A Review of the American College of Veterinary Anesthesiologists Guidelines for Anesthesia of Horses

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The risk of death associated with anesthesia in horses is ~1%. The American College of Veterinary Anesthesiologists has developed guidelines for the anesthesia of horses that provide a pathway for the safe anesthesia of horses, and if followed, they provide a measure of support for veterinarians should their methods be questioned when anesthetic complications occur. Author’s address: Department of Veterinary Clinical Sciences, The Ohio State University, 601 Vernon L. Tharp Street, Columbus, OH 43210; e-mail: John.Hubbell@cvm.osu.edu. © 2008 AAEP.

1. Introduction

Estimates of the risk of death associated with elective general anesthesia in the horse range from 0.1% (1 in 1000) to 1% (1 in 100).1,2 The risk of death increases for anesthesia >1 hr in duration and varies with operation type.3 Anesthesia is safest in horses 2–7 yr of age, and mortality rate is decreased when horses receive pre-anesthetic sedatives and tranquilizers, particularly acepromazine. IV anesthesia seems to be safer than inhalant anesthetics; however, this is difficult to interpret, because procedures performed during IV anesthesia tend to be shorter than those performed under inhalant anesthesia.1

The American College of Veterinary Anesthesiologists (ACVA) recognized that horses provide challenges beyond those of other domestic animals, and in response, they established an Equine Standards Committee to formulate guidelines for equine anesthesia. The guidelines concisely describe recommendations for pre-operative evaluation, selection of anesthetic regimen, monitoring and supportive care, use of injectable adjuncts, local and regional anesthesia, and recovery.4 Attorneys representing plaintiffs in malpractice litigation may refer to the guidelines and question omissions from the suggested procedures when determining if standards of practice have been maintained. The equine guidelines supplement another ACVA document covering suggestions for monitoring veterinary patients; this document includes the establishment of a medical record and regular recordings of intraoperative values.5

This paper will address the contents of the guidelines and how equine veterinarians might use them to improve their patient care and provide justification for their methodologies when necessary. The performance of appropriate evaluations and treatments for the betterment of our equine patients is the primary goal, but it must be recognized that maintaining good medical records and obtaining informed consent are integral to the sustainability of any medical practice.6 Anesthetic complications
and death are one of the top eight categories of claims submitted to the Professional Liability Insurance Trust of the American Veterinary Medical Association (AVMA), which comprises 6% of a recently reported series of cases.\textsuperscript{7} Good medical records and appropriate client communication are important factors in reducing claims. A phrase repeated often in the legal world is, “if it wasn’t written down, it didn’t happen.”

2. Guidelines and Interpretation

I. Pre-operative Evaluation

A. History

1. Response to prior sedation
2. History of any significant illness or injury
3. Current problem

The medical history frequently provides significant information regarding the risk of anesthesia. The attending veterinarian may have a continuing relationship with the client and the horse, but some long-standing conditions (minor ataxia, respiratory noise, or hyperkalemic periodic paralysis) that are being managed chronically become more important when facing anesthesia; therefore, a discussion of their implications for anesthesia would be part of informed consent. The drug, dose, and route of administration selected for pre-anesthetic medication may be dependent on previous responses and the temperament of the horse. Some horses cannot be approached with a syringe and needle. In those instances, oral detomidine (0.06 mg/kg) can be squirited into the mouth like a paste.\textsuperscript{8} A history of exercise intolerance indicates further evaluation of the cardiovascular and respiratory systems. A history of recent respiratory disease is of particular concern. Usually, anesthesia makes respiratory disease worse. Anesthesia-induced reductions in mucociliary clearance, cough reflex, drying of the airway, and positioning may contribute to exacerbations of clinical and subclinical respiratory disease. An assessment of the anticipated duration of anesthesia gives further information with regard to the degree of risk.

B. Physical examination

1. Temperature, pulse rate, and respiratory rate
2. Evaluation of all organ systems with a focus on the presence or absence of cardiovascular and respiratory abnormalities
3. Capillary refill time and mucous membrane color

C. Laboratory blood work

1. Order and/or perform any necessary blood work
2. Recommended tests, if any, will depend on the physical status of the patient and the procedure to be performed

The physical examination should emphasize the cardiovascular and respiratory systems. Palpating the rate, strength, and rhythmnicity of the peripheral pulse and checking the color of the mucous membranes gives evidence of the integrity of the cardiovascular system. Auscultation provides additional information; however, it can be somewhat confusing, because up to 80% of horses have cardiac murmurs.\textsuperscript{9} Fever is frequently a sign that a horse is incubating respiratory disease or another infection that might be exacerbated by the stress of anesthesia. The amount of laboratory work recommended depends on the results of the physical examination. A packed cell volume and plasma total protein provide information on hydration, oxygen-carrying capacity, and overall health. Total white counts (high or low) and a fibrinogen level are valuable indices of present or impending disease. Physical findings such as marked bradycardia, weakness, tenting of the skin, weakness, or ataxia should prompt the veterinarian to include further diagnostic tests.

An assessment of the anesthetic risk should be established and communicated to the owner before the pre-operative evaluation.\textsuperscript{10} This communication is separate from the usual communications about prognosis (such as 60% of horses return to soundness after this operation), because the impact of an anesthetic death is more acute. Signed or witnessed informed consent acknowledging the risks of anesthesia is an important step in risk management.\textsuperscript{11}

II. Selection of Anesthetic Regimen

A. Appropriate regimen

1. Physical status of the patient
2. Duration of anesthesia required
3. Number and skill of personnel available
4. Safety of facility/location where anesthesia (including induction and recovery) will be performed
5. Anesthetic equipment available
6. Monitoring equipment available

The safety of any anesthetic procedure is primarily determined by the skill and experience of the veterinarians in charge and the quality and quantity of people assisting them. Fortunately, most equine patients undergoing anesthesia are healthy and tolerate short anesthetic episodes well. The anticipated duration of anesthesia determines both the risk and the type of anesthetics best used. It is important to cover the “what ifs” before anesthesia is induced including the question of what will happen if the procedure takes longer than I think it will.

Equine veterinarians are best protected when they use drugs that are approved for use in the horse with doses and routes indicated on the labels. Unfortunately, only a limited number of anesthetic drugs are approved for equine use in the United States, and fewer are currently marketed. Ap-
proved drugs for standing chemical restraint include acepromazine (IV, IM, or SQ), promazine (PO, IV, or IM), xylazine (IV or IM), trilufromazine (IV or IM), detomidine (IV or IM), romifidine (IV), pentazocine (IV), and butorphanol (IV). IV agents approved for use in the horse include chloropen (chloral hydrate, magnesium sulfate, and pentobarbital), guaifenesin, thiamylal, thialbarbitone, and pentobarbital. Inhalant anesthetics approved for use in the horse include methoxyflurane, isoflurane, and halothane. Additionally, the number of non-marketed but approved drugs actually equals the number of those marketed. Diazepam, ketamine, thiopental, tiletamine-zolazepam, and sevoflurane are not labeled for use in the horse, but a basis for their use can be found in the literature. They are used widely and thus, would seem to fall under the reasonable extra-label use that is encompassed in normal standard of care.

One area of potential concern is the tendency for equine veterinarians to combine sedatives (xylazine and detomidine), tranquilizers (acepromazine), and opioids (butorphanol) into regimens to produce standing chemical restraint. The potential number of combinations would seem endless if you were to consider variations in the doses. Label recommendations caution against some combinations (the package insert for xylazine says it should not be used in combination with tranquilizers), but in some instances, those same combinations are promoted in the literature. It is the author’s impression that the veterinarian is safest when using approved drugs only. The recommendation of a drug combination, supported in the literature, provides some justification for its use.

B. Total IV anesthesia (TIVA)

1. Recommended for procedures expected to be ≤1 h in duration
2. Muscle relaxation may not be as profound compared with inhalant anesthesia
3. Anesthetic agents may be administered as intermittent boluses or as an IV infusion

The majority of equine anesthetic episodes are of short duration and occur outside of a hospital setting. Injectable anesthetics are most suitable for use in this arena. Most current anesthetic techniques use ketamine as the primary anesthetic agent. Ketamine is relatively supportive of cardiovascular and respiratory function and recoveries from a single administration are usually strong and crisp. The primary complications associated with ketamine anesthesia are insufficient muscle relaxation and inadequate duration of action. These complications can be offset by insuring that horses are fully sedate (usually using an alpha-2 agonist such as xylazine or detomidine) before administering the ketamine and by incorporating a muscle relaxant such as diazepam or guaifenesin. The recommendation for limiting TIVA to ≤1 h stems from the difficulties with oxygenation that horses experience when anesthetized in lateral or dorsal recumbency. When oxygen is supplied and ventilation is assisted, TIVA can safely be used for longer periods. However, the quality of recovery is reduced with extended anesthetic periods; this is caused by accumulation of the drug before it is cleared through hepatic metabolism.

C. Inhalant anesthesia

1. Preferred for lengthy procedures (>1 h of anesthesia time)
2. Requires additional equipment compared with TIVA
3. Commonly used inhalants include halothane, isoflurane, and sevoflurane

Inhalant anesthesia and the associated supplemental oxygen tensions provide greater control of anesthetic depth. The use of inhalants requires a greater level of monitoring, because anesthetics are continually administered. The ACVA recommends monitoring of arterial blood pressure when inhalants are used (see below).

III. Monitoring and Supportive Care

A. IV catheterization is recommended for the administration of anesthetic drugs, fluids, and/or supportive medications

The use of IV catheters helps to ensure that anesthetic medications are given appropriately and makes it more convenient when additional drugs are required intraoperatively. The reduction in the use of chloral hydrate and thiopental has reduced the likelihood of severe sequelae to perivascular administration of anesthetic drugs; however, guaifenesin given outside of the vein can cause swelling. Additionally, the use of a properly functioning catheter eliminates one potential reason (extravascular administration) for lack of a drug effect.

B. Proper position and padding is vital to aid in the prevention of muscle or nerve injury

C. TIVA

1. Oxygen source with flowmeter for nasal insufflation, if indicated
2. Endotracheal tubes and demand valve readily available to ventilate, if necessary
3. Pad/cloth for face and eye

Apnea during field anesthesia is relatively rare, because the use of succinylcholine chloride and barbiturate solutions has largely been replaced with ketamine combinations. Horses can be ventilated in an emergency situation by readapting a stomach tube onto an oxygen source, placing the stomach tube into the nasal cavity, and occluding the nostrils. When the chest rises to a normal level, the nostrils are released, and the animal exhales. This pattern can be repeated until the oxygen source is exhausted. Alternatively, an endotracheal tube can be placed, and the lungs can be inflated using a.
Endotracheal tubes are necessary for the safe administration of inhalant agents as a component of delivery of the gases. These tubes also minimize exposure of personnel to trace anesthetic gas levels. Waste anesthetic gases should be removed, preferably by an active system (one that uses suction). The Occupational Safety and Health Administration has set guidelines for the maximum exposure levels of personnel to the inhalants at 2 ppm. Veterinarians routinely anesthetizing horses for >1 h should consider the purchase of an anesthetic machine with a ventilator.

F. Monitoring of the respiratory system
1. Observation of respiratory rate and rhythm
2. Pulse oximetry, if indicated
3. Capnometry, if indicated (please note that end tidal carbon-dioxide tensions frequently underestimate arterial carbon-dioxide tensions in anesthetized horses)
4. Arterial blood gas analysis, if indicated
5. Hypoventilation is treated with either assisted or controlled ventilation

Observation and recording of respiratory rate and rhythm are sufficient for most short-term anesthesia. Apnea is rare in the absence of barbiturate use, and respiratory rates in the range of 4–12 breaths/min are common. Pulse oximeters are easily applied and provide information on heart rate and hemoglobin saturation; unfortunately, they require frequent repositioning. For longer procedures, capnometry estimates the arterial partial pressure of carbon dioxide, which provides information about the adequacy of ventilation, but it does not replace arterial blood gas analysis. Horses anesthetized for >30 min will hypoventilate. Hypoventilation is relatively well tolerated for periods ≤1 h. Horses anesthetized for >45 min benefit from controlled ventilation as long as arterial blood pressures are maintained. Early ventilation is associated with the highest levels of oxygenation; thus, if long procedures are anticipated, controlled ventilation should be instituted as soon as arterial blood pressures are stabilized. In an emergency situation, spontaneous ventilation might be stimulated by the administration of doxapram (0.2–1.0 mg/kg, IV).

IV. Injectable Adjuncts During Anesthesia
A. May be useful to provide additional anesthesia, analgesia, or muscle relaxation during anesthesia
B. May be administered as a bolus or with certain medications, and may be given as a constant-rate infusion
C. Common adjuncts
1. Opioids (e.g., butorphanol)
2. Ketamine
3. Local anesthetics (IV or as a local/regional technique)
4. Muscle relaxants
   a. Diazepam or midazolam
   b. Guainifenesin
   c. Neuromuscular blocking agents (controlled ventilation and monitoring of neuromuscular function is required during paralysis)

Adjuncts are primarily used as a method to reduce the requirement for inhalant anesthetic during surgery by providing analgesia. Lidocaine is thought...
to increase motility in colic patients and has been shown to reduce the requirement for inhalant anesthetics. The use of neuromuscular blocking drugs is usually limited to ophthalmologic and some complex orthopedic procedures.

V. Local and Regional Analgesia/Anesthesia
A. May be chosen as the sole technique for certain procedures
B. Depending on the temperament of the patient and type of procedure, chemical restraint may also be used in combination with a local or regional technique
C. May also be used as an adjunct to general anesthesia
D. Choice of local anesthetics includes lidocaine, mepivacaine, and bupivacaine; the addition of epinephrine (5 \( \mu \)g/ml) may help to improve the quality and duration of anesthesia
E. Local and regional techniques
   1. Local infiltration (e.g., line block or ring block)
   2. Peripheral nerve block
   3. Intra-articular block
   4. Paravertebral block
   5. Epidural analgesia/anesthesia
      a. Local anesthetics
      b. Alpha-2 agonists

Local and regional techniques are low-risk anesthetic adjuncts for either standing or general anesthetic procedures; however, excessive doses or volumes (epidural) can cause ataxia and recumbency. Epinephrine should not be added if the area to be desensitized is peripheral (such as an ear), because the vasoconstriction could cause necrosis.

VI. Recovery
A. TIVA
   1. If in a padded, confined area (recovery stall), no assistance may be needed
   2. If in an open (outside) area, relatively soft (grass) areas should be available that are free of obstacles (trees, fences); assistance should be provided to prevent too much momentum
      a. Control head and protect eyes
      b. Assist on tail (if possible)
B. Inhalant anesthesia
   1. Depending on temperament, physical status, inhalant used, surgical procedure performed, and design of recovery stall, the horse may recover either unassisted or with assistance on the head and/or tail
   2. If recovery is unassisted, the patient should be observed as often as needed to be able to identify if the horse unexpectedly requires assistance

3. Sedatives and/or analgesics may be administered during the recovery period to aid in a smooth transition to standing

All recoveries from anesthesia should be attended. Approximately 30% of anesthesia-related deaths in horses occur during the recovery phase. In most instances, horses recover within 1 h of the discontinuation of the anesthetic. Recoveries from short anesthetics are usually uncomplicated. Recoveries from inhalant anesthesia with isoflurane or sevoflurane are shorter than those from halothane anesthesia. Many horses benefit from the administration of a small dose of sedative (0.2 mg/kg xylazine, IV, or 0.04 mg/kg detomidine, IV) to slow recovery and allow for additional exhalation of the gases. The horse should be attended until it can stand unassisted.

3. Conclusion
In summary, the ACVA guidelines for equine anesthesia provide a pathway to increase the safety of anesthetized horses. Also, the documentation of what was done and when it was done provides protection for the veterinarian should a crisis ensue.

References


