Colic Prevalence, Risk Factors and Prevention

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INTRODUCTION

Colic is one of the most difficult diseases to study with epidemiologic methods due to the large number of diseases that include colic (abdominal pain) as a clinical sign. Therefore, epidemiologic data related to colic are meaningful only if an accurate diagnosis of the primary disease process can be determined. Nevertheless, epidemiology has provided important information about incidence, mortality, and risk factors for colic, all of which may help the clinician make decisions about individual cases as well as herd problems.

Prevalence

Determining the incidence of colic can help to judge if the rate of colic on farms or in stables is excessive. Out of 100 horses in the general population, four to ten cases of colic are expected during an average year (Tinker et al., 1997a; Kaneene et al., 1997). The annual number of colic cases, however, may vary greatly between farms, ranging from 0 to 25 or 30 cases per 100 horses (Traub-Dargatz et al., 2001; Hillyer et al., 2001; Uhlinger, 1992). Approximately 10 to 15% of colic cases occur in horses that have experienced previous episodes of abdominal pain, with two to four colic episodes per year in some horses (Tinker et al., 1997a). Most colic, 80 to 85% of cases, can be designated as simple colic or ileus because no specific diagnosis is identified, and most horses respond to medical treatment or resolve spontaneously. In one cohort study, approximately 30% of horses with colic were reported by owners, but were never examined by a veterinarian because the colic was transient or resolved with owner treatment (Tinker et al., 1995). Studies of horses with colic that present to veterinary practices have also reported a predominance of simple obstruction or spasmodic colic, with impactions diagnosed in approximately 10% of affected horses (Proudman, 1992). Obstructing or strangulating diseases that require surgery represent only two to four percent of colic cases, though some risk factors in certain populations may increase this rate (White, 1990).

Colic mortality has decreased since the 1998 NAHMS study, when it was second only to old age as a cause of death in horses. In the 2005 NAHMS study, old age was still the most common cause of death while colic was third, almost equal to injuries, which ranked second. In the normal farm population, horse mortality from all types of colic was 0.7 deaths per 100 horse-years, with a colic case fatality rate of 6.7% (Tinker et al., 1997a). The predominant reasons for death were stomach rupture, strangulating lesions, or enteritis (Tinker et al., 1997a).

The true incidence of specific intestinal diseases causing colic in the general equine population is not known. Studies of horses presenting to veterinary teaching hospitals or practices for evaluation of colic rank simple colic and impaction colic as the most common diseases. When the segment of bowel involved can be determined, the large colon is the most commonly affected followed by the small intestine, cecum, and small colon, respectively (White, 1990). Large colon torsion is the most common cause of strangula-

tion obstruction, with strangulating diseases of the small intestine causing the highest case fatality rate (White, 1990; Macdonald et al., 1989; Proudman et al., 2002).

In a study of colic in a population of 28,000 horses, loss of use due to colic averaged two to three days, less than that resulting from trauma, lameness, or neurological disease (Traub-Dargatz et al., 2001). The value of horses lost due to colic in the United States in 1998 and 1999 was estimated at $70 million, while the total cost of colic to the industry was estimated at $144 million. Based on smaller studies, anecdotal information from veterinary hospitals, and the total horse population in the United States (9.2 million), the number of abdominal surgeries performed on horses with colic in the United States could be as high as 24,000 annually, or possibly as many as 2.7 colic surgeries every hour.

General Risk Factors

Since only natural disease has been studied, determining the cause of different diseases that cause colic is problematic. In some cases, such as grain overload or enterolith presence, the proximate cause may be evident, but mechanism or the underlying problems often remain unknown. Determination of risk factors for specific types of colic may help identify the cause and lessen disease incidence by decreasing exposure to an incriminated risk.

The amount of risk is stated as the odds that the colic incidence will increase in a group of horses exposed to a particular factor compared to the colic incidence in a group that is not exposed to that factor. Horses that have had a previous episode of colic are three times more likely to have a second colic episode compared to a horse that has never had colic (Tinker et al., 1997b). Said another way, if the incidence of colic in a normal population of horses with no previous history of colic is 10 out of 100 horses in a year, the rate of colic in a population of horses with a history of previous colic would be 30 out of 100 horses per year. Colic risk may also be categorized into internal and external risks. Breed and enlarged inguinal rings are examples of internal risks, while diet and housing are considered external risks.

Signalment

While colic may affect horses of any breed, several studies suggest an increased incidence of disease in Arabian (Cohen et al., 1995) or Thoroughbred (Traub-Dargatz et al., 2001) horses. Standardbreds, gaited horses, and Warmblood stallions have an apparent increase in incidence of inguinal hernias due to the increased size of their inguinal rings (Schneider et al., 1982). Though rare, the recessive and lethal trait of aganglionosis, which occurs in American Paint Horse foals born to overo mares mated with overo stallions, is the only cause of colic that has been proven to date to have a genetic basis.

Younger (<2 years) and older (>10 years) horses appear to be at less risk for simple colic (Tinker et al., 1997b). Middle-aged horses are at higher risk of colic than older horses; however, older horses with colic are more likely to require surgery (Proudman, 1992). Weanling and yearling horses are more likely to have ileocecal intussusceptions and older horses (>12 years) are at increased risk of strangulating lipoma (Proudman, 1992).

Gender is an apparent risk for conditions such as inguinal hernia in stallions and large colon displacement/volvulus in periparturient mares. Male horses (geldings and stallions) and older horses appear to be at slightly higher risk of entrapment of the small intestine in the epiploic foramen. For the most part, male and female

horses appear to be equally affected by simple colic, which is probably related to management or activity.

Recently increased height has been associated with an increased risk of epiploic foramen entrapment (Archer et al., 2008) . Behavior and response to external environment appeared associated with an increased risk. This suggests that there is an innate risk for gastrointestinal dysfunction in some horses.

Diet

Feeds or feeding activity have long been associated with the incidence of colic, though information is still largely anecdotal. Coarse roughage with low digestibility or particularly coarse fiber is observed to be associated with impaction colic (White and Dabareiner, 1997). Poor dentition has been proposed to predispose to colic due to poor mastication of food, though this has not been confirmed (Hillyer et al., 2002). Grain overload increases the risk of colic and laminitis. Feeds such as lush clover and lush pasture have been implicated as causes of tympany. Horses fed poor-quality Bermuda grass hay have an increased risk of ileal impaction (Little and Blikslager, 2002) and some horses are reported to have more colic when fed alfalfa hay. Feeding hay from round bales is also associated with an increased risk of colic (Hudson et al., 2001).

Case control and cohort studies indicate that increased amounts of grain or changes in the type of hay and grain fed increase the odds of colic compared to horses without grain or changes in feed (Tinker et al., 1997b; Cohen et al., 1999). Daily feeding of concentrate at 2.5 to 5 kg/day and > 5 kg/day to adult horses increased the risk of colic 4.8 and 6.3 times, respectively, compared to horses fed no grain (Tinker et al., 1997b) (Figure 1). Horses fed grain in the form of pellets or sweet feeds had an increased risk of colic compared to horses that were not fed grain or were fed single-grain diets. Horses with duodenitis-proximal jejunitis were more likely to be fed grain and to have grazed pasture than control horses (Cohen et al., 2006).

Grain diets decrease the water content of ingesta in the colon due to a decrease in fiber, which binds to water (Lopes et al., 2004). Grain in the diet also increases gas production and is more likely to create an intraluminal environment that favors gas production or altered motility leading to intestinal displacements.

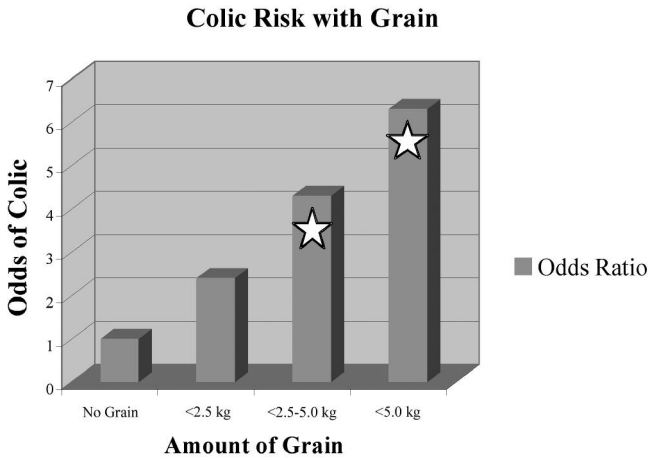

Figure 1. Odds of colic in horses fed concentrate (in kilograms) as part of their daily diet compared to horses fed no grain. The stars indicate a significant difference (P<0.05) for odds of having colic compared to no grain fed (White, 2006).

Feeding small amounts of grain at frequent intervals reduces fluid shifts in the large colon as compared to fluid shifts that occur with twice-daily feeding of larger quantities of concentrate (Clarke et al., 1990). Though no relationship was found between feeding frequency in one study (Reeves et al., 1996), feeding more than twice daily increased the risk of colic in a Virginia-Maryland study (Tinker et al., 1997b). This increased risk was suspected to be due to an increased daily intake of grain rather than the frequency of feeding which would favor small amounts of starch reaching the large intestine and decrease the chance of hindgut acidosis (Geor and Harris, 2007).

Environment/Management

Housing and confinement on the farms in a Virginia-Maryland study were not risk factors for colic (Hillyer et al., 2001; Tinker et al., 1997b). However, other reports suggest there is an increased risk of cecal and large colon impaction in horses that have acute decreases in activity, such as curtailing regular exercise or changing from turn-out activity to strict stall confinement due to an injury or after surgery (Dabareiner and White, 1995). A case-control study in Texas found decreased colic risk with lower horse density on pasture and with access to a pond; these observations are supported by studies from the United Kingdom (Hillyer et al., 2002; Cohen et al., 1999). Turn-out in paddocks without water is associated with an increased risk of colic (Reeves et al., 1996). The type of activity is often related to the type of housing, possibly confounding interpretation of the results in some studies, and further investigations into the relationship between housing and type and frequency of exercise and their effect on the incidence of colic is needed.

Management factors are difficult to compare between farms, and changes in management are difficult to detect. The increased risk of colic associated with care by trainers and managers compared to care by owners is supported by two studies (Reeves et al., 1996; Hillyer et al., 2002). These findings suggest a difference either in the quality or frequency of observation between these two groups or better management by owners compared to trainers in horses with more intensive exercise.

It seems logical that housing, diet, and feeding routine are associated with a risk of colic. Anecdotal information from large breeding farms suggest that the routine of feeding horses grain after being brought in from pasture and then keeping them in stalls for part of the day increases the risk of colic, and specifically colon tympany and displacement of the large colon. By altering this daily routine, including keeping horses turned out after grain feeding, colic incidence is decreased. Similarly when hay is available to horses on lush pasture, the hay will be consumed as part of the diet, and incidence of colic is decreased in horses turned out 24 hours per day.

Specific causes of colic occur at differing frequencies in different regions of the world (White, 1990). Grass sickness is diagnosed in horses in the United Kingdom, Europe, and South America but not in North America. Ileal impactions are found predominantly in horses in the southeastern United States and Europe. Enteroliths are observed more frequently in horses in California, the Midwest, and Florida (White, 1990). Sand colic and impactions are seen where horses graze on pastures with sandy soils or where horses are forced to eat off ground consisting predominantly of sand or fine gravel.

Enteroliths appear to be related to diet and potentially mineral intake. Horses consuming hard water or alfalfa hay, and those with a higher pH and mineral concentrations of colonic ingesta, as well as horses living in California, are at higher risk for this problem (Cohen et al., 2000; Hassel et al., 2001; Hassel et al., 2004).

These diseases are not common causes of colic and their incidence may not be impacted by the same management, diet and environmental changes previously described (Tinker et al., 1997b; Cohen et al., 1999; Hillyer et al., 2002).

Event-Associated Colic Risk

Previous Colic

Horses with a history of previous colic are at higher risk for future colic episodes (Cohen and Honnas, 1996; Tinker et al., 1997a). Horses with a prior history of abdominal surgery are at higher risk of repeat colic, which is often due to adhesions or bowel scarring with stricture (Cohen et al., 1995). Horses have a higher rate of repeat colic (one to two episodes) within the first two to three months after abdominal surgery; after that time, the incidence of colic decreases to near normal (Proudman et al., 2002). Horses with colon impactions have a high rate of repeat colic (Dabareiner and White, 1995). The reason for this increased risk is not known. Decreased numbers of neurons in the myenteric plexus of the pelvic flexure and right dorsal colon in horses with chronic colon obstruction may create alterations in bowel motility predisposing to future obstruction (Schusser and White, 1997).

Parasites

Parasites (ascarids, tapeworms, strongyles) were associated with an increased risk of colic in several studies. Obstructions due to ascarids in foals, tapeworm infestation, and strongyle infestation have all been reported as causes of colic, usually based on small groups of cases. Uhlinger found a decrease in colic after controlling small strongyle infection on several farms with a high colic incidence. Tapeworm infestation is related to an increased frequency of colic, and specifically to colic associated with diseases of the ileum and cecum such as ileocecal intussusception or cecocecal intussusception (Proudman and Holdstock, 2000). Although there are no studies describing the incidence or prevalence of colic associated with thrombosis of the cranial mesenteric artery due to *Strongylus vulgaris* larva, the decrease in mesenteric artery thrombus formation observed in horses at surgery and necropsy appears to parallel the increased use of ivermectin in horses over the last 25 years.

Cribbing

Recently cribbing, long associated with an increased risk of colic, was demonstrated to be associated with an increased risk of simple large colon obstruction and entrapment of the small intestine in the epiploic foramen (Archer et al., 2004; Archer et al., 2008). The act of aerophagia likely creates negative pressure in the abdomen leading to movement of bowel into the potential space within the lesser omental sac. The author speculates a similar event predisposes to inguinal herniation due to pressure changes in the inguinal canal when testicles descend after being retracted during breeding.

Pregnancy

Mares have an increased risk for colon displacement or volvulus during late pregnancy and lactation (Huskamp, 1982; Snyder et al., 1989). However, these risk assessments are based on analysis of studies of selected populations of mares, or mares in regions with high numbers of broodmares. In a Virginia-

Maryland study, mares had an increased risk of colic from 60 to 150 days after foaling (Tinker et al., 1997b). The physiologic events that predispose to this increased risk are not known, but serum calcium concentrations and alterations in diet, including increases in energy due to more concentrates in the diet to support lactation, may be related to this increased risk (Figure 2).

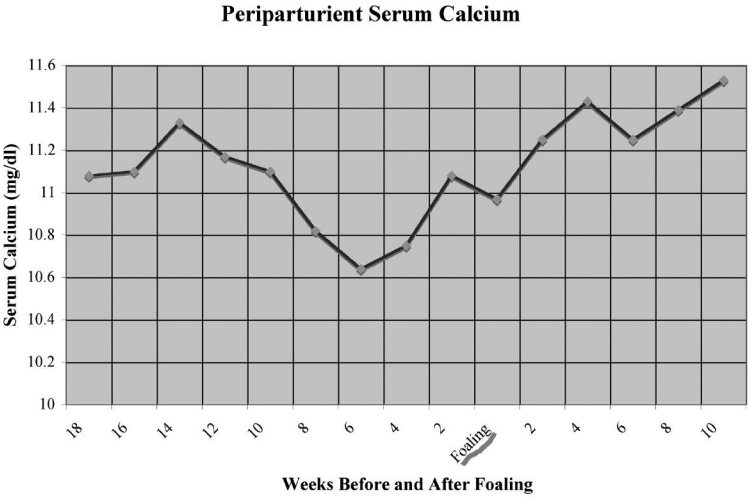

Figure 2. Graph of mean total serum calcium concentrations (g/dl) in 15 periparturient mares plotted at two-week intervals before and after the foaling date. Serum calcium concentrations were significantly decreased at 4, 6, and 8 weeks prior to foaling compared to the weeks before and after, though concentrations were never abnormal (White, 2006).

Exercise/Performance

To date, studies have not fully assessed the relationship between incidence of colic and exercise or activity level. Racehorses, event horses and horses used on endurance rides all have an increased risk of gastric ulceration, which may be linked to some colic episodes (Murray et al., 1989; Murray, 1992; Vatistas et al., 1999; Sandin et al., 2000). Although horses used for racing or eventing had the highest incidence of colic in a Virginia-Maryland study, these activities did not pose a significant increased risk when compared to other factors such as diet (Tinker et al., 1997b). Recent studies found decreased risk of colic in horses on premises where horses were trained for eventing versus those housed in stables which were training horses for racing on the flat track (Hillyer et al., 2002).

Horse Transport

Horse transport increased the risk of colic in several studies (Hillyer et al., 2002; Uhlinger, 1992; Tinker et al., 1997b). Transport-related colic has been suspected by practitioners, who commonly administer a laxative prior to shipping to prevent colic from impactions. The mechanism or cause of the increased incidence is unknown. There was a marked increase in colic risk with the concomitant presence of transport, grain feeding, and cribbing (Tinker, 1995).

Fever

It is logical that horses with infection could have alteration of the gastrointestinal tract predisposing them to colic (Tinker et al., 1997b). Horses with fever within 14 days of a colic episode were two times as likely to have colic in a Virginia-Maryland study (Tinker et al., 1997b). Because the reported cause of fever in these cases was varied, no specific relationship or cause for each colic was established.

Weather

Veterinarians and owners frequently associate weather changes with increased frequency of colic, but many studies have been unable to find statistical evidence of increased risk. Early reports from Europe suggested weather changes were associated with the highest incidence of colic, specifically changes to cold and damp conditions or to warm and wet during advancing weather fronts (Barth, 1980). A recent study in Texas found an increased risk of colic associated with weather changes as recalled by owners of horses with colic (Cohen et al., 1999). Cold weather, which affects water intake, has been linked to increased impaction colic. When examined as a direct exposure factor in a Virginia-Maryland study, weather did not appear to be related to colic (Tinker et al., 1997b). When events were investigated by looking at a 14-day window preceding colic episodes, low humidity and snow marginally increased colic risk (Tinker et al., 1997b). In a study in Virginia, seven cases of colic occurred during a heavy snowstorm over a three-day period (Tinker, 1995). This was unusual as there were only 104 cases of colic in approximately 1000 horses monitored for a full year. What became apparent from records kept by the farms was the change in management due to the snowstorm. Horses were kept in stalls, rather than being turned out, and the diet was not altered, even though horses had no turnout or exercise. The focal increase in colic episodes in this study was most likely not directly related to the weather, but rather due to management changes caused by the weather.

Anesthesia

General anesthesia increases the risk of colic. Specifically, colic after general anesthesia for nonabdominal surgery compared to that for MRI was increased (Andersen et al., 2006). In a multicentered study, the type of surgery was associated with an increased risk. The most common type of colic after nonabdominal surgery was impaction (Senior et al., 2006).

The risk of death during anesthesia in horses undergoing colic surgery was associated with increased heart rate and packed cell volume at admission (Proudman et al., 2006). Draft horses, Thoroughbreds and Thoroughbred crosses were also at higher risk.

Prevention

Two types of factors should be considered when trying to prevent colic: farm factors and horse factors (White, 1990; Tinker et al., 1997b). Farm factors include management, use, feeding, and environment. The associated risks on farms with high rates of colic include poor parasite control, high concentrate levels in the diet, multiple sources of concentrates (including supplements which contain high amounts of soluble carbohydrates), chronic water deficiency, excessive use of NSAIDs, acute changes in hay or grain diet, and horses in training that are confined and fed large amounts of carbohy-

drate and lesser amounts of roughage. Decreasing these risks with appropriate horse management has decreased the incidence of colic on farms with a higher than average annual colic rate.

Based on these known factors, colic prevention should start by making sure horses have a constant source of fresh water, ensuring that forage makes up at least 60% or more of the diet, and that concentrates (soluble carbohydrates) are fed at the minimal level required to maintain weight and performance. One to 1.5 kg of long-stem forage per 100 kg of body weight has been recommended to maintain adequate fiber to decrease the adverse effects of diets high in starch (Geor and Harris, 2007). Dividing the total concentrate in the diet into three or more feedings a day should help decrease both stomach and hindgut acid production (Geor and Harris, 2007). The turn-out and exercise routines should be regular and consistent. Changes in feed should be completed over a seven- to ten-day period.

Parasite control must be optimal. Parasite control starts with fecal egg counts several times a year, or more often when horses are frequently moved on and off farms or stables. Though interval anthelmintic treatment would seem to be sufficient to control common parasites, small strongyles and tapeworms have both been linked to increased colic risk and may not be totally controlled by some programs (Uhlinger, 1990; Proudman and Holdstock, 2000). Control of small strongyle infection on farms was reported to decrease the incidence of colic (Uhlinger, 1990). Anthelmintic resistance is now a concern, making monitoring of parasite-control programs essential.

On farms with a high incidence of colic (>10 colic cases per 100 horses per year), careful monitoring of the daily management and measurement of the energy, protein, and fiber in the diet should be the first steps in assessing the farm for colic risk. An example of the need for this type of feed analysis is inadvertent carbohydrate overload that can occur from feeding bran. Unbeknownst to many owners or managers, bran can have a high soluble carbohydrate content depending on the milling of the grain. If bran is fed as a laxative in addition to a regular grain diet, the soluble carbohydrate intake in a horse's diet can be doubled (Table 1).

Table 1. Analysis of bran from a farm that routinely fed a bran mash to all horses daily. The total digestible nutrients (TDN) of the bran was as high as an equivalent amount of corn and in sufficient quantities could significantly increase the carbohydrate content of the diet. This increase lowers consumption of forage and causes dehydration of ingesta in the colon (ENE T- total energy; NE-net energy; MCAL/lb- megacalorie per pound) (White, 2006).

Date Sampled: 1-16-91	**Forage Description: Bran**	
	Dry Basis	**As Fed Basis**
Dry Matter	88.19%	
Crude Protein	18%	15.87%
Heat Damaged Protein		
Available Protein		
Digestible Protein	13.2%	11.64%
Acid Detergent Fiber	12.59%	11.1%
Neutral Detergent Fiber		
TDN (estimated)	80.13%	70.66%
ENE T/100 lb	74.25	65.48
NE Lactation Mcal/lb	0.8	0.7
NE Maintenance Mcal/lb	0.88	0.77
NE Gain Mcal/lb	0.59	0.52

Alternative sources of energy can decrease the need for grain as a concentrated source of energy. Fat such as corn oil and nonstarch carbohydrates such as sugar beet, soya hulls, and rice bran can be used to lower

starch in the diet (Geor and Harris, 2007). Use of mechanisms to decrease acid production in the cecum and large colon such as a "protected sodium bicarbonate" may be able to prevent the decrease in pH (Pagan et al., 2007). Control of feeding on pasture may also be necessary during periods of rapid growth of forage.

When considering colic in individual horses, internal factors are potential contributors as well as the diet and environment. Known factors that affect individual horses include acute confinement due to injury, lack of turn-out, gastric ulceration due to performance, and aerophagia. These factors are often associated with simple colic with no other diagnosis. These factors may be impossible to control, although some horses respond to turn-out 24 hours a day and a total forage diet. This arrangement may not be compatible with certain types of performance, but often this ad lib exercise and feeding system will decrease recurrent colic. Other horse factors may play a role in diseases such as lipomas or incarcerations in internal hernias. However, factors that affect these types of intestinal disease have not been widely investigated.

Sand ingestion in some areas of the world causes "sand colic" due to obstruction or overload of the large colon. Prevention requires keeping horses from ingesting sand, which in some environments is impossible if horses are turned out on pasture or sand lots. Repeated dosing with psyllium has been recommended, but the use of psyllium has been questioned due to its inefficiency in removing sand from the intestines in horses (Hammock et al., 1998; Ruohoniemi et al., 2001). Use of a combination of probiotics, prebiotics, and psyllium-enhanced sand clearance was compared to a control period, and potentially could be used as a prophylactic treatment (Landes et al., 2007).

Identifying horses at high risk may help determine if there is a generalized colic risk on the farm or if specific individuals are responsible for a majority of colic episodes. Often the problem may be a basic diet or management issue such as lack of fresh water, feeding large amounts concentrates with insufficient forage intake in the diet or excessive use of medications such as NSAIDs. These factors will not always be apparent in the history of the farm or the owner's assessment of management. Therefore, careful independent observations and record-keeping are often prerequisites to understanding the colic risk factors on a farm.

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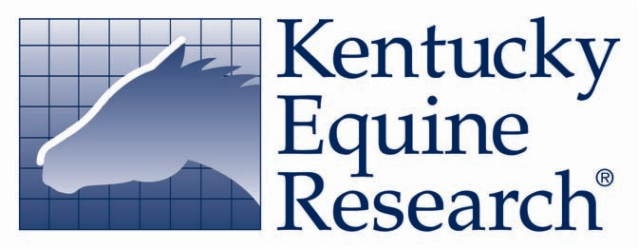

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