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Anesthesia for Trauma Patients

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ABSTRACT An improved understanding of the pathophysiology of combat trauma has evolved over the past decade and has helped guide the anesthetic care of the trauma patient requiring surgical intervention. Trauma anesthesia begins before patient arrival with warming of the operating room, preparation of anesthetic medications and routine anesthetic machine checks. Induction of anesthesia must account for potential hemodynamic instability and intubation must consider airway trauma. Maintenance of anesthesia is accomplished with anesthetic gas, intravenous infusions or a combination of both. Resuscitation must precede or be ongoing with the maintenance of anesthesia. Blood product transfusion, antibiotic administration, and use of pharmacologic adjuncts (e.g., tranexamic acid, calcium) all occur simultaneously. Ventilatory strategies to mitigate lung injury can be initiated in the operating room, and resuscitation must be effectively transitioned to the intensive care setting after the case. Good communication is vital to efficient patient movement along the continuum of care. The resuscitation that is undertaken before, during and after operative management must incorporate important changes in care of the trauma patient. This Clinical Practice Guideline hopes to provide a template for care of this patient population. It outlines a method of anesthesia that incorporates the induction and maintenance of anesthesia into an ongoing resuscitation during surgery for a trauma patient in extremis.

BACKGROUND

Resuscitation goals for trauma patients have undergone significant change in the past decade. Appropriate blood product transfusion ratios, use of pharmacologic adjuncts (e.g., tranexamic acid (TXA)) and other modalities have improved survival for the wounded combatant. In the operating room, this resuscitation occurs in the context of providing an anesthetic that minimizes hemodynamic instability in the severely injured patient. It is imperative, therefore, that the anesthesiologist understands their role in the management of this resuscitation continuum. While recent review articles, checklists and textbooks have drawn attention to the role of the anesthesiologist as resuscitation consultant, there is currently no guideline for the induction, maintenance and transfer of anesthetic care of the military trauma patient in extremis.[1–4]

SPECIFIC CONSIDERATIONS FOR TRAUMA ANESTHESIA

Pre-induction

Hypothermia is one of the arms of the lethal triad of coagulopathy, acidosis, and hypothermia.[5] It is important, therefore, to warm the OR to greater than 30°C and have a warmed intravenous (IV) line, forced air warmer, and rapid infuser with warming capability immediately available.

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Standard checks (e.g., anesthesia machine check, verification that airway equipment, medications, and special tools are in good working order) assure that vital equipment is ready for immediate use.

Establishment of a massive transfusion protocol and effective communication with the blood bank is essential and can improve survival.[6] The Damage Control Resuscitation CPG[7] defines the massive transfusion protocol for the combat theater. At all roles of care, awareness of the individual medical treatment facility's on-hand resources (including walking blood bank) and applicable protocols are key considerations.

The presence of anesthesia in the trauma bay is necessary for smooth transition of care to the OR and offers the opportunity to assist with invasive procedures. Identification of team roles prior to patient arrival facilitates effective transfer from the delivering team.

Induction of Anesthesia

Induction of anesthesia in the exsanguinating patient can be disastrous. Ongoing volume resuscitation to prevent this from occurring is critical. After a patient is identified for surgery, verification of functioning vascular access (either IV or intraosseous) and placement of monitoring devices (e.g., oxygen saturation, blood pressure, and electrocardiogram) must occur quickly. Do not delay induction of the patient in extremis for placement of central access or invasive monitoring. Placing monitors at the same time as the surgical prep and drape can save time in a crisis. A wide draping procedure with "arms out" ensures adequate surgical exposure, while affording access to the arms as needed after the start of surgery. Pre-oxygenation with four full vital capacity breaths can "de-nitrogenate" the end alveoli sufficiently to optimize oxygenation prior to rapid sequence induction. In the obtunded patient, it may not be possible to achieve four vital capacity breaths prior to induction, and one must proceed with induction relying upon apneic oxygenation.

There are a variety of sedative hypnotics available for induction of anesthesia. Standard induction dosages should be reduced and titrated to balance the induction of anesthesia with hemodynamic changes. Ketamine (1 mg/kg) will not decrease the systemic vascular resistance to the same extent as other sedative hypnotics. While propofol is a standard induction agent, it can decrease the systemic vascular resistance significantly. It is prudent, therefore, to use reduced doses of propofol (0.5–1 mg/kg) in hypotensive patients. Ongoing volume resuscitation is vital to prevent vascular collapse.

Neuromuscular relaxation sufficient to facilitate endotracheal intubation can be achieved in approximately 45 seconds with succinylcholine in a standard rapid sequence induction dose (1 mg/kg). Rocuronium is a non-depolarizing neuromuscular relaxant that is useful in cases where succinylcholine may be contraindicated (e.g., burns, spinal cord injury, hyperkalemia). An increased dose of rocuronium (1–1.2 mg/kg) can produce intubating conditions similar to succinylcholine in approximately 60 seconds.

Prompt endotracheal intubation of the trachea following induction mitigates the risk of aspiration. Rapid sequence induction (RSI) with direct laryngoscopy is a safe and effective method to secure the airway of the trauma patient.[8,9] The efficacy of in-line stabilization during RSI is somewhat controversial; however, it remains prudent to minimize the manipulation of the cervical spine to the extent possible during laryngoscopy. Regardless, it is re-assuring to know that spinal cord injury following direct laryngoscopy rarely causes or worsens cervical spine injury.[10]

A variety of airway adjuncts are available to the laryngoscopist. The gum elastic bougie can be helpful in securing a challenging airway and is a low-cost, effective airway adjunct.[11] Video laryngoscopy can provide an improved view of the vocal cords during intubation. This does not, however, necessarily improve successful first pass intubation or result in faster time to intubation.[12] It remains prudent to have a limited number of immediately available airway adjuncts with which one is familiar, rather than a larger selection of less familiar equipment.[13] An alternate plan, including equipment for surgical airway management, must also be immediately available. (Refer to the Trauma Airway Management CPG.)[14]

After endotracheal intubation of the trachea and verification of end tidal carbon dioxide, communication with the surgeon ensures that the operation proceeds in a timely fashion. Placement of an orogastric tube at this point may potentially decrease the risk of aspiration.

MAINTENANCE OF ANESTHESIA

Maintenance of anesthesia can be accomplished via an inhalational volatile agent or via a total IV anesthetic (TIVA).[15] Both approaches must be carefully titrated to the hemodynamic profile while assuring adequate sedation/hypnosis and analgesia. Awareness during anesthesia and the acute pain response can be mitigated during TIVA by assuring that both a sedative hypnotic (e.g., propofol, benzodiazepine) and an analgesic (e.g., narcotic) are being administered. Narcotic dose can be titrated to hemodynamics.

Adequate IV access must be assured immediately (e.g., large bore peripheral IV, intraosseous). Placement of additional IV access or an arterial line (if indicated for continuous monitoring of beat-to-beat blood pressure) can be undertaken without delaying the start of the operation.

Sending a baseline set of labs, to include coagulation studies and base excess, at the start of the case can set a reference point for the remainder of the resuscitation. Consider validation of Point of Care testing (i.e., iSTAT values) with traditional laboratory assays.

The maintenance of anesthesia and the resuscitation can be guided by following the trend in mean arterial pressure (MAP). While the ideal blood pressure is controversial, a MAP < 55 mmHg has been associated with acute kidney injury and myocardial injury during anesthetics for non-cardiac surgery.[16] Maintaining a MAP > 55 mmHg will facilitate end organ perfusion without exacerbating any unsecured bleeding.

Traumatic brain injury represents a unique situation in which isolated episodes of hypotension can worsen mortality.[17] It is, therefore, advisable to maintain systolic blood pressure >90 mmHg in patients with documented or suspected traumatic brain injury. (Refer to the Neurosurgery and Medical Management of Severe Head Injury CPG.)[18]

RESUSCITATION

Ratios of FFP:PRBC approaching 1:1 have been demonstrated to confer a survival benefit in military and civilian trauma patients.[19,20] While the ideal ratio of FFP: PRBC remains somewhat controversial; it is fair to say that early administration of plasma and platelets is appropriate for the trauma patient in extremis.[21] A more exhaustive discussion of damage control resuscitation is found elsewhere in the CPGs and is recommended reading for this subject. Communication with the surgical team regarding the progress of the resuscitation and the stage of the surgery is an important factor in overall success. (See also Damage Control Resuscitation CPG.)[7]

TXA is a potent synthetic lysine derivative that functions as an anti-fibrinolytic. Administration of 1 gm of TXA over 10 min within 3 hours of injury has been demonstrated to improve survival in a highly powered, randomized trial of international trauma patients.[22] The initial bolus dose was followed by an infusion of 1 gm over 8 hours. A survival advantage was also demonstrated with the use of TXA in military trauma.[23]

Hydrocortisone is a potent mineralocorticoid that can augment blood pressure during shock states when the hypothalamic pituitary adrenal axis is suppressed and unable to mount an effective stress response. Administration of hydrocortisone 100 mg can improve vasopressor responsiveness in critically ill trauma patients.[24,25]

Massive blood transfusion can result in hypocalcemia due to chelation of calcium by the citrate preservative in PRBCs. Administration of 1 gm calcium chloride can correct this potentially life-threatening hypocalcemia, and the hypotension associated with it.[26]

Use of vasopressors in trauma is generally associated with higher mortality.[27] In one analysis evaluating trauma patients who received vasopressor support, however, vasopressin was found to be the only vasopressor in which the 95% confidence interval for mortality crossed unity, suggesting non-significance.[28] Vasopressin is now the subject of an ongoing clinical trial. The Arginine Vasopressin During the Early Resuscitation of Traumatic Shock (AVERT) Study is a phase 2 clinical trial that will evaluate the use of vasopressin supplementation in the resuscitation of trauma patients, as well as the utility of using copeptin as a biomarker for vasopressin (available at: http://clinicaltrials.gov/ct2/show/study/NCT01611935). In cases of refractory hypotension, a vasopressin bolus (5–10 units) followed by infusion (0.04 U/min) can be given in concert with aggressive blood product administration.

Timely administration of antibiotics can decrease the incidence of post-operative infections and is part of the anesthetic resuscitation. Consider agents that will be effective against skin flora (gram-positive organisms) or, in the event of bowel injury, gastrointestinal flora (anaerobes and gram-negative organisms). The infection control CPG identifies the optimal antibiotics for multiple clinical scenarios.

POST-OPERATIVE/EMERGENCE

Low lung volume ventilation (6 mL/kg) can decrease mortality in critically ill patients with the acute respiratory distress syndrome.[29] Even in patients who have not developed the acute respiratory distress syndrome; initiation of low lung volume ventilation can improve outcome.[30] Consider initiation of low lung volume ventilation in the OR.

Communication with the next role of care is vital to maintaining continuity of care. In the deployed setting this may entail a face-to-face conversation with the intensive care unit team, or a report transmitted to a critical care air transport team. A detailed written report/anesthetic record documents the operative resuscitation and facilitates transition to the next role of care. Being immediately available in the post-operative period to answer any questions can clarify any issues that may arise.

CONCLUSION

Combat trauma patients are "the sickest of the sick." The necessity for ongoing resuscitation during induction and maintenance of anesthesia can complicate management. Awareness of the patient's entire physiologic and volume status is critical to successful management and outcomes. Refer to the full JTS CPG at https://jts.amedd.army.mil/index.cfm/PI_CPGs/cpgs for further details.

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