REVIEW

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Approach to Patients with Neurotrauma and Thoracic Trauma and Anesthesia Management with Current Guidelines II

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Abstract

There are many causes of trauma such as traffic and work accidents and falling from height. These patients need systematic management in posttraumatic evaluation, airway management, resuscitation, possible surgical process, intensive care follow-up and treatment. The nature of trauma, uncontrollable bleeding after trauma, coagulation anomalies, hypothermia, shock, acidosis disrupt the normal homeostatic mechanism and are associated with poor clinical course. Another paradox is the nature of unexplained events, insufficient anamnesis information and the necessity of emergency intervention in trauma cases. This section aims to discuss anesthesia management with current guidelines.

Keywords: Neurotrauma, thoracic trauma, anesthesia, guidelines

INTRODUCTION

Anesthesia Management in Trauma

Trauma, which means wound in ancient Greek, is the leading cause of death in the 1-44 age group, and the third cause of death following cancer and cardiovascular disease in all age groups. Trauma is defined as tissue damage characterized by structural changes and physiological disorders due to mechanical, thermal, electrical and chemical energies, ionized or nuclear radiation or absence of essential elements of life such as oxygen and heat. Trauma has many reasons such as traffic accidents, work accidents and falling from height (1,2). These patients need a systematic anesthesia management in posttraumatic evaluation, airway management, resuscitation, possible preoperative and postoperative surgical process, intensive care follow-up and treatment (3). The nature of trauma, uncontrollable bleeding after trauma, coagulation anomalies, hypothermia, shock, acidosis disrupt the normal homeostatic mechanism. Acute coagulopathy caused by high blood loss in major traumas is often associated with poor clinical course in trauma patients (4,5). Another paradox is the nature of unexplained events, insufficient anamnesis information and the necessity of emergency intervention in trauma cases.

Initial Assessment of Trauma

Algorithms have been defined for systemic approach to trauma patients and more than fifty scoring systems have been developed. The Trauma score, which was defined in 1981 by adding respiratory rate and systolic blood pressure to the Triage index, is a widely used scoring system. It was revised in 1989 and Revised Trauma score was formed (Table 1). In order for the trauma centers to systematically engage a modern trauma approach in harmony between the other disciplines, it is necessary to establish national guidelines tailored to the needs and ensure their widespread use. Airway obstruction, severe hemorrhage and hypoxia due to tension pneumothorax may be among the causes of early death due to trauma (6-8). From the moment the trauma patient is met, the first step is to apply the

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ABC stages of cardiopulmonary resuscitation (CPR). Airway must be secured first for effective intervention. All trauma patients should be considered to have cervical damage until they are ruled out, and cervical stabilization should be provided during interventions (Figures 1, 2). In the trauma patient, inadequate anamnesis, full stomach, the possibility of cervical trauma and maxillofacial injury should be considered and the physician should be prepared for difficult airway management. Algorithms have been developed for difficult airway management (Figure 3). Considering the location of the patient's injury and experience of the anesthesiologist, the appropriate method such as oropharyngeal airway, supraglottic airway devices, orotracheal intubation, nasal intubation, tracheotomy or cricothyroidotomy is performed in order to provide airway patency (9). Auscultation and confirmation by capnography should be performed in the patient with secured airway. Circulation should be checked; fluid resuscitation should be started and bleeding, if any, should be controlled. Hypothermia in trauma patients is known to be a cause that increases mortality and morbidity (10). Passive isolation or active heating techniques should be used in these patients, and fluids, blood and blood products to be used in infusion should be heated and unwanted hypothermia should be prevented. Since trauma patients may have life-threatening injuries such as pneumothorax and pericardial tamponade, surgical evaluation should be performed concurrently with CPR. Possible injuries should be determined by laboratory tests, invasive-noninvasive radiological imaging methods and treatment plan should be designed (6,9). In trauma patients, systemic inflammatory response to trauma can be reduced by early and appropriately planned fluid resuscitation (11). Early detection and effective resuscitation of post-traumatic shock-prone patients are life saving. Hypovolemic shock is the inadequate tissue perfusion resulting from decreased intravascular volume. In order to diagnose shock that emerges clinically with findings such as tachypnea, tachycardia, hypotension and low pulse pressure,

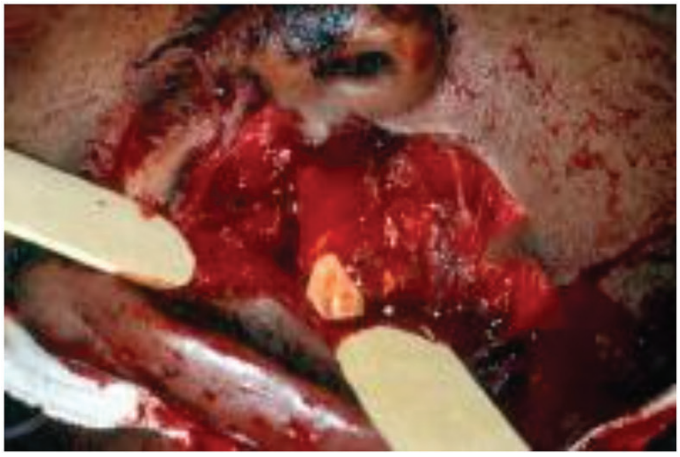

Figure 1. Maxillofacial injury

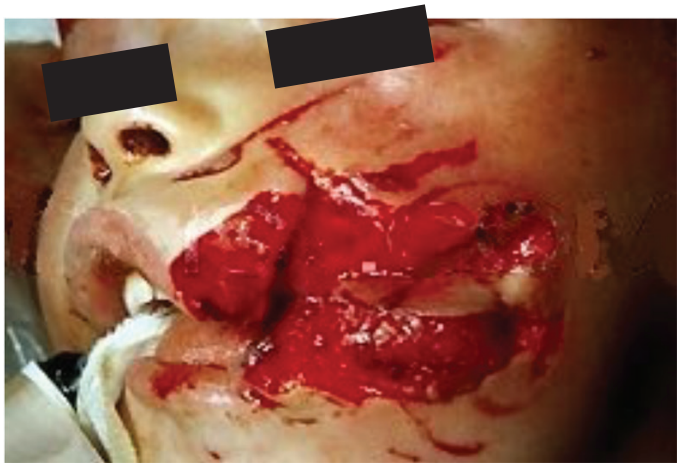

Figure 2. Maxillofacial injury

Table 1. Revised Trauma score

GCS	SBP	RR	Score
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

GCS: Glaskow Coma score, SBP: Systolic blood pressure, RR: Rate ratio

Table 2. Clinical signs of shock according to blood loss

Blood loss	Pulse	SBP	Pulse pressure	Capillary fountain	Respiratory	CNS	Urine output
<15%, 1000 mL	n	↓	n	Delayed	Light tachypnea	Anxiety	20-30 mL/s
30%-40, 1500-2000 mL	>120 weak	↓	↓	Delayed	Serious tachypnea	Confused	20 mL/s
>40%, >2000 mL	>140 nonpalpabl	↓↓	↓↓	Ø	Serious tachypnea	Lethargic	Ø

CNS: Central nervous system, SBP: Systolic blood pressure

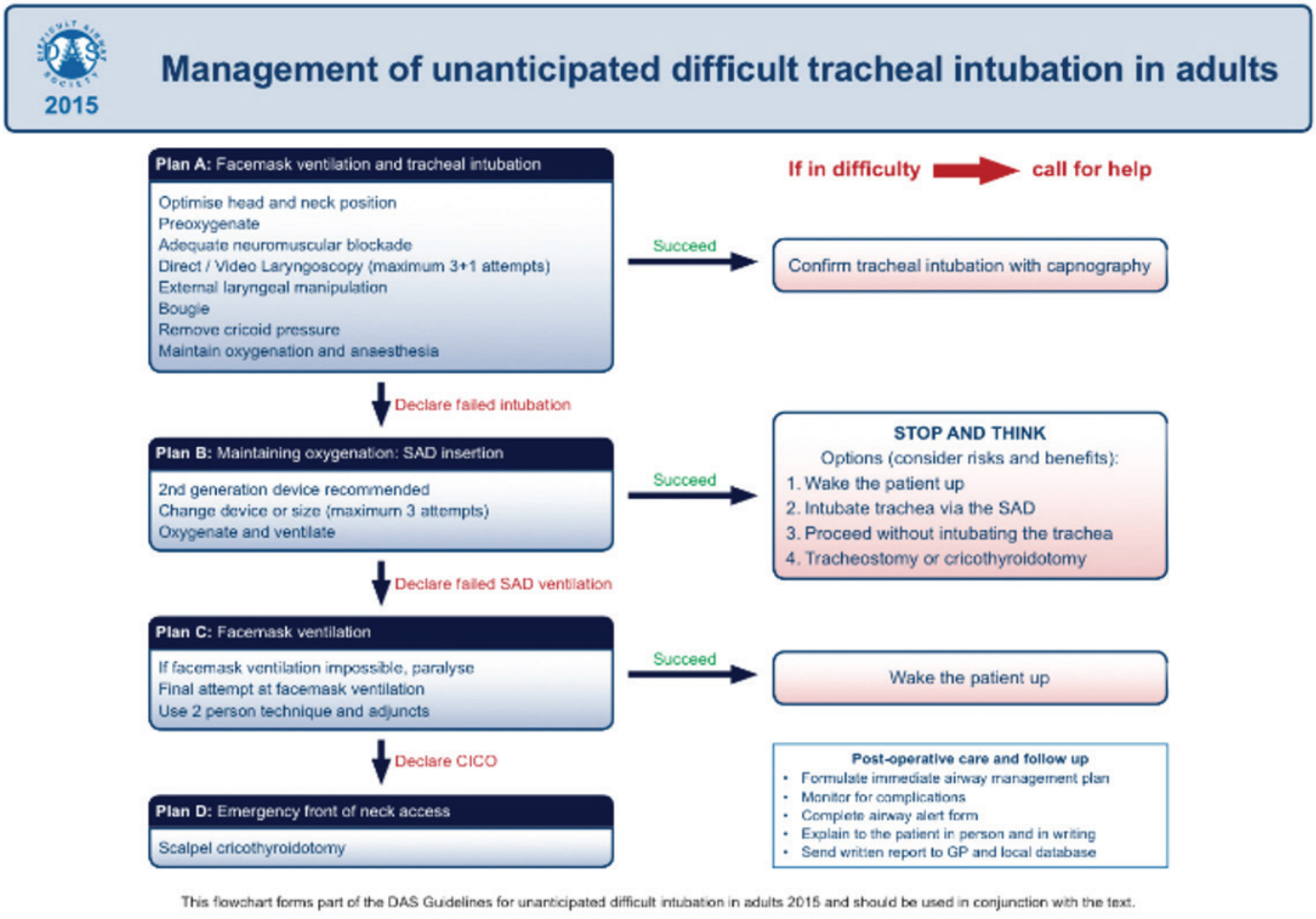

Figure 3. Difficult airline management algorithm
DAS: Difficult Airway Society

lactate measurements, determination of base-excess, and the shock index determined by the ratio of heart rate to systolic blood pressure being above 0.9 may be helpful (Table 2) (12-15). Early fluid replacement is important in correcting hypotension in hypovolemic shock. Crystalloid, colloid fluids, whole blood and blood products are used according to need. More than 10 units of erythrocyte suspension red blood cell (RBC) within 24 hours is called massive blood transfusion (16,17). The answer to question how much transfusion should be performed is still unclear, but massive transfusion protocol with 1:1.5 fresh frozen plasma (FFP)/RBC has been shown to decrease mortality by 74%, leading to an increase in 30-day survival and shorter duration of ventilation and hospitalization (18,19). In massive blood transfusions, citrate-induced hypocalcemia develops especially during the use of FFP, which leads to resistant hypotension. Hypocalcemia below 0.9 mmoL/L should be treated (11,20). The major cause of coagulopathy is the dilution of coagulation factors. Procoagulant factors, fibrinogen, natural anticoagulant factors and antifibrinolytic proteins, which decrease with dilution as a result of massive blood transfusion, lead to coagulopathy. It is important to replace with FFP and platelet suspensions in the early period for treatment. Platelet suspension is recommended if the platelet count is <100.000/mm^3 (21). It has been shown that the use of antifibrinolytic tranexamic acid reduces mortality in patients with bleeding (22). The usefulness of the use of recombinant activated Factor VIIa is controversial, although there are studies showing that early use reduces mortality (23,24). The use of norepinephrine and vasopressin has been found to be beneficial in animal models of trauma, but there are no large-scale studies (11,25). The use of fibrinogen concentrate has been shown to reduce perioperative bleeding by 32% and reduce the need for transfusion (26,27). In the follow-up of these patients, the mean arterial pressure should not be reduced below the brain perfusion pressure and should be higher than 50-60 mmHg. Follow-up of central venous pressure and hourly urine output is beneficial in terms of

showing vital organ perfusion (9). Damage control resuscitation is a relatively new concept in the management of trauma patients consisting of permissive hypotension, prevention of acidemia, reheating and correction of ionized calcium. In patients without contraindications, targeting of mean arterial pressure of "65 mmHg or systolic arterial pressure of" 90 mmHg is called "permissive hypotension" (28). Large amounts of ringer lactate solution to be used in fluid resuscitation may cause cerebral edema. Excessive use of dextrose solutions may cause ischemic brain damage and use of large amounts of isotonic solution may cause hyperchloremic metabolic acidosis. Colloid solutions are effective in providing intravascular volume, but increase the tendency of pulmonary edema with increased hydrostatic pressure. If there is microvascular permeability disorder in the lungs, oncotic pressure increases in the interstitium due to colloid escape from the endothelium, and more fluid may accumulate in the pulmonary interstitium and alveoli, and prolong the need for mechanical ventilation (13). In trauma, insufficient organ perfusion results in metabolic acidosis. Hypothermia, acidosis and coagulopathy are known as the fatal triad of trauma (29). Acid-base imbalance can be eliminated by hydration and correcting organ perfusion. Uncorrected lactic acidosis is defined as an independent risk factor for multiorgan failure (30). Multiorgan failure may occur 12 hours after shock after trauma and may be delayed up to 7-10 days, which is one of the most important causes of mortality (13,31).

ANESTHESIA IN TRAUMA

Sedation Anesthesia

In order to perform simple fracture reduction, shoulder dislocation, tube thoracostomy, and cardioversion, patients may need anesthesia applications that protect cardiorespiratory functions and protective reflexes (32). As in all anesthesia applications, patient needs to be evaluated for sedoanalgesia, monitorized and the necessary emergency response equipment should be available. Regarding anesthetic agent, single or combined applications of conventional benzodiazepine (midazolam), propofol, ketamine, ketofol and fentanyl have been studied. In these studies, ketofol has been found to be superior due to rapid onset, effective sedation depth, low values in sensation of pain, and high patient and staff satisfaction (33-35).

General Anesthesia

General anesthesia begins with rapid induction and rapid intubation strategy, but there is no optimal anesthetic agent for patients with hemorrhagic shock. The most commonly used agents for induction are thiopental sodium, propofol, etomidate and ketamine. Thiopental sodium is a barbiturate commonly used in induction since 1934. Since intracranial pressure (ICP) increases due to cerebral hemorrhage and edema in head trauma, barbiturates, which lead to a decrease in cerebral blood flow (CBF) and ICP by cerebral vasoconstriction, may be preferred (6,36). However, it has been reported that induction with thiopental sodium increases critical respiratory problems approximately 2-fold in the postoperative period. The dose of intravenous (IV) induction is 3-6 mg/kg (6,37). As it causes venous dilatation and hypotension, it is recommended to reduce the dose in patients with unstable hemodynamics (38). Having high lipophilic properties cause propofol to pass through the blood-brain barrier and reach the central nervous system, causing the effect to start very quickly and to be short-term. The dose of IV induction is 1-2.5 mg/kg. It reduces CBF and ICP, and may be preferred in patients with head trauma, but it has myocardial depressant effect. Caution should be exercised in the use of propofol, which causes peripheral vasodilation and reduces systemic vascular resistance, in hemodynamically unstable trauma patients (6,39). Etomidate is an induction agent that acts rapidly with gamma-aminobutyric acid receptor stimulation. The dose of IV induction is 0.3 mg/kg (6). It is widely used in trauma patients because it has a rapid onset and does not impair hemodynamics (40). In traumatic brain injury, etomidate may be preferred because it provides cerebral protection by decreasing cerebral metabolic rate of oxygen (CMRO2), CBF and ICP (41). It has been shown that etomidate can lead to adrenal suppression even with a single dose in rapid intubation (42). Etomidate use in trauma patients was also associated with nosocomial pneumonia (43). Ketamine increases arterial blood pressure, heart rate and cardiac output through central stimulation of the sympathetic nervous system and inhibition of norepinephrine reuptake. It shows its effect on N-methyl-D-aspartate receptors and is a dissociative agent (41). It is suitable for use in cardiac tamponade and hypovolemic patients in trauma, but may lead to cardiac hypotension and cardiovascular collapse in hemorrhagic shock patients with previous maximum sympathetic stimulation and previously depleted catecholamines, it should be administered in small doses by titrating in trauma patients (6,44). It is a potent bronchodilator and a good option for induction, especially in asthma patients with reactive airway. It increases CMRO2, CBF and ICP in accordance with cardiac effects (6,41,45). This limits the use of ketamine in traumatic brain injuries. However, some studies have reported that it increases cerebral perfusion and has no significant effect on ICP (46). Compared with opioids, the use of ketamine in trauma patients has been associated with an

increase in acute and posttraumatic stress disorder, but there are also studies showing the antidepressant effect (47-49). For rapid intubation, succinylcholine, rocuronium and vecuronium may be used as muscle relaxants. Succinylcholine is a depolarizing agent with rapid onset of action (30s) and its duration of action is quite short (5-10 minimum). It can be administered at doses of 1-2 mg/kg IV or 3-4 mg/kg intramuscular. It may be preferred in trauma patients requiring urgent and serial intubation (45). However, it may cause hyperpotasemia in patients with burns and multiple traumas. Succinylcholine is known to increase ICP and intraocular pressure, which can be reduced by the use of lidocaine (1.5 mg/kg) before administration. It should not be used in eye and head trauma (6,50). Rocuronium is a nondepolarizing agent and IV dose is 0.5-0.8 mg/kg for intubation. In cases where rapid intubation is required, administration at a dose of 1 mg/kg creates an effect equivalent to succinylcholine. Another way for rapid intubation is to apply the priming technique. In this technique, 0.06 mg/kg rocuronium is administered IV before the induction and intubation can be performed within 60 seconds with an IV dose of 0.6 mg/kg (45,51). Intubation success rates of succinylcholine and rocuronium were found to be similar in the studies performed in the emergency departments (52). It has been shown that the rocuronium effect can be rapidly eliminated by using 16 mg/kg sugammadex and returned to spontaneous respiration, especially when an unexpected difficult airway is encountered (53).

The intubation dose of vecuronium is 0.08-0.12 mg/kg and its use is limited because it has a long-onset duration of action (80-140s) and in some patients exacerbates bradycardia caused by opioids (6,44). There are many studies focused on ischemic reperfusion injury and organ damage due to the cardioprotective effects of inhalation anesthetics (54). In trauma patients, minimum alveolar concentration (MAC) values of inhalation anesthetics should be reduced (≤0.5 MAC) (6). Patients with severe hypovolemia may not tolerate the vasodilator effect of inhalation anesthetics. In order to avoid increased cerebral blood flow and ICP in traumatic brain injury, the dose of volatile agents should be titrated to less than 1 MAC. Inhalation anesthetics with low blood-gas partition coefficients such as sevoflurane or desflurane may be preferred. Nitrous oxide is not used in trauma patients because it increases cerebral oxygen consumption, ICP, increases pulmonary vascular resistance and causes diffusion hypoxia (9,55). Since opioids show analgesic activity by binding to specific receptors in the central nervous system and other tissues, their combination with other anesthetic drugs may result in marked myocardial depression. It can prevent tissue damage by improving microcirculation in hemorrhagic shock. Fentanyl is a preferred opioid in trauma patients because of its minimal effects on hemodynamics. Fentanyl suppresses increased catecholamines, antidiuretic hormone and cortisol secretion in stress response. It prevents bronchoconstriction against airway stimulation during intubation. However, it may cause chest wall rigidity (6,56). In many studies, it was emphasized that opioid use should be titrated according to the response (50). Midazolam, a fast acting benzodiazepine, provides sedation and amnesia. Induction dose is 0.2 mg/kg IV. It has no analgesic effect and its use is limited in trauma patients because it decreases mean arterial blood pressure. It is frequently used in low dose (0.05 mg/kg) in the emergency department (37,57).

Regional Anesthesia

In trauma, regional anesthesia is contraindicated if the patient is not hemodynamically stable. However, regional technique may be used to increase peripheral blood flow by vasodilatation by blocking sympathetic innervation especially in amputations and extremity trauma with stable hemodynamics (6). Brachial plexus blocks are more common in upper extremity injuries and central blocks are more common in lower extremity injuries. Cases where central and peripheral blocks are applied together have also been reported (58,59). Trauma is a chaotic process involving many pathophysiological changes. In order for anesthetists to cope with high mortality and morbidity in trauma, trauma management procedures should be a good implementer of algorithms. Rapid resuscitation in the traumatic patient, effective surgical hemostasis, and effective struggle with hypothermia, acidosis and coagulopathy will be the secret of success.

Ethics

Peer-review: Internally peer-reviewed.

Authorship Contributions

Concept: N.T., T.M., A.A., M.E., Design: N.T., T.M., A.A., M.E., Data Collection or Processing: T.M., A.A., C.K.B., M.E., Analysis or Interpretation: N.T., T.M., A.A., M.E., Literature Search: T.M., S.T., A.A., M.E., Writing: T.M., C.K.B., S.T., A.A., M.E., İ.A.

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REFERENCES

1. Khorram-Manesh A. Europe on Fire; Medical Management of Terror Attacks - New Era and New considerations. Bull Emerg Trauma 2016;4:183-5.

2. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380:2095-128.

3. American Society of Anesthesiologists. Statement of principles: trauma anesthesiology. In: Standards, Guidelines, Retrieved on 16 October 2013 from http://www.asahq.org/For-Members/Standards-Guide lines-and-Statements.

4. Rossaint R, Bouillon B, Cerny V, Coats TJ, Duranteau J, Fernández-Mondéjar E, et al. Management of bleeding following major trauma: an updated European guideline. Crit Care 2010;14:R52.

5. Ganter MT, Pittet JF. New insights into acute coagulopathy in trauma patients. Best Pract Res Clin Anaesthesiol 2010;24:15-25.

6. Morgan EG, Mikhail MS, Murray MJ, Larson CP. Tulunay M, Cuhruk H, editörler. Klinik Anesteziyoloji. Ankara: Güneş Kitabevi Ltd. Şti; 2004.

7. Anderson NK, Jones AD, Martin EE, Thies RF, Baxter D, Marienau ME, et al. Anesthetic care of the trauma patient: development of a Web-based resource. AANA J 2007;75:49-56.

8. Hajjar WM, Alsubaie N, Nouh TA, Al-Nassar SA. Is it safe to use frova airway intubating device during tracheal intubation in difficult airway patient with multiple and chest trauma. Saudi J Anaesth 2016;10:477-9.

9. Stane JK, grande CM. Anesthesia for trauma. In: Miller RD, editor. Anesthesia. Fift ed. Phidelphia: Churchill Livingstone; 2000.p.2157-72.

10. Tsuei BJ, Kearney PA. Hypothermia in the trauma patient. Injury 2004;35:7-15.

11. Tobin JM, Varon AJ. Update in trauma anesthesiology: perioperative resuscitation management. Anesth Analg 2012;115:1326-33.

12. Şahin A, Ertekin C, Güloğlu R, Yamaner S, Bilsel Y. Şok parametrelerinin şok ve mortaliteyi belirlemedeki etkinlikleri. Ulusal Travma Derg 1997;3:233-42

13. Tümay V, Tokyay R. Hipovolemik Şok. Yoğun Bakım Derg 2002;2:246-54

14. Rady MY, Smithline HA, Blake H, Nowak R, Rivers E.A comparison of the shock index and conventional vital signs to identify acute, critical illness in the emergency department. Ann Emerg Med 1994;24:685-90.

15. Brohi K, Cohen MJ, Davenport RA. Acute coagulopathy of trauma: mechanism, identification and effect. Curr Opin Crit Care 2007;13:680-5.

16. Brummel-Ziedins K, Whelihan MF, Ziedins EG, Mann KG. The resuscitative fluid you choose may potentiate bleeding. J Trauma 2006;61:1350-8.

17. Ho AM, Karmakar MK, Dion PW.Are we giving enough coagulation factors during major trauma resuscitation? Am J Surg 2005;190:479-84.

18. Dente CJ, Shaz BH, Nicholas JM, Harris RS, Wyrzykowski AD, Patel S, et al. Improvements in early mortality and coagulopathy are sustained better in patients with blunt trauma after institution of a massive transfusion protocol in a civilian level I trauma center. J Trauma 2009;66:1616-24.

19. Cotton BA, Au BK, Nunez TC, Gunter OL, Robertson AM, Young PP. Predefined massive transfusion protocols are associated with a reduction in organ failure and postinjury complications. J Trauma 2009;66:41-8.

20. Lier H, Krep H, Schroeder S, Stuber F. Preconditions of hemostasis in trauma: a review. The influence of acidosis, hypocalcemia, anemia, and hypothermia on functional hemostasis in trauma. J Trauma 2008;65:951-60.

21. Rossaint R, Bouillon B, Cerny V, Coats TJ, Duranteau J, Fernández-Mondéjar E, et al. Management of bleeding following major trauma: an updated European guideline. Crit Care 2010;14:52.

22. Shakur H, Roberts I, Bautista R, Caballero J, Coats T, Dewan Y, et al. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): arandomised, placebo-controlled trial. Lancet 2010;376:23-32

23. Spinella PC, Perkins JG, McLaughlin DF, Niles SE, Grathwohl KW, Beekley AC, et al. The effect of recombinant activated factor VII on mortality in combat-related casualties with severe trauma and massive transfusion. J Trauma 2008;64:286-93.

24. Spinella PC, Holcomb JB. Resuscitation and transfusion principles for traumatic hemorrhagic shock. Blood Rev 2009;23:231-40.

25. Sheffy N, Chemsian RV, Grabinsky A. Anaesthesia considerations in penetrating trauma. Br J Anaesth 2014;113:276-85.

26. Karlsson M, Ternström L, Hyllner M, Baghaei F, Flinck A, Skrtic S, et al. Prophylactic fibrinogen infusion reduces bleeding after coronary artery bypass surgery. A prospective randomised pilot study. Thromb Haemost 2009;102:137-44.

27. Rahe-Meyer N, Pichlmaier M, Haverich A, Solomon C, Winterhalter M, Piepenbrock S, et al. Bleeding management with fibrinogen concentrate targeting a high-normal plasma fibrinogen level: a pilot study. Br J Anaesth 2009;102:785-92

28. Lier H, Böttiger BW, Hinkelbein J, Krep H, Bernhard M. Coagulation management in multiple trauma: a systematic review. Intensive Care Med 2011;37:572-82.

29. Ryan Gerecht. CMTE Trauma's Lethal Triad of Hypothermia, Acidosis & Coagulopathy Create a Deadly Cycle for Trauma Patients Journal of emergency medical service Wed, Aprl 2, 2014

30. Mahonee L, Flaherty M. Travma için anestezi. In: Duke J, editor. Dikmen Y, çeviri editörü. Anestezinin Sırları. 2. Baskı. İstanbul: Nobel Tıp Kitabevleri; 2006.p.287-91.

31. Dewar D, Moore FA, Moore EE, Balogh Z. Postinjury multiple organ failure. Injury 2009;40:912-8.

32. Godwin SA, Burton JH, Gerardo CJ, Hatten BW, Mace SE, Silvers SM, et al. Clinical Policy: Procedural Sedation and Analgesia in the Emergency Department. Ann Emerg Med 2017;70:758.

33. Andolfatto G, Abu-Laban RB, Zed PJ, Staniforth SM, Stackhouse S, Moadebi S, et al. Ketamine-propofol combination (ketofol) versus propofol alone for emergency department procedural sedation and analgesia: a randomized double-blind trial. Ann Emerg Med 2012;59:504-12.e1-2.

34. Nejati A, Moharari RS, Ashraf H, Labaf A, Golshani K. Ketamine/propofol versus midazolam/fentanyl for procedural sedation and analgesia in the emergency department: a randomized, prospective, double-blind trial. Acad Emerg Med 2011;18:800-6.

35. Andolfatto G, Willman E. A prospective case series of pediatric procedural sedation and analgesia in the emergency department using single-syringe ketamine-propofol combination (ketofol). Acad Emerg Med 2010;17:194-201.

36. Yaghoobi S, Khezri MB, Alamouti AM. A Pilot Study of Cerebral and Hemodynamic Changes During Sedation with Low Dose of Thiopental Sodium or Propofol in Patients with Acute Brain Injury. J Clin Diagn Res 2015;9:UC05-7.

37. Caro D, Sedation or induction agents for rapid seqence intubation in adults. Ed. Walls RM. www.uptodate.com 2015 UpToDate.

38. Reich DL, Hossain S, Krol M, Baez B, Patel P, Bernstein A, et al. Predictors of hypotension after induction of general anesthesia. Anesth Analg 2005;101:622-8

39. Fields AM, Rosbolt MB, Cohn SM. Induction agents for intubation of the trauma patient. J Trauma 2009;67:867-9.

40. Hinkewich C, Green R. The impact of etomidate on mortality in trauma patients. Can J Anaesth 2014;61:650-5.

41. Agarwala A, Dershwitz M. Intravenous induction agents. In: Vacanti CA, Sikka PK, Urman RD, Dershwitz M, Segal BS, editors. Essential clinical anesthesia. New York: Cambridge University Press; 2011.p.227-32.

42. Chan CM, Mitchell AL, Shorr AF. Etomidate is associated with mortality and adrenal insufficiency in sepsis: a meta-analysis. Crit Care Med 2012;40:2945-53.

43. Asehnoune K, Mahe PJ, Seguin P, Jaber S, Jung B, Guitton C, et al. Etomidate increases susceptibility to pneumonia in trauma patients. Intensive Care Med 2012;38:1673-82.

44. Stollings JL, Diedrich DA, Oyen LJ, Brown DR. Rapidsequence intubation: a review of the process and considerations when choosing medications. Ann Pharmacother 2014;48:62-76.

45. Bassett MD, Smith CE. General anesthesia for trauma. In: Varon AJ, Smith CE, editors. Essentials of trauma anesthesia. New York: Cambridge University Press; 2012.p.76-94.

46. Filanovsky Y, Miller P, Kao J. Myth: ketamine should not be used as an induction agent for intubation in patients with head injury. CJEM 2010;12:154-7.

47. Schönenberg M, Reichwald U, Domes G, Badke A, Hautzinger M. Ketamine aggravates symptoms of acute stress disorder in a naturalistic sample of accident victims. J Psychopharmacol 2008;22:493-7.

48. Berman RM, Cappiello A, Anand A, Oren DA, Heninger GR, Charney DS, et al. Antidepressant effects of ketamine in depressed patients. Biol Psychiatry 2000;47:351-4.

49. Zarate CA Jr, Singh JB, Carlson PJ, Brutsche NE, Ameli R, Luckenbaugh DA, et al. A randomized trial of an N-methyl-D-aspartate antagonist in treatment-resistant major depression. Arch Gen Psychiatry 2006;63:856-64.

50. Robert A. Sikorski A. Ken Koerner L. Yvette Fouche-Weber Samuel M. Galvagno Jr. Choice of General Anesthetics for Trauma Patients. Curr Anesthesiol Rep 2014;4:225-32.

51. Suzuki T, Aono M, Fukano N, Kobayashi M, Saeki S, Ogawa S. Effectiveness of the timing principle with high-dose rocuronium during rapid sequence induction with lidocaine, remifentanil and propofol. J Anesth 2010;24:177-81.

52. Patanwala AE, Stahle SA, Sakles JC, Erstad BL. Comparison of succinylcholine and rocuronium for first-attempt intubation success in the emergency department. Acad Emerg Med 2011;18:10-4.

53. Lee C, Jahr JS, Candiotti KA, Warriner B, Zornow MH, Naguib M. Reversal of profound neuromuscular block by sugammadex administered three minutes after rocuronium: a comparison with spontaneous recovery from succinylcholine. Anesthesiology 2009;110:1020-5.

54. De Hert SG, Turani F, Mathur S, Stowe DF.Cardioprotection with volatile anesthetics: mechanisms and clinical implications. Anesth Analg 2005;100:1584-93.

55. Enlund M, Edmark L, Revenäs B. Is nitrous oxide a real gentlemen? Acta Anaesthesiol Scand 2001;45:922-3.

56. Brookes ZL, Brown NJ, Reilly CS. The dose-dependent effects of fentanyl on rat skeletal muscle microcirculation in vivo. Anesth Analg 2003;96:456-62

57. Sagarin MJ, Barton ED, Sakles JC, Vissers RJ, Chiang V, Walls RM, et al. Underdosing of midazolam in emergency endotracheal intubation. Acad Emerg Med 2003;10:329-38.

58. Çelik F, Tüfek A, Temel V, Kavak GO. Combination of spinal anesthesia and peripheral nerve block: Case report. Dicle Med J 2010;37:401-3.

59. Kıroğlu Ş, Aldemir MT, Süren M, Çömlekçi M, Peker AG, Ertuğrul F. Üç olguda üst ekstremite periferik sinir bloğu ile birlikte spinal anestezi uygulaması. Bildiri Özeti P-RA-94 TARK 2008.