THE DEADLY DOZEN OF CHEST TRAUMA

With interpersonal violence remaining on epidemic levels in South Africa thoracic trauma is frequently encountered and managed by our general practitioners, particularly in remote areas.

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Approximately 85% of all thoracic trauma can be treated without specialised surgical intervention; probably the most common presentation is related to rib fractures. The patient complains of pain aggravated by breathing or coughing. Compression of the rib cage elicits pain and fractures are seen on chest or rib X-rays. Chest X-rays are of paramount importance and should be obtained as early as possible. In all penetrating wounds radio-opaque markers should be placed to facilitate estimation of the wounding trajectory. Associated injuries such as pneumothorax, haemothorax or pulmonary contusion must be excluded. Spinal injuries should be considered in the appropriate scenario. The treatment is oral analgesics in mild to moderate pain, and consideration of opioids, nerve block, epidural or intrapleural analgesia in the presence of severe pain. The complications of pneumothorax or haemothorax are treated with insertion of an intercostal drain, placed at the level of the fifth intercostal space in the anterior axillary line.

Severe chest injuries are responsible for 25% of all trauma deaths, and in a further 25% they are a contributing cause of mortality. Life-threatening injuries can be remembered as the *deadly dozen* — six are immediately life threatening and should be sought during the primary survey and six are potentially life threatening and should be detected during the secondary survey. A reproducible and safe approach in their diagnosis and management is taught by the Advanced Trauma Life Support (ATLS) course.

IMMEDIATE LIFE-THREATENING INJURIES

1. Airway obstruction

Early preventable trauma deaths are often due to lack of or delay in airway control. The most common cause in the unconscious patient is obstruction caused by the tongue. Dentures, teeth, secretions and blood can contribute to airway obstruction in trauma. Bilateral mandibular fracture, expanding neck haematoma producing deviation of the pharynx and mechanical compression of the trachea, laryngeal trauma such as thyroid or cricoid fractures and tracheal injury include other causes of airway obstruction.

These patients need intubation (with simultaneous protection of the cervical spine). Early intubation is very important, particularly in cases of neck haematomas or possible airway oedema. Airway oedema can be insidious and progressive and can make delayed intubation more difficult if not impossible.

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2. Tension pneumothorax

A tension pneumothorax develops when a 'one-way-valve' air leak occurs, either from the lung or through the chest wall. Air is forced into the thoracic cavity without any means of escape, completely collapsing the affected lung. The mediastinum gets displaced to the opposite side, decreasing venous return and compressing the opposite lung.

The most common causes are penetrating chest trauma, blunt chest trauma with parenchymal lung injury that did not spontaneously close, iatrogenic lung punctures and mechanical positive pressure ventilation.

The clinical presentation is dramatic. The patient is panicky, with tachypnoea, dyspnoea and distended neck veins (similar to pericardial tamponade). Clinical examination can reveal tracheal deviation (a late finding — not necessary to clinically confirm diagnosis), hyper-resonance and absent breath sounds over the affected hemithorax. Tension pneumothorax is a clinical diagnosis and treatment should not be delayed by waiting for radiological confirmation.

Treatment consists of immediate decompression and is managed initially by rapidly inserting a large-bore needle into the second intercostal space in the midclavicular line of the affected hemithorax. This is immediately followed with a chest tube insertion.

3. Pericardial tamponade

Pericardial tamponade needs to be differentiated from tension pneumothorax in the shocked patient with distended neck veins. It is most commonly the result of penetrating trauma. Accumulation of a relatively small amount of blood into the non-distendable pericardial sac can produce tamponade physiology. The clinical diagnosis can be straightforward or very difficult. All patients with penetrating injury anywhere near the heart plus shock must be considered to have cardiac injury until proven otherwise. The classic diagnostic Beck's triad consists of venous pressure elevation, decline in arterial pressure and muffled heart sounds. Pulsus paradoxus and Kussmaul's sign could further suggest pericardial tamponade. High index of suspicion and further diagnostic investigations (chest X-ray, showing enlarged heart shadow or cardiac echo showing fluid in the pericardial sac) are required for the subclinical case. In cases where major bleeding from other sites has taken place, the neck veins may be flat. Pericardiocentesis has a high potential for iatrogenic injury to the heart and it should, at the most, be applied as a desperate temporising measure in a transport situation (under ECG control). The correct immediate treatment of tamponade is operative (sternotomy or left thoracotomy) with repair of the heart, if time allows it in an operating theatre, otherwise in the emergency room.

Fig. 1. Chest radiograph: A stabbed heart with a haemopericardium and right-sided haemothorax.

4. Open pneumothorax ('sucking chest wound')

This is due to a large open defect in the chest (> 3 cm), leading to equilibration between intrathoracic and atmospheric pressure. Air accumulates in the hemithorax with each inspiration, leading to profound hypoventilation and hypoxia. Signs and symptoms are usually proportionate to the size of the defect.

Initial management consists of promptly closing the defect with a sterile occlusive dressing taped on three sides to act as a flutter-type valve. If the patient is not intubated a chest tube is inserted as soon as possible in a site remote to the injury site. Definitive treatment may warrant formal debridement and closure, preferably in the operating room, and all such patients should be referred early.

5. Massive haemothorax

Accumulation of blood in a hemithorax can significantly compromise respiratory efforts by compressing the lung and preventing adequate ventilation. Such massive accumulation of blood presents as haemorrhagic shock, unilateral absence of breath sounds, dullness to percussion, and flat neck veins. The treatment consists of correcting the hypovolaemic shock, insertion of an intercostal drain, and in some cases intubation.

Blood in the pleural space should be removed as completely and rapidly as

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possible in order to prevent ongoing bleeding, empyema or late fibrothorax. Clamping a chest drain to tamponade a massive haemothorax is usually not helpful.

Initial drainage of more than 1 500 ml of blood or ongoing haemorrhage of more than 200 ml/h over 3 - 4 hours are generally considered indications for urgent thoracotomy. Caution is required in the case of a patient who drains 500 ml into the drain bottle, but has persistent dullness or radiographic opacification.

6. Flail chest

A flail chest occurs when a segment of the chest wall does not have bony continuity with the rest of the thoracic cage. This condition usually results from blunt trauma associated with multiple rib fractures, i.e. two or more ribs fractured in two or more places. The blunt force required to disrupt the integrity of the thoracic cage typically produces an underlying pulmonary contusion. The diagnosis is clinical, not radiographic. The chest wall must be observed for paradoxical motion of a chest wall segment for several respiratory cycles and during coughing. Voluntary splinting due to pain, mechanically impaired chest wall movement and the associated lung contusion all cause hypoxia. The patient is also at high risk for immediate or delayed pneumothorax or haemothorax.

Traditional treatment consisted of mechanical ventilation to 'internally splint' the chest until fibrous union of the broken ribs occurred. The price for that was considerable in terms of ICU resources and ventilation-dependent morbidity. Currently the treatment consists of oxygen administration, adequate analgesia and physiotherapy. Ventilation is reserved for patients developing respiratory failure. Operation is another treatment option for flail chest, after having been discarded in the past due to the view that underlying pulmonary contusion was the dominant pathology. Now a selected group with isolated, severe chest injury and flail segments has been shown to benefit from internal operative fixation.

POTENTIALLY LIFE-THREATENING INJURIES

1. Thoracic aortic disruption

Traumatic aortic rupture is a common cause of sudden death after an automobile collision or fall from a great height. For the subgroup of immediate survivors salvage is frequently possible if aortic rupture is identified and treated early. It should be clinically suspected in patients with a discrepancy of the blood pressure between left and right arm or between upper and lower limbs, a widened pulse pressure and chest wall contusion. Erect chest X-ray can also suggest thoracic aortic disruption, the most common radiological finding being a widened mediastinum. The diagnosis is confirmed by aortography, or contrast spiral CT scan of the mediastinum and to a lesser extent by transoesophageal echocardiography.

The treatment is immediate open operative intervention. In selective cases conservative management consisting of control of the systolic arterial blood pressure (~ 100 mg Hg) and postponement of the operation is advisable in patients who are physiologically unstable due to trauma in other anatomical areas.

2. Tracheobronchial injuries

Severe subcutaneous emphysema with respiratory compromise can suggest tracheobronchial disruption. The chest drain placed on the affected side will reveal a large air leak, and the collapsed lung may fail to re-expand. If after insertion of two drains the lung fails to re-expand the peripheral doctor should arrange referral to a trauma centre.

Bronchoscopy is diagnostic. Treatment involves intubation of the unaffected bronchus followed by operative repair.

3. Blunt myocardial injury

Significant blunt cardiac injury that causes haemodynamic instability is rare. Blunt myocardial injury should be suspected in any patient with significant blunt trauma who develops ECG abnormalities in the resuscitation room.

Diagnostic tools are 12-lead ECG tracings and two-dimensional echocardiography that can show wall motion abnormalities.

There is no evidence that enzyme studies have a place in diagnosis or management.

All patients with myocardial contusion diagnosed by conduction abnormalities are at risk for sudden dysrhythmias and should be monitored for the first 24 hours. After this interval the risk for sudden dysrhythmias decreases substantially, unless significant stress like a general anaesthetic is added.

4. Diaphragmatic injuries

A high index of suspicion is needed in stab wounds below the nipple line as in normal expiration the diaphragm rises up to the fifth intercostal space. Diagnosis of blunt diaphragmatic rupture is missed even more often in the acute phase due to associated

injuries. There is no single gold standard of investigation. Chest radiography after placement of a nasogastric tube, contrast studies of upper or lower gastrointestinal tract, CT scan, and diagnostic peritoneal lavage have an only limited positive or negative predictive value. Most accurate evaluation is by video-assisted thoracoscopy or laparoscopy, the latter offering the advantage of easier repair and additional evaluation of the abdominal organs.

Operative repair is recommended in all cases.

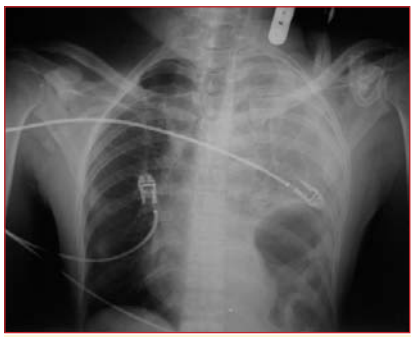

Fig. 2. Chest radiograph: Blunt trauma, left-sided diaphragmatic rupture and haemothorax and right-sided pneumothorax.

5. Oesophageal injury

Most injuries result from penetrating trauma; blunt injury is rare. A high index of suspicion is required. The patient can present with odynophagia, subcutaneous or mediastinal emphysema, pleural effusion, retro-oesophageal air, and unexplained fever within 24 hours of injury. The mortality rises exponentially if treatment is delayed more than 12 - 24 hours. Mediastinal and deep cervical emphysema must be seen as evidence of an aero-digestive injury until proven otherwise! Combination of oesophagogram in decubitus position and oesophagoscopy confirm the diagnosis in the great majority of cases. The treatment is operative.

6. Pulmonary contusion

Pulmonary contusion is caused by haemorrhage into the lung parenchyma, usually underneath a flail segment or fractured ribs. This is a very common potentially lethal chest injury and the major cause of hypoxaemia after blunt trauma. It is an independent risk factor for pneumonia and adult respiratory distress syndrome (ARDS). The natural progression of pulmonary contusion manifests as worsening hypoxaemia for the first 24 - 48 hours. The chest X-ray findings are typically delayed and non-segmental. Contrast CT scan can be confirmatory. If abnormalities are seen on the admission chest X-ray, the pulmonary contusion is severe. Haemoptysis or blood in the endotracheal tube is a sign of pulmonary contusion. In mild contusion the treatment is oxygen administration, aggressive pulmonary toilet and adequate analgesia. In more severe cases mechanical ventilation is necessary. While one should avoid fluid-overloading these patients to counteract a trend to pulmonary oedema, establishment of normovolaemia is critical for adequate tissue perfusion and fluid restriction is not advised.

CONCLUSION

Chest injuries are often life threatening, either in their own right or in conjunction with other system injuries. Efficient initial assessment according to the ATLS principles should focus on identifying and correcting the immediate threats to life. A high index of suspicion must be maintained thereafter to diagnose the potential threats to life as their symptoms and signs can be very subtle. Early consultation and referral to a trauma centre is advised in cases of doubt.

Further reading

Advanced Trauma Life Support Course Manual. Chicago: American College of Surgeons, 1997.
Guidelines for Practice Management: Blunt Myocardial Injury. The Eastern Association for the Surgery of Trauma (EAST). Online: **http//:www.east.org** (2004)
Guidelines for Practice Management: Prophylactic Antibiotics in Tube Thoracostomy. The Eastern Association for the Surgery of Trauma (EAST). Online: **http//:www.east.org** (2004)

IN A NUTSHELL

A significant proportion of deaths from thoracic trauma occur virtually immediately (i.e. at the time of injury), for example rapid exsanguination following traumatic rupture of the aorta, or major vascular disruption after penetrating injury.

Of survivors with thoracic injury who reach hospital, a significant proportion die in hospital as the result of mis-assessment or delay in the institution of treatment. These deaths occur early as a consequence of shock, or late as the result of ARDS and sepsis.

Most life-threatening thoracic injuries can be simply and promptly treated after identification, by needle or tube placement for drainage. These are simple and effective techniques that can be performed by any medical practitioner.

Emergency room thoracotomy (ERT) has distinct and specific indications. Indiscriminate use will not alter the morbidity or mortality, but will increase the risk of communicable disease transmission in health workers.

Injuries to the chest wall and thoracic viscera can directly impair oxygen transport mechanisms. The hypoxia and hypoxaemia that results may cause secondary injury, especially to the brain.

Brain injury can secondarily aggravate thoracic injuries by disrupting normal ventilatory patterns. In addition, the lung is a target organ for secondary injury following shock and remote injury.