Daily Serum Cortisol Concentrations in Horses With Colic Requiring Exploratory Celiotomy

Tim Mair, BVSc, PhD, DEIM, DESTS, Diplomate ECEIM, MRCVS; and Ceri Sherlock, BVetMed, MRCVS*  

Horses that survive to discharge have serum cortisol concentrations that gradually decrease during hospitalization and are significantly lower on the day of discharge than they were at admission. In contrast, horses that do not survive to discharge have persistently high serum cortisol levels that remain elevated on the day of death or euthanasia. Evaluation of serum cortisol concentrations daily in horses after exploratory celiotomy could assist with assessment and prognostication of the patient. Authors' addresses: Bell Equine Veterinary Clinic, Butchers Lane, Mereworth, Kent, ME18 5GS United Kingdom (Mair); and Department of Large Animal Medicine, University of Georgia, 501 DW Brooks Drive, Athens, Georgia 30602-7385 (Sherlock); e-mail: sherlock@uga.edu (Sherlock). © 2009 AAEP. *Presenting author.

1. Introduction
Horses with colic may show signs of abdominal pain, cardiovascular abnormalities, and endotoxemia, all of which cause physiological stress. This physiological stress induces stimulation of the hypothalamic-pituitary-adrenal (HPA) axis that ultimately stimulates cortisol release from the adrenal gland.1

There are limited studies that have evaluated serum cortisol levels in horses with colic.2–7 Interestingly, horses with colic that do not survive to discharge from hospital have significantly higher plasma cortisol concentrations at admission compared with horses that do survive to discharge.3,7 Additionally, horses with higher heart rates, packed cell volumes, more severe colic signs, and strangulating lesions have higher serum cortisol concentrations at admission than those with low heart rates, normal packed cell volumes, mild colic signs, and non-strangulating lesions.7 Additionally, in humans with septic shock, high basal cortisol levels are described,8 and these are associated with an increased risk of death.9–11

In all mammals, there is a large individual variation in cortisol concentrations in response to stress.7,12–14 The large individual variation makes interpretation of individual cortisol concentrations recorded at one time point confusing; however, this may be overcome by examination of serial cortisol concentrations from other species.15,16 The objectives of this study were, therefore, to report the daily serum cortisol concentrations in a group of horses that underwent general anesthesia and exploratory celiotomy for treatment of colic unresponsive to analgesia. We hypothesized that horses that survived would show a decrease in cortisol concentrations from admission through hospitalization and that horses that died or were euthanized would show persistent elevations in cortisol concentrations.
2. Materials and Methods

A prospective observational study was performed between July 2008 and March 2009. All horses undergoing exploratory celiotomy at Bell Equine Veterinary Clinic for acute colic (clinical signs ≤36 h in duration) that was temporarily responsive or unresponsive to analgesia were considered eligible for inclusion in this study. Horses were excluded if evaluation of serum cortisol concentration was not performed at the time of admission and subsequently every day that the horse was hospitalized post-operatively; samples were obtained between 7:30 and 9:00 am. Serum cortisol concentration was evaluated in a blood sample from the jugular vein collected in an evacuated glass tube without anticoagulant. The blood was allowed to clot and was then centrifuged at 1500 g for 10 min before removal of the serum. Serum was labeled and submitted to arrive within 24 h of collection at the Cambridge Specialist Laboratory Services for measurement of total serum cortisol concentration (cortisol concentration) by radioimmunoassay.

The information recorded for each horse in the study included the age, breed, gender, type of surgical lesion (strangulating or non-strangulating), anatomic location of the lesion (stomach, small intestine, or large intestine), post-operative complications (colic, thrombophlebitis, pyrexia, post-operative ileus, incisional infection, and necessity for a repeat celiotomy), and outcome to discharge from the hospital (alive, euthanized, or died).

Means ± SD are reported for cortisol concentrations. Comparisons of cortisol concentrations between groups and at different time points were made using student’s t-tests. Groups evaluated included horses with strangulating and non-strangulating lesions, horses with lesions in the small and large intestine, and horses that survived or did not survive to discharge from the hospital (alive, euthanized, or died).

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tion of 382 ± 236 mmol/l at admission than at discharge (168 ± 27 mmol/l; p = 0.013).

Horses that were discharged on day 5 post-operatively (n = 9; 31%) followed a similar trend (admission cortisol = 389 ± 220 mmol/l; discharge cortisol = 151 ± 64 mmol/l; p = 0.015).

Horses that survived to discharge had a cortisol concentration of 410 ± 247 mmol/l at admission that was significantly lower than those that did not survive to discharge (764 ± 348 mmol/l; p = 0.006). Horses that died or were euthanized during hospitalization had a cortisol level of 764 ± 348 mmol/l at admission and a cortisol level of 880 ± 324 mmol/l at the last sampling time before death; the difference was not significant.

Horses that survived to discharge had a cortisol concentration of 319 ± 168 mmol/l on day 1 after surgery that differed significantly from those that did not survive to discharge (484 ± 145 mmol/l; p = 0.028). The difference in cortisol concentrations between survivors and non-survivors continued during all 6 days of the study period (Fig. 1); however, in the non-survivor group, only six horses were included on days 2 and 3, four horses were included on days 4 and 5, and only two horses were included on day 6.

4. Discussion

In conclusion, this study shows that cortisol concentrations gradually decrease in horses that survive after exploratory celiotomy for colic, whereas cortisol concentrations in horses that are non-survivors remain elevated until death or euthanasia. This information, combined with clinical assessment and other laboratory data, may aid in assessment and prognostication of horses after exploratory celiotomies for colic.

The age, breed, use, and gender of horses included in this study are representative of horses undergoing exploratory celiotomy at Bell Equine Veterinary Clinic. Although not assessed in this study, there seems to be no age-, breed-, or gender-associated effects on cortisol concentrations in horses with colic.

Horses with strangulating lesions had a significantly higher cortisol concentration at admission than horses with non-strangulating lesions, which is supportive of the results of previous studies. Horses with small intestinal lesions seemed to have higher cortisol concentrations than those with large intestinal lesions; however, this was not significant as reported previously. It seems most likely that this trend was caused by the fact that the majority of strangulating lesions affected the small intestine and the majority of non-strangulating lesion affected the large intestine.

This study confirms that horses that survive to discharge have lower cortisol concentrations at admission than horses that do not survive to discharge, which is consistent with previous results. Interestingly, significant differences in cortisol concentrations between survivors and non-survivors remain at all time points post-operatively; however, because few non-surviving horses were included at day 6, these results must be interpreted with caution.

In all horses, cortisol concentrations decrease 1 day after surgery. A decrease in cortisol would be expected because of the removal of some of the causes of physiological stress, such as pain, and this finding has been reported in a previous study that examined horses that underwent surgical intervention for colic. Interestingly, this is in contrast to normal horses whose cortisol concentrations rise after anesthesia; however, by 24 h after anesthesia, the levels in both colic and control groups are similar.

Calculations were also performed to solely examine any changes in cortisol concentrations in surviving horses between pre-operative and post-operative values. No significant differences were appreciated on day 1, but by day 2, there were significant differences. By day 2, there was a significant decrease in cortisol concentration from pre-operative values in survivors; however, there was no difference between pre-operative values and values on day 2 in non-survivors. It is presumed that the lack of a statistically significant decrease seen on day 1 in this study is associated with the relatively low number of cases.

The cortisol concentrations in surviving horses show a gradual decrease; however, the cortisol concentration in non-surviving horses is erratic and
variable. These variable cortisol concentrations in non-survivors are most likely attributable to the apparent large variation in cortisol secretion in response to stress\textsuperscript{7,12–14} as well as the small number of horses that ultimately did not survive.\textsuperscript{7} There were just two non-surviving horses on day 6 after surgery, one of which underwent a repeat celiotomy on day 3. It seems that there is minimal variation and a predictable trend in cortisol concentration in horses that show appropriate clinical improvement until discharge from the hospital, but horses with continued physiological stress caused by complications of the colic episode show continued elevation of cortisol above normal values in an unpredictable fashion.

This preliminary study shows that there are differences in cortisol concentrations in surviving and non-surviving horses after exploratory celiotomy for colic. Future studies with more case numbers are warranted to further investigate the use of serial cortisol concentrations as an aid in assessment and prognostication for horses after colic surgery.

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References and Footnote


\textsuperscript{a}Sherlock C and Mair T. Unpublished data, 2008.