Part X: Trauma

Chapter 66: Management of Severe and Multiple Trauma

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Trauma can be defined as physical injury. It frequently leads to death, hospital admission, and use of ICU resources. Trauma is usually categorized as either blunt or penetrating. In Western countries, severe blunt trauma is common, and is most frequently caused by road crashes, falls, and less commonly, blows and assaults. Severe penetrating trauma, usually from gunshots and stabbings, is less common except in larger cities of USA. In some respects, blunt trauma is more difficult to manage than penetrating trauma. Assessment is harder, because injuries are frequently internal and not initially obvious. They are also often multiple.

Of the trauma admissions to hospital, only a minority have severe or multiple trauma. Their life-threatening injuries are, in order of frequency, to the head, abdomen, and chest. However, the hospital resources used by these patients are out of proportion to their numbers. Required services include resuscitation, imaging tests, laparotomy and major surgery, respiratory support and Intensive Care. Craniotomy and thoracotomy are needed less frequently.

Emergency Assessment and Setting Priorities

1. Triage

An important first step in the management of severe trauma is triage, ie, to sort patients with acute life-threatening injuries and complications, from those whose lives are not in danger. The severity of total body injury is related to the number of separate injuries present, and to the severity of the individual injuries. Assessment can be made either at the scene of injury, or on arrival at hospital. As in any emergency, assessment, diagnosis and treatment must be concurrent. There is no time for detailed histories, examinations, investigations, and well-considered diagnoses, before starting resuscitation and emergency care. Those with severe injury can usually be distinguished early by the presence of (a) a depressed level of consciousness, (b) abnormal breathing, or (c) signs of shock.

(a) *Coma* in the trauma patient can be related to brain injury, hypoxaemia, shock, alcohol, or other drugs which have been taken. Frequently, a combination of factors is present, and the degree of physical head trauma is not known precisely.

(b) *Breathing difficulties* are common in patients with trauma to the head, face, neck and chest. If rapid or distressed breathing is present, airway obstruction, laryngeal injury, pulmonary aspiration, and lung or chest wall injury (especially pneumothorax and lung contusion) should be considered.

(c) *Shock* always requires explanation and is almost always hypovolaemic. However, cardiogenic shock does occur in the trauma patient. The earliest, most constant and reliable signs of shock are seen in the peripheral circulation. A patient with cold, pale peripheries has

shock until proved otherwise. Hypotension is a later sign of shock, and tachycardia is not always present.

2. Priorities

A trauma patient often has multiple problems which require attention, and determining priorities is often not easy. In general terms, the priorities are:

(a) *Support life* - The patient is kept alive with whatever resuscitative techniques necessary, while various injuries and complications are attended to.

(b) *Locate and control bleeding* which may be external, internal or both.

(c) *Prevent brain stem compression and spinal cord damage.*

(d) *Diagnose, evaluate and treat* all other injuries and complications.

Basic Management Principles

A systematic approach to the management of severe and multiple trauma is important. A number of basic principles apply to the management of all patients with severe trauma:

1. Emergency Assessment

Before anything else, the following must be recognized and treated:

(a) *A - Airway obstruction* suggested by noisy (or silent) breathing with paradoxical respiration and respiratory distress.

(b) *B - Breathing difficulty* suggested by tachypnoea, mental confusion, cyanosis, and abnormal pattern of breathing.

(c) *C - Circulatory shock* manifested by cold peripheries with delayed capillary refill, low blood pressure, and rapid weak pulse.

2. Oxygen Therapy

High-flow oxygen by mask is given to any patient with fractured femur or a worse injury, because mild or moderate hypoxaemia is common. Patients with severe trauma frequently also require ventilatory support. A restless uncooperative patient may require anaesthesia with intubation and ventilation just to facilitate resuscitation.

3. Blood Cross-Match

Blood is cross-matched urgently. Six units should be requested in the first instance, instead of attempting to estimate the amount of blood loss beforehand. At the same time, blood is sent for baseline haematological, urea and electrolytes, and liver function tests.

4. Fluid Resuscitation

Resuscitation fluids are given. If necessary, 2 or 3 large 14 or 16-gauge intravenous cannulas are inserted in upper limb or neck veins.

5. Analgesia

Analgesia is often overlooked. Opioid drugs should be titrated intravenously, and never given intramuscularly or subcutaneously.

6. Urine Output

A urinary catheter is inserted, unless a ruptured urethra is suspected (because of blood at the urinary meatus or a severe fractured pelvis). Urine output monitoring is an important guide to resuscitation from shock.

7. Other Injuries

All injuries should be evaluated.

Evaluation of Injuries

Injuries are easily missed in an emergency, especially when one injury is obviously present. It is important to look systematically at all body regions, ie, head, face, neck, chest, abdomen, spine, pelvis, and extremities. The back of the patient, as well as the front should also be examined, and special attention is paid to regions with external lacerations, contusions, and abrasions.

1. *Head* - Neurological observations are made and the ears and nose are inspected for the presence of cerebrospinal fluid and blood.

2. *Face* - Bleeding into the airway should be excluded.

3. *Spine* - Signs of spinal cord injury should be looked for, ie, paralysis, diaphragmatic breathing, priapism, loss of vasomotor tone, and loss of anal tone. A cervical spine fracture or dislocation is assumed in all patients with head injury until proved otherwise.

4. *Chest* - Fractured ribs per se, are not usually important, but haemothorax, pneumothorax, lung contusion, and flail chest often require attention. Less common but very serious injuries occur to the heart and great vessels.

5. *Abdomen* - The spleen, liver, and mesenteries are often damaged. Retroperitoneal haemorrhage is common. Injuries to the pancreas, duodenum, and other viscera are less frequent, and are often missed until signs of peritonitis occurs. Renal injury with retroperitoneal haemorrhage is suggested by haematuria and loin pain.

6. *Pelvis* - Pelvic fractures may be difficult to detect clinically, especially in the unconscious patient. Blood loss may be massive, particularly with posterior fractures involving sacro-iliac dislocation. Ruptured bladder and ruptured urethra may be seen with anterior fractures.

7. *Extremities* - A litre of blood or more may be lost around a fractured femur. Long bone fractures are more serious if they are open, comminuted, or displaced, or if there is associated nerve or arterial damage.

8. *External* - Contusions nay be extensive and serious, especially in patients who jump or fall from high places, and may be overlooked if the back of the patient is not examined. Road crash victims may sustain serious burns.

Shock in the Trauma Patient

Cardiogenic Shock

If the trauma patient with shock has distended neck veins, possible injuries are cardiac tamponade, tension pneumothorax, myocardial contusion, and concurrent myocardial infarction.

Hypovolaemic Shock

If the neck veins are empty, hypovolaemic shock should be inferred. There are 5 possible sites of blood loss causing shock. Bleeding can be from one or more of these sites:

1. *External* - which is obvious from blood soaked clothing and the ambulance trolley.

2. *Major fractures* - which are obvious clinically (ie, femurs) or seen on a plain X-ray (ie, pelvis).

3. *Chest* - The chest X-ray will detect blood in the chest, and intrapleural drains will reveal the amount and rate of blood loss. The chest X-ray will also show signs of ruptured aorta, pneumo-haemothorax, lung contusion, and rib fractures.

4. *Peritoneal cavity* - as diagnosed by laparotomy, diagnostic peritoneal lavage or CT scanning.

5. *Retroperitoneum* - inferred, when all of the above are negative.

Diagnostic Peritoneal Lavage

Peritoneal lavage should be used to diagnose intra-abdominal bleeding, using 1 L of isotonic saline, particularly when the patient is unconscious or has multiple injuries. Clinical examination can be grossly misleading in these two situations. Caution is needed with pregnancy, previous abdominal surgery, or massive pelvic injury. A positive result is frank blood on incising peritoneum, or the return of pink lavage fluid. If lavage is not followed by

laparotomy, a specimen of fluid should be sent to the laboratory for red and white cell counts and amylase level. Positive peritoneal lavages inevitably result in some laparotomies which do not reveal any intra-abdominal bleeding. However, in severe trauma, the additional morbidity of a negative laparotomy is negligible.

Fluid Resuscitation

Initial Fluids

The main fluid lost in trauma is blood, and almost all patients who are hypotensive or noticeably vasoconstricted, will need blood transfusion. However, since cross-matched blood is not immediately available, other fluids are used first. Uncross-matched, group O Rh negative blood is occasionally indicated in the patient who is exsanguinating, but in general, it is wasteful of blood products to infuse large quantities while bleeding is uncontrolled.

The first intravenous fluid given to a trauma patient should be isotonic saline or a balanced salt solution. Patients with shock may need 2-3 L in the first few minutes. One litre bags or bottles and giving sets with in-line pumps should be used on all IV lines. A colloid plasma expander can be the second fluid used, and by 20-30 minutes, cross-matched blood should be available. Freeze dried plasma should be reserved for massive transfusion or suspected coagulopathy. In these situations platelets may also be needed.

All resuscitation fluids have a high sodium concentration similar to that of extracellular fluid. Few trauma patients require any other type of fluid in the first day. It is not possible to have a resuscitation fluid which is low in sodium. Glucose 5% and glucose-saline solutions are not effective resuscitation fluids.

Urine Output

Hourly urine output is a useful guide to resuscitation from shock. The absolute minimal acceptable urine output is 0.5 mL/kg/h, but 1-2 mL/kg/h is more adequate. Frusemide has no place in initial resuscitation.

Inadequate Resuscitation

Patients in shock have depletion of interstitial fluid and need resuscitation fluid volumes greater than the actual volume of blood lost. With blunt injury, volume losses often continue for 24-48 hours. Prolonged shock from delayed and inadequate resuscitation and inappropriate fluids, leads to oliguric and non-oliguric renal failure, adult respiratory distress syndrome (ARDS), sepsis, and multisystem failure.

Pulmonary Oedema

Pulmonary oedema during trauma resuscitation is not usually related to fluid overload. Direct lung trauma, pulmonary aspiration of gastric contents, pulmonary responses to non-thoracic trauma, and reactions to resuscitation fluids can all cause "leaky" capillaries and produce non-cardiogenic pulmonary oedema.

Head Trauma

Serious injuries to the head are common, although those requiring an urgent cranial operation, less so. Their assessment and management can be difficult especially when other injuries are present. Head injury is frequently only one part of multiple trauma. Although the head injury may initially be the most obvious injury, it may not be the most important.

Emergency Treatment

Patients with airway obstruction or inadequate airway protection should be immediately intubated and hyperventilated under anaesthesia, to ensure optimal cerebral oxygenation and blood flow, until full evaluation of cerebral status is possible. Those with one or two unreactive pupils should be given mannitol 1 g/kg IV in an attempt to relieve brainstem compression, until definitive diagnosis and treatment can be arranged.

Shock cannot be attributed to brain injury unless brain death has occurred or is imminent. Shocked patients with head injury require the same fluid resuscitation as those without head injury. Management of shock and maintenance of cerebral perfusion is a vital part of managing head injuries. Contrary to common belief, sodium containing fluids are not inherently dangerous in head trauma. However, oncre resuscitation is complete, further sodium administration is inappropriate. On the other hand, excessive water administration is also inappropriate. Free water is potentially dangerous as it can lead to hyponatraemia, hypo-osmolality, and brain swelling. After initial resuscitation, a patient with head trauma may need less than 500 mL of water to maintain normal serum biochemistry.

Neurological Evaluation

Factors such as hypoxaemia, shock, alcohol and other drugs all depress consciousness and worsen neurological signs. Analgesia and anaesthetic drugs and muscle relaxants also interfere with neurological assessment, but are often essential for effective resuscitation. Clinical neurological information to be recorded, if possible, on all trauma patients include the following clinical observations for the Glasgow Coma Scale:

1. Does the patient obey a simple command?

2. Does the patient open his eyes?

3. The vocal responses, ie, whether uses conversation, words, grunts and moans, or remains silent.

4. The motor responses of each limb, ie, whether localizing, flexion, extension, or no movement.

5. Spontaneous eye movements and position.

6. Pupillary responses.

The above information, and changes with time, will enable management decisions to be made. A deteriorating level of consciousness, or the presence of lateralizing motor or pupillary signs, are indications for CT scanning if available, or for emergency burr holes. CT scanning is indicated in all patients who are unresponsive to vocal command, especially if rendered neurologically "inaccessible" by sedative and relaxant drugs.

Radiology for Trauma Patients

Patients with depressed consciousness, breathing difficulties, or unstable circulation, should not be sent to a remote Radiology Department, away from skilled supervision and facilities. They need X-rays where they can be cared for at the same time. Similarly, extensive radiography of distressed shocked patients in the Emergency Department is unacceptable. Less urgent imaging examinations should be performed in the Operating Room or the ICU. Only 5 examinations should be requested as portable procedures in the Emergency Department:

1. *Chest* - This is the only X-ray ever justified in an unresuscitated patient. If a pneumothorax is obviously clinically present, it is unnecessary to await a chest X-ray before insertion of an intrapleural drain. A supine film is usually most practical in the first instance, although an erect film gives more information. An erect film is a better examination for showing intrapleular air or fluid, ruptured diaphragm, and for defining an abnormal mediastinum.

2. *Lateral cervical spine* - This should be done in all patients with head injury or multiple injuries, as cervical spine fractures are often missed. In a patient with head or facial injuries, a cervical fracture should be assumed initially, and a cervical collar applied. A lateral cervical spine X-ray is taken later, when the patient has been resuscitated.

3. *Pelvis* - A pelvic fracture which is not clinically obvious can be the site of unexplained blood loss. A dislocated hip can be missed in a patient with multiple injuries, especially if unconscious.

4. *"One shot" intravenous urogram (IVU)* - In suspected renal trauma, this is a useful procedure before laparotomy. It often avoids the need for a lengthy investigation in the Radiology Department.

5. *Skull* - Plain skull X-rays do not often guide immediate management unless there is a depressed skull fracture present. A CT scan is more useful.

Other X-rays should be deferred until after adequate resuscitation, to be performed in the Radiology Department or the ICU.

1. *Extremities* - X-rays of the extremities for assessing orthopaedic injuries are not urgent unless there is vascular injury. Fractures of the extremities are usually obvious. These films should, therefore, not be taken in the Emergency Department unless the patient is going directly to the Operating Room.

2. *Spine* - X-rays of thoracic or lumbo-sacral spine are also seldom indicated in the Emergency Department. Clinical examination is more important.

3. *Abdomen* - A plain abdominal X-ray is of limited value in the initial evaluation of trauma. Abdominal CT is valuable in evaluation of the patient who is haemodynamically stable.

4. *Aortography* - If aortic rupture is suspected either from the nature of the injury, symptoms and signs, or chest X-ray, the radiologist responsible for aortography should be consulted immediately. In general, diagnosis of ruptured aorta takes priority over all other injuries, except in the patient who needs immediate laparotomy or craniotomy on clinical grounds. This approach is a calculated risk because the incidence of positive aortography is low.

5. *Interventional Radiology* - Percutaneous transcatheter embolization can be a life-saving haemostatic procedure in massive retroperitoneal haemorrhage associated with pelvic fracture. However, the logistics of caring for such haemodynamically unstable patients in the Radiology Department are formidable.

Severity and Morbidity of Trauma

An important development in trauma care has been systemic grading of the severity of injury. This is the Abbreviated Injury Scale (AIS), which can provide a basis for research, audit and allocation of resources. In concept, the AIS divides the body into 6 regions: heand and neck, face, thorax, abdomen, pelvis and extremities, and external. Criteria are laid down to grade specific injuries, and the severity within each body region is graded from 1-5. The AIS works best for blunt trauma, and is specifically designed for motor vehicle accidents. Multiple injuries are catered for by the Injury Severity Score (ISS), which is an empirical system based on the AIS grades for the various body regions. It gives a score between 0-75 for total body injury. Total severity of trauma is related not just to the severity of individual injuries, but also to the combined effects of multiple injuries.

Severity of injury measured by ISS corresponds with the need for therapeutic modalities like ventilatory support, duration of stay in ICU, and with mortality. An ISS of 16 or more is indicative of major trauma. Death with an ISS of 24 or less ir rare, and is usually related to management error. Mortality rises abruptly with a scale of 25 and over, mostly from the severe head injuries. Mortality is even higher at a score of 30 or more, particularly from exsanguination, but also from complications of respiratory failure and sepsis. With a rating of 50 or more, survival is not common, but is increasing, especially in young patients. There is very little margin for management error with injury of this severity.

AIS and ISS, unfortunately study only the anatomy of injury. Obviously other factors influence trauma mortality and morbidity. These include age, pre-existing health, pre-hospital and early hospital care, and complications. The degree and duration of shock is particularly important, proportionate with the probability of complications. Complications from trauma include aspiration, thromboembolism, renal failure, ARDS, sepsis, liver failure, and multi-organ failure.

In Western countries, trauma is a leading cause of death and disability under the age of 40, with the majority of deaths occurring at the scene of injury. Reduction of mortality depends on public education, on-site advanced care, rapid evacuation, trauma expertise (ie, trauma centres), and coordination of services.