Trauma care today, what's new?

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ABSTRACT

Injury is the fourth leading cause of death in the US, and the leading cause of death in younger age. Trauma is primarily a disease of the young and accounts for more years of productive life lost than any other illness. Consequently, almost every health care provider encounters trauma patients from time to time. Many of these patients are critically ill and pose several challenges in the acute phase, including airway and ventilation, fluid management, intracranial pressure control, etc. In the last decade, several strategies and treatment options have been studied in trauma care along with improvement in technologies. In this review, we will discuss a few of the new developments and updates in trauma care.

Key Words: Airway, bleeding, coagulopathy, injury, resuscitation, trauma

INTRODUCTION

Regardless of race, gender and economic status, injuries remain the fourth leading cause of death in the US and the leading cause of death in younger age (less than 45 years).[1] Injury management continues to develop rapidly with the invention of new technologies which have provided us more precise diagnostic modalities, allowing us to streamline the evaluation and making important decisions early. Modern trauma care is a multidisciplinary approach which starts with the initial management in the field by paramedics, flight nurses or emergency physicians. The role of the “golden hour” in trauma care is still valid and early problem directed treatment is life saving for the patient and affects the patient outcome. While prolonged treatment and time spent at the scene is not helpful for the patient, rapid airway assessment and management, control of bleeding, and maintaining cardiovascular stability are the key for patient survival. The patient care needs to continue in the emergency department (trauma bay) in which a fast and organized response following the ATLS guidelines is essential to decide rapidly which other life-saving interventions are required. From the emergency department, the patient will be transported to a dedicated trauma intensive care unit for stabilization or the patient will undergo surgery in the operating room or angiographic procedure in the angiography suite. The key elements of trauma care are the ABCs of the Advanced Trauma Life Support (ATLS) guidelines. Anesthesiologists have a special role in trauma care as they are often involved in all aspects of trauma care from the pre-hospital phase, though the emergency department, the operating room and the intensive care unit. In this role, the anesthesiologist can guarantee a minimum of consistency in patient care and follow the patient through the ICU.

AIRWAY MANAGEMENT

Loss of airway or breathing is the most rapid cause of death and it is essential to secure the airway of a severely injured patient as soon as possible. Oftentimes, the airway of a trauma patient is secured by paramedics in the field. If not, upon arrival to the emergency room, airway can be secured by emergency physicians or anesthesiology provider. Even for the experienced anesthesiologist, airway management of trauma patients can be challenging. One of the oldest, but often underutilized, devices has been the gum elastic bougie.[2] The Eschmann stylet or gum elastic bougie has been used by anesthesiologists, especially in Europe, since its introduction by Macintosh in 1949, but attracted attention in the US only in recent years.[3-6] Laryngeal mask airways (LMAs) have been an integral part of difficult airway management and a part of the American Society of Anesthesiologists’ (ASA) difficult airway algorithm.[7] A special version of the LMA is the intubating LMA (Fast-trach) which combines the ease of insertion of supraglottic airway device and the possibility to place an endotracheal tube through the LMA, thus creating a secured airway. This technique has been shown as a successful backup intubation tool after
other intubation techniques have failed,[8,9] or in patients with difficult airway or conditions that result in limited access to the patient's airway.[10,11]

The more recent developments in the airway management include video-assisted laryngoscopes such as Glidescope®, Pentax AWS®, Storz systems® and McGrath Laryngoscope® (LMA/airway management). Video-assisted laryngoscopy seems to be especially useful for cases with suspected cervical spine injury when neck movement needs to be reduced or eliminated. Video-assisted devices have been shown to reduce cervical spine movement during intubation in comparison to direct laryngoscopy.[12]

**FLUID RESUSCITATION**

An increasingly accepted view holds that moderate hypotension (systolic blood pressure no greater than 90 mm Hg) in trauma patients without traumatic brain injury (TBI) is sufficient to maintain vital organ perfusion, without the risk of precipitating further hemorrhage by dislodging blood clots. Kowalenko et al. investigated progressive hemorrhage to a mean arterial pressure (MAP) of 30 mm Hg followed by free intraperitoneal hemorrhage in pigs in an attempt to mimic uncontrolled hemorrhagic shock. Resuscitation consisted of saline infusion to reach an MAP of 40 mm Hg (group 1), 80 mm Hg (group 2), or no resuscitation (group 3). One-hour survival was 87.5, 37.5 and 12.5% for groups 1, 2 and 3, respectively. The authors concluded that the attempt to restore normotension with aggressive saline infusion failed to improve survival in the setting of severe uncontrolled hemorrhage. Permissive hypotension caused less blood loss and may be preferable until definitive surgical repair of the bleeding source is established.[13] Similar results have been reported by Stern et al. in an experimental model of uncontrolled intra-abdominal bleeding in pigs. The authors found that attempts to restore blood pressure with crystalloids result in increased hemorrhage and mortality.[14] Crystalloids are the first fluid administered to trauma patients for maintaining blood pressure, but crystalloids are only temporary volume expanders to maintain blood pressure. Excessive amounts of crystalloids contribute to hemodilution, hypothermia, coagulopathy and abdominal compartment syndrome. Crystalloids should be reduced to a minimum when the massive trauma resuscitation protocol is initiated. Rather than aggressive fluid replacement, the ability to control ongoing blood loss is one of the most important determinants in the outcome of a seriously injured patient.[15] There is an emerging opinion that massive transfusion of red cells and clotting factors in trauma patients should be given in broadly similar proportions from the outset.[16] Recent studies showed significant benefit of high ratio of fresh frozen plasma (FFP) to red blood cell concentrate (RBC).[16-18] compared to the traditional approach where red blood cells are given first and FFP later after receiving coagulation tests results from the laboratory. In trauma care, the transfusion of blood products is often based on the clinical picture and anticipated blood loss in the emergency room and during surgery. Trauma patients can have significant occult blood loss from long bone fracture, intrathoracic or intra-abdominal injuries. In these patients, it is often not feasible to wait for laboratory results.

In general, it is recommended to maintain hemoglobin between 7 and 9 g/dl. Consider a minimum platelet count of 100 × 10⁹/l for patients with multiple trauma or TBI. The use of cryoprecipitate is based on the assumptions that low fibrinogen levels are associated with an increased risk of bleeding. The evidence for the clinical efficacy of cryoprecipitate and fibrinogen in trauma patients is limited; no clinical randomized studies have been performed to determine whether the administration of cryoprecipitate or fibrinogen improves clinical outcome in severely bleeding trauma patients, but available evidence suggests that an initial dose of cryoprecipitate or fibrinogen that raises fibrinogen plasma levels above 100 mg/dl will provide sufficient hemostasis.

The amount of lactate produced by anaerobic glycolysis is an indirect marker of oxygen debt, tissue hypoperfusion, and the severity of hemorrhagic shock. Together, both the initial serum lactate and serial lactate levels are reliable indicators of morbidity and mortality following trauma.[19,20] Base deficit values derived from arterial blood gas analysis provide an indirect estimation of global tissue acidosis due to impaired perfusion. The initial base deficit is a sensitive diagnostic marker of the degree and duration of inadequate perfusion and a prognostic parameter for post-traumatic complications and death.[21,22]

A new development in patient monitoring in trauma patients is the tissue oxygen saturation derived from a relatively new technology, near-infrared spectroscopy (NIRS). Studies in both humans and animals have demonstrated that NIRS measurement accurately reflects systemic and regional perfusion in shock states.[23] A recent prospective observational study at a single US combat support hospital in Iraq demonstrated that NIRS-derived tissue oxygen saturation predicts life-saving intervention or blood component therapy early in the course of the care of trauma patients.[24]  

**Recombinant Factor VII**

As reported by the Western Trauma Association Multicenter Trial Group, 82% of deaths in the operating room are a direct result of uncontrolled bleeding and more
than 20% bleeding is secondary to coagulopathy, despite the surgical control of bleeding sites. Coagulopathy in trauma victims has become a major focus of surgical research. Use of recombinant factor VII (rFVIIa) was proposed by Holcomb as part of damage control resuscitation (DCR) with the very first units of red cells and plasma. Current FDA approved indications for rFVIIa in the treatment of hemophilia, with trauma use being off-label. Most of the data in support of the use of rFVIIa come from anecdotal experience and relatively small case series. It has been used in the modern combat casualties as a part of DCR. Evaluating the effects of rFVIIa on mortality was extremely difficult as Clark et al in their retrospective study dminated rFVIIa as a “last-ditch” effort in the face of massive hemorrhage and coagulopathy, and it was ineffective. In 2005, Boffard et al. conducted a prospective, multicenter, randomized trial using rFVIIa in the setting of hemorrhage in trauma patients. They reported that there was a considerable reduction in the need for blood products in blunt trauma patients who received rFVIIa, without any demonstrable survival benefits. In a recent case registry, data collected from multiple trauma centers suggest that rFVIIa has limited efficacy in controlling coagulopathic bleeding following trauma. Based on their review, they recommend that when rFVIIa is used, effort should be directed first at correcting shock, thrombocytopenia, and acidosis. Al-Ruzzeh and colleagues suggest that rFVIIa should be considered as one facet in a multimodal approach to traumatic coagulopathy. The use of rFVIIa in trauma victims remains controversial, and further evidence is needed before making any recommendations. Some of the clinical trials focusing on replacing clotting factors and platelets in ratios along with red blood cell transfusion have shown to reduce the need for procoagulants like rFVIIa.

**ANGIOGRAPHIC EMBOLIZATION IN TRAUMA**

Angiographic embolization has been increasingly utilized as an adjuvant to the trauma care. The non-operative management (NOM) of blunt abdominal injuries and in a stable or stabilized patient has been the standard of care. The success rate of NOM has increased after the introduction of angiographic embolization. Several hospitals have investigated the implementation of protocols that incorporated angiographic embolization and the success rate of NOM in blunt abdominal injuries. They report that angiographic embolization has expanded the use of NOM, and as a result decreased the total laparotomy rate with improved patient outcome. Severely injured patient following damage control laparotomy may still be hemodynamically unstable, and ongoing arterial bleeding cannot be ruled out. In these patient populations, angiographic embolization could be a valuable adjunct.

**DAMAGE CONTROL RESUSCITATION**

DCR has become an integral part of modern trauma care with increasing relevance and popularity over the past decade. Hemorrhage ranks second only to central nervous system injuries as the leading cause of trauma-related mortality, accounting for 30–40% of fatalities, and is the leading cause of preventable deaths in trauma victims. New data from both civilian and military hospitals from Iraq and Afghanistan conflicts have allowed for a reappraisal of how we resuscitate trauma victims. DCR includes focusing on the interventions necessary to control hemorrhage, contamination and reestablishing a survivable physiologic status. After the initial damage control surgery, patients would undergo continued resuscitation and aggressive correction of their coagulopathy, hypothermia and acidosis in the intensive care unit before returning to the operating room for definitive surgical procedure. This treatment strategy has been shown to have better survival rates for abdominal surgery and now DCR has been extended to include thoracic surgery and early fracture care. DCR is popular among military hospitals, and now this concept is being studied in the civilian setting. DCR differs from current resuscitation approaches by attempting an earlier and more aggressive correction of coagulopathy and metabolic derangement. Several key concepts of DCR, namely, permissive hypotension, use of blood products over crystalloids for volume replacement, and rapid and early correction of coagulopathy with component therapy have shown to improve the outcome in severely injured patients.

**ANTIFIBRINOLYTICS**

Tranexamic acid is a synthetic derivative of the aminoacid lysine. It acts through the blockade of lysine binding sites on plasminogen molecules. Several studies have shown that tranexamic acid has reduced the need for blood transfusion by a third in patients undergoing elective surgery; however, the overall mortality was not reduced significantly. The hemostatic response in both surgery and trauma is similar; tranexamic acid may reduce the mortality secondary to hemorrhage in a trauma patient. A multicenter, multinational, randomized, controlled trial (CRASH-2) evaluated the effects of tranexamic acid in adult trauma patients. It was reported that the early administration of a short course of tranexamic acid (loading dose 1 g over 10 min, then infusion of 1 g over 8 h) in a bleeding trauma patient reduced the risk of death. The authors recommend that the use tranexamic acid should be considered in adult trauma patients with significant hemorrhage.
CONCLUSION

Trauma is the leading cause of death and loss of productive years in people under the age of 45 years. Significant scientific progress in trauma care has been made in the last few years; however, many areas of uncertainty still remain. In the coming decades, we can expect evaluation of trauma patient to become less invasive with optimum precision. NOM of trauma victims is slowly replacing invasive management along with more popularity toward minimally invasive techniques such as interventional radiological procedures and laparoscopic control of intra-abdominal hemorrhage. Hemorrhage is still one of the leading causes of death in trauma patients, and there has been plenty of research focusing on control of bleeding in trauma. Optimal ratios of various blood products to be transfused in massive transfusion are being evaluated in military and civilian settings. Resuscitation of trauma patients revolves around prevention of the lethal triad of acidosis, hypothermia and coagulopathy.

REFERENCES


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