- Hypotension
- Tachypnoea
- Decreased urine output
- Changes in mental state.

General observations such as pallor, hypothermia and cool extremities help to make the diagnosis. Physiological compensation for blood loss may prevent a measurable fall in blood pressure until up to 30% of the circulating volume has been lost.

(See Appendix 5: Vital signs and Blood Loss.)

Shock in a trauma patient is classified as haemorrhagic or non haemorrhagic.

Haemorrhagic shock is due to acute loss of blood and nearly all patients with multiple injuries have some hypovolaemia due to haemorrhage. The amount of blood loss after trauma is often poorly assessed and in blunt trauma is usually greatly underestimated. Large volumes of blood may be hidden in the chest, abdomen and pelvis or in the retroperitoneal space.

The treatment principles in haemorrhagic shock are to stop the bleeding and replace the blood loss.

Non haemorrhagic shock includes cardiogenic shock, (myocardial dysfunction, cardiac

tamponade and tension pneumothorax), neurogenic shock, burns and septic shock.

Cardiogenic shock is due to inadequate heart function. This may be from

- Myocardial contusion
- Cardiac tamponade from both blunt and penetrating injury
- Tension pneumothorax (preventing blood returning to heart)
- Myocardial infarction

Clinical assessment of the jugular venous pressure is important in cardiogenic shock. It is often increased. Continuous ECG monitoring and central venous pressure (CVP) measurement can be useful as can the use of diagnostic ultrasound.

Neurogenic shock is due to the loss of sympathetic tone, usually resulting from spinal cord injury. Isolated intracranial injuries do not cause shock. The features of neurogenic shock are hypotension without compensatory tachycardia or skin vasoconstriction. Hypotension in patients with spinal cord injury can often also be due to bleeding.

Septic shock is rare in the early phase of trauma but is a common cause of late death via multi-organ failure in the weeks following injury. Septic shock may occur with penetrating abdominal injury and contamination of the peritoneal cavity by intestinal contents. If the patient does not have a fever it may be difficult to distinguish from haemorrhagic shock.

Most non haemorrhagic shock responds to fluid resuscitation, although the response is partial and or short lasting. Therefore if the clinical signs of shock are present, treatment is started as if the patient has haemorrhagic shock while the cause of the shock is identified.

The most common cause of shock in trauma is haemorrhage.

Haemorrhage, Hypovolaemia and Resuscitation

It is important to stop the bleeding but this may not always be straightforward especially if the source of haemorrhage is within the chest, abdomen or pelvis. The goal is to restore blood and oxygen flow to the vital organs by the administration of fluid and blood to replace the intravascular volume lost.

Management

- Insert at least two large-bore IV cannulas (16 gauge or larger). Jugular, femoral or subclavian venous access, cut down or intraosseous infusions may be necessary.
- Take blood for type, cross match and laboratory tests.
- First line infusion fluids are crystalloid electrolyte solutions e.g. Ringers Lactate (Hartmann's solution) or Normal Saline. Blood loss of more than 10% of blood volume (7 ml/kg in adults) or continuing expected blood loss will require blood transfusion (See Appendix 6).
- All fluids must be warmed to body temperature if possible. Hypothermia prevents clotting.
- Do not give IV solutions containing glucose.
- The routine use of vasoconstrictors is not recommended.

The exact amount of fluid and blood required is very difficult to estimate and is evaluated by the response of blood pressure and pulse to the resuscitation fluids. An initial fast bolus of 250ml is recommended in adults, followed by re-assessment. If there is no change in the vital signs, this bolus is repeated as necessary and ongoing haemorrhage must be excluded. The aim is to restore the blood pressure and pulse toward normal values.

Hypotensive resuscitation (to a mean BP of 70mmHg) may be used for penetrating trauma and also for severe pelvic fractures where the bleeding cannot be stopped without surgery, but hypotension is potentially harmful in patients with significant head injuries. *(See also Appendix 6)*

Urine output is an important sign of adequate resuscitation and renal perfusion. Urine output should be more than 0.5 ml/kg/hr in adults and 1 ml/kg/hr in children. Unconscious patients may need a urinary catheter.

In remote locations where IV Fluids are unavailable and long distance patient transfer is necessary oral fluids might be useful. If many hours have elapsed since the injury, the patient may also need to "catch up" on maintenance fluids - 125 ml per hour elapsed.

The improvement of the blood pressure, pulse and general observations (colour, perfusion, mental status) in response to the resuscitation fluids is evidence that the loss of circulating volume is being corrected.

Blood Transfusion

(See also appendix 6: Massive Transfusion)

Blood transfusion must be considered if a patient has persistent hypotension and tachycardia despite receiving adequate/large volumes of resuscitation crystalloid fluids. Transfusion may also be necessary if there is on-going haemorrhage and/or the haemoglobin level is less than 7 g/dl.

Blood may be difficult to obtain and blood products such as fresh frozen plasma, cryoprecipitate, and platelets may be unavailable. In this situation, fresh whole blood from "walking" donors or relatives is best.

If type specific or fully cross-matched blood is not available, O negative packed red blood cells should be used in patients who are at risk of life-threatening bleeding.

Tranexamic acid, if available, can reduce bleeding and risk of death. It should be used early in resuscitation, with a loading dose of 1 gram over 10 minutes and then an infusion of 1 gram over 8 hours.

Sites of Haemorrhage

The priority is to identify the sites of haemorrhage and stop the bleeding.

In external bleeding sites, direct pressure is the most useful method to stop haemorrhage.

Injuries to the limbs

Tourniquets may be used if there is life threatening bleeding and direct pressure or a pressure dressing fails to control haemorrhage. Pre-hospital tourniquets save lives in military trauma, especially if applied before the onset of shock. It is important to note the time of tourniquet application. Complications can occur as a result of tourniquets.

Injuries to the chest

Sources of bleeding include aortic rupture, myocardial rupture and injuries to the pulmonary vessels. Other sources of haemorrhage are chest wall injuries involving intercostal or mammary blood vessels. Insertion of a chest tube allows the measurement of blood loss, re-expansion of the lung and tamponade of the bleeding source.

Injuries to the Abdomen and Pelvis

A laparotomy should be done as soon as possible in patients where there is a clinical indication that the bleeding is within the abdomen and fluid resuscitation cannot maintain a systolic BP at 80-90 mm Hg.

The sole objective of a damage control laparotomy is to stop immediate life threatening bleeding with sutures and packs. After resuscitation and stabilization a "second look" laparotomy is performed with definitive surgical procedures.

Pelvic fractures should be reduced by the application of a pelvic sling, which may help to control bleeding.

Chest Trauma

Approximately a quarter of the deaths due to trauma are attributed to chest injury. Immediate deaths can result from disruption to the airway, injury to the great vessels or from injury to the heart.

The majority of chest injuries can be successfully managed with chest tube insertion and analgesia and do not require surgery.

Based on the mechanism, these injuries can be broadly classified into *penetrating* and *blunt*. Clinical evaluation starts with obtaining a good history regarding the mechanism followed by clinical examination and most often a radiological evaluation. Do not delay treatment whilst waiting for an X-Ray if it is difficult to obtain. Further investigations may be needed in specific circumstances.

Rib Fractures

Rib fractures are sustained easily in the elderly and are very painful. Fractures can lead to trauma of the underlying lung resulting in pneumo- or haemothorax. Rib fractures are managed with analgesia alone as they tend to heal without complications.

Pneumothorax

A *tension pneumothorax* develops when air enters the pleural space and cannot leave, leading to an increase in the intrathoracic pressure on the affected side. The patient will be very restless and short of breath. Clinical signs include absent breath sounds and resonance to percussion on the affected side with tracheal shift to the opposite side (may be difficult to detect). Immediate management consists of needle decompression by introducing a large bore needle in the second intercostal space in the midclavicular line. This should be followed by insertion of a thoracic drain. Tension pneumothorax is a clinical diagnosis. Do not wait for an X-Ray.

A **simple pneumothorax** does not have an increase in intrathoracic pressure on the affected side. It can develop into a tension pneumothorax. It should be treated with a thoracic drain especially if the patient is to be ventilated.

Flail Chest

Flail chest occurs when a segment of the thoracic cage is separated from the rest of the chest wall. This is usually defined as two or more fractures per rib in at least two ribs. The flail segment moves independently of the rest of the thoracic cage. This can lead to ventilatory failure. Presence of a flail chest implies significant transfer of energy to the chest with a potential for underlying lung contusion. Management includes provision of good pain relief and ventilatory support in the presence of features of respiratory failure.

Haemothorax

Haemothorax is the presence of blood in the chest cavity. It commonly follows penetrating trauma. Large volumes may be lost into the chest leading to hypotension. The insertion of an intercostal tube to drain blood and re-expand the lung is often the only intervention needed. However the following findings would require surgical referral:

- Haemothorax exceeding 1.5 litres upon initial drainage
- On-going blood losses of more than 250ml/hr after drain insertion.
- Failure of the lung to expand after chest drain insertion.

Pulmonary Contusion

Pulmonary contusion can occur in penetrating or blunt trauma. The presence of this condition may not be very clear at the time of initial presentation. A high degree of suspicion based on the mechanism of injury is necessary. The condition can progressively deteriorate resulting in ventilatory failure. X rays are not very specific in diagnosing the condition. Ventilatory support may be needed in severe cases.

Open (Sucking) Chest Wound

Open chest wounds can lead to complete collapse of the lung on the affected side because air is sucked into the chest cavity. The mediastinum may shift to the opposite side. As a temporary stabilising measure a dressing may be applied on top of the wound with three sides sealed to act as a 'valve'. This will allow air to exit the wound while not allowing it to re-enter. Management is by the insertion of an intercostal drain (not through the wound).

Myocardial Contusion

This can follow blunt trauma (e.g. steering wheel injury with fracture of sternum). An abnormal ECG and later signs of heart failure and low blood pressure indicate an underlying cardiac contusion. These patients will need admission to high level care for further management.

Pericardial Tamponade

Pericardial tamponade generally follows penetrating trauma of the heart. Blood accumulates in the pericardial space leading to cardiogenic shock. The classic Beck's Triad (elevated JVP, muffled heart sounds and hypotension) may be difficult to detect in the hypotensive trauma patient. The management consists of pericardial drainage (pericardiocentesis) followed by urgent surgical intervention for repairing the injury.

Rupture of the aorta

This has a very high immediate on-site mortality rate. It occurs in the presence of severe decelerating force such as car accidents or fall from significant heights. Stable patients should undergo further investigations if rupture of the aorta is suspected.

Rupture of trachea or major bronchi

This carries a mortality rate of up to 50%. The majority of bronchial ruptures occur within 2.5 cm of the carina. Clinical signs include shortness of breath, haemoptysis and collapsed lung on the affected side on X-Ray. This condition needs urgent surgical intervention.

Injury to the oesophagus

This generally follows penetrating trauma. Clinical signs may be few. Strong suspicion is necessary based on the path of penetration. Plain X-Ray is not very helpful and missed injuries can be fatal. Contrast studies or endoscopy may be needed and surgeons should be involved very early in managing this condition.

Injury to the Diaphragm

This can follow blunt or penetrating trauma. The diagnosis is often missed initially. The presence of bowel sounds in the chest on auscultation, or findings on X-Rays including visualisation of bowel in the hemithorax, elevation of the hemidiaphragm

or appearance of the nasogastric tube in the chest are suggestive of an injury.

Contrast studies may be needed in doubtful cases. Surgeons should be involved in managing suspicious cases.

Abdominal and Pelvic Trauma

Patients involved in major trauma should be considered to have an abdominal injury until otherwise excluded. Blunt and penetrating trauma can present with significant abdominal injuries,

Hidden intra-abdominal haemorrhage and other unrecognised intra abdominal injuries are common causes of death following polytrauma, so a high index of suspicion is important.

The initial assessment of the abdominal trauma patient is the Primary Survey: ABCDE. The assessment of the "Circulation" during the Primary Survey involves careful evaluation of the abdomen and pelvis for possible hidden haemorrhage, especially in hypotensive patients.

There are three distinct regions of the abdomen: the peritoneal cavity, the retroperitoneal space and the pelvic cavity. Injuries to the retroperitoneal visceral structures are often difficult to diagnose and traumatic injuries, especially penetrating injuries, can involve more than one intra-abdominal cavity. Trauma does not respect anatomical boundaries and no examination should be taken in isolation – chest and abdominal injuries commonly occur together; repeated evaluation is necessary to ensure injuries are not missed.

The site of injury, energy transfer and mechanism are important factors in the assessment of abdominal trauma. Blunt trauma can often affect solid organs and all viscera are at risk from penetrating injuries. It is important, in the case of knife and gun shot wounds, to attempt to gauge trajectory as this may indicate potential internal injuries.

Classification of the mechanism of injury:

- Penetrating trauma e.g. gunshot, knife wounds
- Blunt trauma e.g. compression, crush and deceleration injuries
- Explosions can cause both blunt and penetrating trauma as well as blast pressure injuries to the lungs and hollow viscera.

Assessment and management of abdominal trauma – is there

visceral damage or bleeding?

Blunt abdominal trauma can be very difficult to evaluate. This is especially important in patients who are unconscious or intoxicated or in patients with polytrauma to a number of anatomical cavities. The pain from significant rib or pelvic injuries can mask abdominal injury. Ten percent of polytrauma patients with no abnormal clinical signs have evidence of intra-abdominal injury on radiological imaging. Evaluation of the retroperitoneum for injuries to colon, pancreas and kidneys is difficult and these patients should be referred to a surgeon.

Repeating the primary survey and serial physical examinations of the abdomen will identify clinical deterioration and assist in making the diagnosis.

Physical examination includes inspection, auscultation, percussion and palpation of the abdomen as well as examination of:

- Urethra, perineum, and gluteal region
- Rectum (tone, blood, prostate position),
- Vagina
- Pelvis (fractures and stability)

The haemodynamic status of the patient determines the diagnostic and management priorities. Hypotensive patients may need an urgent diagnostic laparotomy.

Diagnostic peritoneal lavage (DPL) and, if available, ultrasound (Focused Assessment Sonography in Trauma or FAST) and abdominal computed tomography (CT) are diagnostically useful but should not delay transfer of the patient for definitive care.

DPL

- Sensitive and specific test for intraperitoneal blood, an indication for surgery
- More sensitive than ultrasound for hollow viscus injury
- Does not exclude retroperitoneal injury
- Operator dependent

FAST

- Replacing DPL when available
- Sensitive and specific for intraperitoneal and pericardial fluid
- Rapid, repeatable and non invasive
- Ultrasound does not predict the need for surgery
- Negative ultrasound examination does not exclude organ injury

CT

- Investigation of choice, when available, for haemodynamically stable patients
- Sensitive and specific for solid organ pathology, less sensitive for hollow viscus
- Normal CT scan has a high negative predictive value
- Diagnostic test of choice for the retroperitoneal space and diaphragm
- However, a surgeon should assess patients and negative CT scanning should be treated with caution.

Other diagnostic aids

- Nasogastric tube (not in base of skull and mid face fractures)
- Urinary catheter (caution with pelvic fractures, and urethral meatal bleeding)
- Chest and pelvis x-rays are mandatory if available. Abdomen x-ray is rarely helpful.
- Contrast studies of gastro or genitourinary systems

Assessment and management of pelvic fractures: is there visceral damage, bleeding or pelvic fracture?

Pelvic fractures are often complicated by visceral injury and massive haemorrhage. Life threatening haemorrhage is a frequent complication of major pelvic fractures and causes 30% of polytrauma deaths.

Both orthopaedic and general surgeons should assess patients due to the high risk of concurrent bony, vascular and visceral injury.

Physical examination includes:

- Urethra (meatal blood), perineum (bruises) and gluteal region

- Rectum (laceration, blood, high riding prostate), vagina
- Leg length difference or rotational deformity
- Mechanical instability of the pelvis by gentle compression/distraction

The management of pelvic fractures includes early identification and immobilisation to stop bleeding, using either simple stabilisation with a sheet pulled tight and tied round the hips (femoral greater trochanters) or commercially available pelvic slings.

Limb Trauma

Management of limb trauma begins with the Primary Survey ABCDE.

Peripheral haemorrhage is a preventable cause of early death with limb trauma.

Early treatment of limb injuries reduces late disability.

Examination must include inspection and palpation:

- Skin colour and temperature
- Grazes and bleeding sites
- Limb alignment and deformities
- Active and passive movements
- Pulse assessment comparing proximal to distal to a fracture and with the other side
- Unusual movements and crepitation
- Level of pain.

Management of limb injuries should aim to:

- Keep blood flowing to peripheral tissues
- Prevent skin necrosis and infection
- Prevent damage to peripheral nerves
- Provide pain relief.

Special issues relating to limb trauma

Active bleeding: Stop the bleeding and replace the blood loss.

Open fractures and joint injuries: Any fracture or joint injury situated near a wound must be considered as “open”. Principles of the treatment include:

- Stop external bleeding
- Immobilise
- Relieve pain
- Early surgical consultation.

Amputated parts of extremities: Cover the wound with sterile gauze. Wrap the amputated part with moistened saline gauze and place into a sterile plastic bag.

Later complications include:

Compartment syndrome. Suspect it in patients that have pain out of proportion to the injury. It is frequently missed. The earliest and most important sign is increasing pain especially on passive stretching of the muscles. Loss of pulse or

sensation are very late signs.

Management is by early detection and fasciotomy.

Crush syndrome is a severe systemic result of trauma and ischaemia due to prolonged severe crushing of soft tissues, principally skeletal muscle of the upper limbs, lower limbs and pelvis, with sensory and motor disturbances in the compressed limb. The limb may become tense, swollen and pulseless.

Myoglobinuria and/or haemoglobinuria due to skeletal muscle destruction make the urine tea-coloured quite early on. Hypovolaemic shock and acidosis are present.

The main goal of treatment is to prevent crush injury syndrome developing. Start IV fluids (ideally before the limb is freed and decompressed) and insert a urinary catheter.

Deep penetrating foreign bodies should remain in situ until exploration in theatre
--

Head Trauma

Head trauma is a major cause of death and disability in children and adults. Rapid and effective assessment and management in the *Primary Survey* saves lives and reduces disability. Hypoxia and hypotension double the mortality of head-injured patients. The most important management priorities in a head injured patient are opening the airway, giving oxygen and maintaining a good blood pressure.

Any patient with a head injury must have the cervical spine protected and immobilised.

Primary Brain Injury: is the damage that occurs at the moment of trauma when tissues and blood vessels are stretched, compressed or torn.

Secondary brain injury: results from brain swelling, hypoxia and high intracranial pressure. Early assessment and management of the Airway, Breathing and Circulation in the Primary Survey can prevent it.

Assessment of Head Trauma

- Primary survey (Airway and cervical spine, Breathing, Circulation and Disability: different sized pupils and AVPU)
- Secondary Survey
- Full neurological examination

Good clinical assessment can lead to early recognition of some important brain injuries that can be managed immediately or referred for surgery early. It is important to treat what you can within your expertise and resources.

The Glasgow Coma Score (GCS) reflects level of consciousness, and should be done repeatedly and complemented by neurological examination to look for signs of focal brain abnormality such as unequal pupils or limb weakness. Hypotension or a recent epileptic seizure can make GCS interpretation difficult. Decline in the GCS or developing focal deficits can mean that there is an intracranial problem which needs treatment.

Eye Opening (4)	Spontaneously	4	<ul style="list-style-type: none"> • GCS 8 or less: severe head injury • GCS 9-12: moderate head injury • GCS 13-15: minor head injury
	To voice	3	
	To pain	2	
	None	1	
Verbal (5)	Normal	5	
	Confused talk	4	
	Inappropriate words	3	
	Inappropriate sounds	2	
	None	1	
Best Motor Response (6)	Obeys commands	6	
	Localises pain	5	
	Flexes limbs normally to pain	4	
	Flexes limbs abnormally to pain	3	
	Extends limbs to pain	2	
	None	1	

If CT Scanning is available, this should be done, guided by the criteria in the table.

Criteria for CT Scan, if available, in Head Injury	
GCS<13 on initial assessment	In addition, adult patients who have experienced some loss of consciousness and amnesia since the injury and: <ul style="list-style-type: none"> • Age > 65 years • Clotting problems or anticoagulant drugs • Dangerous mechanism of injury, e.g. fall from height, pedestrian struck by motor vehicle, etc.
GCS<15 at 2 hours after injury	
Suspected open or depressed skull fracture	
Any sign of basal skull fracture	
Post-traumatic seizure	
Focal neurological deficit	
More than one episode of vomiting	
Amnesia for events > 30 min before impact	

Watch out for:

- Drowsiness or excessive sleepiness
- Confusion or disorientation
- Severe headache, vomiting or fever.
- Limb weakness
- Inequality of pupils
- Convulsions, seizure or unconsciousness
- Discharge of blood or fluid from ear or nose

The following conditions are potentially life-threatening but difficult to treat in district hospitals.

Extradural haematoma commonly results after an impact to the head. It results from bleeding from an artery often associated with a skull fracture. Often there is

little primary brain injury and so rapid treatment may offer a good outcome.

Features of acute extradural haematoma include:

- An initial loss of consciousness after the impact
- The patient may wake up (lucid interval)
- Then rapid deterioration and unconsciousness
- Arterial bleeding with rapid increase in intracranial pressure
- Boggy scalp swelling over the site of the fracture
- The development of paralysis on the opposite side with a fixed pupil on the same side as the impact to the head.

Acute subdural haematoma commonly occurs in association with severe head injury. It results from bleeding from blood vessels around the brain and may be associated with significant primary brain injury. Features include:

- Venous bleeding and clotted blood in the subdural space
- Frequently severe bruising or damage to the underlying brain.

After the Primary Survey, the management of these injuries is surgical. If possible make a rapid transfer to a hospital where neurosurgery can be done. If this is not possible and if appropriate skills are locally available, an exploratory burr-hole should be made immediately for diagnosis/drainage on the side of the dilating pupil.

The conditions below may sometimes be treated with more conservative medical management (Airway, Breathing, Circulation and regular monitoring and observations), as neurosurgical intervention is often not indicated initially.

- *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
- *Closed depressed skull fracture* without neurological deficits.
- *Intracerebral haematoma* - may result from acute injury or progressive damage secondary to brain bruising (some haematomas may expand by late bleeding/oedema to cause mass effect and delayed clinical deterioration).
- *Diffuse brain injury* with altered conscious level but no haematoma on CT scan.

Remember

- Deterioration may occur due to further bleeding in or around the brain.

Regular review with repeated GCS and neurological observations are important

- 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. Look for another cause.

The Cushing response is a specific response to a severe rise in intracranial pressure, and is a late and poor prognostic sign. The signs are:

- Low heart rate
- High blood pressure
- Decreased respiratory rate.

Management

The priority of management is stabilisation of the airway, breathing and circulation, with immobilisation of the cervical spine.

Keeping the oxygen level as high as possible and the systolic blood pressure above 90mmHg is the most important aim in emergency treatment for patients with head injury. Specific further management consists of:

- Stabilisation of ABC.
- Immobilise the cervical spine.
- Continuous oxygen.
- Supporting and controlling ventilation; avoid CO₂ rise.
- Intubation if severe head injury with GCS <8.
- Monitoring of vital signs, pupils and regular neurological observations (including repeated GCS measurement).
- Elevate the head of the bed if possible, without bending the neck.
- Keep the temperature stable.
- Do not withhold pain relief, but take care not to make the patient too drowsy.
- Mannitol 20% infusion may reduce intracranial pressure. Its best use is to allow short-term benefit before obtaining a CT scan or transfer to a neurosurgical facility.
- If CT scan is not immediately available and an intracranial haematoma suspected due to clinical deterioration, exploratory burr holes may be indicated.

Alteration of consciousness is the hallmark of brain injury

Spinal Trauma

Nerve injury is common in multiple trauma, both of the spinal cord and other nerves. Cervical spine injury is common in patients with moderate to severe head injury.

The first priority is the Primary survey (Airway and cervical spine, Breathing, Circulation, Disability and Exposure)

Assessment

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 the spine. The patient should be:

- Log-rolled
- Properly immobilised (manual in-line immobilisation; or stiff neck cervical collar, sandbags and tape).

With vertebral (bony) injury, which may be associated with spinal cord injury, look for:

- Local tenderness along the back
- Deformities and stepping
- Swelling and bruising

Clinical findings indicating injury of the cervical spine include:

- Difficulties in respiration (diaphragmatic breathing - check for paradoxical breathing)
- Floppy limbs and no reflexes
- Loose anal sphincter and loss of sensation in perineum
- Urinary and bowel incontinence or retention
- Hypotension with bradycardia (without hypovolaemia or blood loss).

Assessment of the level of spinal injury

If the patient is conscious, ask the patient questions about sensation in the limbs and on the torso. Note where the sensation changes. Ask the patient to do minor movements of the upper and lower limbs, starting with the fingers and toes. Note where there is no movement and what movements the patient can do.

(See appendix 9 for more details)

X-rays (if available)

All patients with a suspicion of cervical spine injury should have an AP and a lateral neck X-ray with a view of the atlas-axis joint. All seven cervical vertebrae and the junction with T1 must be seen on the AP and lateral views.

Spinal Injury Management

- Stabilise the airway, breathing and circulation
- Immobilise the cervical spine with a hard collar, sand bags or whatever you have available
- Keep the patient lying flat on the back and in a neutral position
- Pain relief and anti-nausea medication if available
- Keep the temperature stable
- Insert a urinary catheter
- Transport the patient for surgical care in a neutral position; do not sit them up

Paediatric Trauma

The burden of paediatric trauma is greatest in low- and middle-income countries where more than 95% of all injury deaths occur. Paediatric injuries are a growing global public health problem with trauma due to falls, road traffic accidents and burns being important causes. Many of these injuries are preventable. The survival of children who sustain major trauma depends on pre-hospital care and early resuscitation.

The principles in managing trauma in children are the same as for the adults: Primary Survey (ABCDE).

Immediately assess the child's weight, either by asking the child's parent, using a formula or a method such as the Broselow paediatric measuring tape. Accurate dosing of medications and fluids is essential.

Specific challenges in the Primary Survey

- The relatively larger head, especially the occiput, and tongue
- Small babies rely on nose breathing
- The jaw is smaller, the larynx is higher and the epiglottis is proportionally bigger and more "U"-shaped
- The cricoid is the narrowest part of the airway which limits the size of the ET tube
- By puberty, the larynx has grown and the narrowest part is at the cords
- The trachea in the full-term new-born is about 4 cm long and will admit a 3.0 or 3.5 mm diameter endotracheal tube (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 using a cuffed ETT, avoid high cuff pressures to minimise subglottic swelling and ulceration
- Oral intubation is easier than nasal for infants and young children

Cardiac output in paediatric patients is primarily determined by heart rate. 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 must be commenced. Survival from paediatric cardiac arrest following trauma is very low.

Signs of shock in paediatric patients include:

- Tachycardia
- Weak or absent peripheral pulses
- Capillary refill > 2 seconds
- Tachypnoea
- Agitation

Children have increased blood loss associated with long bone and pelvic fractures compared with adults; therefore, early splinting and stabilisation are even more important.

Children have tremendous reserves to compensate for hypovolaemia, so when they start to show signs of shock it may already be at an advanced stage. Children initially compensate for hypovolaemia with tachycardia and may not drop their blood pressure until they have lost 45% of their circulating volume.

Intraosseous access

This is a relatively safe and very effective method of fluid administration. If an intraosseous needle or bone marrow needle is not available then a large spinal needle can be used. The best site is on the anteromedial aspect of the tibia below the tibial tuberosity, aiming slightly downwards away from the epiphyseal growth plate.

The clinical technique of intraosseous access will be demonstrated on one of the skill stations.

Fluid replacement in children

An initial bolus of 20 ml per kilogram body weight of Normal Saline may be given.

If no response is obtained after a second bolus then 20 ml/kg type specific blood or (10 ml/kg) packed red blood cells should be administered; O Rh negative products can be used if type specific blood is not available. Consider giving 5ml/kg of 10% dextrose if severely malnourished.

Aim to produce a *urine output* of 1–2 ml/kg/hour for the infant, and 0.5–1 ml/kg/hour in the adolescent.

Specific challenges in Primary Survey: Disability and Exposure

The clinical examination is of the utmost importance because radiographs are difficult to interpret and spinal cord injuries may not be apparent on X-Ray.

Hypothermia is a major problem in children because of their relatively large surface area to volume ratio. They lose proportionally more heat through the head. Fluids should be warmed.

Exposure of the child is necessary for assessment but consider covering as soon as possible

Consider early transfer to a paediatric trauma centre.

(Paediatric 'NORMAL' values are included in Appendix 10)

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

Trauma in Pregnancy

Trauma is the largest cause of non-obstetric morbidity and mortality in pregnant women. Significant trauma complicates 6-7% of pregnancies. The Primary Survey ABCDE priorities of trauma management in pregnant patients are the same as those in non-pregnant patients.

Specific considerations in the pregnant patient include:

- Resuscitation involves both mother and baby. Resuscitation of the mother is the priority.
- Intubation may be more difficult and risk of aspiration of gastric contents is higher
- Hypotension in the pregnant woman is a late sign in hypovolaemia
- Monitoring of the foetus is important
- Early involvement of the obstetrician is essential.

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

Anatomical changes

The 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 it is at the xiphoid.

Physiological changes

Increased respiratory rate and oxygen utilisation

Increased heart rate

30% increased cardiac output

Blood pressure is usually 15 mmHg lower

Aortocaval compression in the third trimester can cause the “supine hypotension syndrome”.

Specific assessment and management in pregnancy include:

- Resuscitation with displacement of the uterus to the left to avoid aortocaval compression. This can be by pushing the uterus over to the left or by rotation of the whole body, to avoid worsening spinal trauma.

- Vaginal examination (speculum) for vaginal bleeding and cervical dilatation
- Involvement of obstetric staff, if available.

Blunt trauma may lead to

- Premature labour
- Partial or complete rupture of the uterus
- Partial or complete placental separation (up to 48 hours after trauma)
- Severe blood loss with pelvic fracture

Intercostal drains may be placed 1 or 2 interspaces higher than in non-pregnant patients.

Anti D may be necessary if the mother is Rhesus negative.

Burns

The principles of initial assessment of patients with burns are the same as all other trauma patients and start with the Primary Survey.

There are specific considerations during resuscitation of a patient with burns:

Airway

Burns to the airway are suggested by hoarseness, stridor (laryngeal oedema) facial and mouth burns, burning of nasal hair, soot in nostrils or on palate. These burns may lead to swelling and airway compromise. Give Oxygen. Consider early endotracheal intubation before airway compromise worsens.

Breathing

Wheeze, or evidence of increased work of breathing.

Beware circumferential, full-thickness burns of chest or neck which may impair breathing.

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

Circulation

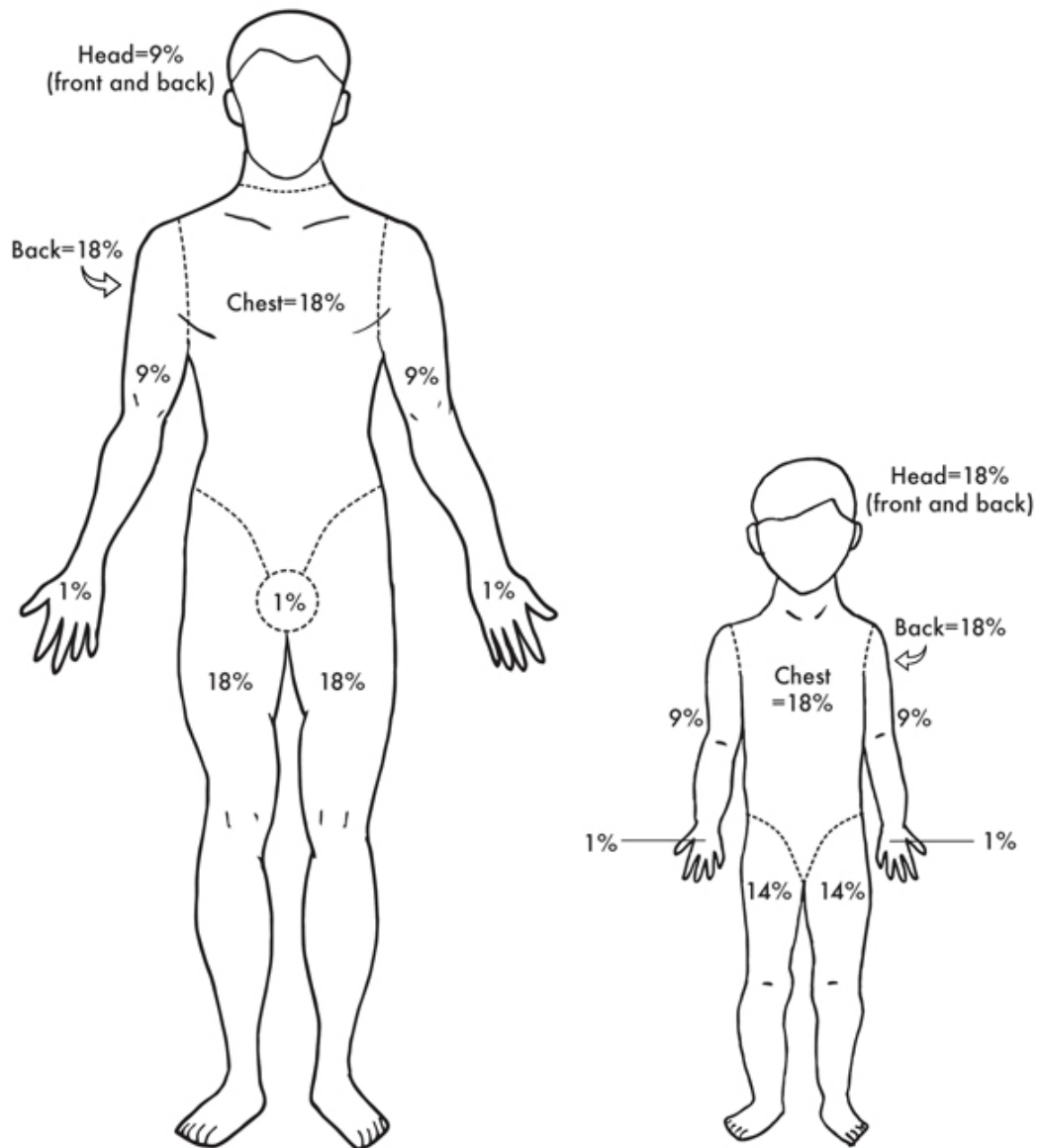
Hypovolaemic shock is a feature of severe burns. Good IV or Intra Osseous access & appropriate clinically guided fluid replacement are important. (Formulae include the Parkland Formula, described below.)

Disability

Patients may be hypoxic/hypercapnic with confusion. Early detection of peripheral neurovascular compromise due to circumferential limb and digit burns. Consider early escharotomy or fasciotomy.

Exposure and environmental control

Estimate the burn area, including the back, by using the rule of 9s (patient's palm is 1%).



RULES OF 9s

Patients with burns are at risk of hypothermia due to loss of skin and prolonged exposure during assessment. The burn should be covered, as soon as possible after assessment, with sterile dressings such as plastic cling film.

The source of burn is important e.g. fire, hot water, paraffin, kerosene etc. Electrical burns are often more serious than they appear due to current flowing preferentially through deep tissues. Damaged muscle can result in acute renal failure.

Specific issues of Fluid Resuscitation in Burns patient:

Burns covering more than 15% in Adults and 10% in children require intravenous fluid resuscitation.

The *Parkland Formula* for burns resuscitation is one easy method to calculate fluid requirements in the first 24hrs.

- Start with 2-4ml / kg / % Area of Burn, giving half in first 8 hours (from the time of the burn)
- Give the remaining half in the next 16 hours.
- The goal is to achieve a urinary output of 0.5–1.0 ml/kg/hr. (1.0-1.5ml/kg/hr in children).
- Infusion rate is determined by urine output.

Undertake the following:

- Pain relief
- Nasogastric drainage
- Prevent Hypothermia
- Tetanus prophylaxis
- Do not use early prophylactic antibiotics

All published fluid formulas are only guidelines. Individual clinical assessment and particularly urine output **must** guide treatment and more fluid is commonly required.

Secondary Survey

The Secondary Survey is a head to toe and systems examination with the aim of identifying all injuries that have not been detected in the Primary Survey.

The Secondary Survey is undertaken when the Primary Survey is completed and the Airway, Breathing and Circulation are stable. If the patient deteriorates during the Secondary Survey, then you should STOP immediately and repeat the Primary Survey.

Documentation is required for all procedures undertaken.

Take a brief history of the cause of injury and a relevant patient history.

Head examination

Scalp and ocular abnormalities

External ear and tympanic membrane

Maxillofacial injuries.

Neck examination

Penetrating wounds

Subcutaneous emphysema

Tracheal deviation

Neck vein appearance

Pain / tenderness

Neurological examination

Brain function assessment using the Glasgow Coma Scale (GCS)

Spinal cord motor activity

Sensation and reflex.

Chest examination

Clavicles and all ribs

Breath and heart sounds

Abdominal examination

Penetrating wound of abdomen requiring surgical exploration

Signs of blunt trauma and hidden haemorrhage

Genital examination

Rectal and vaginal examination

Pelvis and limbs

Fractures and pain

Peripheral pulses

Evidence of weakness, loss of function or sensory change.

Back

Log Roll and check for injury

Perform rectal examination (if not already done).

Investigations*Imaging*

X-Ray chest, cervical spine and pelvis

Other X-rays as clinically indicated

Ultrasound (FAST)

CT Scan (If available)

Blood

Any additional investigations

Other

ECG

Procedures

Nasogastric tube

Urinary Catheter for urine output

Transport of Critically Ill Patients

Transporting patients entails risk. It requires good communication, planning and appropriate staffing. Any patient who requires transportation must be 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, 4WD, boat etc.)
- The staff to accompany the patient
- The equipment and supplies required during the journey for routine and emergency treatment. Plan this, and think about problems which could arise, using ABCDE.
- Potential complications
- The monitoring and final packaging of the patient.

Effective communication is essential with:

- The receiving centre
- The transport service
- Escorting staff
- The patient and relatives.

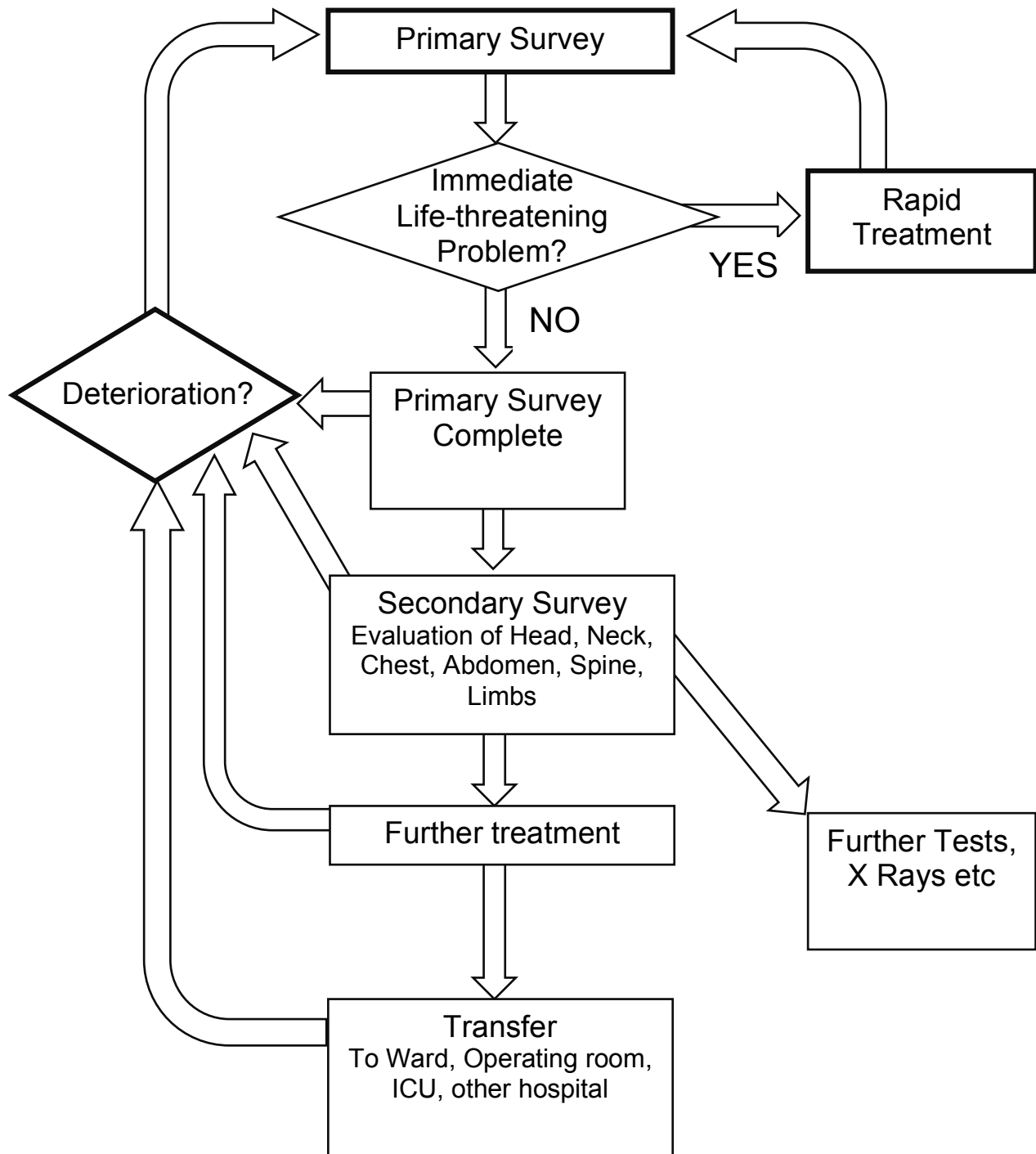
Effective stabilisation requires:

- Prompt initial resuscitation
- Control of haemorrhage and maintenance of the circulation
- Immobilisation of fractures
- Analgesia

Remember: if the patient deteriorates, re-evaluate with a primary survey, checking and treating life-threatening conditions, then make a careful assessment focussing on the affected system.

Be prepared: if anything can go wrong it will, and at the worst possible time.
--

Appendix 1 – Primary Survey Flow Chart



Appendix 2: Airway Management Techniques

Basic techniques

Chin lift and jaw thrust

The chin lift can be performed by placing two fingers under the mandible and gently lifting upward to bring the chin anteriorly. During this movement the neck should not be hyperextended but kept stable in an 'in-line' (neutral) position. This is 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 its tip reaches the soft palate and is then rotated 180 degrees. Take care in children because of the possibility of soft tissue damage.

Nasopharyngeal airway

Insert via a nostril (well lubricated) and pass it into the posterior oropharynx. It is well tolerated. Do not use a nasopharyngeal airway in a patient with a suspected base of skull fracture.

Suction

Suction should be performed under direct vision. Be careful not to induce vomiting, cause more injury or push a foreign body further down.

Bag-valve-mask ventilation (BVM)

If the patient requires more oxygen or needs assistance with ventilation, a face mask and self-inflating bag is used.

One-person technique with BVM: Maintain jaw thrust with the left hand little finger, ring finger and middle finger. Use the thumb and index finger to hold the mask firmly over the mouth and nose. Make sure there is no air leak. Use the right hand to squeeze the bag and ventilate the patient. Watch the chest wall rise and fall with each given breath.

Two-person technique with BVM: this is a more reliable method than the one-person technique. One person can maintain jaw thrust and hold the mask over the nose and mouth using both hands. The second person squeezes the bag.

Sometimes using an oral and/or nasal airway with the BVM can improve the delivery of an effective breath.

Remember: if any neck injury is suspected then the cervical spine must be immobilised during bag-valve-mask ventilation.

Advanced techniques

Supraglottic airway devices including Laryngeal Mask Airway (LMA) and i-Gel

The LMA is a supraglottic airway which consists of an airway tube with a pharyngeal cuff. It may improve ventilation and oxygenation when bag-mask-ventilation is not effective. Suggested LMA sizes are: 4 or 5 for adult males, 3 or 4 for adult females and 2 or less for children. The LMA does not protect against regurgitation and aspiration, but it can be an emergency life-saving device for patients who cannot be intubated. The i-Gel is a similar device without a cuff.

Orotracheal intubation

Tracheal intubation must be considered for these reasons:

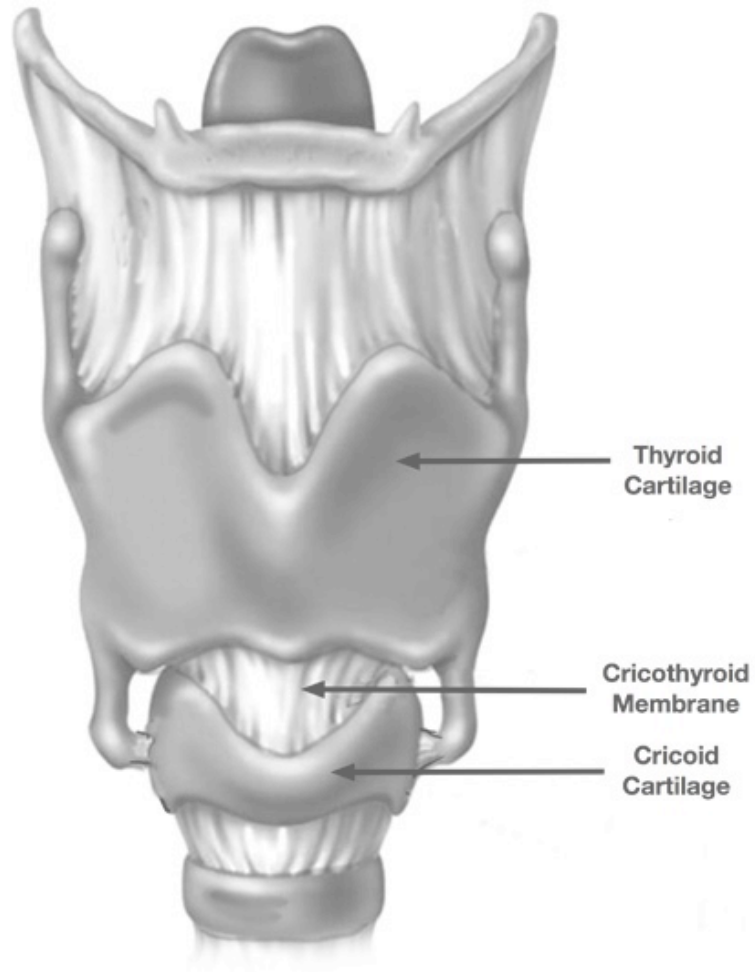
- To establish and maintain a secure open airway and prevent aspiration
- If basic airway techniques fail and the patient remains hypoxic
- To assist or control ventilation.

Orotracheal intubation may produce cervical hyperextension. It is essential to maintain in line head and neck immobilisation (by an assistant). Cricoid pressure may be necessary if a full stomach is suspected. The cuff must be inflated and correct placement of the tube checked by listening with a stethoscope for normal breath sounds and watching the chest rise and fall on both sides).

This should be performed in no more than 30 seconds: if unable to intubate then ventilation of the patient with a BVM must continue.

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.

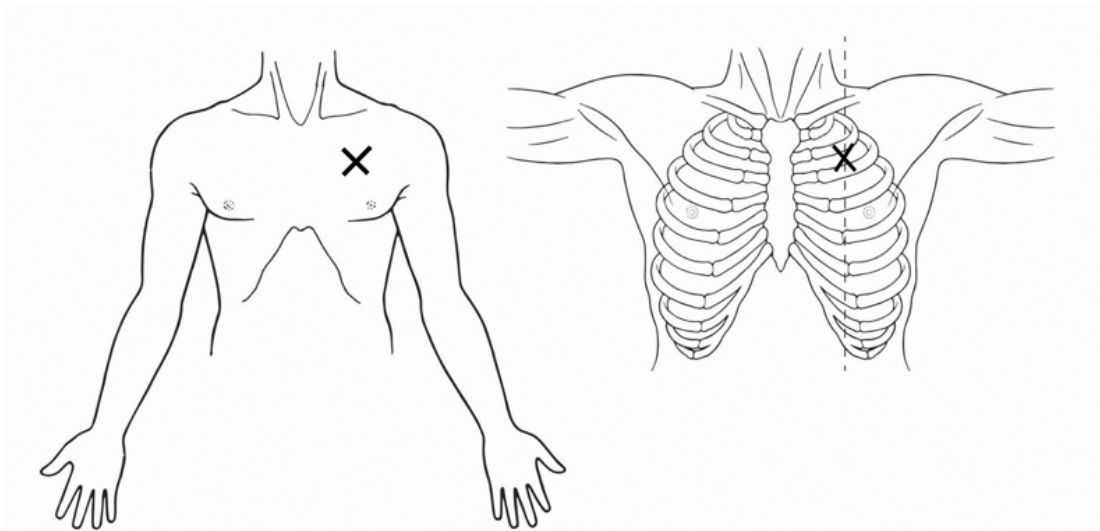


Remember: patients die from lack of oxygen, not a lack of a tracheal tube

Appendix 3: Breathing Management and Chest Injuries

Needle thoracostomy

If a tension pneumothorax is suspected, then insert a large-bore needle or cannula into the pleural cavity on the affected side at the second intercostal space, mid-clavicular line. This is a short term emergency and life-saving intervention. A proper chest tube should be inserted afterwards by a skilled clinician.



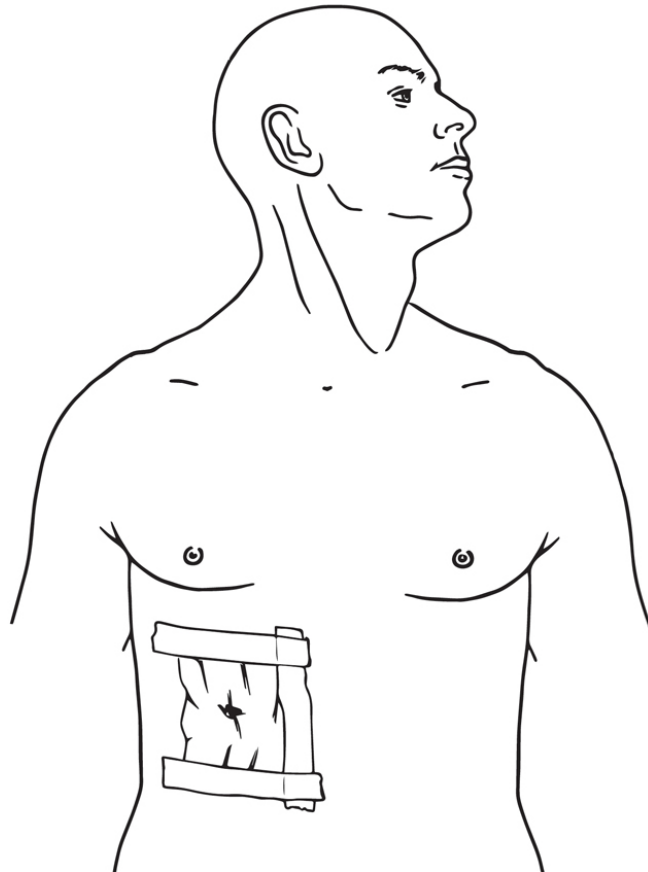
Chest tube insertion

To drain a haemothorax or large pneumothorax (or after a needle thoracostomy for tension pneumothorax), a chest tube can be inserted in the 5th intercostal space in the mid-axillary line. Method:

- Explain the procedure to the patient and use universal and sterile precautions
- Feel for and mark the site of insertion
- Use local anaesthetic
- Avoid the neurovascular bundle by dissecting over the top of the rib, using blunt techniques as much as possible
- Do not use the sharp trochar to insert the intercostal drain. Forceps can be used to enter the pleural cavity.
- Secure the chest tube to the skin and connect to an underwater drain

3-way dressing

For a sucking chest wound, a 3-way dressing is applied. The edges of a square dressing (gauze, clean plastic or material) are taped firmly to the skin over the open wound along 3 sides, and leaving one side un-taped. This acts as a valve over the wound.



Appendix 4: Equipment requirements for airway and breathing management

Equipment requirements for basic airway management

Oral or nasal airway

Suction device (manual or electric pump) with rigid suction tip and tubing

Bag-valve-mask

Basic trauma kit (scalpel, scissors, sutures, gauze, clamps, syringe, needles)

Equipment requirements for advanced airway management

Laryngoscope

Endotracheal tubes

Gum elastic bougie if available

Magill forceps

Equipment required for breathing management

Stethoscope

Oxygen supply, nasal prongs, mask and tubing

Bag-valve-mask

Needle and syringe

Chest tubes

Underwater seal (or equivalent)

Pulse Oximeter

Appendix 5: Adult Vital Signs and Blood Loss

Blood Loss	Heart Rate	Blood Pressure	Capillary Refill Time	Respiratory Rate	Urine Output	Mental State
<750 mls <15% blood volume	< 100	normal < 100	normal < 2 seconds	normal 14 - 20	> 30 mls/hr	Anxiety +
750 - 1500 mls 15 - 30%	100-120	normal	delayed	increased 20 - 30	20 - 30 mls/hr	Anxiety++
1500 - 2000 mls 30 - 40%	120-140	decreased	delayed	increased 30 - 40	5 - 15 mls/hr	Anxiety+++ confused
> 2000 mls > 40% blood volume	> 140	decreased	delayed	increased > 35	< 5 mls/hr	Confused coma

Appendix 6: Massive Transfusion

This topic includes concepts of damage control resuscitation (permissive or hypotensive resuscitation, haemostatic resuscitation) and damage control surgery. Massive Transfusion Protocols have been introduced to improve and standardise transfusion management.

Acute coagulopathy, hypothermia and acidosis constitute the "lethal triad" of the exsanguinating and shocked trauma patient.

The aetiology of the acute coagulopathy of trauma shock is multifactorial: tissue injury, reduced perfusion, induced anticoagulation and hyperfibrinolysis, consumption, dilution and dysfunction of clotting factors.

Haemostatic resuscitation is the early use of blood and blood products as primary resuscitation fluids, to treat the acute traumatic coagulopathy and to prevent the development of dilutional coagulopathy.

Massive transfusion must be anticipated. The presence of at least 2 of the following predicts massive transfusion:

- Penetrating injury
- Blood pressure < 90 mmHg
- Heart rate >120
- Positive FAST or DPL.

Massive Transfusion Protocol (MTP) for

Actual or expected blood loss greater than 50% of blood volume

- Stop the bleeding: compression, tourniquet, packing
- Immediate blood sample for Cross-match, haematocrit and coagulation tests
- Inform blood transfusion lab - "samples coming, immediate action needed"
- Keep the patient oxygenated and actively warm
- Cross-match 4 units of red cells, prepare FFP (cryoprecipitate) & platelets if available OR Cross match 4 units of fresh whole blood
- Give Tranexamic acid 1g over 10 minutes then 1 g over 8 hours
- Consider immediate damage control surgery to stabilise patient.

During treatment:

- If no head injury, accept a mean BP of 65mmHg and do not try to increase this with more crystalloid
- Monitor urinary output
- Monitor important clotting parameters if possible, as well as arterial blood gases & lactate

Appendix 7: Pain Management in Trauma

Pain Management should be an important part of the management of the Trauma patient. Failure to treat pain will have negative results for the patient, increasing stress and preventing deep breathing and slowing recovery from injury. There is no evidence to support the belief that opioid analgesia makes diagnosis more difficult in polytrauma or that it is contraindicated in head injuries.

It is important to **R**ecognise, **A**ssess and **T**reat pain (remember RAT). Ask the patient about his pain, and look for signs of pain. Use a scale to measure pain. This is discussed further in the *Essential Pain Management* course, details of which can be found below.

Non-drug methods of pain control are important. These include reassurance, immobilisation and splinting of fractures, and for burns initial cooling and covering the burns with a dressing such as cling film.

A range of drugs can be used for pain relief. In some countries it may be difficult to obtain or use strong opioids, and supplies of drugs may be difficult. In all cases it is important to titrate analgesic drugs watching for pain relief and side effects.

Because of vasoconstriction and reduced blood supply to the skin and muscle in hypovolaemia the absorption of drugs from intramuscular or subcutaneous injections will not be reliable. If available, it is most appropriate to titrate with small (incremental) doses of a strong opioid such as morphine against the pain relief. Addiction is not a problem with short-term use of morphine and other opioids, and with careful titration of morphine, observing the patient, respiratory depression is avoidable.

Morphine is the most suitable drug to use. In some countries morphine is not available; depending on availability, other drugs such as pethidine (meperidine) or tramadol may be used. Paracetamol (acetaminophen) and non-steroidal drugs can be used to contribute to pain relief.

Ketamine is often available in many countries, and in small doses (well below

those required for sedation or anaesthesia) such as 0.1-0.2 mg/kg by intravenous titration and repeated as necessary, it can provide effective analgesia. Ketamine may also have a morphine sparing effect.

Consider also the use of local anaesthetic techniques if appropriately skilled staff are available. These can include femoral nerve blocks, other nerve blocks and intercostal blocks.

Further resources for Pain Management

The Essential Pain Management course manual is recommended, with details at <http://www.fpm.anzca.edu.au/fellows/essential-pain-management>

A WHO Model List of Essential Medicines for Pain Management is given at <http://www.who.int/medicines/publications/essentialmedicines/en>

Appendix 8: FAST

Focused Assessment with Sonography for Trauma (FAST) is a limited ultrasound examination used for identifying the presence of free intraperitoneal or pericardial fluid.

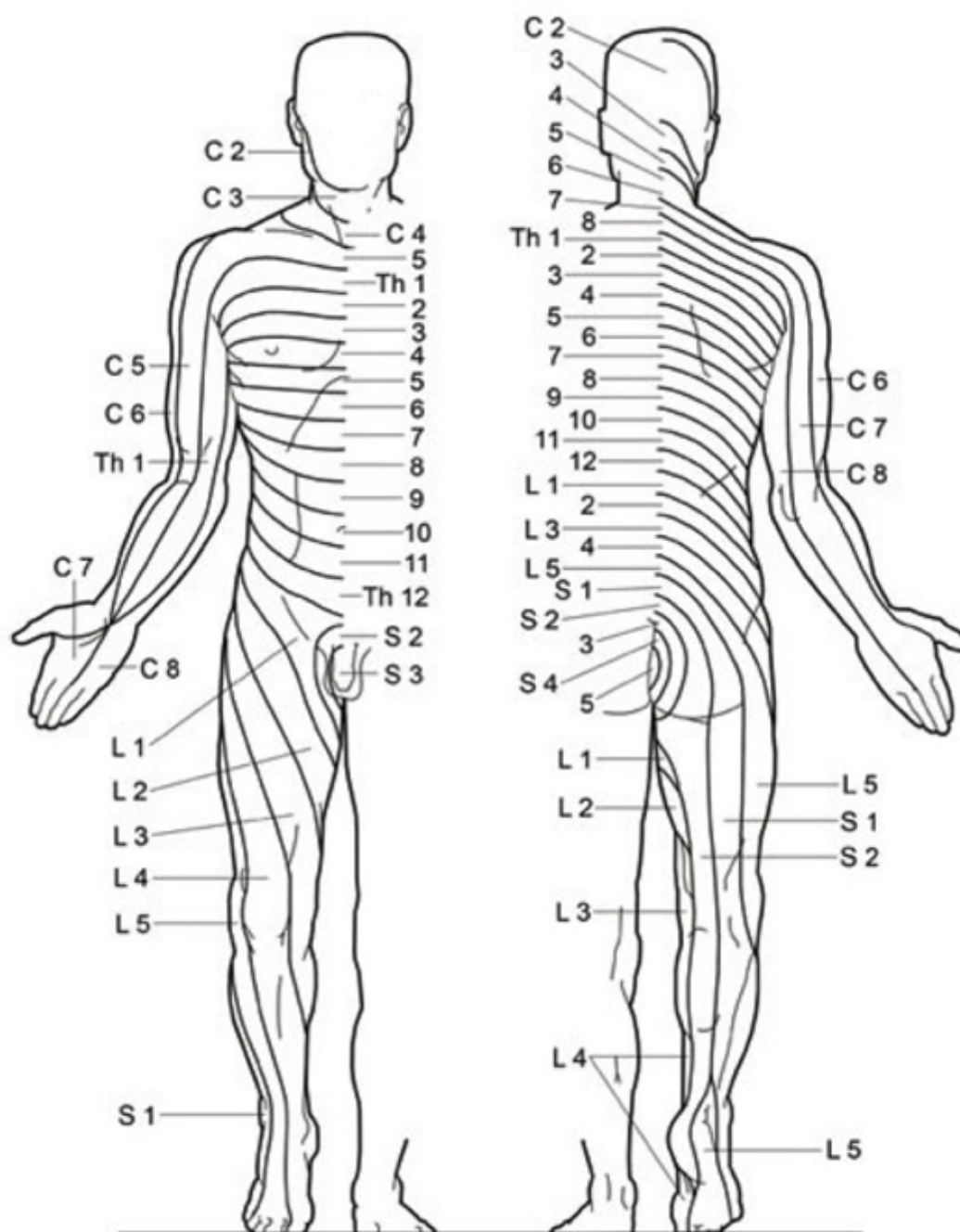
	DPL	FAST	CT Scan
Time	Rapid / intermediate	Rapid	Rapid
Transport	No / In an operating room	No	Yes Needs transfer
Sensitivity	High	High? / operator dependant	High
Specificity	Low	Intermediate	High
Eligibility	All patients / In suspected injury and no radiology available. Not in pregnant lady. Previous surgery.	All patients	Haemodynamically Stable Takes time

In patients with traumatic injury, free fluid is usually due to haemorrhage and contributes to the assessment of the circulation

Glossary

DPL:	Diagnostic Peritoneal lavage,
FAST:	Focused Assessment with Sonography for Trauma
CT Scan:	Computerised Tomogram Scan.

Appendix 9: Dermatomes



Appendix 10: Paediatric Physiological Values

A formula for estimated weight (kg) of a child between 1-5 years is:

$$(2 \times \text{age in years}) + 8$$

and between 6-12 years it is:

$$(3 \times \text{age in years}) + 7$$

Variable	New born	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 (beats per minute)	Systolic blood pressure (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

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 11: Trauma Triage

Trauma Triage refers to sorting of the injured patients according to their individual need for emergency medical treatment. This process prioritises patient's needs by a very brief observation based on Primary Survey ABCD principles. Its aim is to identify the victims in need of urgent treatment and to achieve the greatest good for the greatest number of casualties by using available resources. It is a dynamic process with recognition that patients who are allocated to one level can change to another level.

Patients are prioritised in Triage groups as: RED Immediate; YELLOW Urgent; GREEN Walking wounded and BLACK dead or dying.

Equipment & Supplies at Emergency Department:

A large number of stretchers or trolleys are needed at the entrance of the hospital. Blanket and sheets are required in the triage area and lines on which to hang infusion sets. Complete sets of supplies for triage should be prepared and stored in boxes or containers which can be easily carried to the triage area from a storage area.

Triage Boxes should include:

- Disposable gloves
- I/V Fluids: Ringers/ Saline
- Venepuncture equipment/ IV Cannula/ Intra osseous needles
- Dressing bandages/ Scissors
- Catheters, nasogastric tubes
- Drugs which are likely to be needed
- Standard Documentation charts and patient folders with a unique number
- Each folder should include a triage admission card, lab & X-ray request form.

Training

The hospital team should regularly practice different triage scenarios. Clinical protocols and guidelines for the triage and patient management must be standardised and understood by all doctors and nurses. After every triage incident and when feasible, a general meeting (De-briefing) of the staff should be held to discuss what went well and how to improve.

Triage groups/ Nursing teams:

Such teams should be formed for the triage area, with responsibility for the following tasks:

- Setting up intravenous lines and taking blood for grouping and cross matching.
- Administration of tetanus prophylaxis, antibiotics, analgesics and other medications as prescribed.
- Dressing wounds and splinting fractures.
- Bladder catheterisation, if indicated.
- Arranging of an orderly flow of categorised casualties according to colour coding to the operating theatre or to designated areas for continuing resuscitation, delayed, or minimal treatment.

Appendix 12: Preparing for Mass Casualties

Preparation for a major incident involves planning, training and acquisition of equipment. The hospital team must be prepared for any kind of crises: every hospital should have a disaster/ triage plan. The aim of the plan is to organise personnel, space, equipment, supplies, infrastructure and services. Training of the hospital team, communications and security measures are also very important. The hospital team should hold a series of meetings to discuss the organisation of the disaster/ triage plan. Everyone in the hospital should be aware of the plan and their respective role during the crises.

Five critical steps before patients arrive in the Emergency Department:

1. Inform Head of the Hospital Disaster Team
2. Create Space by moving patients by discharge or admission to any empty bed or alternative location in the hospital.
3. Team meeting (Nurses/Doctors)
4. Establish Security Perimeter and Stretcher/Porters
5. Call more staff to Casualty reception area

List of Essential roles:

- Doctors – who are team players and will follow the protocols and orders
- Nurses – it may be necessary to move nurses to ED from other areas
- Security Supervisor
- Someone to arrange Ward and ICU beds – Nursing Supervisor
- A person ensuring quick X-Ray turnover.
- Someone looking for stretchers and wheelchairs
- Pharmacist/Store supervisor
- Patient transport force - Porters
- Record Keeper/Manager
- Public Relations Officer – Informing public/press every 15 minutes to hourly
- A person ensuring quick Blood Bank turnaround.

Leadership in the Emergency Department (ED)

The person in charge of the ED during a disaster should be a clinician who is familiar with the systems and staff of the department, and is not necessarily the most senior physician or surgeon or the most important professor. They should be clearly identified as the leader in the ED with a name tag or special coloured vest.

The Hospital Command Centre should be situated away from the ED, but be in close communication with what is happening in the ED and what the patient load is. Senior staff can create problems by coming to the ED and not following the command structure at that time.

Make the Emergency Department Secure:

- Clear and practiced Security Protocols (including Non-Hospital Personnel)
- Security Perimeters
- Outer Perimeter : combination of volunteers and police
- Medium Perimeter : Hospital Security and Police
- Inner Perimeter : Police
- Disaster Drop Off Area
- Hospital Porters at the ambulance drop off
- A 5 second security check before bringing the victims inside
- Build Linkages with the community and educate press