Anesthetic induction with guaifenesin and propofol in adult horses

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Objective—To evaluate whether guaifenesin can prevent adverse anesthetic induction events caused by propofol and whether a guaifenesin-propofol induction combination has brief cardiovascular effects commensurate with rapid drug washout.

Animals—8 healthy adult horses.

Procedures—Guaifenesin was administered IV for 3 minutes followed by IV injection of a bolus of propofol (2 mg/kg). Additional propofol was administered if purposeful movement was detected. Anesthesia was maintained for 2 hours with isoflurane or sevoflurane at 1.2 times the minimum alveolar concentration with controlled normocapnic ventilation. Normotension was maintained via a dobutamine infusion. Plasma concentrations of propofol and guaifenesin were measured every 30 minutes.

Results—Mean ± SD guaifenesin and propofol doses inducing anesthesia in half of the horses were 73 ± 18 mg/kg and 2.2 ± 0.3 mg/kg, respectively. No adverse anesthetic induction events were observed. By 70 minutes, there was no significant temporal change in the dobutamine infusion rate required to maintain normotension for horses anesthetized with isoflurane or sevoflurane. Mean plasma guaifenesin concentrations were 122 ± 30 µM, 101 ± 33 µM, 93 ± 28 µM, and 80 ± 24 µM at 30, 60, 90, and 120 minutes after anesthetic induction, respectively. All plasma propofol concentrations were below the limit of quantitation.

Conclusions and Clinical Relevance—Guaifenesin prevented adverse anesthetic induction events caused by propofol. Guaifenesin (90 mg/kg) followed by propofol (3 mg/kg) should be sufficient to immobilize > 99% of calm healthy adult horses. Anesthetic drug washout was rapid, and there was no change in inotrope requirements after anesthesia for 70 minutes. (Am J Vet Res 2011;72:1569–1575)
Other muscle relaxants or sedatives have been administered in an effort to improve anesthetic induction quality for propofol in horses. Premedication with the \( \alpha_1 \)-adrenergic receptor agonist detomidine,\(^6,14 \) xylazine,\(^6,8,10,11 \) or a combination of xylazine plus the opioid butorphanol\(^9 \) reduces the incidence and severity of paddling and muscle rigidity but does not prevent it. Coadministration of the benzodiazepine midazolam with propofol to xylazine-premedicated horses does not appear to further improve anesthetic induction quality.\(^15,16 \) However, administration of guaifenesin prior to anesthetic induction with propofol in horses sedated with xylazine\(^7 \) or butorphanol\(^17 \) results in excellent muscle relaxation and prevents the stereotypical gallowing movement associated with other propofol induction techniques. To our knowledge, whether guaifenesin alone can allow for a satisfactory anesthetic induction with propofol has not been evaluated.

Guaifenesin (glyceryl guaiacolate) is a centrally acting muscle relaxant with an undetermined mechanism of action. When guaifenesin is administered IV, pharmacokinetics in horses has been described by a 1-compartment model\(^18 \) or a 2-compartment model with a short (3.45-minute) distribution half-life.\(^19 \) Guaifenesin has reasonably rapid elimination kinetics, with calculated drug clearance ranging from 6 to 10 mL/kg/min and a half-life ranging from 60 to 108 minutes.\(^16-20 \)

Moreover, in contrast to \( \alpha_1 \)-adrenergic receptor agonists and opioids, guaifenesin causes only mild cardiovascular and respiratory depression, even at doses sufficient to cause recumbency.\(^21,22 \)

The purpose of the study reported here was to determine whether guaifenesin administered at a dose sufficient to induce profound muscle relaxation would allow for a rapid anesthetic induction with propofol without muscle rigidity and limb paddling in healthy adult horses. We hypothesized that the contribution of guaifenesin and propofol to cardiovascular depression during anesthetic maintenance with isoflurane or sevoflurane, as measured by the dose of the positive inotrope dobutamine required to maintain normotension, would be limited in duration and would correspond to rapid elimination of these anesthetic induction drugs.

**Materials and Methods**

**Animals**—Eight healthy adult horses that were part of a university research herd were included in the study. Food, but not water, was withheld for 12 hours prior to anesthesia. The Institutional Animal Use and Care Committee at the University of California-Davis approved the protocol for the study.

**Anesthetic induction and maintenance**—A 14-gauge, 13-cm catheter was inserted into a jugular vein in each horse. The mouth of each horse was rinsed with water, and horses were placed in a recovery stall in a standing position. Horses were not administered any preanesthetic medications. A solution of 5% guaifenesin\(^5 \) formulated in a 1-L bag pressurized to 300 mm Hg was administered IV for 3 minutes, then propofol\(^5 \) (2 mg/kg) was administered rapidly IV as a bolus injection via a port on the guaifenesin administration set. If gross purposeful movement (ie, lifting of the head, swallowing, or gentle nonpaddling limb extension) was detected after a horse became recumbent, additional propofol was administered (approx 2 mg/kg/min) until the horse was immobile. The guaifenesin infusion was then stopped, a 26-mm cuffed endotracheal tube was inserted via the mouth, and the horse was immediately connected to a large animal anesthetic circuit\(^4 \) with a bag-in-barrel ventilator\(^4 \) that was primed with oxygen plus an inhalation anesthetic (isoflurane\(^5 \) or sevoflurane\(^5 \)). The selection of the inhalation agent was determined on the basis of the an a priori allocation of horses to groups (4 horses/group) by use of a random number table.\(^23 \) In our experiences with the combination of guaifenesin and propofol, the duration of the anesthetic induction effect would have been insufficient to allow transport of the horses without transition to an inhalation anesthetic or administration of supplemental doses of an injectable anesthetic.

Horses then were ventilated at a rate of 6 to 8 breaths/min for approximately 5 minutes to facilitate rapid transition of anesthesia from propofol to the inhalation agent. Horses remained connected to the anesthetic machine during positioning in left lateral recumbency on a padded table and transport to the laboratory. Anesthesia was maintained with 1.2 times the MAC of the inhalation anesthetic determined for horses, which corresponded to 1.57% isoflurane\(^24 \) or 3.41% sevoflurane.\(^24 \) Lactated Ringer’s solution was administered IV at a rate of 5 mL/kg/h throughout the experiment.

Horses were anesthetized for 2 hours. All horses recovered from anesthesia as part of a separate and unrelated study of anesthetic recovery techniques in horses. No injuries were sustained during recovery from anesthesia, and all horses were returned to the research herd after the study.

**Physiologic monitoring and sample collection**—End-tidal concentrations of inhalation anesthetics and CO\(_2\), were measured by use of infrared analyzers.\(^4 \) Analyzers were calibrated against multiple gas standards that spanned the measured concentration ranges for each gas. Samples were collected from the end-expired breath by use of glass syringes.

A 20-gauge catheter was placed percutaneously in the right ascending facial or right transverse facial artery of each horse. The catheter was connected by high-pressure tubing filled with heparinized saline (0.9% NaCl) solution to a transducer\(^5 \) calibrated against a mercury manometer at multiple pressures that spanned the measurement range; this catheter was used to verify response linearity. Blood pressure data were recorded by use of an electronic data acquisition system.\(^1 \) A base-apex ECG was used to measure heart rate. Body temperature was measured by use of a nasopharyngeal thermistor probe\(^5 \) calibrated against a certified mercury thermometer.

Every 30 minutes after anesthetic induction, blood samples for gas analysis were collected anaerobically from the catheter in the ascending facial or transverse facial artery and measured by use of an automated blood gas analyzer.\(^4 \) Additionally, 10 mL of arterial blood was collected in heparinized glass tubes. These samples were immediately centrifuged, and the plasma was harvested and placed into cryogenic tubes, which were stored at −20°C until analysis.
Horses were ventilated with a peak inspiratory pressure of 20 to 22 cm H₂O and an end-expiratory pressure of 0. Respiratory rate was adjusted to maintain the PCO₂ between 40 and 50 mm Hg. Within 15 to 20 minutes after induction of anesthesia, dobutamine was administered IV by an infusion pump to maintain MAP between 70 and 80 mm Hg, which was in accordance with a predefined protocol. Once horses were transported into the laboratory, a dobutamine infusion was started at a rate of 2 µg/kg/min. Then, when arterial blood pressure measurements were available, the dobutamine infusion rate was increased by 0.5 µg/kg/min if MAP was < 70 mm Hg or decreased by 0.5 µg/kg/min if MAP was > 80 mm Hg. The dobutamine infusion rate necessary to maintain normotension was recorded every 10 minutes.

**Guaifenesin and propofol analysis—**Stock solutions of propofol and guaifenesin at 1 mg/mL were prepared in ethyl acetate and stored at −20°C. Calibration of propofol and guaifenesin at 1 mg/mL was recorded every 10 minutes.

The infusion rate necessary to maintain normotension was re-estimated. Propofol and guaifenesin plasma concentrations were determined by a gas chromatograph coupled with a triple quadrupole. All plasma samples were analyzed by use of a gas chromatograph coupled with a triple quadrupole.

An aliquot (100 µL) of equine plasma was transferred to a 1.3-mL microcentrifuge tube; 5 µL of 0.05N sodium hydroxide and 0.200 mL of ethyl acetate were added to each microcentrifuge tube. Samples and extraction solvent were mixed thoroughly by shaking at 800 revolutions/min for 20 minutes at 23°C. The ethyl acetate phase was separated after centrifugation of the extracts at 50 µL aliquots from the ethyl acetate layer were transferred into a clean 1.5-mL microcentrifuge tube. Samples were subjected to trimethylsilylation with N-methyl-N-trifluoroacetamide; 80 µL of N-methyl-N-trifluoroacetamide was added to a 20-µL aliquot of ethyl acetate and incubated at 37°C for 30 minutes and then analyzed by use of the gas chromatograph coupled with a triple quadrupole.

One-microliter aliquots were injected into the gas chromatograph via a standard split and splitless injector. The injector was maintained at a constant temperature of 250°C for splitless conditions, and a helium purge flow of 3 mL/min was applied at 1 minute (56.5 kPa). To save gas, a flow of 20 mL/min was used for 3 minutes. Starting temperature for the gas chromatograph was 60°C (initial time, 0.5 minutes), and temperature was increased at a rate of 20°C/min until a temperature of 325°C was achieved (final time, 6.25 minutes), which resulted in a 20-minute run time. A 30-m-long, 0.25-mm-diameter 5% phenyl-methyl polysiloxane capillary column and a film thickness of 0.25 µm were used. A constant flow of helium (1.2 mL/min) was used as the carrier gas.

The triple quadrupole detector was set at a signal data rate of 9.8 cycles/s. The triple quadrupole mass spectrometer was turned on after a solvent delay time of 4.5 minutes, and the triple quadrupole collision cell was supplied with helium as a quench gas at a flow rate of 1.5 mL/min and nitrogen as a collision gas at a flow rate of 2.25 mL/min. Both quadrupoles were scanned at a wide resolution setting. Transfer line, ion source, and quadrupole temperatures were set to 280°C, 250°C, and 150°C, respectively. Single reaction monitoring transitions for propofol were set by use of a precursor ion of 250 m/z, a product ion of 235 m/z, and a collision-induced dissociation of 15 V. Single reaction monitoring transitions for guaifenesin were set by use of a precursor ion of 196 m/z, a product ion of 161 m/z, and a collision-induced dissociation of 10 V. For single reaction monitoring transitions, both quadrupoles were scanned at wide resolution. Prior to acquisition, the triple quadrupole was autotuned by use of perfluorotributylamine. Limits of quantitation for propofol and guaifenesin were 0.56 and 5.0 µM, respectively.

**Data analysis—**Data were reported as mean ± SD. Normality of data distributions was evaluated by use of a Shapiro-Wilk test. Changes in physiologic responses and dobutamine infusions over time were analyzed by use of a repeated-measures ANOVA with Greenhouse-Geisser sphericity adjustments and with Dunn-Sidak corrections for post hoc comparisons. Differences between isoflurane- and sevoflurane-anesthetized horses were analyzed by use of a 1-way ANOVA. Because guaifenesin plasma concentrations were not normally distributed, these data were analyzed by use of a Friedman test with Wilcoxon signed rank post hoc comparisons. Values of P < 0.05 were considered significant.

**Results**

Drug doses for anesthetic induction of horses subsequently anesthetized with isoflurane or sevoflurane were summarized (Table 1). Induction doses did not differ significantly between groups. When data were

<table>
<thead>
<tr>
<th>Variable</th>
<th>Isoflurane</th>
<th>Sevoflurane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed (No. of horses)</td>
<td>Quarter Horse (2), Thoroughbred (2)</td>
<td>Quarter Horse (3), Thoroughbred (1)</td>
</tr>
<tr>
<td>Sex (No. of horses)</td>
<td>Gelding (3), Mare (1)</td>
<td>Gelding (2), Mare (2)</td>
</tr>
<tr>
<td>Age (y)*</td>
<td>6 ± 3</td>
<td>7 ± 2</td>
</tr>
<tr>
<td>Body weight (kg)*</td>
<td>524 ± 41</td>
<td>527 ± 62</td>
</tr>
<tr>
<td>Guaifenesin (mg/kg)*</td>
<td>73 ± 20</td>
<td>74 ± 18</td>
</tr>
<tr>
<td>Propofol (mg/kg)*</td>
<td>2.2 ± 0.1</td>
<td>2.2 ± 0.4</td>
</tr>
<tr>
<td>Paddling†</td>
<td>0/4</td>
<td>0/4</td>
</tr>
</tbody>
</table>

*Data are reported as mean ± SD. †Data are reported as the number of horses with paddling/number of horses in the group.

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Table 1—Demographic data, anesthetic induction dose, and anesthetic induction quality for healthy adult horses in which anesthesia was induced by IV administration of guaifenesin followed by IV injection of a bolus of propofol (2 mg/kg) and subsequently maintained by the administration of isoflurane (n = 4 horses) or sevoflurane (4) at 1.2 times the respective MAC, which corresponded to 1.57% isoflurane or 3.41% sevoflurane.
pooled, mean ± SD total drug doses were 73 ± 18 mg/kg for guaifenesin and 2.2 ± 0.3 mg/kg for propofol. Horses became recumbent within 30 seconds after the initial IV injection of the bolus of propofol (2 mg/kg), and the anesthetic induction sequence proceeded without excitement, paddling, muscle rigidity, or other adverse anesthetic induction events, although all horses maintained palpebral reflexes. Supplemental propofol (range, 0.1 to 0.8 mg/kg) was required in 6 of 8 horses to prevent gross purposeful movement. The dose of guaifenesin that would induce anesthesia in 99% of horses was estimated at 92 mg/kg, and the dose for propofol was estimated at 2.5 mg/kg. The 95% confidence interval for no adverse anesthetic induction events in the present study of 8 horses was 0% to 31%.

For each horse, plasma guaifenesin concentrations decreased significantly over time (Figure 1), but there was no correlation between guaifenesin dose and the plasma guaifenesin concentration measurement at 30 minutes (the time of propofol anesthetic induction was designated as time 0). Furthermore, changes in guaifenesin concentration after 1 hour, although significantly different from prior time points, were numerically small. Propofol plasma concentrations were below the limit of quantitation at all time points.

Cardiovascular and respiratory variables were similar during anesthesia maintained by administration of isoflurane and sevoflurane, except for higher heart rates in horses anesthetized with sevoflurane (Table 2). There was a significant temporal increase in PaO₂ during maintenance of anesthesia with both inhalation agents, but this difference was not considered to be of physiologic importance. There was also a significant temporal decrease in the rate of administration of dobutamine required to maintain normotension (Figure 2). However, after 60 to 70 minutes, no further significant decreases in dobutamine infusion requirements could be detected. Dobutamine infusion requirements did not differ significantly between horses in which anesthesia was maintained with isoflurane versus sevoflurane.

**Discussion**

Propofol has been used in horses for sedation, anesthetic maintenance, and postanesthetic recovery. However, as an anesthetic induction agent, propofol is associated with a high incidence of excitement, myotonus, and paddling; hence, authors in several reports have cautioned against the routine use of propofol alone as an anesthetic induction agent in horses, even horses sedated with an α₂-adrenoreceptor agonist. In the present study, administration of guaifenesin alone in sufficient quantity provided excellent anesthetic induction with propofol was designated as time 0. Horses were positioned in left lateral recumbency during anesthesia. Blood gases were measured at 37°C.

### Table 2—Mean ± SD physiologic responses for healthy adult horses in which anesthesia was induced by IV administration of guaifenesin followed by IV injection of a bolus of propofol (2 mg/kg) and subsequently maintained by the administration of isoflurane (n = 4 horses) or sevoflurane (4) at 1.2 times the respective MAC.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Inhalation agent</th>
<th>30 minutes</th>
<th>60 minutes</th>
<th>90 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (beats/min)</td>
<td>Isoflurane</td>
<td>39 ± 5</td>
<td>40 ± 7</td>
<td>41 ± 5</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>44 ± 8</td>
<td>47 ± 7</td>
<td>51 ± 2</td>
</tr>
<tr>
<td>MAP (mm Hg)</td>
<td>Isoflurane</td>
<td>72 ± 5</td>
<td>75 ± 3</td>
<td>74 ± 4</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>72 ± 5</td>
<td>79 ± 2</td>
<td>75 ± 2</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>Isoflurane</td>
<td>6 ± 1</td>
<td>7 ± 2</td>
<td>7 ± 0</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>6 ± 2</td>
<td>7 ± 2</td>
<td>6 ± 2</td>
</tr>
<tr>
<td>Body temperature (°C)</td>
<td>Isoflurane</td>
<td>36.5 ± 0.6</td>
<td>36.4 ± 0.5</td>
<td>36.2 ± 0.7</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>36.4 ± 0.6</td>
<td>36.2 ± 0.4</td>
<td>36.2 ± 0.4</td>
</tr>
<tr>
<td>Arterial pH</td>
<td>Isoflurane</td>
<td>7.39 ± 0.03</td>
<td>7.38 ± 0.03</td>
<td>7.39 ± 0.02</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>7.36 ± 0.02</td>
<td>7.36 ± 0.02</td>
<td>7.36 ± 0.02</td>
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<tr>
<td>PaO₂ (mm Hg)*</td>
<td>Isoflurane</td>
<td>494 ± 59</td>
<td>540 ± 65</td>
<td>552 ± 54</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>485 ± 16</td>
<td>566 ± 22</td>
<td>555 ± 33</td>
</tr>
<tr>
<td>Paco₂ (mm Hg)*</td>
<td>Isoflurane</td>
<td>44.8 ± 1.6</td>
<td>44.8 ± 4.6</td>
<td>44.8 ± 1.8</td>
</tr>
<tr>
<td></td>
<td>Sevoflurane</td>
<td>46.0 ± 3.3</td>
<td>45.0 ± 0.8</td>
<td>45.0 ± 1.6</td>
</tr>
</tbody>
</table>

*Blood gases were measured at 37°C.
muscle relaxation and prevented violent paddling following anesthetic induction with propofol. A comparison group of horses in which anesthesia was induced with propofol without guaifenesin was not included here; undesirable characteristics of this technique have been established by many other investigators and thus would have posed unnecessary risks of injury to the horses and the researchers. Moreover, the reported incidence of adverse anesthetic induction events in horses for anesthetic induction with propofol with or without concurrent administration of other sedatives is higher than the 95% confidence interval (0% to 31%) for no adverse anesthetic induction events estimated in the horses of the present study in which anesthesia was induced with guaifenesin and propofol.

The plasma propofol concentrations were below the limit of quantitation at all time points, and the limit of quantitation in the study reported here was less than half of the values previously detected in a study of propofol pharmacokinetics in xylazine-sedated horses. Although α₂-adrenoreceptor agonist dobutamine decreases plasma propofol concentrations in proportion to its effect on cardiac output. Because dobutamine was administered to maintain normotension in all horses throughout most of the period of anesthesia in the present study (Figure 2), propofol clearance was likely increased. Plasma guaifenesin concentrations were only one-fourth as large as values reported in horses receiving comparable doses; these differences were also likely the result of increased cardiac output in response to dobutamine infusions in the present study that consequently increased hepatic blood flow and drug clearance.

Plasma propofol concentrations in the present study as well as concentrations predicted by another pharmacokinetic model in horses were much lower than the effective concentration of propofol that induced anesthesia in 50% of horses. Furthermore, by 60 minutes after anesthetic induction, propofol concentrations are so low as to have no predicted effects at inhibitory or excitatory anesthetic-sensitive ion channels that putatively mediate anesthetic effects at the cellular level. A corollary is that at these concentrations that yield negligible cellular effects, the propofol plasma concentrations > 1 hour after induction of anesthesia in horses should also minimally affect MAC and cardiorespiratory function.

The effect of guaifenesin on the effective concentration of the inhalation anesthetic that induces anesthesia in 50% of horses is unknown, but the plasma guaifenesin concentration required to induce recumbency in unmedicated horses in another study was > 13 times as high as the earliest guaifenesin concentrations measured in the present study. Regarding its cardiovascular effects, guaifenesin transiently increases systemic blood pressure at a dose of 80 mg/kg21 but modestly decreases blood pressure at a dose of 134 mg/kg (a dose that induces recumbency for at least 45 minutes in 50% of horses). Plasma guaifenesin concentrations reported for the present study during dobutamine infusions in isoflurane- or sevoflurane-anesthetized horses were equivalent to published drug concentrations measured 3 to 5 hours after a higher recumbency-inducing dose of guaifenesin. Thus, there are probably only limited cardiovascular effects in response to guaifenesin at such concentrations. Indeed, after constant-dose anesthesia for 70 minutes, there was no detectable temporal effect on the rate of dobutamine infusion required to maintain normotension (Figure 2), which corresponded to a change of only 4 µg/ml in the plasma guaifenesin concentration over this same period (Figure 1).

The dobutamine infusion rate required to maintain normotension may have reflected cardiovascular depression caused by the drugs used for anesthetic induction and maintenance of anesthesia. Isoflurane-anesthetized horses undergoing arthroscopic surgery are reported to require approximately 0.3 µg/kg/min more dobutamine than do horses anesthetized with sevoflurane to maintain MAP > 70 mm Hg. However, no differences in dobutamine requirement or target blood pressures were found between inhalation agents at any time point in the present study, which is consistent with similar hemodynamic responses observed in spontaneously breathing horses anesthetized with isoflurane or sevoflurane. The reason heart rate differed between the groups is unclear, but it could have indicated an interaction between the specific anesthetic agent and the positive chronotropic effects of dobutamine.

A change in the dobutamine requirement over the first 30 to 60 minutes of anesthesia may have been caused by the waning cardiovascular effects of the anesthetic induction drugs, particularly guaifenesin. However, it could also have been related to improved cardiovascular performance that was a function of anesthetic time. In horses, blood pressure increases over the first 2 hours of isoflurane-induced anesthesia because of increased stroke volume but modestly decreases anesthesia because of increased systemic vascular resistance, although sometimes there are no temporal increases in blood pressure during anesthesia with in-
haled. Consequently, use of the dobutamine requirement to infer a waning contribution of guaifenesin or propofol to hypotension during anesthesia may serve to overestimate the duration of the effects of these anesthetic induction drugs.

Assuming study horses were representative of the clinical equine population, guaifenesin administered IV at a dose of 90 mg/kg over 3 minutes followed immediately by a bolus injection of propofol (3 mg/kg) should be sufficient to induce anesthesia in > 99% of calm, healthy, and unsedated horses. When used alone in unmedicated horses, a minimum propofol dose of 4 to 8 mg/kg is required to induce anesthesia.3,12 This suggests that guaifenesin improves the quality of anesthetic induction when propofol is used in horses and that it also decreases the median effective dose of propofol needed for induction of anesthesia. Use of sedatives, such as α₂-adrenoceptor agonists, before induction of anesthesia may further reduce the dose of guaifenesin or propofol required to achieve recumbency without adverse anesthetic induction events.7

In addition to clinical settings, the guaifenesin-propofol combination may also be useful for future studies in horses that require anesthesia. To obtain physiologic or pharmacological measurements in which a constant anesthetic concentration at the effect site is required, a single inhalation agent is often used to induce and maintain anesthesia. This avoids confounding effects from induction with injectable anesthetic drugs whose plasma concentrations change with time and are difficult to rapidly quantify and whose precise physiologic effects at various plasma concentrations are unknown or difficult to incorporate into a study design. Techniques for the use of inhalation agents to induce anesthesia in healthy adult horses have been described33,35; these techniques require the use of a specialized hydraulic table, several highly skilled and experienced personnel, and an equine research subject with a suitable temperament. Hence, anesthetic induction with inhalation agents is not a feasible option in many research settings.

As an alternative to the use of inhalation agents for anesthetic inductions in horses, it is reasonable to allow a sufficient washout time after induction with injectable anesthetic drugs before collecting measurements under constant anesthetic conditions maintained by administration of an inhalation agent. Because propofol is rapidly cleared, it may be an ideal agent for anesthetic induction in such studies. On the basis of plasma drug concentrations and dobutamine infusion requirements measured in the study reported here, use of a guaifenesin-propofol combination for anesthetic induction may yield a washout time of as little as 70 minutes, which may be sufficient to establish physiologic conditions that differ little from the effects for the inhalation anesthetic alone. In contrast, the use of the relatively short-acting sedative and muscle relaxant xylazine can decrease MAC, blood pressure, and heart rate in a dose-dependent manner for at least 4 hours after administration36; thus, use of xylazine requires an unacceptable long washout time. The muscle relaxant guaifenesin can prevent excitation, myotonus, and paddling that otherwise characterize anesthetic induction with propofol in unmedicated horses. The contribution of the guaifenesin-propofol combination to hypotension during inhalation anesthesia in healthy horses is short-lived. Therefore, guaifenesin may be administered to improve the quality and safety of propofol-induced anesthesia in horses.

References


