**The Top Five Anesthetic Complications**

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**Introduction**

Common anesthetic complications include hypothermia, hypotension, cardiac arrhythmias, hypoventilation, and a difficult recovery. The goal of managing anesthesia is to minimize the risk of anesthetic complications by maintaining good medical practices, using quality equipment, and maintaining good communication with our co-workers.

Patient safety should always be the priority when managing anesthesia. We must remember that no anesthesia should be considered minor. Complications can occur at any time so we must practice vigilance during the perianesthetic period. To mitigate the risks, develop an individualized anesthetic plan based on the preanesthetic assessment, have a dedicated trained anesthetist to vigilantly monitor the patient, and anticipate and prepare for complications. Following these recommendations will lead to increased patient safety and improved outcomes.

**Hypothermia**

Hypothermia, a body temperature less than 98°F or 36.7°C, is a well-recognized risk of anesthesia. Heat loss begins at the time of premedication and continues well into the recovery period. The hypothalamus is responsible for thermoregulation. When a patient is anesthetized, the chemoreceptor in the brain responsible for thermoregulation has a decreased ability to respond to fluctuations in body temperature. During anesthesia, the brain cannot respond with either shivering or vasoconstriction.

Many of our anesthetic drugs cause vasodilation, including acepromazine, opioids, propofol, and inhalant anesthetics. Vasodilation allows for heat loss and, coupled with un-humidified cold oxygen as a carrier for gas inhalants, body temperature will decrease under anesthesia, especially when high flow rates are delivered.

Risks of hypothermia can be significant and include a delay in wound healing and increased infection rate due to vasoconstriction reducing oxygen delivery to subcutaneous tissues. Increased blood loss may occur with hypothermia due to platelet dysfunction and coagulation cascade enzyme dysfunction.

Hypothermia leads to an increased duration of action of anesthetic drugs. The MAC of inhalant anesthetics are reduced, increasing their potency and will require you to assess anesthetic depth and adjust your vaporizer concentration accordingly.

Hypothermia will cause shivering during recovery. The consequences of shivering include increased oxygen consumption, increased CO2 production, increased cardiac work, increased glucose requirement, and patient discomfort.

 Prevention and treatment of hypothermia can involve applying external heat sources early and includes circulating water blankets, electric blankets, and forced warmed air units. Using booties on the lower limbs or covering the patient with bubble or plastic wrap may help prevent heat loss. Fluid warmers can be used to keep intravenous fluids warm while being administered to the patient.

**Hypotension**

Hypotension occurs at a systolic arterial blood pressure less than 90 mmHg or a mean arterial pressure less than 60 mmHg. Consequences of hypotension involve reduced blood perfusion to vital organs.

There are many causes of hypotension and the first step when developing a plan to treat hypotension is to determine the cause. Decreased cardiac output can result from decreased myocardial contractility or heart rate. Anesthetic drugs, such as acepromazine, propofol, alfaxalone, and inhalant anesthetics reduce cardiac output in a dose-dependent manner. Bradycardia can be a side effect of opioid administration or observed in patients with high vagal tone.

Vasodilation can be produced from the anesthetic drugs we administer. A decrease in blood volume, or hypovolemia, can be a result of hemorrhage, dehydration, sepsis, or shock.

When treating hypotension during anesthesia that is due to low cardiac output, it is important to remember that the two biggest influences of cardiac output are heart rate and stroke volume; and that the anesthetic drugs we have administered are likely contributing to the hypotension. When hypotension is recognized, the anesthetist should reduce the amount of drug that may be contributing to hypotension. Typically, this involves lowering the vaporizer concentration of inhalant anesthetic. If this results in the patient being too light for the procedure, then a balanced anesthetic regimen using a partial intravenous anesthetic technique may be helpful.

An IV fluid bolus of a crystalloid fluid, if not contraindicated, can be administered to correct potential hypovolemia and to maximize preload. The type and amount of the fluid bolus you choose to administer will depend on several factors, such as any pre-existing cardiac disease.

If cardiac output does not improve following modification of the anesthetic technique, then pharmacologic intervention is recommended. Drugs with positive inotropic effects will increase cardiac contractility and cardiac output. Positive inotropic drugs include dobutamine and dopamine. When the patient is bradycardic and this is contributing to low cardiac output, anticholinergic drugs, such as atropine or glycopyrrolate, can increase heart rate and improve blood pressure.

Vasodilation contributes to hypotension due to reduced systemic vascular resistance. Perianesthetic drugs that cause vasodilation include acepromazine, propofol, and inhalant anesthetics. Treatment is to reduce inhalant concentration, consider if an IV fluid bolus is appropriate, and transition to a PIVA or TIVA technique. Pharmacologic intervention, when other treatments have not resolved the hypotension, include the administration of vasopressor drugs to produce vasoconstriction. These include phenylephrine, ephedrine, and norepinephrine.

**Cardiac Arrhythmias**

*Bradycardia*

A heart rate that is regular but is too low is sinus bradycardia. For dogs 60 beats per minutes is often considered bradycardic, which could be true for a small breed dog. However, large breed dogs may tolerate a heart rate of 60 beats per minute under anesthesia and may drop below this rate without negative consequences. In anesthetized cats, a heart rate below 100 beats/min may be associated with a decrease in cardiac output. Often under anesthesia, many anesthetic drugs cause bradycardia. Remember that hypothermia can also cause bradycardia.

Treatment of bradycardia is recommended when it contributes to hypotension that can lead to decreased tissue perfusion. Treatment of bradycardiais with the administration of an anticholinergic drug, either atropine or glycopyrrolate. Also, anesthetic depth should be assessed and, if too deep, lighten the plane of anesthesia. Reversal or partial reversal drugs, such as an opioid or alpha-2 antagonist may also be considered to reverse bradycardia.

*2nd-degree AV block*

2nd degree AV block is a rhythm that is slow, irregular, and there is an absent QRS complex following some p waves. This arrhythmia can be commonly seen in patients with increased vagal tone, following opioid and or alpha 2 agonist administration, and extremely athletic patients. Treatment depends on the severity of the bradycardia and if the bradycardia is contributing to hypotension.

*Sinus Tachycardia*

Sinus tachycardia is a sinus rhythm that is too fast. What is considered too fast for a normal sinus rhythm not only depends on the number of beats per minute but also the type of patient and the environment. When sinus tachycardia is present, there is usually an underlying cause that has triggered sympathetic nervous system stimulation. In anesthetized patients, causes can include pain or too light a plane of anesthesia for the procedure being performed. The drugs we administer can also cause an increase in heart rate, including anticholinergic and dissociative drugs. Other causes include hypotension and hypoventilation.

Treatment involves a bit of trouble shooting first. The anesthetist should identify the underlying cause and determine the best course of action. If the patient is painful, an analgesic drug should be administered. If the patient is hypoventilating, then assisted or controlled ventilation may be required.

*Ventricular Premature Contractions*

VPCs are usually characterized by an early appearance, or premature, of a wider-than-normal QRS complex with an accompanying T wave. There is no associated P wave. The rhythm is irregular because of the premature ectopic depolarizations. You will often see a compensatory pause following the VPC and prior to the subsequent sinus beat. Causes of VPCs include pain, stress, trauma, acid-base abnormalities, and underlying cardiac disease, such as cardiomyopathy. Dogs with GDV or splenic disease have a high incidence of VPCs.

Treatment starts with identifying and correcting any underlying cause of increased sympathetic tone, such as pain or stress. Pharmacologic management is needed when VPCs are frequent, multifocal, or occur in a series. The drug of choice is lidocaine, which can be given as a bolus, repeated until the maximum safe dose if given, or a constant rate infusion may be used. Be mindful of the higher toxicity of lidocaine in cats. Some practitioners choose to avoid this drug in cats and may use esmolol instead.

**Hypoventilation**

Hypoventilation is defined as respiratory depression leading to inadequate gas exchange in the alveoli. Decreased elimination of carbon dioxide from the lungs results in a high level of CO2 in the blood called either hypercapnia or hypercarbia. Increased CO2 can be detected as an increased end tidal CO2 and or increased arterial CO2 in a blood gas sample.

Many anesthetic drugs, including opioids, induction drugs, and inhalant anesthetics will produce dose-dependent respiratory depression, therefore hypoventilation is a common complication. Hypercapnia from rebreathing of CO2 can result from exhausted CO2 absorbent and or excessive dead space in the breathing circuit. Rebreathing of CO2 can also occur with malfunctioning unidirectional valves, or, with a non-rebreathing circuit with too low an oxygen flow rate.

Recognition and treatment of hypoventilation is important because as hypoventilation and respiratory acidosis worsen, the patient becomes at risk of cardiovascular depression and cardiac arrhythmias. Monitoring of the respiratory system includes evaluation of both respiratory rate and tidal volume. The use of capnography can help you identify ventilation problems by analyzing the waveforms. If hyperventilation is detected, You may also need to assist or control ventilation as you assess your patient and equipment. Patient assess includes checking anesthetic depth, confirming proper endotracheal tube placement, and Checking the anesthetic machine and breathing circuit, including the oxygen flow rate, function of unidirectional valves and status of CO2 absorbent, and check to see if there is a disconnection or leak in the breathing system.

**Difficult Recovery**

The recovery period is a time when we cannot lesson our vigilance in patient monitoring and support so that our patients have a gradual, calm transition to wakefulness. A difficult recovery can be due to pain, emergence delirium, post-anesthetic dysphoria or any combination of these causes. The most effective way to treat a difficult recovery is to prevent its occurrence. Prior to discontinuing the maintenance anesthetic, or early in the recovery period, be sure to eliminate any potential causes of patient discomfort, such as expressing the bladder, having the patient in a comfortable body position, with no extreme joint flexion or extension, administrating an anti-nausea medication, and using external warming devices to prevent hypothermia. You may also need to evaluate the timing and effects of your premedication drugs and consider the potential need to administer a sedative or analgesic drug early in the recovery period.

Pain assessment should be performed during the recovery period and analgesic drugs administered if indicated. If you suspect your patient is painful, it is better to administer an analgesic drug than the risk of leaving pain untreated. You can then wait a few minutes to see if the patient settles down. If still agitated or vocalizing, you can administer a low dose of a sedative, such as dexmedetomidine or acepromazine.