Multiple trauma: Problematic issues for the anesthetist

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The victim of multiple trauma has certain unique problems that distinguish him from the elective surgical patient. These frequently include the lack of a complete preanesthetic evaluation, a full stomach, alcohol intoxication, circulatory shock, and undiagnosed injury. Current approaches to the anesthetic management of these problems are presented by the author in this article.

The National Academy of Sciences has referred to trauma as the neglected epidemic of modern society. The victim usually makes his appearance in the middle of the night or during a holiday weekend, a fact which has contributed to the lack of interest in the epidemic.

Trauma can be defined as a wound or injury, and multiple trauma is the leading cause of death between one year and 44 years of age. Until the recent decade, care of the trauma patient had been left to ambulance drivers and emergency room nurses and residents. However, we have recently witnessed the development of specialty programs for professionals interested in rendering emergency medical care. As a result of improvements in trauma management, anesthetists now see larger numbers of trauma patients in the operating room.

Many undesirable problems unique to the trauma victim distinguish him from the elective surgical patient. Principal among these are the lack of a comprehensive preanesthetic evaluation, a full stomach, possible alcohol intoxication, circulatory shock, and the potential presence of undiagnosed injuries.

Preanesthetic evaluation

Unless the patient is rapidly exsanguinating, he invariably benefits from a full evaluation of his condition so that a rational plan of action can be developed and corrective, supportive therapy can be instituted. Carnes recommends that the following conditions be required prior to acceptance of an adult trauma victim for general anesthesia, recognizing in many cases that these requirements must be abandoned.

The patient's sensorium should be clear, his pulse rate should be less than 120 beats per minute, his blood pressure should be normal to high, his urine volume should be at least 30 to 50 ml per hour, his hematocrit should be above 30%, and his urine sodium excretion should equal 30 mEq per liter or more. The latter indicates that he has adequate total body sodium and will not have to excrete potassium instead.

A chest film is suggested for all trauma patients to rule out contusion of the heart or any part of the respiratory system. In the unconscious patient, medic-alert bracelets are helpful in communicating allergies, medications, or medical conditions which may affect the anesthetic course.
The full stomach

In survivors of acute injury, gastric emptying is prolonged by a reflex inhibition caused by pain, fear, or clinical shock. Major trauma in Korean battle casualties was shown to delay stomach emptying for periods as long as 24 hours after a meal. Injury victims tend to accumulate acid secretions in their stomachs and are likely to place these secretions into their tracheas.

There are three possible ways to prevent aspiration of acidic stomach contents: (1) emptying the stomach, (2) reducing the acidity of the stomach contents, and (3) endotracheal intubation. As for the first, there is no reliable way of ensuring gastric emptying. Stomach acidity may be reduced by use of magnesium trisilicate; however, the acutely injured accident victim may be unable to swallow.

Therefore, one should rely on endotracheal intubation as the best method to protect the airway. The most widely used technique is preoxygenation followed by rapid sequence induction, cricoid pressure, and intubation. In rapid sequence induction, fasciculations produced by succinylcholine may increase intraabdominal pressure and result in regurgitation. Defasciculation with a small dose of a non-depolarizing relaxant is recommended.

In the event of regurgitation, Cucchiara advocates the insertion of an endotracheal tube into the esophagus. This allows stomach contents to flow freely away without risk of aspiration or obstructing the anesthetist's view during subsequent tracheal intubation.

A device the anesthetist is likely to see with increasing frequency is the esophageal obturator airway. It is currently used by paramedics at accident sites, and allows ventilation of the comatose patient without distention of the stomach. This device should be left in place, with the cuff inflated until tracheal intubation has occurred, to avoid aspiration of gastric contents.

If there is concern about laryngoscopy or airway management, awake intubation is the technique of choice. However, if time is critical or the patient is uncooperative, this technique is not suitable.

Alcohol intoxication

Ethanol intoxication is frequently a precursor of trauma, especially in automobile accidents where more than 25% of those injured were intoxicated. In acute intoxication, nerve function at all levels is impaired; thus, reflexes protecting the airway are severely depressed. Once a certain blood alcohol level is reached, gastric stasis occurs, increasing further the risk of aspiration. Respiratory tidal volume is decreased, causing acidosis and carbon dioxide retention. Cutaneous vasodilatation secondary to alcohol intoxication renders the accident victim more susceptible to hypothermia and creates a relative hypovolemia.

These problems, and the diuresis caused by ethanolic inhibition of the antidiuretic hormone, combine to make this patient vulnerable to shock. Electrolyte depletion accompanies the diuresis. In addition, Webb and Degerli have indicated that with increasing blood alcohol levels, there is a concomitant increase in cardiac output and blood pressure which increases cardiac work. This phenomenon is accompanied by an increase in coronary artery resistance and a decrease in coronary blood flow.

The combination of shock, acidosis, increased myocardial work, and decreased coronary flow will predispose the patient to dysrhythmias. For the optimist, there is one positive factor to be remembered: ethanol has excellent amnestic properties. Thus, narcotics and sedatives will probably not be required to supplement the anesthetic.

Circulatory shock

The most common problem experienced by the major trauma patient is hypovolemic shock. In evaluating the severity of shock, one is likely to look first at arterial blood pressure. After a loss of 20 to 30% of blood volume, the blood pressure begins to fall. Vasoconstriction and tachycardia are already maximal at this point. When blood loss exceeds 50%, blood pressure is barely recordable.

Frequent estimations of the extent of blood loss are necessary. On theoretical grounds, a 5-unit reduction in hematocrit is produced by a half-liter blood loss. In practice, the hematocrit is used primarily to establish whether or not an internal hemorrhage is continuing since hemorrhaging almost invariably is accompanied by a progressive hemodilution. It takes at least several hours for hemoglobin and red-cell concentrations to reach levels that reflect the amount of blood lost.

A practical method for evaluating if hypovolemia is present or not is to compare the patient's level of diastolic arterial blood pressure while in a supine position and in a 10-degree reverse Trendelenberg position. A decrease of 15 mm or more during tilt is evidence of hypovolemia.

Serious hypovolemia can result without a drop of blood being shed externally. A patient can bleed to death into the peritoneal cavity without even
showing abdominal distention. Not one of the usual clinical parameters taken alone is reliable for judging the degree of blood loss or adequacy of volume replacement.

Taken together, however, the usual indicators (blood pressure, heart rate, skin temperature, capillary refill, central venous pressure, pupillary dilatation, hematocrit, and urinary output) are usually reliable, especially if followed serially. Pulmonary compliance is a good criterion for early detection of fluid overloading. The development of metabolic acidosis is a relatively late manifestation of circulatory insufficiency.

In the young acute trauma victim, central venous pressure alone is an excellent guide to fluid replacement therapy. In older or critically ill patients, Swan-Ganz™ catheters are recommended. The level of oxygen saturation of the mixed venous blood is a reliable guide to the cardiac output in victims of shock.

It is dangerous to induce general anesthesia in a hypovolemic patient because of vasodilatation and myocardial depression, both produced by general anesthetics. Hypovolemia exaggerates the normal pulmonary venoarterial shunt of desaturated blood, and high inspired oxygen concentrations are suggested.

There are two primary components to the treatment of hypovolemic shock. First, cellular hypoxia and metabolic acidosis cause a functional deficit of extracellular fluid which must be replaced with balanced salt solution. Secondly, volume must be replaced with colloidal replacement fluid.

**Crystallloid therapy**

Initially, resuscitation of the patient is begun with a balanced electrolyte solution, lactated Ringer's solution. Most authors recommend giving a rapid infusion of 1500 ml within 10 minutes or less. A quantity of 1500 ml of this solution should produce some stabilization of the vital signs and an adequate urine output. If it does not, the anesthetist must reevaluate the cause of the circulatory failure.

It is important that dextrose solutions be avoided at this time. The renal threshold for glucose is approximately 180 mg. If the dextrose solution is rapidly infused, the blood sugar will rise above the renal threshold with resulting diuresis. Diuresis eliminates one of the best parameters that the anesthetist has for estimating volume replacement needs.

Ringer's lactate solution is slightly more physiologic than a normal saline solution because its electrolyte concentrations are closer to those of blood serum. However, it has several disadvantages; namely, it dilutes serum proteins and elevates arterial lactate that may be a useful measurement in assessing the degree of shock.

In addition, Ringer's lactate should probably be avoided when treating patients who have a severe degree of circulatory inadequacy because they may be unable to metabolize the lactate adequately and will thus become increasingly acidic. The differences between normal saline solution and Ringer's lactate solution are relatively minor in the context of resuscitation from hemorrhage. The patient in acute shock may be more effectively managed with saline.

Both Ringer's lactate solution and normal saline solution are effective in replacing blood loss because a certain percentage of each remains in the plasma space. The fraction that remains intravascular is not constant, however. Initially, at least one third of the administered fluid remains, but if hemorrhaging and replacement continue, less of the subsequently administered saline remains intravascular as the plasma albumin concentration declines.

If crystalloid is used for resuscitation, the patient will become anemic. By increasing the level of 2,3-diphosphoglyceric acid in the remaining red cells, the function of the hemoglobin is significantly improved and more oxygen per gram of hemoglobin is delivered. The borderline anemic patient who is stable and faces no further challenges to his oxygen-delivering system does not need to be transfused.

One of the overall principles of resuscitation is that volume is more important than the oxygen-carrying capacity. This principle is based upon the observation that ischemia is far worse than hypoxia with preserved perfusion. In experiments involving controlled hemodilution where hematocrits have dropped to 5%, patients stayed alive primarily because there was adequate circulating volume.

**Non-red cell colloid therapy**

The use of albumin in trauma victims is a much debated issue at present. Those who disfavor its use point to the following arguments. If the colloid fluid crosses a leak in the capillary and ends up in the interstitium, the only way to mobilize it is via the lymphatics. As a result, interstitial edema in the pulmonary circulation occurs because of an overload of lymphatics.

In addition, there is no data showing that one needs albumin in resuscitating the trauma patient;
there is no indication that he has lost albumin. Man normally has approximately 40 gm of albumin in reserve in his liver. If this albumin were not available, the serum albumin would be diluted much more than is observed clinically when only blood and lactated Ringer's solution are given.

The main advantage of albumin is the restoration of plasma-specific osmotic activity. If large volumes of balanced salt solution are given, albumin can minimize interstitial flooding and the tendency for pulmonary edema to develop.

**Transfusion therapy**

Humans normally contain 25% more hemoglobin than we actually need. The ideal balance between the oxygen-transporting capacity of the circulation and the viscosity of the blood is probably best attained when the hematocrit is approximately 30%. The normal person who loses 20% of his blood volume or decreases his hemoglobin concentration to 10 gm per deciliter generally does not need blood transfusion.

The patient whose condition is poor, however, will benefit from transfusion at this point. In addition, the patient who continues to lose blood below a hematocrit of 30% needs transfusion. The cardiac output has to be increased fourfold to affect oxygen transport in patients with a hematocrit below 30%.

The massively injured trauma victim who needs blood may have none immediately available to him. Partly as a result of this unavailability of blood, intraoperative blood scavenging and autotransfusion have been developed and are used in major trauma centers. Many of the inherent risks of blood transfusion—the most feared being the hemolytic transfusion reaction—can be eliminated by autotransfusion.

Devices for autotransfusion are similar to cardiotomy reservoirs used in open-heart surgery and usually consist of a vacuum source and a reservoir for collecting blood. For example, the system is connected to a thoracostomy tube and the blood is aspirated. It is then reinfused through intravenous lines after filtration with a 125-micron blood filter. Patients with simple perforating wounds or blunt trauma to the chest are ideal candidates. Other candidates are victims of moderate injury and those with acute blood loss from simple wounds of the abdomen that do not involve the hollow viscera.

Contraindications for autotransfusion include the presence of malignant lesions; gross contamination involving colon, small bowel, and stomach injury; wounds which are more than 4-hours old; and hepatic or renal insufficiency.

Intraoperative scavenging has two main disadvantages. The first of these is hemolysis; there is a certain amount of red cell destruction which occurs from tissue contact with foreign surfaces. Hemolysis can be minimized by limiting suction to periods of peak blood loss.

The second disadvantage of intraoperative scavenging is the occurrence of thrombocytopenia. The apparent cause of thrombocytopenia is foreign surface contact and trapping of platelets on the filter. However, one must remember that there are very few viable platelets in a unit of bank blood after 8 hours of refrigeration. Therefore, the patient may obtain more platelets through the use of autotransfusion than through the use of bank blood.

The need for blood filters in massive transfusion is currently under investigation. Hirsch and colleagues reported a case in which there was no change in pulmonary vascular resistance after an infusion of 90 units of unfiltered blood. Carnes suggests using a filter whenever the blood to be transfused is more than 5 days old. Recent work has shown a marked rise in microaggregates in a unit of stored blood on the fifth day.

**Drug therapy**

Metabolic acidosis inhibits cardiac contractility and diminishes peripheral vascular response to catecholamines. Sodium bicarbonate alleviates the acidosis. However, even in severe shock with blood pressures below 70 mm of mercury, the pH has not been found to be reduced to a dangerous level, and there seems to be no justification for the routine use of bicarbonate in shock. Beneficial effects of large glucocorticoid doses for hemorrhagic shock have been reported. The glucocorticoids appear to improve the cardiac output and decrease peripheral resistance.

In general, vasoactive drugs should be used only after the primary cause of shock has been corrected. When severe drops in blood pressure occur that may threaten life, and when adequate fluids for reconstituting the circulation are lacking, vasopressors may be lifesaving and should be saved for such situations. If the patient is adequately transfused and the central venous pressure has been elevated, yet arterial blood pressure has not risen, digitalization is warranted.

Calcium is frequently given to patients with myocardial depression. An increased Q-T interval on the electrocardiogram is probably the best guide for determining the need for calcium.
Undiagnosed injury

The greatest challenge in the anesthetic management of the trauma victim probably results from undiagnosed injuries.

In selecting agents, one must consider the possible existence of undiagnosed air-filled spaces before electing to use nitrous oxide. Caution must also be used in applying positive pressure ventilation in the presence of a chest injury where pleural drainage has not been carried out. Decreased respiratory sounds may signal the development of a pneumothorax. A tension pneumothorax must be suspected if the patient suddenly becomes hypotensive, cyanosed, and difficult to ventilate. Both types of pneumothorax can be treated effectively by inserting a chest drain.

Pericardial tamponade is caused by blood or air in the pericardium which restricts the filling of the heart. It should be suspected in trauma victims with severe hypotension out of proportion to apparent blood loss. Treatment consists of pericardiocentesis.

If a cervical injury is present but undiagnosed, careless positioning of the head for tracheal intubation can result in tetraplegia or even death. Trauma patients should be evaluated for cervical injury before being moved. Blind nasotracheal intubation is the technique of choice. Prior to induction, the neck must be stabilized with a collar or cervical traction; the awake patient will reflexively stabilize his neck.

Conclusion

The trauma victim presents the anesthetist with many opportunities to exercise skill and judgement. The lack of a complete preanesthetic evaluation, a full stomach, possible alcohol intoxication, circulatory shock, and the presence of undiagnosed injuries are among the major problems faced in anesthetic management.

REFERENCES


ADDITIONAL REFERENCES

For further reading on this article’s topic, the author developed a list of some 36 references that were not cited in the text.

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