

Trauma update 2013

Brannigan LB

Correspondence to: Liam Brannigan, e-mail: lliambrannigan@yahoo.com

Peer reviewed © Medpharm

S Afr Fam Pract 2013;55(3)(Suppl 1):S3-S7

Introduction

All over the world, and not least in South Africa, clinicians continue to face the scourge of traumatic injury. The regularity with which patients require the collaborative effort of all or many of an institution's resources, simultaneously, makes this disease difficult to manage clinically, as well as socio-economically.

Also, understanding of the pathophysiology of trauma has given insight into the heterogeneity of injury and the ensuing physiological response, as well as the response to, and effectiveness of, resuscitative efforts. While the development of a protocol-based intervention with regard to the trauma patient, especially during early care, has resulted in significant improvements in trauma-related mortality, protocols are often deficient within the hospital setting, especially within the realm of the operating room or the intensive care unit.

This update aims to focus on the identification and treatment of trauma patients along this spectrum of presentation, present modern management of the major contributors to mortality and morbidity, and highlight common pitfalls of which clinicians should be aware when managing the trauma patient.

Understanding the heterogeneity of the traumatised population

"Protocols are for the guidance of wise men, and the blind obedience of fools", said Douglas Bader. Understanding the heterogeneity of presentation and therapeutic

response within the trauma population is of paramount importance if the modern-day anaesthesiologist wishes to provide tailored care to his or her patients. Patient factors, such as genetic makeup, level of fitness prior to the injury, time from the injury to care, and injury-related factors, such as force exerted and body area affected, contribute to this heterogeneity. These factors, and many others, add to the heterogeneity of presentation that creates a spectrum, illustrated in Figure 1. Attempting to first understand where an individual patient fits along this line will help the clinician to utilise the most efficient and effective strategy with which to manage this problem.

There are many ways in which to classify and approach the trauma patient, but some analysis of where each individual patient lie on a spectrum, such as this one, is helpful in directing further management of the patient.

Key concepts in the management of the trauma patient include:

- Damage control strategies.
- Haemostasis and resuscitation.
- Physiological housekeeping.

Damage control strategies

Toward the end of the last century, the concept of the damage control strategy was utilised and is now a well-established technique for the management of the severely traumatised patient. Damage control is defined as the "planned temporary sacrifice of normal anatomy in order to preserve vital physiology."

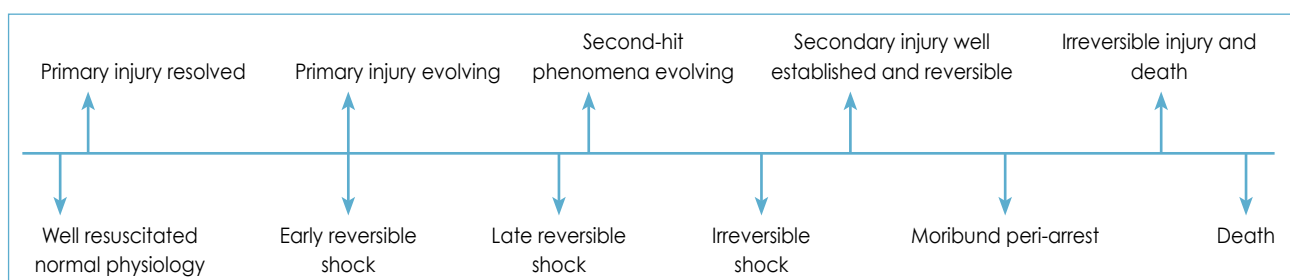


Figure 1: The spectrum of presentation of trauma patients, both with respect to injury (top) and physiological insult (bottom)

This strategy has a number of valuable consequences of which the anaesthesiologist should be aware:

- Often, the theatre team is involved in the primary resuscitation phase as patients are expedited to theatre in order to achieve damage control. This results in a patient arriving on the red line, and still requiring a number of procedures, as well as aggressive resuscitation.
- As damage control strategies are now part of the primary resuscitation effort for trauma patients, and the goal of initial surgery is resuscitation rather than repair, anaesthesiologists are one part of a continuum of resuscitation, beginning at the roadside or casualty, and ending in the trauma intensive care unit.
- Often, the anaesthesiologist is placed in the role of coordinator. Coordination of blood bank services, transport to radiological services, initiation and handing over to critical care services, and running the theatre environment, are all tasks that the attending anaesthesiologist may need to perform simultaneously. Theatre preparedness and planning of the necessary cooperation and coordination of services needs to be established at an institutional level. The anaesthesiologist plays a vital role in this process.

Haemostasis and resuscitation

Prior to the initiation of resuscitative efforts, some important aspects of the pathophysiology of trauma and injury need to be understood. The identification and management of the lethal trauma triad (bleeding coagulopathy, hypothermia and acidosis) as well as other aspects of care, such as macro- and microcirculatory function, will be discussed.

Haemorrhage and the trauma-induced coagulopathy

The cessation of trauma-related haemorrhage remains the most important aspect of trauma care, and an understanding of how, and why, the haemorrhage occurs, is fundamental to management of this problem. While it is obvious that the traumatised patient must have surgical control of his or her bleeding instituted as early as possible, what is less intuitive is the understanding that trauma is responsible for the development of marked coagulation abnormalities. Early trauma is associated with a normal or hypercoagulable state, but frequently this rapidly deteriorates to a scenario of progressive hypocoagulability and hyperfibrinolysis. Also, the most seriously injured patients often present in theatre with the latter already well established.

The common findings of dilutional coagulopathy, hypothermia and a metabolic acidosis, act synergistically

with this innate trauma coagulopathy to produce conditions that are ideal for severe and sustained blood loss. The use of traditional measures of coagulation, such as the platelet count, fibrinogen level, international normalised ratio and partial thromboplastin time, has major deficiencies with regard to the ability to assess the coagulation performance of any patient in real time. Hence, there is now a body of work that supports the use of real-time viscoelastic monitoring technologies, such as ROTEM® and TEG®, which provide a specific analysis of the patient's haemostatic condition.

The modern-day approach, whether using viscoelastic targeted resuscitation, or a damage control approach according to protocol, emphasises the need for more aggressive and early use of blood products. The backbone is packed red blood cells augmented with fresh frozen plasma, cryoprecipitate and platelets. This approach also limits the use of clear fluid resuscitation so that it is necessary to maintain minimal safe haemodynamic parameters, while awaiting the arrival of the blood products. Many protocols are available in the literature which institutions could consider adopting. A massive transfusion protocol should be in place at every institution that manages major trauma.

The use of haemostatic drugs is a more controversial issue. The use of antifibrinolytics should be based on a real-time assessment of hyperfibrinolysis, but regardless of the decision-making process, these drugs should be given early after the initiating trauma, ideally within the first three hours. Recently, late use of these drugs has been shown to increase mortality within the trauma population. The use of recombinant factor VII remains highly controversial as a treatment for refractory haemostatic failure because of the risk of microembolic phenomena, the ineffectiveness of the drug under acidotic conditions, the need for substrate availability, such as platelets, and the cost. Its use should only be undertaken in consultation with a clinical haematologist.

Acidosis

The trauma patient most commonly presents with a metabolic acidosis that is secondary to all, or one, of the following factors:

- Hypoperfusion, with the development of a massive oxygen debt (Figure 2).
- Hyperlactataemia, secondary to dead muscle or bowel.
- Alcohol and/or drug intoxication.
- Other more rare causes, such as thiamine deficiency, diabetic ketoacidosis and over-aggressive normal saline resuscitation.

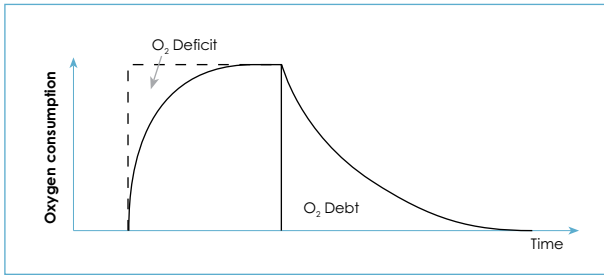


Figure 2: Oxygen debt: a mismatch between the delivery and consumption of oxygen

Frequently, there is a compensatory physiological effort, resulting in a respiratory alkalosis. This state is often exacerbated by pain and/or anxiety. The anaesthetist must be careful, especially on initiation of positive pressure ventilation, to guard against the development of concomitant respiratory acidosis, secondary to hypoventilation, the results of which may be catastrophic.

The treatment of a trauma-induced metabolic acidosis should be directed at correcting the underlying cause, normalising haemodynamics and preventing secondary injury. The use of lactate, rather than base excess, has been shown to be a good marker of response to resuscitation.

The use of bicarbonate-containing solutions remains highly controversial for many reasons. These include the potential for worsening the intracellular acid-base environment; correction of the numbers, rather than the patient; and the risk of hypernatraemia. From an evidence-based point of view, bicarbonate should only be considered in patients with severe and/or life-threatening metabolic acidosis which requires bridging while definitive therapies are given.

Hypothermia

Usually, the development of trauma-induced hypothermia is multifactorial and includes environmental and surgical exposure, fluid resuscitation, vasodilatation secondary to alcohol exposure, as well as anaesthetic agent exposure and others.

Although the trauma patient who presents with established hypothermia may have a worsened outcome, the evidence for this is quite poor. Hypothermia may have a negative impact on coagulation, wound healing, cardiac stability and infection rates, but the literature that supports this standpoint is relatively poor. Most institutions target normothermia, especially during the resuscitation phase, and use a variety of devices and techniques, such as forced air warmers, warmed environments, fluid-warming devices and contact warming.

Currently, there is good evidence to support the avoidance of hyperthermia in trauma patients, but especially those with a neurological injury. The role of therapeutic hypothermia remains an area of great controversy and study.

The macro- and microcirculatory response to trauma

Understanding the effect that traumatic injury, and the resuscitation thereof, has on the macro- and microcirculation is very important as perception of the pathophysiology of trauma is furthered, and as better modalities for treatment are sought.

The belief that the macro- and microcirculation exerts a large degree of coupling has recently been shown to be false. Large changes in macrocirculatory function are often accompanied by minimal or no change in microcirculatory flow or function. This may be reflective of an important mechanism for cellular homeostasis, but also has serious implications for the understanding and application of resuscitative efforts.

Also, changes which occur at a microcirculatory level in response to injury are initially adaptive, and are designed to protect the cell from unabated injury. Therefore, the time point at which the changes in the microcirculatory bed, both at the level of the endothelium and at the capillary level, become maladaptive, is probably also important.

Currently, although our understanding of the above physiology is poor, the following can be said:

- Current resuscitation methods focus on the correction and maintenance of macrocirculatory variables, such as mean arterial pressure, cardiac output and the delivery of oxygen. Very little is known about the effects of these on microcirculatory function, and therefore cellular function. However, poor microcirculatory flow is associated with a progressive reduction in endothelial function.
- There is some understanding of the impact of fluid resuscitation on the denudation and degradation of the endothelial glycocalyx. Marked, early degradation is associated with crystalloid usage, and less so with synthetic colloid usage, and least of all with blood usage.
- Patients who do not re-establish flow within the microcirculatory bed after resuscitation have a worsened outcome than those who do. The use of technologies, such as orthogonal polarisation spectral imaging and electron micrography of the endothelium, has enhanced the ability to understand the pathophysiology of trauma on a microcirculatory and molecular level. Hopefully, this will yield better resuscitative techniques in the future.

Physiological housekeeping

While the cessation of bleeding, the prevention of the deadly triad, fluid resuscitation, and other aspects of care are important during the resuscitation phase, it is equally

important not to lose control of other key management aspects during care of the trauma patient.

These include, but are not limited to:

- Glucose and electrolyte homeostasis.
- Modulation of the immune response.
- Modulation of the risk of the development of infection and sepsis.
- Identification and treatment of the complications of the injury, and of the resuscitation.

Glucose and electrolyte homeostasis

Hyperglycaemia is extremely commonplace in the trauma population, and is associated with significantly worsened mortality. While some controversy exists as to the safest level of glucose control and the mechanism by which control exerts its mortality benefit, most units aim to keep the serum glucose between 6-8 mmol/l.

The most common electrolyte abnormalities that occur around resuscitation of the trauma patient are hyperkalaemia and hypocalcaemia, both of which should be aggressively managed back to the normal range to prevent the life-threatening complications that ensue from their derangement.

Modulation of the immune response and adrenal insufficiency

Although it is well-established that adrenal insufficiency is common among severely injured patients, the management of this problem remains controversial. The Hydrocortisone Polytraumatise (HYPOLYTE) study showed benefit with the use of corticosteroids for shocked trauma patients. There was a statistically significant reduction in hospital-acquired pneumonia rates. This was in direct contradiction with the Corticosteroid Randomisation After Severe Head injury (CRASH) data which pre-dated this trial. It is the practice of the author to administer replacement-dose corticosteroids (hydrocortisone 100 mg eight-hourly) to patients who have inotrope-dependent shock.

Modulation of the risk of the development of infection

It is the responsibility of every healthcare provider who is involved in the management of trauma patients to consider a strategy for the prevention of infection, as this remains the most important late cause of mortality in this group. The use of corticosteroids has been briefly discussed above.

The implementation of an antibiotic stewardship programme and use of a standardised prevention of infection strategy is highly recommended.

Prophylactic antibiotics must be administered to all trauma patients prior to commencement of damage control surgery, and four-hourly thereafter until the surgery is completed, or earlier, if marked blood loss has occurred.

Other techniques that are required for the prevention of surgical-related infection are beyond the scope of this refresher, but are easily accessible on the Internet.

Early identification and management of the complications of the traumatic injury, as well as resuscitation

Trauma patients suffer many early and late complications which relate to the injury and also from efforts at resuscitation. The ability to recognise these complications, and then to manage them, is largely within the realm of the critical care environment, but is worth mentioning as the anaesthesiologist may regularly be called upon to do.

Abdominal compartment syndrome

Abdominal compartment syndrome is a common problem after damage control surgery. Risk factors include large-volume resuscitation, the degree of metabolic derangement, hypothermia and inotrope requirement. Detection of this complication through vigilant intra-abdominal pressure monitoring and organ monitoring must form part of the intra- to postoperative continuum. Management may be divided into medical and surgical. Medical management revolves around support of the circulation, limitation of intravenous fluids, the use of diuretics, analgesics and muscle relaxation, where necessary, and giving meticulous attention to and preventing end-organ impairment, such as renal dysfunction. Surgery may be required to relieve the intra-abdominal hypertension. Numerous techniques and approaches exist to tackle this challenge.

Fluid overload or transfusion-associated fluid overload

Once the resuscitation of trauma patients is complete, the concept of fluid creep may become lethal and certainly expose patients to excess morbidity risk for events such as delirium, acute renal dysfunction, poor wound healing, cardiac dysfunction, the need for ventilation and poor gut function with delayed nutrition. While aggressive fluid resuscitation is necessary early on in the management of these patients, an equally aggressive approach to the reduction of unnecessary intravascular fluid administration should be employed thereafter to avoid the above complications.

Transfusion-related lung injury and acute respiratory distress syndrome

Transfusion-related lung injury and acute respiratory distress syndrome may occur in trauma patients for a number of reasons, including a massive transfusion requirement, a significant primary lung injury, aspiration, pneumonia, fluid overload and severe inflammation.

The limitation of lung-injurious ventilation techniques,

aggressive curtailment of intravascular fluid administration after the resuscitation phase, early nutrition and limitation of immunomodulatory exercises, such as transfusion until deemed truly necessary, may prevent this complication from occurring.

Missed injuries

Distraction pain, occult anatomical location, an inability to view the structure, and the stress of managing the trauma patient, may lead to missed injuries. Missed cardiac contusions, occult bleeding and long bone fractures are among the most common overlooked injuries, and may lead to further injury and death for the trauma population. Prevention of this complication through hypervigilance, utilisation of multiple techniques to detect injury, and re-evaluation of the mechanism of injury and the clinical state of the patient, may prevent this complication from occurring.

In conclusion

Management of the modern trauma patient is complex and fraught with many daunting clinical problems which need to be overcome. However, successful management of these patients is most rewarding and begins with the establishment of systems in the hospital that allow for cohesive and efficient treatment of these patients.

Bibliography

1. Lane RK, Lee J-Woo, Civetta, Taylor and Kirby's critical care. 4th ed. Philadelphia: Lippincott Williams and Wilkins, 2010.
2. Rotondo MF, Schwab CW, McGonigal MD, et al. Damage control: an approach for improved survival in exsanguinating penetrating abdominal injury. *J Trauma*. 1993;35(3):375-382.
3. Shere-Wolfe RF, Galvagno SM Jnr, Grissom TE. Critical care considerations in the management of the trauma patient following initial resuscitation. *Scand J Trauma Resusc Emerg Med*. 2012;20:68.
4. Eddy VA, Morris JA Jnr, Cullinane DC. Hypothermia, coagulopathy and acidosis. *Surg Clin North Am*. 2000;80(3):845-854.
5. Johannsen PI, Ostrowski SR. Acute coagulopathy of trauma: balancing progressive catecholamine induced endothelial activation and damage by fluid phase anticoagulation. *Med Hypotheses*. 2010;75(6):564-567.
6. Durham RM, Moran JJ, Mazuski JE, et al. Multiple organ failure in trauma patients. *J Trauma*. 2003;55(4):608-616.
7. Meregelli A, Oliveira RP, Friedman G. Occult hypoperfusion is associated with increased mortality in haemodynamically stable, high risk, surgical patients. *Crit Care*. 2004;8(2):R60-R65.