

Analgesic effects of butorphanol tartrate and phenylbutazone administered alone and in combination in young horses undergoing routine castration

Macarena G. Sanz, DVM, MS, DACVIM; Debra C. Sellon, DVM, PhD, DACVIM; Julie A. Cary, DVM, MS, DACVS; Melissa T. Hines, DVM, PhD, DACVIM; Kelly D. Farnsworth, DVM, MS, DACVS

Objective—To compare the analgesic efficacy of administration of butorphanol tartrate, phenylbutazone, or both drugs in combination in colts undergoing routine castration.

Design—Randomized controlled clinical trial.

Animals—36 client-owned colts.

Procedures—Horses received treatment with butorphanol alone (0.05 mg/kg [0.023 mg/lb], IM, prior to surgery and then q 4 h for 24 hours), phenylbutazone alone (4.4 mg/kg [2.0 mg/lb], IV, prior to surgery and then 2.2 mg/kg [1.0 mg/lb], PO, q 12 h for 3 days), or butorphanol and phenylbutazone at the aforementioned dosages (12 horses/group). For single-drug-treated horses, appropriate placebos were administered to balance treatment protocols among groups. All horses were anesthetized, and lidocaine hydrochloride was injected into each testis. Physical and physiological variables, plasma cortisol concentration, body weight, and water consumption were assessed before and at intervals after surgery, and induction of and recovery from anesthesia were subjectively characterized. Observers assessed signs of pain by use of a visual analogue scale and a numerical rating scale.

Results—Significant changes in gastrointestinal sounds, fecal output, and plasma cortisol concentrations were evident in each treatment group over time, compared with preoperative values. At any time point, assessed variables and signs of pain did not differ significantly among groups, although the duration of recumbency after surgery was longest for the butorphanol-phenylbutazone-treated horses.

Conclusions and Clinical Relevance—With intratesticular injections of lidocaine, administration of butorphanol to anesthetized young horses undergoing routine castration had the same apparent analgesic effect as phenylbutazone treatment. Combined butorphanol-phenylbutazone treatment was not apparently superior to either drug used alone. (*J Am Vet Med Assoc* 2009;235:1194–1203)

Public attention to animal welfare practices is increasing worldwide consumer demand for products created in an environment perceived as cruelty free.¹ As a result, assessment of the effects of analgesia before and after castration of production animal species has increased markedly in the last decade.^{1–10} In contrast, comparatively little research has been done to evaluate analgesic protocols and surgical techniques for castration of horses.^{11–14}

Among equine practitioners, there is considerable debate regarding the severity of pain that horses have after castration,^{12,15–17} with minimal, and often conflicting, data to inform the debate.^{11,18} Some investigators have suggested that provision of analgesia in any form is unnecessary and indicative of supposedly “unwarranted subjective sympathy.”¹⁸ A survey of 282 equine veterinarians in the United Kingdom revealed that

From the Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Washington State University, Pullman, WA 99164.

Dr. Sanz' present address is Faculty of Veterinary Science, University of Pretoria, Pretoria 0002, South Africa.

Supported by Fort Dodge Animal Health Inc.

The authors thank Peggy Bryan for assistance with the statistical analysis.

Address correspondence to Dr. Sellon (dsellon@vetmed.wsu.edu).

ABBREVIATIONS

NRS Numerical rating scale
VAS Visual analogue scale

45.4% of veterinarians do not administer supplemental analgesics after castration, 17.7% administer analgesics only occasionally, and 36.9% administer analgesics routinely.¹⁹ Survey respondents who were 40 years of age or older were almost 3 times as likely to provide no analgesia after castration as were respondents 30 years old or younger.²⁰

Direct measurement of a subjective experience such as pain is not possible in nonverbal species. Instead, assessment of pain in animals relies on measurement of pain-induced behavioral and physiologic variables as indirect indicators of the presence of pain.²¹ This type of evaluation is highly species specific.²² The ideal pain scoring system needs to be linear, weighted, specific to the type of pain, and minimally impacted by observer variability.²³ To date, most assessments of distress and pain caused by castration in lambs and other farm animals have involved changes in posture, locomotor activity, and plasma cortisol concentration as indirect indicators of pain.^{1,2,4–6,9,21,24,25}

Despite the lack of agreement among veterinarians regarding the severity of pain experienced after castration of domestic animals and the difficulty in measuring pain in nonverbal species, there is ample evidence that signs of pain do develop in animals as a result of castration and that administration of analgesics decreases the severity of the signs. Findings of studies^{1,4-6,8,9,13,26,27} in horses and in agricultural species have consistently indicated that analgesic protocols diminish stress and abnormal behavior after castration. The use of local anesthesia prior to castration decreases pain-associated behaviors and plasma or serum cortisol concentration in pigs,⁴ lambs,^{1,5,6,8,26,27} and calves.⁹ Intratesticular injection of lidocaine attenuates pain-associated physiologic changes such as increases in arterial blood pressure and cremaster muscle tension in isoflurane-anesthetized stallions.¹⁴ Administration of eltenac, an NSAID, to colts shortly after castration significantly decreases the extent of swelling and signs of pain, compared with findings in an untreated control group.¹¹

Given the substantive body of evidence that horses and other animals develop signs of pain and stress after routine castration, the objective of the study reported here was not to confirm those findings but to compare the analgesic efficacy of administration of butorphanol tartrate, phenylbutazone, or both drugs in combination in colts undergoing routine castration. We hypothesized that horses receiving a combination of butorphanol (an opioid receptor agonist-antagonist) and phenylbutazone (an NSAID) during the immediate perioperative period would have less alteration in behavioral, physical, and physiologic responses after castration than would horses receiving only butorphanol or phenylbutazone.

Materials and Methods

Animals—Thirty-six sexually intact light-breed colts with a median age of 11 months (range, 7 to 30 months) were used in the study. Horses included in the study weighed 124 to 434 kg (272.8 to 954.8 lb). The breeds represented in the study included Quarter Horse (n = 22), Paint Horse (6), Appaloosa (4), Morgan (1), Mustang (1), Arabian (1), and Tennessee Walking Horse (1). Before inclusion in the study, the horses were determined to be in good health on the basis of results of a complete physical examination. Horses were allowed a minimum of 24 hours of acclimatization in the hospital after arrival, were housed individually in stalls with free access to grass hay and water, and were discharged from the hospital 4 days after surgery. In any week during the study period, a maximum of 4 horses were processed and were discharged from the hospital before the next group arrived. Each group of 4 horses was kept in a separate barn without interaction with other horses or employees other than the study observers and the cleaning personnel. All horses were required to be accustomed to routine handling and have an appropriate vaccination and deworming history prior to inclusion in the study. Informed consent was obtained from all owners prior to surgery, and the experimental protocol was approved by the Washington State University Institutional Animal Care and Use Committee.

Experimental design—Horses were assigned to 1 of 3 treatment groups in a prospective randomized

study in which individuals evaluating the horses were masked to treatment. Horses in group 1 received butorphanol tartrate^a (0.05 mg/kg [0.023 mg/lb]) IM immediately before surgery and every 4 hours for a period of 24 hours after surgery. Saline (0.9% NaCl) solution (approx 5 to 10 mL depending on the weight of the horse) was administered IV once before surgery to mimic the IV administration of phenylbutazone^b in the other 2 groups. Molasses (approx 20 to 30 mL) was administered orally via syringe to horses in group 1 at intervals to mimic the oral administrations of phenylbutazone in the other 2 groups. Horses in group 2 received phenylbutazone (4.4 mg/kg [2.0 mg/lb]) IV once before surgery; thereafter, phenylbutazone (2.2 mg/kg [1.0 mg/lb]) was administered PO every 12 hours for 3 days. The group 2 horses also received IM injections of saline solution at the same time points as did the butorphanol-treated horses (group 1). Horses in group 3 received both drugs at the aforementioned dosages. The duration of drug administration for groups 1 and 2 differed from that for group 3 because the major goal of the study was to investigate whether the 2 drugs administered together in a multimodal analgesic protocol would have a synergistic (beneficial) effect, compared with the effect of either drug alone.

For each horse, the experimental procedures were performed over a period of 4 days. Each day was defined as a 24-hour period beginning at 6 AM and ending at 5:59 AM the following day. The hours were designated in reference to the approximate time of surgery. Therefore, day 1 was the day prior to castration (6 AM of day 1 was designated as -28 hours; day 1 extended from -28 to -4 hours), day 2 was the day of castration (ie, -4 hours to 20 hours; 10 AM of day 2 was designated as 0 hours because it was the approx time of surgery for each horse), and days 3 (ie, 20 to 44 hours) and 4 (ie, 44 to 68 hours) were the first and second days after castration, respectively. Physical examinations, behavioral and observational information, and blood samples were collected at each time point during the experimental period. On days 1, 3, and 4, data were collected every 6 hours; on day 2, data were collected every 4 hours. Data collection started in the morning (6 AM) of day 1 and was completed at midnight on day 4.

Intravenous administrations of phenylbutazone or saline solution were achieved via a 14-gauge, 5-inch catheter^c that was placed in a jugular vein of each horse by use of routine sterile technique on the morning of the day that castration was performed (day 2). Intramuscular injections were given in the ventral half of the neck, alternating between right and left sides.

Anesthesia and surgery—All horses had free access to water throughout the experimental period. Feed was withheld from all horses for 12 hours before surgery. Xylazine hydrochloride (1.1 mg/kg [0.5 mg/lb]) was administered IV as a preanesthetic medication, and anesthesia was induced via IV administration of ketamine (2.2 mg/kg). Xylazine and ketamine hydrochloride were administered via the jugular venous catheter. Anesthesia depth was monitored by assessment of palpebral reflex, presence or absence of nystagmus, heart and respiratory rates, and movement. If the depth of anesthesia was deemed to be inadequate,

ketamine (1.1 mg/kg) was administered IV to provide additional time for completion of surgery. Induction of and recovery from anesthesia were evaluated by use of previously reported scoring systems.^{28,29} In brief, quality of induction was assessed on a scale of 1 to 5, wherein 1 indicated vigorous struggling during induction of anesthesia with paddling motions of the limbs and increased coordinated muscle activity during the transition to lateral recumbency, and 5 indicated a smooth, timely collapse to lateral recumbency with good muscle relaxation.²⁸ Quality of recovery from anesthesia was assessed on a scale of 0 to 5, wherein 0 indicated very violent recovery with self-inflicted injury, and 5 indicated no ataxia or struggling as the horse stood successfully on the first attempt as if fully conscious.²⁹ For each horse, the interval from the induction of anesthesia to lifting of the head (designated as time to head lift) and the interval from the induction of anesthesia to attaining a standing position after the completion of surgery (designated as time to standing) were recorded.

All surgeries were performed by 1 of 2 experienced surgeons (JAC or KDF). Surgery was performed with each horse in dorsal or lateral recumbency. The scrotum was cleaned for 5 minutes with 70% alcohol and 7.5% povidone-iodine solution. Sterile huck towels were used to define the scrotal area. After anesthesia was induced and sterile preparation of the area was completed, 10 mL of 2% lidocaine hydrochloride solution was injected into each testis. Approximately 10 minutes after administration of the 2 intratesticular injections, castration was performed by use of a routine closed technique as previously described.³⁰ After surgery, horses recovered from anesthesia without assistance inside the surgery stall under visual supervision of a veterinarian.

Physiologic data—Physiologic data (heart rate, respiratory rate, rectal temperature, gastrointestinal tract motility, fecal output, and water and hay consumptions) were recorded for each horse at each time point. Horses were monitored daily for surgical or catheter site complications such as hemorrhage, swelling, heat, or presence of discharge. Gastrointestinal tract sounds were evaluated via auscultation of the dorsal and ventral aspects of the flank on both sides of the body. The number of quadrants in which intestinal motility was heard during 1 minute of abdominal auscultation was recorded, and a score of 1 was assigned to each quadrant if sounds were ausculted. Thus,

for each horse, a gastrointestinal motility score that ranged from 0 to 4 was assigned at each time point.^{31,32} Rectal temperature was recorded by use of a digital thermometer. Heart and respiratory rates were determined via auscultation over the left ventral aspect of the thorax and the trachea, respectively. Packed cell volume and total solids concentration were evaluated via centrifugation and refractometry, respectively, once a day after surgery. Body weight was measured daily by use of an electronic scale.

Physical activity was measured continuously from day 1 to day 4 by use of an electronic pedometer^d that was placed over the midlateral aspect of a radius of each horse, as previously described.^{32,33} The pedometer was held in place by use of a light bandage. Pedometer-registered activity was set as the number of steps. The number of steps was recorded at every data collection time point, and the pedometer was reset to zero each time. All horses were walked for 10 minutes twice daily after surgery to decrease swelling of the incision site. These steps were excluded from the pedometer activity reading.

Incisional swelling was measured 24 hours after surgery by use of a pair of modified calipers; the swelling was recorded in centimeters. No attempt was made to quantify the sensitivity of the lesions by evoking a response to palpation or stimulation.

Plasma cortisol analysis—For determination of plasma cortisol concentration, 20 mL of venous blood was collected via venipuncture twice on day 1 (in the morning and evening) and placed in glass heparinized tubes. At all other time points on days 2 through 4, blood samples were collected via the jugular catheter. The catheter was cleaned with an alcohol swab prior to blood sample collection, and 12 mL of blood was aspirated and discarded; 20 mL of blood was collected and placed in heparinized glass tubes. The catheter was flushed with 10 mL of saline solution containing heparin after each sample collection. Heparinized blood samples were centrifuged for 10 minutes, and the plasma was separated, transferred to plastic tubes, and stored at -80°C until completion of the study. Plasma cortisol concentrations were determined by use of a commercial radioimmunoassay.^e Mean plasma cortisol concentrations at all sample collection times were compared with concentrations at midnight of day 4. This time point was selected as a control time point because it was associated with the lowest observed

Table 1—Anesthesia data obtained from 36 horses undergoing castration that received butorphanol alone (0.05 mg/kg [0.023 mg/lb], IM, prior to surgery and then q 4 h for 24 hours [group 1]), phenylbutazone alone (4.4 mg/kg [2.0 mg/lb], IV, prior to surgery and then 2.2 mg/kg [1.0 mg/lb], PO, q 12 h for 3 days [group 2]), or butorphanol and phenylbutazone at the aforementioned dosages (group 3; 12 horses/group).

Treatment group	Induction score	Recovery score	Ketamine (mL)*	Xylazine (mL)†	Time to lift head (min)	Time to standing (min)
Butorphanol only	3.8 ± 0.6	3.8 ± 0.8	7.4 ± 1.9	2.9 ± 0.6	29.4 ± 6.5	31.9 ± 10.3
Phenylbutazone only	4.1 ± 0.9	4.3 ± 0.6	10.6 ± 3.6	3.1 ± 0.5	28.8 ± 4.2	32.9 ± 6.9
Butorphanol and phenylbutazone	4.1 ± 0.7	4.3 ± 0.5	9.2 ± 2.9	3.2 ± 0.8	42.0 ± 5.5‡	42.0 ± 5.3‡

For single-drug-treated horses, appropriate placebos were administered to balance treatment protocols among groups. Lidocaine hydrochloride was injected into each testis prior to surgery. Induction of and recovery from anesthesia were evaluated by use of previously reported scoring systems.^{28,29}
 *Preanesthetic medication. †Administered to induce anesthesia and maintain adequate depth of anesthesia to complete surgery. ‡Within a variable, value was significantly ($P < 0.05$) different from values in the other 2 groups.

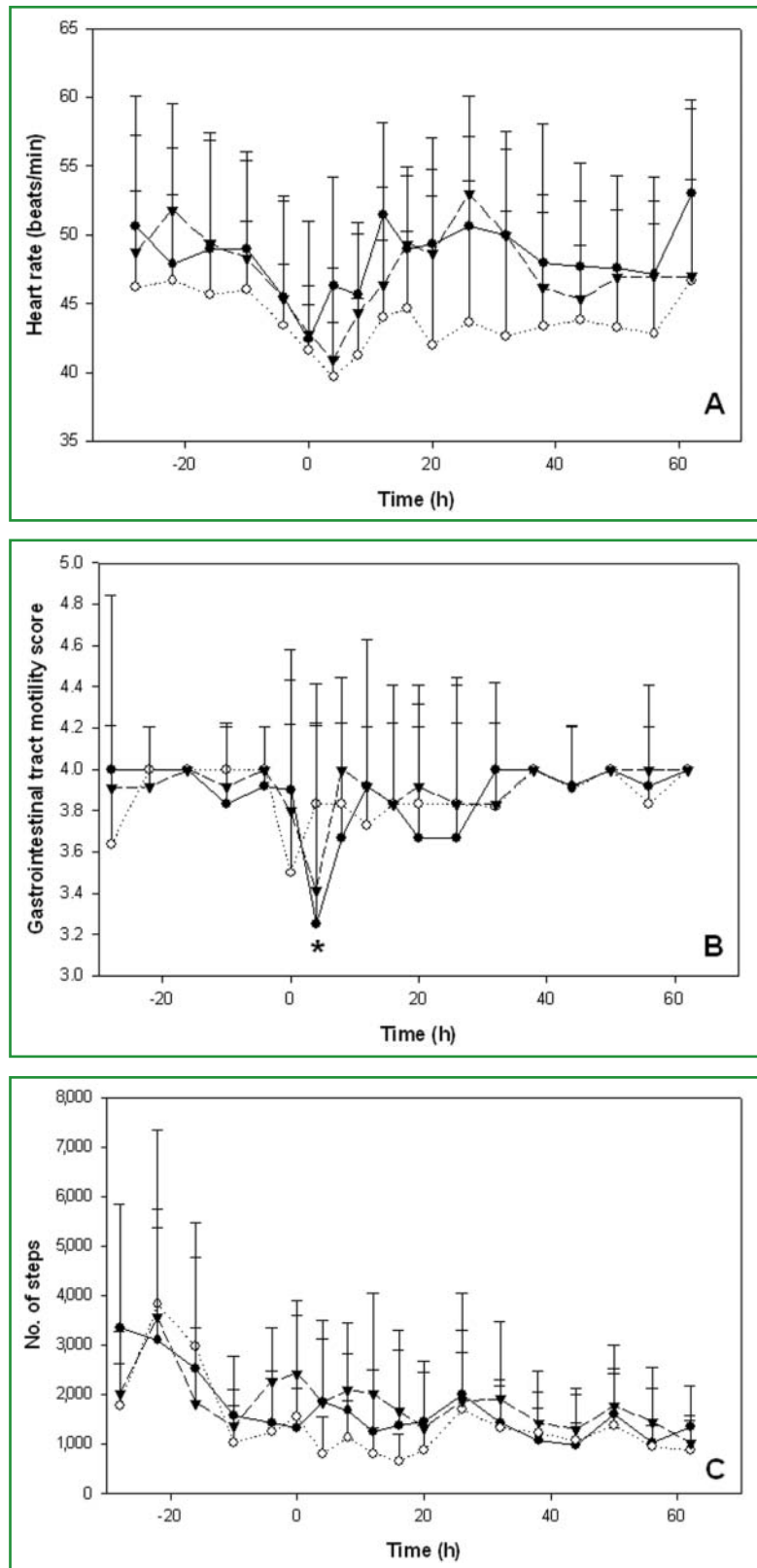
mean value, probably as a result of normal diurnal evening variation and the duration of hospitalization (which had allowed horses to acclimate to the hospital environment).

Behavioral data—Information regarding behavior was obtained at each time point by use of a VAS and an NRS (Appendix³⁴) similar to that previously described for evaluation of signs of pain after abdominal surgery in horses.^{34,35} The VAS involved use of a 10-cm-long horizontal line on which one of several trained observers drew a vertical line at a point that represented the perceived degree of pain for that horse at the given time point. The left side of the line was marked 0 cm (representing no signs of pain), and the right end of the line was marked 10 cm (representing the worst signs of pain possible). The vertical line marked on the scale was then translated to a numerical score by measuring the distance from the 0-cm mark at the left side. All observers were veterinary students trained by one of the authors (MGS) to provide consistent behavioral evaluations.

Two types of behaviors were measured by use of the NRS: undisturbed behavior that was visible to the observer without disturbing the horse and socialization behaviors observed in response to interactions with the

observer (Appendix). The behavior definitions were refined by the investigators until the definitions were mutually exclusive. Each behavior was assigned a score. A total score (the integrated pain score) was calculated as the sum

Figure 1—Mean \pm SD heart rate (A), gastrointestinal tract motility score (B), and locomotor activity (evaluated as number of steps walked since preceding time point; C) assessed before and at intervals after castration in 36 horses that received butorphanol alone (0.05 mg/kg [0.023 mg/lb], IM, prior to surgery and then q 4 h for 24 hours [group 1; black circles]), phenylbutazone alone (4.4 mg/kg [2.0 mg/lb], IV, prior to surgery and then 2.2 mg/kg [1.0 mg/lb], PO, q 12 h for 3 days [group 2; white circles]), or butorphanol and phenylbutazone at the aforementioned dosages (group 3; black inverted triangles; 12 horses/group). For single-drug-treated horses, appropriate placebos were administered to balance treatment protocols among groups. All horses were anesthetized, and 10 mL of 2% lidocaine hydrochloride was injected into each testis prior to surgery. For each horse, the experimental procedures were performed over a period of 4 days. Each day was defined as a 24-hour period beginning at 6 AM and ending at 5:59 AM the following day; time 0 was defined as the time of surgery. Data collection started in the morning (6 AM) of day 1 and was completed at midnight on day 4. Day 1 was the day prior to castration (beginning at -28 hours), day 2 was the day of castration (beginning at -4 hours), and days 3 and 4 were the first and second days after castration, respectively (beginning at 20 and 44 hours, respectively). On days 1, 3, and 4, data were collected every 6 hours; on day 2, data were collected every 4 hours. The gastrointestinal tract motility score was determined on the basis of the number of quadrants in which intestinal motility was heard during 1 minute of abdominal auscultation (a score of 1 was assigned to each quadrant if sounds were auscultated); thus, for each horse, a gastrointestinal tract motility score that ranged from 0 to 4 was assigned at each time point. *In an all pairwise multiple comparison procedure, the mean value for all horses is significantly ($P \leq 0.05$) different at 4 hours (immediately after surgery), as compared with values at most other time points.



of scores for all behavioral observations at each time point. Diurnal variations in behavior were considered probable in response to changes in hospital activity levels. Therefore, mean 24-hour behavior NRS scores were calculated as previously described³⁵ for each horse for the time prior to surgery (ie, day 1), the day of surgery (ie, day 2), and the 2 days following surgery (ie, days 3 and 4).

Statistical analysis—A repeated-measures analysis of the data was performed by use of Fisher least significant difference values obtained from a mixed procedure in a computer software package^f to assess differences between treatments at each time point and differences within treatments between time points. A Fisher exact test was used to detect differences between groups with respect to gastrointestinal tract sounds at each time point, and Kruskal-Wallis ANOVA was used to analyze VAS scores. A value of $P < 0.05$ was considered significant.

Results

Horses—Mean \pm SD ages of the horses assigned to groups 1, 2, and 3 were 11.6 ± 4.8 months, 12.7 ± 4.1 months, and 13.1 ± 6.3 months, respectively; there was no significant difference in age among groups. Prior to anesthesia and surgery, mean weights of the horses assigned to groups 1, 2, and 3 were 289 ± 65 kg (636 ± 142 lb), 313 ± 54 kg (688 ± 118 lb), and 281 ± 79 kg (618 ± 174 lb), respectively; there was no significant difference in weight among groups. No adverse effects were observed in any horse with any analgesic protocol.

Anesthesia and surgery—The volumes of xylazine and ketamine used for induction and maintenance of anesthesia did not differ significantly among the 3 treatment groups (Table 1). Eighteen horses required a second dose of xylazine or ketamine; these included 4 of 12 horses in group 1, 9 of 12 horses in group 2, and 5 of 12 horses in group 3. The time to head lift and time to standing were significantly longer in the horses that received both drugs (group 3) than findings in either group 1 or 2 ($P = 0.005$ and $P = 0.011$, respectively). The scores for the quality of induction of and recovery from anesthesia were not significantly different among groups. No surgical incision or catheter site complications were observed during the study. Three horses (1 in each group) became febrile (rectal temperature, 38.6° to 40.4°C [101.5° to 104.7°F]) on day 4, but the fevers resolved without treatment. These 3 horses were hospitalized for a longer period than other study participants. All other horses were discharged from the hospital at the expected time.

Physiologic variables—Hematologic analyses revealed that PCV and total solids concentration did not differ significantly over time or among groups at any time. Heart rate (Figure 1), respiratory rate, rectal temperature, and water intake did not differ over time or among groups. With regard to findings of gastrointestinal tract auscultation, there was no significant difference among

groups at any time point; however, auscultation revealed decreased gastrointestinal tract sounds in horses in all groups after surgery. Gastrointestinal motility returned to presurgical levels within 12 hours. Fecal output was not significantly different among groups; however, there was a significant overall effect of time, and all groups excreted less feces on day 2, compared with amounts excreted on day 1 (data not shown).

Although horses' locomotion generally decreased during the 24-hour period immediately after castration, there were no significant differences in recorded pedometer steps at any time after surgery, compared with the number of steps during the 12-hour period prior to surgery, in any group (Figure 1).

The extent of postoperative scrotal swelling 24 hours after castration did not differ significantly among groups (Table 2). Data from 1 horse in group 3 were not included in the analysis because a scrotal hematoma developed during surgery, which precluded accurate assessment of inflammatory swelling.

Plasma cortisol concentration—Plasma cortisol concentrations were not different among the 3 groups at any time point (Figure 2). However, plasma cortisol

Table 2—Scrotal swelling (thickness measured by calipers spanning the testes from left to right) assessed at 24 hours after castration in the 36 horses in Table 1 (12 horses/group).

Thickness of swelling	Treatment group		
	Butorphanol	Phenylbutazone	Butorphanol and phenylbutazone
< 1 cm	1	0	0
1–2 cm	3	5	3
2–3 cm	3	1	4
> 3 cm	4	5	5

Data are reported as the number of horses affected.

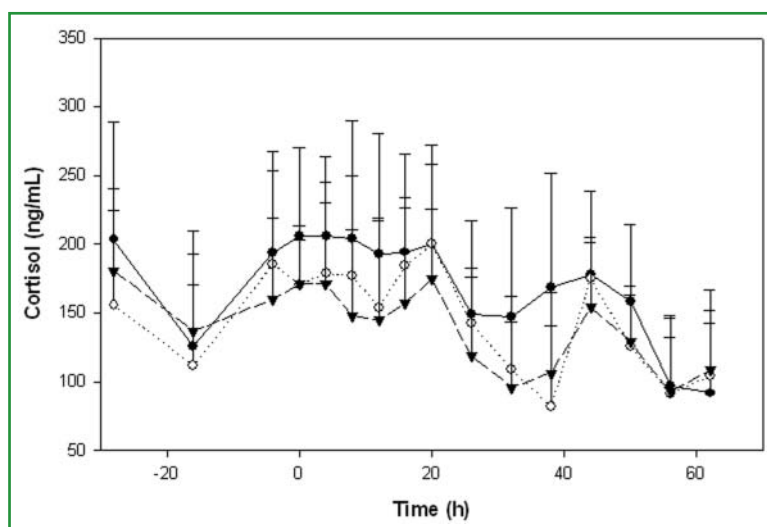


Figure 2—Mean \pm SD plasma cortisol concentration (ng/mL) assessed before and at intervals after castration in the horses in Figure 1 that received butorphanol alone IM prior to surgery and then every 4 hours for 24 hours (group 1; black circles), phenylbutazone alone IV prior to surgery and then orally every 12 hours for 3 days (group 2; white circles), or butorphanol and phenylbutazone at the aforementioned dosages (group 3; black inverted triangles; 12 horses/group). See Figure 1 for remainder of key.

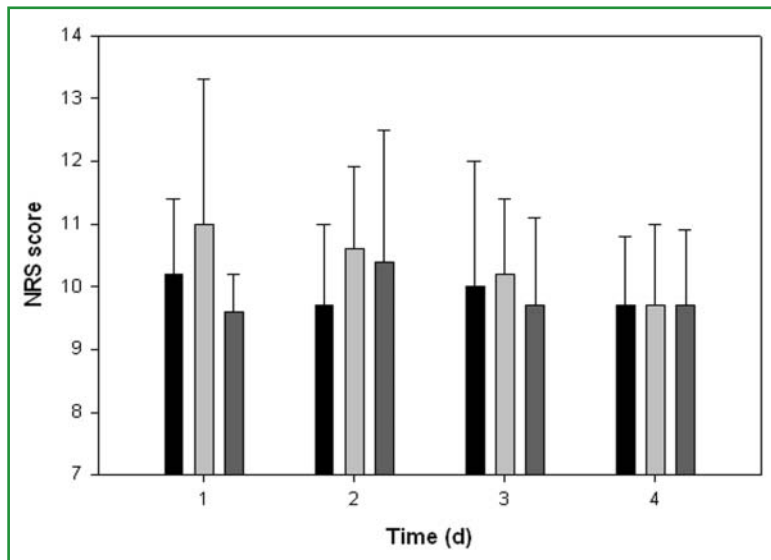


Figure 3—Mean \pm SD daily NRS score assessed before and after castration in the horses in Figure 1 that received butorphanol alone IM prior to surgery and then every 4 hours for 24 hours (group 1; black bars), phenylbutazone alone IV prior to surgery and then orally every 12 hours for 3 days (group 2; light gray bars), or butorphanol and phenylbutazone at the aforementioned dosages (group 3; dark gray bars; 12 horses/group). Day 1 was the day prior to castration, day 2 was the day of castration, and days 3 and 4 were the first and second days after castration, respectively. The NRS was used at each sample collection time point to assess behavior that was visible to the observer without disturbing the horse and socialization behaviors observed in response to interactions with the observer. Each behavior of interest was assigned a score; a total score was calculated as the sum of scores for all behavioral observations at each time point. Mean 24-hour behavior NRS scores were calculated as previously described.³⁵ There were no significant differences in NRS scores within a treatment group over time or among treatment groups. See Figure 1 for remainder of key.

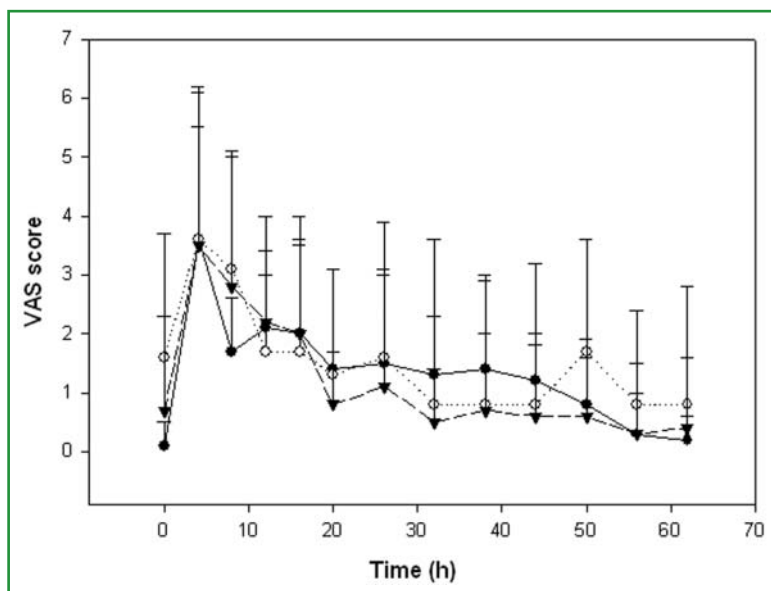


Figure 4—Mean \pm SD VAS score assessed beginning on the day of castration and at intervals after castration in the horses in Figure 1 that received butorphanol alone IM prior to surgery and then every 4 hours for 24 hours (group 1; black circles), phenylbutazone alone IV prior to surgery and then orally every 12 hours for 3 days (group 2; white circles), or butorphanol and phenylbutazone at the aforementioned dosages (group 3; black inverted triangles; 12 horses/group). The VAS involved use of a 10-cm-long horizontal line on which the observer drew a vertical line at a point that represented the perceived degree of pain for that horse at the given time point. The left side of the line was marked 0 cm (representing no signs of pain), and the right end of the line was marked 10 cm (representing the worst signs of pain possible). The vertical line marked on the scale was then translated to a numerical score by measuring the distance from the 0-cm mark at the left side. There were no significant differences in VAS score among the treatment groups at any time point. For all horses, VAS scores decreased significantly ($P < 0.05$) over time after surgery. See Figure 1 for remainder of key.

concentrations in all groups were significantly higher at $-28, -4, 0, 4, 8, 12, 16, 20, 26, 44,$ and 50 hours, compared with values obtained at 62 hours. The horses had marked diurnal variation in plasma cortisol concentration, with lower values in the evening on days 1, 3, and 4; however, cortisol concentrations remained elevated in all groups throughout the second day (day of castration) with no diurnal variation.

Behavioral data—On the basis of NRS and VAS data, there were no significant differences in behaviors among groups (Figures 3 and 4). However, VAS scores varied over time in all groups. The highest VAS scores were evident at 4 and 8 hours after surgery; mean \pm SDs were 3.5 ± 2.3 and 2.4 ± 1.9 , respectively, but varied from 0 to 8. Of the 36 horses, 27 (75%) had a VAS score ≤ 5 at 4 hours after surgery; at 8 hours after surgery, 33 of 35 (94%) horses (data were unavailable for 1 horse) had a score of ≤ 5 . The mean 24-hour VAS scores were significantly higher for all horses on day 2, compared with values on day 3 or 4, and were significantly higher for all horses on day 3, compared with the values on day 4. The mean 24-hour NRS behavior scores did not change significantly over time in any group.

Discussion

Assessment of severity of signs of pain in horses after castration is controversial.^{12,15-17} In a survey²⁰ of equine veterinarians in the United Kingdom, 48 of 68 (71%) respondents considered the degree of pain after castration to be low; however, when the same question was asked of 408 veterinarians in Canada, routine castration of horses (without analgesia) was rated as 7.4 on a scale of 1 to 10 (10 being most painful).³⁶ The assumption in our study was that all horses have some degree of pain after castration. This is a reasonable assumption given the findings of previously published studies^{11,14} of horses undergoing castration, which confirmed the beneficial effects of intratesticular injection of lidocaine or IV administration of an NSAID during the perioperative period. All horses in the study of this report received locally administered (lidocaine) and some form of systemically administered (butorphanol, phenylbutazone, or both) analgesic treatments. An untreated control group was not included because there is ample evidence that administration of NSAIDs during the perioperative period diminishes physiologic and behavioral evidence of postcastration pain in many species including horses. The question we wished to investigate was not whether horses have signs of pain during and after castration, but whether we could detect behavioral or physiologic differences

in the degree of pain that developed following castration and administration of 3 different analgesic treatments.

The protocol for anesthesia selected in the present study was chosen because it is a common anesthetic approach among equine practitioners. In a survey¹⁹ of 282 equine veterinarians in the United Kingdom, 76% of respondents who performed castrations of horses with anesthesia in the field used a combination of α_2 -adrenoceptor agonists and ketamine to induce and maintain anesthesia. Similar results were obtained from a survey of Canadian veterinarians.³⁶ In our study, the total duration of anesthesia (time to standing) and the time for horses to lift their head after surgery were significantly longer in the group that received butorphanol and phenylbutazone. With regard to sedation, butorphanol and α_2 -adrenoceptor agonist drugs have a synergistic effect, as determined in a study³⁷ of horses undergoing castration with administration of butorphanol in combination with romifidine versus administration of romifidine alone. However in that study,³⁷ recovery times were not significantly different between groups. Because there were no other recognized differences in anesthetic protocol, induction score, or recovery score among the treatment groups in our study, it is possible that prolonged recumbency of the study horses that received both butorphanol and phenylbutazone was a result of decreased perception of pain and, therefore, increased comfort; such prolonged recumbency in colts that received both drugs has been reported previously.³⁰

Marked to moderate nociceptive response to castration has been detected in horses when a volatile anesthetic agent is used^{13,14,38,39} or during standing laparoscopic castration.⁴⁰ Intratesticular administration of lidocaine significantly decreases arterial blood pressure and cremaster muscle tension in horses that are castrated under isoflurane anesthesia.¹⁴ These effects are most likely caused by inhibition of visceral afferent nerve fibers in the spermatic cord.¹⁴ The specific quantity of lidocaine (for intratesticular injection) required to provide adequate analgesia in horses during castration has not been determined. Infusion of a 10-mL volume of 2% lidocaine into each testis was considered sufficient on the basis of the size of the horses' testes and previous anecdotal experiences.⁴⁰

Results of a survey performed in the United Kingdom by Price et al²⁰ in 2002 indicate that veterinarians rely heavily on assessment of behavior (demeanor) and heart rate to evaluate pain in horses. In our study, there were no significant differences in heart rate, respiratory rate, or rectal temperature among the 3 treatment groups. Our findings are consistent with those of other studies^{22,35,41,42} of physiologic indicators of postoperative pain in horses. Heart rate is affected by factors other than pain, including movement, eating, hydration status, and variations in sympathetic and parasympathetic tone.²¹ Haga and Dolvik¹³ reported a decrease in heart rate associated with an increase in mean arterial blood pressure at the time of castration in anesthetized horses. The authors proposed an increased vagal tone as the cause of this phenomenon.¹³ Power spectral analysis of heart rate variability, a function of resting autonomic tone, is a helpful technique for measuring stress

response to pain; however, sophisticated equipment and specific training are needed for this technique, and it is not widely available.⁴³ Heart rate and respiratory rate are considered to have moderate sensitivity and specificity as pain indicators, but were not useful for assessment of pain level when used to evaluate signs of pain in horses with experimentally induced synovitis (considered representative of orthopedic pain); similarly, rectal temperature was not considered a sensitive or specific pain indicator in those horses.⁴⁴

Gastrointestinal tract sounds were not significantly different among groups in the present study at any time point. However, gastrointestinal tract sounds were decreased, as was fecal output, in all groups on day 2 (day of castration) at approximately 4 hours after surgery. Potential inhibitory effects of butorphanol on gastrointestinal tract motility have been reported.⁴⁵ Because the decreased gastrointestinal sounds and fecal output were detected in all treatment groups in our study, we concluded that withholding of food and anesthesia were the most likely causes.^{46,47} Gastrointestinal tract sounds and appetite are reported to have an intermediate specificity for assessment of orthopedic pain in horses.⁴⁴

After abdominal surgery in horses, multimodal analgesia can be associated with decreased weight loss during hospitalization.³⁵ The lack of effect of multimodal analgesia on weight gain or loss in the present study may be attributable to the comparatively short period of hospitalization after castration, a lack of effect of the analgesic protocols used, or development of less severe pain after castration, compared with the degree of pain after abdominal surgery. Body weight does not change during the initial few days after castration in other species.⁴⁸

In our study, feed was withheld from the horses for 12 hours before surgery, and hunger may have contributed to increased locomotion because of restlessness and frequent foraging for food on the morning of day 2 (at -4 and 0 hours on the day of surgery). However, horses in all groups took fewer total steps on day 2, compared with the number of steps taken on other study days. One reason for this may have been the absence from the stall for approximately 3 hours. All horses undergoing surgery on a given day were moved out of their individual stalls into induction boxes and subsequently placed back into their regular stalls at the same time to prevent excitation. During the interval that a horse was out of the stall for anesthesia and surgery, the pedometer readings were not recorded. There was decreased exploring activity shortly after surgery (at 4 hours), likely because the horses were fed within 2 hours after surgery and did not move from the feeder. However, we cannot eliminate the possibility that the decreased number of steps by horses in all groups on day 2 was a result of postsurgical pain. Reluctance to move has been previously described as a pain-associated behavior in horses after arthroscopic surgery²² or abdominal exploratory celiotomy.³⁵

Eltenac, an NSAID, markedly improves the degree of swelling and signs of pain observed in colts after routine castration.¹¹ In the present study, the lack of a significant difference in swelling between the group that only received butorphanol (group 1) and the other 2

treatment groups that received phenylbutazone (groups 2 and 3) was surprising. Butorphanol has no anti-inflammatory properties, and horses that received only butorphanol as an analgesic were expected to have more scrotal swelling after surgery. One possible explanation is that swelling may have been decreased in the butorphanol group because of increased walking activity. Overall, walking activity was lower the day after surgery for the horses that received phenylbutazone, compared with findings for group 1, but this difference was not significant and did not persist over time. Alternatively, differences in swelling may have been detected if the horses were observed for a period longer than 48 hours after surgery,¹¹ if the number of horses investigated was larger, if lidocaine had not been administered intratesticularly, or if a more sensitive method of measurement of swelling was used.

In 1 study,⁴⁴ plasma cortisol concentration had good specificity and moderate sensitivity as an indicator of pain in horses after intra-articular injection of amphotericin B. There are, however, interfering variables that can limit the use of plasma cortisol concentration for assessment of pain, including individual variation, diurnal changes, and the wide range of stressors that activate the hypothalamic-pituitary-adrenal gland system.²¹ Despite this fluctuation, plasma cortisol concentration has been useful for assessment of pain in horses.³⁵ However, in a clinical study⁴² of horses that underwent arthroscopic surgery, plasma cortisol concentration was not a good indicator of pain. Serial measurements of plasma cortisol concentrations were performed before and after castration in our study to account for the individual characteristics of release and elimination of the hormone and to determine whether any changes were a result of the treatment. All study horses were maintained in the same environment and exposed to the same stressors; the only identified difference among groups was the analgesic protocol used.

All groups had diurnal fluctuation in plasma cortisol concentration over time on days 1, 3, and 4 of the study with lower concentrations in the evening hours, as previously reported.⁴⁹ Mean plasma cortisol concentrations at all sample collection times were compared with concentrations at midnight of day 4. Significant differences in plasma cortisol concentration, compared with concentrations at this designated control time point, were evident at -28, -4, 0, 4, 8, 12, 16, 20, 26, 44, and 50 hours. The significant differences detected at -28, -4, 20, and 44 hours were expected because those samples were collected at 6 AM on days 1 through 4 and the high plasma cortisol concentrations are explained as diurnal increases. The high plasma concentrations of cortisol detected at 0, 4, 8, 12, 16, and 26 hours indicated that cortisol concentrations remained elevated on day 2 (day of surgery) and that diurnal decreases that were expected at 8, 12, and 16 hours of the study did not occur. Compared with findings in the other 2 treatment groups, the loss of diurnal variation was greater and plasma cortisol concentrations remained higher for a longer period in the group that received only butorphanol (group 1), but these differences were not significant.

The loss of diurnal fluctuation in plasma cortisol concentrations indicated that castration resulted in a

stress-associated response, regardless of which treatment the horses received. The loss of diurnal fluctuation of cortisol may be attributed in part to the stress effects of general anesthesia. Previous studies^{35,50} have revealed an increase in plasma cortisol concentration in horses undergoing anesthesia without surgery; however, those effects were of shorter duration and lesser magnitude than those detected in the present study.

In other species, there is a ceiling effect on the increase in plasma cortisol concentration after castration and the maximal response is obtained when only 1 testis is removed.^{6,21} In the horses of our study, a ceiling effect could not be identified because both testes were removed simultaneously and plasma cortisol concentration was evaluated before and after castration and not at a time point between removal of the first and second testis. In general, horses that received only butorphanol (group 1) had higher (albeit not significantly so) plasma cortisol concentrations on days 2 and 3 and also had the least amount of normal diurnal variation in that variable, compared with findings in the other 2 treatment groups. This may be an indication that administration of phenylbutazone alone or in combination with butorphanol is more beneficial for decreasing signs of pain associated with castration in horses than the administration of butorphanol alone. Administration of eltenac to colts shortly after castration significantly decreases swelling and signs of pain, compared with findings in untreated horses.¹¹ Provision of local anesthesia injected into the testes prior to castration in calves decreased cortisol response to surgery significantly in 1 study⁵¹ and had no effect in another.⁹ All of the young horses in the present study, regardless of treatment allocation, received intratesticular injections of local anesthetic before surgery, and that may have blunted detectable differences in analgesic effects of the study treatments.

In the present study, the VAS scores differed among treatment groups at most time points, but the differences were not significant. Severity of the signs of pain was highly variable among horses; however, the highest VAS scores were consistently detected at 4 and 8 hours after surgery in all groups. Mean scores for these time points were 3.5 ± 2.3 and 2.4 ± 1.9 , respectively, which were indicative of signs of mild to moderate pain; of the 36 horses, 75% and 91% had a VAS score ≤ 5 at 4 and 8 hours after surgery, respectively. It is likely that the horses in our study displayed less pain-associated behaviors than expected because they all received intratesticular injections of lidocaine prior to surgery. Mean 24-hour NRS scores for behavior were not different among treatment groups. The NRS scores increased in all groups on day 2 and returned to their previous values in most horses within the following 24 hours (ie, on day 3).

The results of the present study suggested that there are minimal differences between the use of butorphanol, phenylbutazone, or both drugs for perioperative analgesia in healthy anesthetized colts undergoing routine castration following intratesticular administration of lidocaine. Interpretation of results must be made cautiously because the duration of analgesic administration between horses in groups 1 and 2 differed.

This decision was made in an attempt to compare protocols that might be reasonable for field management of routine castration in horses. Oral administration of phenylbutazone to horses for a few days after surgery is a common practice. However, IM administration of butorphanol for a period of 3 days would be an uncommon, impractical, and expensive undertaking. It is important to note that our objective was not to compare efficacy of phenylbutazone versus butorphanol for analgesia in horses after castration but rather to investigate whether administration of the 2 drugs in combination would have a synergistic (beneficial) effect and improve analgesia after castration. No adverse effects were observed with any analgesic protocol. It is possible that the behavioral assessment method used in our study was not sufficiently sensitive to detect subtle behavioral changes indicative of mild to moderate pain without investigation of a much larger number of horses. Alternatively, it is possible that intratesticular administration of lidocaine provides such potent perioperative analgesia that effects of additional systemic analgesic treatment are minimal. Additional research is needed to assess the benefits, if any, of these drug protocols, compared with the effects of intratesticular administration of lidocaine only at the time of castration. Until that information is available, it is reasonable to use either perioperative phenylbutazone or butorphanol for perioperative analgesia in horses undergoing castration when lidocaine is administered intratesticularly prior to surgery.

- a. Torbugesic, Fort Dodge Animal Health, Fort Dodge, Iowa.
- b. Equi-Phar, Vedco Inc, St Joseph, Mo.
- c. BD Angiocath, Becton Dickinson Infusion Therapy Systems Inc, Sandy, Utah.
- d. Omron HJ-105 Pedometer, OMRON Electronics LLC, Schaumburg, Ill.
- e. Michigan State University Animal Health Diagnostic Laboratory, Lansing, Mich.
- f. SAS, SAS Institute Inc, Cary, NC.

References

1. Mellor DJ, Stafford KJ. Acute castration and/or tailing distress and its alleviation in lambs. *N Z Vet J* 2000;48:33–43.
2. Molony V, Kent JE, McKendrick IJ. Validation of a method for assessment of an acute pain in lambs. *Appl Anim Behav Sci* 2002;76:215–238.
3. Kent JE, Jackson RE, Molony V, et al. Effects of acute pain reduction methods on the chronic inflammatory lesions and behaviour of lambs castrated and tail docked with rubber rings at less than two days of age. *Vet J* 2000;160:33–41.
4. McGlone JJ, Hellman JM. Local and general anesthetic effects on behavior and performance of two- and seven-week-old castrated and uncastrated piglets. *J Anim Sci* 1988;66:3049–3058.
5. Thornton PD, Waterman-Pearson AE. Quantification of the pain and distress responses to castration in young lambs. *Res Vet Sci* 1999;66:107–118.
6. Wood GN, Molony V, Fleetwood-Walker SM, et al. Effects of local anesthesia and intravenous naloxone on the changes in behaviour and plasma concentrations of cortisol produced by castration and tail docking with tight rubber rings in young lambs. *Res Vet Sci* 1991;51:193–199.
7. Kent JE, Thrusfield MV, Molony V, et al. Randomised, controlled field trial of two new techniques for the castration and tail docking of lambs less than two days of age. *Vet Rec* 2004;154:193–200.
8. Molony V, Kent JE, Hosie BD, et al. Reduction in pain suffered by lambs at castration. *Vet J* 1997;153:205–213.
9. Stafford KJ, Mellor DJ, Todd SE, et al. Effects of local anaesthesia or local anaesthesia plus a non-steroidal anti-inflammatory drug on the acute cortisol response of calves to five different methods of castration. *Res Vet Sci* 2002;73:61–70.
10. Haga HA, Ranheim B. Castration of piglets: the analgesic effects of intratesticular and intrafunicular lidocaine injection. *Vet Anaesth Analg* 2005;32:1–9.
11. Prügner W, Huber R, Lühmann R. Eltenac, a new anti-inflammatory and analgesic drug for horses: clinical aspects. *J Vet Pharmacol Ther* 1991;14:193–199.
12. Flecknell PA, Raptopoulous D, Gasthuys F, et al. Castration of horses and analgesia. *Vet Rec* 2001;149:159–160.
13. Haga HA, Dolvik NI. Electroencephalographic and cardiovascular variables as nociceptive indicators in isoflurane-anaesthetized horses. *Vet Anaesth Analg* 2005;32:128–135.
14. Haga HA, Lykkjen S, Revold T, et al. Effect of intratesticular injection of lidocaine on cardiovascular responses to castration in isoflurane-anesthetized stallions. *Am J Vet Res* 2006;67:403–408.
15. Capner C. Castration of horses and analgesia (lett). *Vet Rec* 2001;149:252.
16. Harris R. Castration of horses and analgesia (lett). *Vet Rec* 2001;149:279–280.
17. Jones R. Castration of horses and analgesia (lett). *Vet Rec* 2001;149:252.
18. Green P. Castration of horses and analgesia (lett). *Vet Rec* 2001;149:159–160.
19. Price J, Eager RA, Welsh EM, et al. Current practice relating to equine castration in the UK. *Res Vet Sci* 2005;78:277–280.
20. Price J, Marques JM, Welsh EM, et al. Pilot epidemiological study of attitudes towards pain in horses. *Vet Rec* 2002;151:570–575.
21. Molony V, Kent JE. Assessment of acute pain in farm animals using behavioral and physiological measurements. *J Anim Sci* 1997;75:266–272.
22. Price J, Catriona S, Welsh EM, et al. Preliminary evaluation of a behaviour-based system for assessment of post-operative pain in horses following arthroscopic surgery. *Vet Anaesth Analg* 2003;30:124–137.
23. Ashley FH, Waterman-Pearson AE, Whay HR. Behavioural assessment of pain in horses and donkeys: application to clinical practice and future studies. *Equine Vet J* 2005;37:565–575.
24. Mellor DJ, Murray L. Changes in the cortisol responses of lambs to tail docking, castration and ACTH injection during the first seven days after birth. *Res Vet Sci* 1989;46:392–395.
25. Graham MJ, Kent JE, Molony V. The influence of the site of application on the behavioural responses of lambs to tail docking by rubber ring. *Vet J* 2002;164:240–243.
26. Graham MJ, Kent JE, Molony V. Effects of four analgesic treatments on the behavioural and cortisol responses of 3-week-old lambs to tail docking. *Vet J* 1997;153:87–97.
27. Kent JE, Molony V, Robertson IS. Comparison of the Burdizzo and rubber ring methods for castrating and tail docking lambs. *Vet Rec* 1995;136:192–196.
28. Mama KR, Steffey EP, Pascoe PJ. Evaluation of propofol for general anesthesia in premedicated horses. *Am J Vet Res* 1996;57:512–516.
29. Young SS, Taylor PM. Factors influencing the outcome of equine anaesthesia: a review of 1,314 cases. *Equine Vet J* 1993;25:147–151.
30. Schumacher J. The testis. In: *Equine surgery*. 3rd ed. Philadelphia: WB Saunders Co, 2005;788–793.
31. Sellon DC, Monroe VL, Roberts MC, et al. Pharmacokinetics and adverse effects of butorphanol administered by single intravenous injection or continuous intravenous infusion in horses. *Am J Vet Res* 2001;62:183–189.
32. Arguedas MG, Hines MT, Papich MG, et al. Pharmacokinetics of butorphanol and evaluation of physiologic and behavioral effects after intravenous and intramuscular administration to neonatal foals. *J Vet Intern Med* 2008;22:1417–1426.
33. Holland JL, Kronfeld DS, Meacham TN. Behavior of horses is affected by soy lecithin and corn oil in the diet. *J Anim Sci* 1996;74:1252–1255.
34. Pritchett LC, Ulibarri C, Roberts MC, et al. Identification of potential physiological and behavioral indicators of postoperative pain in horses after exploratory celiotomy for colic. *Appl Anim Behav Sci* 2003;80:31–43.
35. Sellon DC, Roberts MC, Bliklager AT, et al. Effects of continu-

- ous rate intravenous infusion of butorphanol on physiologic and outcome variables in horses after celiotomy. *J Vet Intern Med* 2004;18:555–563.
36. Hewson CJ, Dohoo IR, Lemke KA, et al. Canadian veterinarians' use of analgesics in cattle, pigs, and horses in 2004 and 2005. *Can Vet J* 2007;48:155–164.
 37. Corletto F, Raisis AA, Brearley JC. Comparison of morphine and butorphanol as pre-anaesthetic agents in combination with romifidine for field castration in ponies. *Vet Anaesth Analg* 2005;32:16–22.
 38. Taylor PM, Kirby JJ, Shrimpton DJ, et al. Cardiovascular effects of surgical castration during anaesthesia maintained with halothane or infusion of detomidine, ketamine and guaifenesin in ponies. *Equine Vet J* 1998;30:304–309.
 39. Murrell JC, Johnson CB, White KL, et al. Changes in the EEG during castration in horses and ponies anaesthetized with halothane. *Vet Anaesth Analg* 2003;30:138–146.
 40. Joyce J, Hendrickson DA. Comparison of intraoperative pain responses following intratesticular or mesorchial injection of lidocaine in standing horses undergoing laparoscopic cryptorchidectomy. *J Am Vet Med Assoc* 2006;229:1779–1783.
 41. Holton LL, Scott EM, Nolan AM, et al. Relationship between physiological factors and clinical pain in dogs scored using a numerical rating scale. *J Small Anim Pract* 1998;39:469–474.
 42. Raekallio M, Taylor PM, Bennett RC. Preliminary investigations of pain and analgesia assessment in horses administered phenylbutazone or placebo after arthroscopic surgery. *Vet Surg* 1997;26:150–155.
 43. Rietmann TR, Stauffacher M, Bernasconi P, et al. The association between heart rate, heart rate variability, endocrine and behavioural pain measures in horses suffering from laminitis. *J Vet Med A Physiol Pathol Clin Med* 2004;51:218–225.
 44. Bussi eres G, Jacques C, Lainay O, et al. Development of a composite orthopaedic pain scale in horses. *Res Vet Sci* 2008;85:294–306.
 45. Sojka JE, Adams SB, Lamar CH, et al. Effect of butorphanol, pentazocine, meperidine, or metoclopramide on intestinal motility in female ponies. *Am J Vet Res* 1988;49:527–529.
 46. Little D, Redding WR, Blikslager AT. Risk factors for reduced postoperative fecal output in horses: 37 cases (1997–1998). *J Am Vet Med Assoc* 2001;218:414–420.
 47. Singh S, McDonnell WN, Young SS, et al. Cardiopulmonary and gastrointestinal motility effects of xylazine/ketamine-induced anesthesia in horses previously treated with glycopyrrolate. *Am J Vet Res* 1996;57:1762–1770.
 48. Stafford KJ, Mellor DJ. The welfare significance of the castration of cattle: a review. *N Z Vet J* 2005;53:271–278.
 49. Dybdal NO, Hargreaves KM, Madigan JE, et al. Diagnostic testing for pituitary pars intermedia dysfunction in horses. *J Am Vet Med Assoc* 1994;204:627–632.
 50. Taylor PM. Equine stress responses to anesthesia. *Br J Anaesth* 1989;63:702–709.
 51. Fisher AD, Crowe MA, Alonso de la Varga ME, et al. Effect of castration method and the provision of local anesthesia on plasma cortisol, scrotal circumference, growth, and feed intake of bull calves. *J Anim Sci* 1996;74:2336–2343.

Appendix

Numerical rating scale used for behavioral evaluation of horses following castration.

Behavior category	Score			
	1	2	3	4
Gross pain behaviors*	None	—	Occasional	Continuous
Head position	Above withers†	—	At withers†	Below withers†
Ear position	Pinnae forward, frequent movement	—	Pinnae slightly back, little movement	—
Location in stall	At door and watching environment	Standing in middle and facing stall door	Standing in middle and facing side of stall	Standing in middle and facing back of stall or standing at the back of stall
Spontaneous locomotion	Moves freely	Takes occasional steps	—	No movement
Response to approach	Moves to observer; pinnae forward	Looks at observer; pinnae forward	Moves away from observer	Does not move; pinnae laid back
Lifting feet	Freely lift feet when required	Lift feet after mild encouragement	—	Extremely unwilling to lift feet
Response to provision of grain	Moves to door and reaches grain	Looks at door	—	No response
Standing/recumbency	Weight bearing in all 4 limbs or resting in sternal recumbency	Resting 1 limb or in lateral recumbency	—	Weight shifting

*Gross pain behaviors include pawing, looking at the flank, flehmen response, and lying down and standing up repeatedly.³⁴ †Withers = Highest point along thoracic vertebral column.
 — = No defined category.