Traumatic Anesthesia

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Speaker Notes

“To provide high quality care, the veterinary technician is challenged to draw from their knowledge and experiences, remain flexible and be creative.”

Harold Davis RVT, VTS (ECC, Anesthesia)

Trauma is a general term and a lot of thought needs to go into working with a patient that has undergone a traumatic event. In addition to the challenges that our patients face in a traumatic situation, we often need to anesthetize them to deal with their injuries. In order to do this safely there is a lot to consider. We will begin by looking at the major body systems and how they can be affected by trauma.

**Traumatic Injury...What is the Worst that can happen?**

**Cardiovascular Considerations**

The trauma patient may suffer from hypovolemia. This can be due to hemorrhage or due to relative hypovolemia (vasodilation and shock). It is important to address this with the appropriate fluid therapy in order to stabilize the patient prior to anesthetizing it, if at all possible, in order to protect vital organs from hypoperfusion.

Cardiac performance can also be affected by contusions, ischemic damage, and trauma related arrhythmias. A trauma patient should be monitored with an ECG and heart rate should be compared to the pulse rate to ensure pulses are being conducted.

**Respiratory Considerations**

A traumatic event can adversely affect the respiratory system in so many ways. Functional residual capacity (FRC) is the amount of air left in the lungs after an expiration. A decreased FRC will leave the patient with the inability to ventilate and oxygenate properly. This may be due to a rib fracture causing pain and preventing full lung expansion. This can also be due to air, blood, or chyle in the thoracic cavity decreasing the pleural space. Contusions may not show up right away on radiographs but are essentially bruises on the lungs that prevent effective gas exchange. A patient may also have pulmonary edema, either non cardiogenic (maybe from a near choking event) or cardiogenic in the case of a patient with primary heart disease that is no longer able to compensate after a traumatic event. Blunt trauma to the chest may also cause avulsion of any portion of the tracheobronchial tree. Prior to anesthesia, trauma patients should be preoxygenated and thoracocentecis should be performed if necessary.

**Urogenital**

A bladder rupture, uretral avulsion, or urethral tear will result in a uroabdomen or uroretroperitoneum. The inability to urinate will result in hyperkalemia and a metabolic acidosis that can be deadly. These patients should be monitored with an ECG and treated with calcium, insulin, and/or bicarbonate prior to anesthesia if possible.

**Nervous system**

A patient with head trauma or brain injury will have increased intracranial pressure due to swelling. These patients are at risk for a progressive secondary injury if the swelling is not treated. Head trauma patients may also have symphaseal, mandibular, skull, or dental fractures.
Patients with spinal fractures may need to be anesthetized to prevent spinal cord trauma. The anesthetist should be prepared to ventilate these patients depending on the location of the fracture or extent of the head trauma.

The peripheral nervous system can also suffer injury due to nerve compression (see compartment syndrome) or avulsion.

**GI/hepatic/splenic**  
Abdominal trauma may lead to fracture of the spleen, liver, or kidney causing hemorrhage and hypovolemic shock. If the gastrointestinal system is breached the patient is at risk for septic shock.

**Musculoskeletal**  
Damage to the musculoskeletal system can result in hemorrhage and soft tissue damage. These patients are at risk for compartment syndrome (to be discussed later) and potentially reperfusion injury. Significant soft tissue damage can also be seen with these injuries.

**Trauma is a pain in the…**  
It is important to treat pain in these patients. The trauma patient is using all of its energy to achieve homeostasis and has no reserves to deal with pain. Pain can cause cardiac arrhythmias, hypoventilation, and impede healing. In addition the patient may be experiencing anxiety which will contribute to the patient’s perception of pain and should be treated.

Trauma patients may present with many forms of pain. Primary tissue trauma in the form of a laceration or fracture may be present. Secondary tissue trauma due to inflammation will also likely be present. Inflammation is the body’s signal to recruit leukocytes or the “clean up crew”. These inflammatory mediators and leukocytes unfortunately also sensitize the C nerve fibers which causes hyperalgesia, magnification of the pain sensation. Left untreated, pathologic pain can result in allodynia, the perception of pain to an innocuous stimulus. Wind up, the increased perception of pain over time, may also occur.

Pain associated with trauma may come from different sources. Compartment syndrome may be caused by blood or fluid being trapped in a closed space including swollen or edematous tissues. The build up of pressure will decrease circulation and thus oxygen delivery to tissues which will then lead to ischemia and necrosis. In addition, potassium and hydrogen ions released form the dying sells sensitize pain nociceptors. Swelling may also impinge nerves causing both pain and neurological deficits.

The trauma patient may also suffer from a crush injury. The sequelae of a crush injury are similar to those of compartment syndrome. The destruction of tissues release hydrogen, potassium and myoglobin. Hyperkalemia and hyperglobinuria may not be noted in these patients until they are reperfused.

A trauma patient is the ideal candidate for a multimodal anesthetic/analgesic plan. A balanced protocol will allow the anesthetist to use a smaller dose of each drug to create a synergistic effect. By using smaller doses of each drug, the risk of adverse side effects is greatly reduced. This is beneficial to the trauma patient that may decompensate easily.

**Drug Classes and the Trauma Patient**
When giving drugs to a trauma patient, try to use a reversible drug. If the patient decompensates, reverse it!

Opioids
Opioids are the main line of defense when treating trauma patients. They are potent analgesics, reversible, and can be given via many different routes. It is known that opioids can reduce a patient’s respiratory rate. Human patients are more susceptible to this side effect than our veterinary patients are, but it is worth keeping in mind with the trauma patient. A depressed respiratory rate may lead to hypercarbia and increased intracranial pressure. This is of particular concern in the head trauma patient. These patients should still receive opioids, but their respiratory rate should be watched. Opioids are cardiovascularly sparing with higher doses causing bradycardia. Hypovolemic patients may have a reduced cardiac output with this decreased heart rate. Patients should have their blood pressure and ECG monitored regularly. Opioids do cause a decrease in GI motility and regurgitation can be seen. Aspiration is a risk for these patients.

Benzodiazepines
Benzodiazepines should be part of a balanced anesthetic plan for the trauma patient. These drugs reduce anxiety and produce sedation and muscle relaxation. They have minimal cardiovascular and respiratory effects and are reversible. They can be given IV or IM (midazolam) but do not make good drugs for CRI use due to their sensitivity to light and diazepam’s affinity for plastic. When given just prior to induction the dose of induction drug may be reduced by about two thirds. When given alone benzodiazepines may cause central nervous system arousal and I like to have my induction drugs in hand when giving benzodiazepines on the induction table.

Phenothiazines
Phenothiazines are potent anxiolytic and antiemetic drugs. In my opinion, this class of drug should not be used with the trauma patient. They are not reversible, cause vasodilation, hypotension, and sequester valuable blood to the spleen.

Alpha 2 Agonists
Alpha 2 agonists are another class of drug that is not ideal for the trauma patient. While they produce sedation and analgesia and can be reversed, the cardiovascular changes that they produce are too significant. I have found that even after reversal the patient may still have a lingering hypotension under anesthesia. In addition, this class of drug does not provide a reliable sedation for the aggressive animal which will put the staff at risk of injury.

Dissociative Agents
Dissociative agents have both anesthetic and analgesia qualities. In addition they are NMDA antagonists and help to prevent wind up pain. These drugs can not be reversed but have minimal respiratory effects (other than apneustic breathing) and are considered to be cardiovascularly sparing, although a patient with hypovolemia or myocardial trauma may not be able to respond appropriately. It is also important to consider the CNS effects of these drugs when treating the head trauma patient. Dissociative agents increase oxygen consumption in the brain and may increase the intracranial pressure. Muscle rigidity will be seen if these drugs are not paired with a muscle relaxant such as a benzodiazepine.

NSAIDS
NSAIDS do not really have a place in the initial treatment of trauma patients. They will be inadequate pain control for the trauma patient when given alone. In addition the renal and GI systems rely on prostaglandins to maintain blood flow and mucosal integrity during periods of hypovolemia/hypotension. Some NSAIDS may even prevent platelet aggregation. An NSAID may be given to the a normovolemic patient (with a fracture for example) as an adjunct to the rest of the analgesic protocol, but it is recommended to give a patient 24 hours to recover from initial trauma prior to administering NSAIDS.

Locals
Local blocks may be used to perform short procedures on the sedated trauma patient without risking full anesthesia. Lidocaine may also be used in the trauma patient to treat arrhythmias. The addition of lidocaine to an opioid CRI will have a synergistic effect on analgesia as well as contributing a cytoprotective effect.

IV Induction Agents
Propofol is a popular induction agent with a rapid onset. Its use decreases the cerebral metabolic rate which makes it a good choice for the head trauma patient. Propofol is a powerful dose dependant vasodilator and respiratory depressant. A balanced anesthetic protocol will allow a lower dose of propofol necessary to induce a patient. These patients should be on intubated, on IV fluids, and have their blood pressure monitored.

Thiopentol is not the best choice for injectable anesthesia in the trauma patient in my opinion. Like propofol, thiopental is a powerful cardiovascular and respiratory depressant and in addition will sensitize the myocardium to catecholamine induced arrhythmias. Thiopentol is metabolized by the liver but will also redistribute and accumulate in other tissues making it a poor choice for a CRI. If the use of thiopental is desired, it can be mixed in a 1:1 ratio with propofol to reduce the dose of each drug.

Etomidate produces few cardiovascular or respiratory effects making it a good choice for the trauma patient. It may cause vomiting at lower doses and should not be given without a muscle relaxant. Etomidate also interferes with the body's synthesis of cortisol for up to eight hours. When given to septic patients or those with adrenocortical dysfunction a physiological dose of steroids should also be given.

Inhalants
All inhalants produce dose dependant vasodilation and respiratory depression. Inhalants do decrease cerebral metabolism which may be good for the head trauma patient, but remember that a decreased respiratory rate will increase intracranial pressure. It is important for these reasons to use the lowest dose of inhalant possible. This can be achieved by using a balanced anesthetic/analgesic protocol. Also, consider that a sick patient will have a lower MAC than the healthy patient that you may be used to working with. “Boxing down” a trauma patient should be avoided if at all possible.

CRI
A constant rate of infusion can come in very handy when treating trauma patients. This route allows for the continuous delivery, titration, and bolus administration of a drug if necessary. Analgesic CRIs allow constant pain control without the peaks and valleys of bolus injections that allow break through pain to occur. A CRI can also be used to combat hypotension and cardiac arrhythmias.
Fentanyl is a potent opioid and has a very short half life. These qualities make it a perfect analgesic/anesthetic CRI drug for use in the trauma patient. It has a wide safety margin and can be used at lower doses for pain control and at much higher doses as an adjunct to the anesthetic protocol. A bolus can be given for a short procedure, loading dose, or premedicant. When dealing with CRIs and micrograms, I find that it is easiest to make a concentration of 1ml=1mcg/kg.

-Rule of 6

1. \( \text{BW(kg)} \times 6 = \text{mg of drug to be added to 100 ml of diluent} \)

2. Administer at \( X \text{ ml/hr} \) for a dose of \( X \text{ mcg/kg/min} \)