

3

Strategies for Preventing Colic

So, *can colic be prevented?* The short answer is *Yes, sometimes*. Of course, many of the risk factors identified in Chapter 2 are outside our control, particularly the intrinsic (horse) factors such as age, breed, and gender. But most, if not all, of the *management factors* can be modified in some way to reduce the incidence of colic both in an individual horse and in an entire group of horses. The anthelmintic study outlined on page 42–43 is an excellent example: the annual incidence of colic was reduced from 24–46 cases per 100 horses to less than 5 cases per 100 horses (a decrease of 80–90%!) just by instituting an effective deworming program.

Simple Management Strategies

In that study, the incidence of colic was substantially reduced by altering one management factor, but those farms still reported between 2 and 5 cases of colic per 100 horses per year. This highlights an important point: colic has numerous possible causes and contributing factors, so while altering one key factor can decrease the colic incidence, it is unlikely to prevent every case of colic.

Because colic is a multifactorial problem, *colic prevention requires a multifactorial approach*. As most cases of colic have at least one management component, and management is the one area we can influence to any great degree, *prevention focuses on management*. Below is a list of 10 management strategies that can reduce the incidence of colic in an individual horse and on the farm as a whole.

Ten Management Strategies for Preventing Colic

1. Match the horse's natural diet as closely as possible.
2. Match the horse's natural feeding patterns as closely as possible.
3. Match the horse's natural activity pattern as closely as possible.
4. Minimize changes in diet, housing, and activity level.
5. Feed only good quality feedstuffs.
6. Ensure ample access to fresh, clean water.
7. Maintain a good deworming program.
8. Maintain a regular schedule of dental care.
9. Maintain good environmental management.
10. Pay attention to your horse(s).

These are all basic things, many of which most horse owners are already doing, to some degree. But often the success or failure of a program lies in the details. In the following sections I'll explain why the individual strategies are important, and provide practical suggestions for implementing them. Management changes sometimes require a few tough decisions, changes in old habits, and probably

most important, commitment — a willingness to make it happen and stick to it. It may also take some creative thinking to find modifications that will work in your situation.

Aside from reducing the incidence of colic, these strategies are worth implementing for another reason: they can decrease the incidence and severity of lung diseases such as chronic obstructive pulmonary disease (COPD, 'heaves,' recurrent airway obstruction) and exercise-related muscle problems ('tying-up,' myositis, exertional rhabdomyolysis). Some can even help with behavioral problems.

1. Match the horse's natural diet

The equine digestive system is designed to extract the bulk of the horse's nutritional requirements from forage — grass and other high-fiber plant materials, also termed *roughage*. In the natural state, very little of the horse's nutritional needs are met by grain (*i.e.*, grass seeds) or other food that is rich in readily digestible carbohydrates. Instead, the horse relies on microbial breakdown of plant fiber in the large intestine to supply the bulk of its energy needs.

Domesticated horses are no different in this respect from their wild counterparts. Regardless of whether it's a child's pony, an Olympic-level dressage horse, or a racehorse, optimal digestive health and function requires that the bulk of the horse's diet be roughage (pasture and/or hay). Nutritionists often put it this way: *horses have an absolute need for roughage*.

Meeting the horse's roughage requirements

Following are some guidelines for feeding horses, provided by the National Research Council, in their publication *Nutrient Requirements of Horses*:

- horses should be fed *1% to 2% of their body weight per day* of good quality roughage (pasture or hay)
 - for a 450-kilogram (1,000-pound) horse with no pasture access, feeding 1% of the horse's body weight is 4.5 kilograms (10 pounds) of hay per day; that is the recommended *minimum* amount
 - this recommendation applies across the board in horses older than 12 months of age, regardless of what else they are fed
 - another way of putting it is to feed *at least 1 kg of roughage per 100 kg of body weight* (or 1 lb of roughage per 100 lb of body weight)
- when grain must be fed to meet the horse's energy needs, *at least 50% of the total ration should be roughage*
 - this means that for every pound of grain fed, *at least* one pound of hay must be fed
 - specific exceptions are horses performing intense work and horses that are growing rapidly; but even in these cases, *at least 1% of the horse's body weight should be fed as roughage*
 - the proportions of roughage to grain for different types of horses are listed in Table 3.1 on page 81

Calculating pasture intake. The roughage requirement (1–2% of body weight per day) is for *dry matter*. Well-cured hay is almost 100% dry matter (it's >90% dry matter), but fresh grass can be as little as 20% dry matter, so the water content must be factored in when calculating the contribution of pasture to a horse's roughage intake. When the water content of the pasture is not known, follow these general guidelines:

- multiply the roughage requirement by 3 to estimate the amount of fresh grass needed to supply this amount of dry matter
 - averaged over the growing season, fresh grass is about 30% dry matter and 70% water
- figure that the average adult horse eats about 1.6 kilograms (3.5 pounds) of grass per hour of grazing (although this figure is *highly* variable)

So, to provide even 1% of body weight as dry matter, a 450-kilogram (1,000-pound) horse would need to graze steadily for at least 8 hours.

“Since the advent of modern anthelmintics, the most important cause of colic in horses is nutritional mismanagement. Nutritionally induced colic can be grouped into two categories:

1. Improper forage:grain ratios, or inadequate amounts of forage.
2. Use of tainted feedstuffs.

[By far] the more important of these two is inadequate fiber intake.

...

There are few, if any, instances when overfeeding hay can lead to a problem, but there are numerous problems that can develop if hay is limited.”¹

Feeding for energy needs

Energy is the most crucial nutritional component; not protein or calcium, or any other nutrient. Each of the bodily functions requires energy, so insufficient dietary energy can have profound effects on many systems; and an excess of dietary energy can have such diverse effects as colic, diarrhea, laminitis, exercise-related muscle disorders, developmental orthopedic diseases (physitis/epiphysitis, osteochondrosis, flexural limb deformities, *etc.*), and infertility.

Thus, formulating a ration should begin with assessing the horse’s energy requirements, based on body weight, life stage, and activity type and intensity. Table 3.2 on page 82 lists some daily nutrient requirements for adult, nonpregnant and nonlactating horses of different sizes, performing various levels of work.

Overfeeding. One of the most common feeding errors, and one that predisposes horses to colic, is overfeeding grain or other grain-based concentrates (sweet feed or pellets). These feedstuffs contain high levels of readily digestible carbohydrates which, when fed in large amounts, can alter conditions within the large intestine. As discussed in Chapter 2, the colic risk increases as the amount of grain-based concentrate increases. Thus, concentrates should be fed *only as supplements* when the horse’s energy requirements for work, growth, pregnancy, or lactation cannot be fully met by roughage alone.

The micro-organisms in the horse’s large intestine break down most types of plant fiber into substances that can be absorbed by the horse and used to produce energy. Thus, *hay or pasture is an energy source*. In fact, the maintenance energy requirements of an adult horse can usually be fully met by hay or pasture alone. Provided the hay/pasture is of good quality, the maintenance requirements for protein, calcium, and phosphorus are also fully met.

However, two points about roughage-only diets are important to note:

1. This diet may be deficient in certain vitamins and minerals, so salt and a good multivitamin-mineral supplement may be needed.

2. Lush grass can be very high in digestible energy, far in excess of the adult horse's maintenance needs, so pasture access may need to be limited in overweight and laminitis-prone horses, and the roughage requirement (1–2% of body weight per day) met with good quality hay until the pasture matures.

How much is too much? In the Virginia-Maryland study discussed in Chapter 2, the colic risk became significant when more than 2.5 kilograms (5½ pounds) of grain-based concentrate was fed per day. Whether this figure applies across the board, to all types of horses in various management situations, awaits further study. But for now, it is as good a guidepost as we have. Feeding more than 2.5 kg of grain per day may not *cause* colic, but it could increase the risk for colic to develop. Strategies for feeding concentrates when a high-energy diet is required are discussed on page 63.

Dietary fat. Adding fat to the ration is an excellent way of reducing the amount of grain when a horse's energy needs demand a high-energy diet. The average equine diet contains very little fat (usually around 2–3%), but unlike grains, increasing the amount of fat above that normally found in the diet does not cause digestive problems.

The aim is to meet part of the horse's energy needs with fat, thereby allowing the amount of grain to be decreased. Fat can be added in several forms (*e.g.*, vegetable oil, rice bran, oily seeds), but the commercial high-fat balanced rations are often best because they ensure that the horse's diet contains sufficient vitamins and minerals. Before feeding a high-fat diet, it is a good idea to consult with an equine nutritionist to ensure that the final ration is balanced and meets the individual horse's needs.

2. Match the horse's natural feeding schedule

Horses kept on pasture graze for most of the day and much of the night. When grass is all they have to eat, it is necessary during much of the year for them to graze for this long simply to supply their energy needs. Confined horses do not need to eat all day and night to supply their energy needs which, although not ideal, can be met in a couple of concentrated meals. However, their digestive systems function best when there is fairly continuous intake of high-fiber food throughout the day and night.

In horses that are kept in stalls, pens, or small paddocks, matching the natural feeding schedule is easily accomplished by making sure the horse has hay at all times. With this approach, the horse can 'graze' throughout the day and night as it would at pasture.

Exception. Some overweight horses and ponies gain weight when hay is available at all times, especially if they get little or no regular exercise. (Paddock or dry lot turnout does not constitute 'exercise' in these inactive horses.) In such cases, the hay ration — at least 1% of the horse's body weight per day — should be divided into two or three portions and fed at intervals, such as morning and evening or morning, afternoon, and night.

Once-a-day feeding, with no access to roughage in between feedings, is not a good idea. Studies on the development and healing of gastric ulcers^{2,3} have shown that the concentrations of acid and bile in the stomach can reach levels capable of causing ulceration within 14 hours of fasting. So if confined horses are not provided with hay throughout the day and night, they should be given hay at least twice a day.

Feeding grain and other concentrates

As discussed in Chapter 2, it takes 8 to 12 hours for balance in the large intestine to be restored after a large carbohydrate meal. So, feeding large amounts of grain-based concentrate more often than every 8 hours can upset the balance and increase the potential for colic to develop. Furthermore, as one study

showed, dividing the daily concentrate ration into two or more meals does not reduce the colic risk associated with feeding large amounts of grain.

So, how can you minimize the colic risk when grain-based concentrates must be fed to meet the horse's energy needs? There are two alternatives:

1. Divide the daily concentrate ration into several (6 to 8) small meals and feed them every 3 to 4 hours. The objective is to feed amounts that the small intestine is able to digest and absorb in full so that little or no readily fermentable carbohydrate reaches the large intestine. But obviously, this strategy is impractical in most settings.
2. Divide the daily concentrate ration into two meals and feed them at least 8 hours (and preferably 12 hours) apart. With this strategy, colic risk will be minimized *only if the total amount of concentrate fed is kept to a minimum*. Studies are lacking on how much carbohydrate it takes to overwhelm the small intestine's ability to digest and absorb it, but it is probably best to limit the amount of concentrates fed in a single meal to less than 1.5 kilograms (about 3 pounds). That said, there are certain instances in which this strategy is not ideal (see Exceptions, below).

With either alternative, roughage should be available at all times. This may be even more important in horses on high-energy diets than in those on maintenance diets. For one thing, horses on high-energy diets still need to eat at least 1% of body weight per day as roughage. For another, feeding roughage with each concentrate meal may slow emptying of the stomach, and therefore delivery of carbohydrates to the small intestine.

Chopped roughage (*e.g.*, chopped hay [chaff], hay cubes or pellets) or beet pulp may be more effective in this regard than regular hay because it can be fed mixed with the concentrate. An alternative is to feed some hay before the grain meal. Ample and regular intake of roughage may also moderate the swings in fluid and acidity in the colon.

Exceptions. There are three groups of horses for which the twice-daily grain feeding strategy is not ideal: (1) horses with gastric ulcers whose work level requires a high-energy diet, (2) horses that have had large amounts of small intestine removed during surgery, and (3) horses performing intensive power work (racing, three-day-eventing, polo, *etc.*). The first strategy (small, nutrient-rich meals several times a day) is preferable in these horses; in fact, complete balanced rations may be useful in such situations. Managing horses with gastric ulcers is discussed further on page 77.

3. Match the horse's natural activity pattern

In a natural setting, a horse's normal activity pattern consists of grazing for most of the day and much of the night, gradually moving from one area to another in search of good grass. Grazing is interspersed with rest periods, trips to the nearest water source, and short bursts of activity (*e.g.*, play, running from danger, breeding).

As discussed in Chapter 2, the colic risk is lower in horses on pasture than in those confined to stalls. Diet, water intake, and the horse's occupation probably have as much to do with this as the daily activity pattern. Nevertheless, pasture turnout is ideal for most horses, provided safety (good fencing, compatible company, *etc.*) is kept in mind.

When pasturing is not an option, stabled horses should be turned out for as long as possible every day (unless the horse has a medical condition for which activity is inadvisable). When turnout in a pasture or dry lot is not an option, the horse should be exercised (ridden, driven, or longed) every day and, if

possible, hand-walked or hand-grazed for as long as is practical at least once a day. This is a poor substitute for pasture turnout, but it is a vast improvement on spending all day and night confined to a stall or yard.

In one recent study, the colic incidence was lower in horses that were turned out for more than 12 hours a day than in horses that were confined to a stall for more than 12 hours a day.⁴

Cold weather

Horses are well adapted to coping with cold weather, so unless the horse is sick, very thin, or body clipped, or wind-chill factors are well into the negative figures, cold weather is no excuse for not turning a horse out for at least a few hours each day. Horses are also well designed to cope with rain.

4. Minimize changes

Several studies have shown that changes in the horse's diet, housing, and activity level increase the risk for colic. Of these three factors, dietary changes carry the most risk for colic. So, keep the horse's digestive system running like clockwork by following these guidelines:

- make any dietary changes slowly, over a period of 1–2 weeks (see Adaptability, below)
 - it is usually safe to suddenly *decrease* the amount of grain, but it can be harmful to suddenly begin feeding large amounts or rapidly increase the amount of grain fed
 - when increasing the amount of concentrates, it is usually safe to increase the amount fed by ½ pound per day
 - when making changes in hay feeding, start feeding the new hay, mixed with the old, before running out of the old batch
 - try to buy hay of similar quality each time, preferably from the same source
- keep feeding times regular, even on weekends
- follow the suggestions for feeding concentrates on page 63 (the objective being to minimize fluctuations within the colon)

When injury or illness requires that a horse be confined, even for only a few days, immediately decreasing or cutting out the grain is not a problem. In fact, it is the best strategy for avoiding digestive upsets, muscle problems (*e.g.*, 'tying up'), and behavioral problems associated with confinement. When the horse resumes training, grain can be gradually reintroduced, if needed.

Adaptability

The horse's digestive system is quite adaptable, when given sufficient time. The large and diverse population of micro-organisms in the cecum and colon responds to changes in the diet by adjusting the relative proportions of carbohydrate-fermenting and fiber-digesting microbes. This is a good strategy for ensuring digestive efficiency under a variety of feeding conditions.

But if the diet is changed too quickly, especially if the amount of carbohydrates is suddenly increased, an imbalance in the microbial population occurs which can be harmful. Colic is one potential consequence; laminitis ('founder') is another.

However, not all horses that experience dietary changes or inconsistencies develop colic. For example, colic is uncommon in horses that are kept on pasture year-round, despite the fact that forage quality can change dramatically from one season to the next. There is considerable variation in nutrient content (not to mention water content and digestibility) between lush spring grass and the mature, almost woody stalks of late summer.

The key here is that the nutrient composition typically changes gradually, over weeks or months. When sudden changes do occur, such as with the first spring flush or a greening-up after rain in summer or early autumn, horses on pasture sometimes develop mild spasmodic or 'gas' colic from the sudden increase in readily digestible carbohydrates.

The microbial population in the large intestine takes at least 2 weeks (and probably longer) to fully adapt to a sudden introduction of carbohydrates. So when changing a horse's diet, do it gradually, giving the microbes time to make the necessary adjustments.

A recent study in ponies showed that suddenly adding grain to a hay-only diet dramatically alters the ratio of carbohydrate-fermenting and fiber-digesting microbes in the colon. Three diets were compared: 100% grass hay; 70% hay and 30% rolled barley; and 50% hay and 50% barley. Microbial adaptation to the 50%-grain diet was incomplete, and fiber digestibility with both the 30% and 50% grain diets was significantly decreased, even after 2 weeks on the new diet.⁵

Changes in housing and activity

A change in housing refers to changing from pasture turnout to confinement, or *vice versa*, or substantially changing the amount of turnout each day; not moving the horse to a different barn. (Although, moving the horse to another barn may involve management or environmental factors that could increase the colic risk.)

The changes most likely to increase the colic risk are those that decrease the amount of turnout time. The most likely factors involved are roughage availability, type, and quality, and the amount of daily activity. Psychological factors (lack of compatible company, changes in surroundings and routine, restriction, *etc.*) could also be involved in some situations.

Making housing changes. Changes in housing often are inevitable with changes in season, with illness or injury, and when boarding a horse at a barn with limited turnout facilities. In these instances, pay particular attention to roughage and water intake and quality, provide daily exercise (if appropriate), and wherever possible, make any changes gradually.

Making changes in activity level. Changes in a horse's activity level are also inevitable from time to time. A *decrease* in activity is likely to affect the colic risk only if the horse is confined (*e.g.*, stabled because of injury) but the amount of concentrate fed is not reduced. Turning a horse out at the end of the competition season is unlikely to increase the colic risk. An *increase* in activity could affect the colic risk if the diet is also changed (*e.g.*, the amount of concentrates is increased) or if the horse finds the new workload stressful. Again, making any changes as gradually as possible minimizes the colic risk.

5. Feed good quality feedstuffs

This strategy involves identifying and avoiding: (1) poor quality feeds and (2) spoiled or contaminated feeds.

Avoid poor quality feeds

To minimize the colic risk, feedstuffs of the best possible quality should be fed. Even if the horse in question is an overweight pony that no-one rides anymore, and its propensity for laminitis requires that it be confined to a dry lot and fed only grass hay, that hay should be of the best quality available. Poor quality hay not only has low nutritional value, it may cause impaction colic. It can be false economy to feed a poor quality hay as a way of controlling the horse's calorie intake. It is often far better, both nutritionally and financially, to feed less of a good quality hay.

Hay quality. Good quality grass hay is leafy and soft, with relatively narrow, flexible stems; it should have few or no seed heads, and be free of weeds. A definite green color usually indicates high vitamin and protein content, whereas browning indicates a loss of certain nutrients. The North Carolina Co-operative Extension Service lists the following favorable characteristics of some legume hays:

- alfalfa — pale or bright green; small stems with abundant leaves; harvested in bud or when only 10% of the stems have flowers
- red clover — light or dark brown in color; 25–50% of the stems have flowers
- lespedeza — usually bright green; ideally, cut in early bloom

Forage testing is the most objective way of evaluating hay quality. In general, high quality grass hays and grass-legume hay mixes have a total digestible nutrient (TDN) content of at least 57%. High quality legume hays contain over 60% TDN.

Hay belly: Some people are concerned that their horse will get a 'hay belly' (a large abdomen) on a hay-only diet. But 'hay belly' results from *feeding poor quality roughage* and *lack of regular exercise*, not simply from feeding hay. (When the deworming history is suspect, internal parasites should also be considered, particularly in immature horses.)

The same is true for 'grass belly'. Typically, the roughage source is very fibrous and has a low protein content and poor digestibility, so the horse must eat more to supply its nutritional needs. Combine (1) a large colon filled with poorly digestible fibrous matter, and (2) poor muscle tone along the topline and in the abdominal muscles, and you get a flabby horse with a big belly.

Unusual feed sources. Nontraditional feed sources (*e.g.*, cottonseed, peanut, or rice hulls; human food industry byproducts) should not be fed to horses without first consulting an equine nutritionist. Just because a feedstuff is fed to cattle or other livestock does not mean it is suitable for feeding to horses. When using these materials, it is important to ensure adequate digestibility in horses, and that the final ration is well balanced.

Avoid spoiled or contaminated feeds

Spoiled or contaminated feed should not be fed, regardless of whether the horse is willing to eat it. Certain micro-organisms found in these feeds produce toxins that can cause serious illness (including, but not limited to colic), and even death. Examples include botulism and mycotoxicosis (see Chapter 2).

Identifying spoiled feed. Spoilage from improper harvesting or storage usually involves excess moisture. Moldy feed typically has a musty smell and may seem dusty (the dust is actually a cloud of fungal spores). Moldy feed may also have tiny black spots (mildew), and improperly cured hay may feel quite warm and damp. However, feeds contaminated with botulism organisms or their toxins are impossible to identify without laboratory testing.

Botulism. Specific foodstuffs incriminated in botulism outbreaks in adult horses include silage (fermented forage usually fed to cattle); grass hay stored as large round bales; hay in which a dead pasture animal (*e.g.*, mouse, bird, snake) has been baled; and grain in which a mouse, bird, or other small animal has died. Hay or grain in which an animal carcass is found should be thrown out.

Blister beetles. Another feed contaminant that causes severe colic, and sometimes even death, is blister beetles in alfalfa hay. As few as 2 or 3 beetles can cause severe colitis (see Chapter 2). When feeding alfalfa hay, it is best to buy it from areas in which blister beetle infestation is unlikely (ask your local hay dealer where the hay came from) or from growers or dealers who can certify that the crop is blister-beetle free. It is worth inspecting each batch of alfalfa hay before feeding it. However, the distribution of beetles in infested alfalfa can be very patchy, so these small insects are easily missed.

Feeds formulated for other animals. Do not feed horses rations that are formulated for cattle, pigs, or poultry. For one thing, the nutritional needs of the various species are different. And for another, certain feed additives used in rations for other species can be harmful to horses; some are potentially fatal. The most striking example may be monensin in cattle feeds (see Chapter 2). When buying premixed feeds, it is best to choose rations that are specifically formulated for horses.

6. Ample access to fresh, clean water

Always make sure the horse has fresh water available, even if turning the horse out for just an hour or two. That hour or two can easily stretch into the whole morning or afternoon if you are held up or get busy with something else. As one study showed, the colic risk was increased in horses turned out, even for just a few hours, without access to water (see Chapter 2).

Water intake during transport and exercise. Ensuring ample water intake during long-distance transport or exercise that lasts for several hours (*e.g.*, long trail rides, endurance events) can take a little planning. Stopping every few hours and offering the horse some water is worthwhile during long-distance transport, although it can be difficult when transporting several horses. So, ensuring that the horse has free access to fresh, clean water during long stops (*e.g.*, meal breaks, overnight rest stops) and on arrival is essential. Giving the horse mineral oil by stomach tube before a long trip is of doubtful value in preventing impaction colic: what the horse needs is *water*.

Adequate water intake is even more important in horses exercising for several hours, because the horse is losing body water and electrolytes in the form of sweat. Dehydration predisposes to large colon impaction, and loss or redistribution of electrolytes (especially potassium and calcium) adds to the colic risk by altering bowel motility. Adding electrolytes to the ration or administering an electrolyte-rich oral paste increases the horse's water intake, but it is very important that the horse be given access to plenty of fresh, electrolyte-free water after such treatment.

Water requirements: The basic water requirement for a mature, nonlactating horse is about 15 liters, or 4 gallons, per day. However, horses on hay-only diets need more. The National Research Council (NRC) recommends supplying *2–3 liters of water per kilogram of dry matter fed*, per day. So, a 500-kilogram (1,100-pound) horse fed 2% of its body weight (10 kg, or 22 lb) in dry matter needs 20–30 liters, or 5–8 gallons, of water per day.

In hot weather, horses may need up to 8 liters of water per kilogram of dry matter per day. That's up to 80 liters, or 21 gallons, of water per day for a 500-kg (1,100-lb) horse. Exercise further increases the water requirement by up to 300%.

Importance of clean water. Ensuring that the water is fresh and clean is important for at least two reasons:

- stale, tainted, or contaminated water is unpalatable, which reduces the horse's water intake
 - water with a high salt content is also unpalatable
- certain algae that multiply in stagnant water such as ponds during warm weather can cause serious illness
 - 'blue-green' algae have been responsible for sudden death in whole groups of livestock

Heated drinking water in winter. Some horses drink less when the water temperature is near-freezing. Even though a study in Michigan found that heating the drinking water in winter did not affect the colic risk, it is probably worth ensuring adequate water intake during the winter months by making warm water available. Suitable methods include using a bucket or trough heater and providing hot water by bucket twice a day, as outlined in Chapter 2 (page 41).

7. Deworming program

No single deworming program fits all horses. The ideal program depends on the type, number, and ages of the horses, the pasture management system, and the geographic location (*i.e.*, environmental conditions throughout the year). It is best to work out an appropriate deworming program with your regular veterinarian.

Efficacy of deworming products and programs

No deworming product is 100% effective in ridding every horse of all internal parasites. However, it is not necessary for a product to kill every worm in order to minimize the incidence of colic, optimize health and feed efficiency, and reduce pasture contamination with parasite eggs and larvae. As discussed in Chapter 2, the particular deworming product or schedule used may not be very important on its own — in terms of colic risk — provided the horse is regularly dewormed with an effective product.

Fecal egg counts. The fecal egg count is a laboratory estimate of the number of parasite eggs in the horse's manure, usually reported as 'eggs per gram' (epg). A common recommendation is to keep the herd's average fecal egg count below 100 epg.

Whichever product and program is chosen (daily vs. monthly, 2-monthly, or 3-monthly; single product vs. rotation of products, *etc.*), it is worth having your veterinarian perform fecal egg counts once or twice a year, to make sure the program is effective. However, it is important to realize that the standard method of performing fecal egg counts can be quite inaccurate in detecting tapeworms and encysted (immature) small strongyles. These two parasites require special considerations when designing a deworming program.

Tapeworms

Tapeworms are not eliminated by most dewormers. Products that are effective for treating tapeworm infestation in horses include these:

- pyrantel pamoate (Strongid P® or its generic equivalent), given *once* at 2–3 times the standard dose, and repeated in 8 weeks if necessary

- daily pyrantel tartrate (Strongid C® or its generic equivalent) at the recommended dose for at least 2 weeks
- praziquantel, the second active ingredient in combination products such as Zimecterin® Gold, Quest® Plus, and various others*

[*2016 Note: Praziquantel was not approved for use in horses when *Preventing Colic in Horses* was first published. Now there are several dewormers on the market for horses that contain praziquantel.]

The tapeworm lifecycle involves a tiny pasture mite that is active only during the warmer months; it is killed by freezing. Once the mite has eaten the tapeworm egg, it takes 2 to 4 months for the egg to develop into an infective stage within the mite. It then takes a couple more months for the infective stage that is swallowed (along with the mite) by the grazing horse to mature into an adult tapeworm.

So, in temperate climates, it is usually recommended that treatment be given in the autumn, after the first frost. In warmer areas, where the mites may remain active on the pasture well into the autumn, treatment may be worthwhile throughout the autumn and winter.

Is tapeworm treatment really necessary? As discussed in Chapter 2, tapeworms do not cause obvious problems in most horses. However, they increase the risk for ileal impaction, intussusception involving the ileum and cecum, and spasmodic colic. (These conditions are each explained in Chapters 1 and 2.) So, deciding whether or not to treat for tapeworms may involve weighing the cost of treatment (which is quite low) against the potential for serious problems (also low, but when they do occur, problems such as ileal impaction and intussusception can require costly surgery). Occasionally, horses with heavy tapeworm burdens colic after treatment; however, serious problems are rare in these cases.

Two other points may aid in decision making: (1) young horses (less than 6 years of age) may be most at risk for tapeworm-related problems; and (2) horses with no pasture access are not at risk, unless they have been on pasture in recent years.

Small strongyles

Small strongyles, or cyathostomes, are among the most problematic internal parasites in horses.* For part of their lifecycle, larvae are encysted in the bowel wall, insusceptible to most dewormers. The encysted stage typically lasts a few months (*e.g.*, over winter), but it can persist for more than 2 years. A further problem is that infestation with encysted small strongyles is undetectable by fecal egg count, as larvae do not produce eggs.

[*2016 Note: Large strongyles, notably *Strongylus vulgaris* (bloodworms or redworms), are once again on the rise, owing to casual deworming practices in this post-ivermectin era.]

Ivermectin and most other dewormers* are effective against the adult worms. But only two currently available dewormers claim to be effective against the encysted stages:

- moxidectin (Quest®), at the recommended dose and schedule
- fenbendazole (Panacur®, Safe-Guard®, and others), at *2x the standard dose*, daily for 5 days

These products/schedules are often referred to as *larvicidal* treatments, because they are targeted against the larvae. According to some studies, moxidectin is less effective against the *early* encysted stages (the early third-stage larvae, or EL3s) than the 5-day course of double-dose fenbendazole. As the majority of encysted larvae are EL3s rather than late L3s or L4s, the fenbendazole program

may be more effective than moxidectin. [2016 Note: However, larvicidal treatment with fenbendazole may cause more inflammation in the bowel wall than with moxidectin, at least in immature horses.^{6,7}]

(*It is now fairly common for adult small strongyles to be resistant to standard doses of pyrantel pamoate and to several of the benzimidazole anthelmintics, including mebendazole, oxfendazole, thiabendazole, and fenbendazole. However, it seems that the 5-day, double-dose fenbendazole regimen is effective against both adult strongyles and encysted larvae.)

When to treat. When to use the larvicidal treatment depends on geographic location, time of year, pasture management, and the deworming program. As infective larvae are picked up while the horse is grazing, a common recommendation for horses in cooler climates is to use the larvicidal treatment in the autumn, after the grazing season has ended.

In areas of the country in which horses may graze year-round, where in the deworming program to include the larvicidal treatment should be a decision for you and your veterinarian to make together. The manufacturer of Panacur recommends using the larvicidal treatment in July for horses in the south-central states and the southwest, and in May and again in November for horses in the deep south. They also recommend giving every newly introduced horse the larvicidal treatment on arrival, which is a very good strategy.

Strongid C. Daily pyrantel tartrate (Strongid C or its generic equivalent) is not effective against encysted small strongyles. But when used consistently, it effectively prevents new infections, and thus invasion of the bowel wall with incoming larvae. However, before beginning the Strongid C program, adult horses should be given a larvicidal treatment (either moxidectin or fenbendazole) to remove any encysted larvae already present.

8. Regular dental care

Regular dental care means having the horse's teeth examined every 6 to 12 months by an equine veterinarian who has an interest in equine dentistry. Whether or not the horse's teeth need floating (or more involved dental procedures) this frequently will depend on the horse's age, head/jaw conformation, dental history, and diet. Regular dental examination is particularly important in older horses (late teens and beyond).

9. Environmental management

In terms of colic incidence, good environmental management includes minimizing the following:

- opportunities for intake of foreign materials, such as baling twine, rope, and sand
 - inspect hay for baling twine, sticks, and other foreign material before feeding it
 - do not leave baling twine lying around where curious horses can nibble on it and possibly swallow it
 - avoid using rubber fencing, particularly with young horses; swallowed pieces of rubber can cause intestinal obstruction
 - recommendations for reducing sand intake are discussed on page 75
- the incentive for behavioral problems ('stable vices')
 - turn out horses for as much of the day as possible, preferably with compatible company

- make sure that stabled horses always have hay and can see other horses nearby; provide stall toys if necessary, although they are a poor substitute for outdoor activity and social interaction
- exposure to poisonous plants and chemicals
 - inspect the pastures for poisonous plants; contact your county extension agent for help in identifying suspect plants
 - avoid overgrazing pastures; well-fed horses usually avoid poisonous plants
 - follow the label instructions when using insecticides, and store all harmful chemicals away from feed storage areas
 - do not administer any prescription drugs (including anti-inflammatory medications) without or against veterinary advice

10. Pay attention

This strategy is not intended to point the finger at people whose horses have colicked. Horses can and do develop colic under the best of management situations and with the most caring and diligent of owners. The following is not an exhaustive list, but is simply meant as a reminder of some common sources of problems:

- check feeders before each meal to see if the horse is eating all its feed
- if the horse is leaving feed, check the feed quality before investigating a problem with the horse — unless, of course, the horse appears to be ill
 - moist feed additives can quickly turn any leftover feed sour in warm weather, and high-fat products may become rancid
 - check each new batch of hay for foreign material, mold, weeds, and overall quality
- note the amount, color, and consistency of the horse's manure when cleaning stalls or paddocks
- monitor the amount horses are drinking if water is provided in a bucket or trough
 - this is particularly important in very hot and very cold weather
 - check automatic waterers daily, especially in the winter when water pipes may be frozen
- when horses are fed in groups, watch to make sure each horse gets its share of feed
 - add an extra pile of hay to prevent fighting and ensure that every horse gets enough
 - when feeding grain or supplements, feed each horse separately
- monitor each horse's body weight or body condition regularly, and keep records throughout the year
- check pastured horses at least once a day to make sure they are well and have plenty of water
 - check broodmares at least twice a day during the last few months of pregnancy and the first few months after foaling
- regularly inspect pastures by walking through them
 - what may seem like a reasonable amount of grass from a distance can be meager up close or consist mostly of weeds
 - horses are selective grazers, often leaving grass that seems fine to us; don't assume that what they've left they'll eat later

- inspect pastures frequently toward the end of the grazing season as the grass matures and becomes very dry and stemmy
- provide good quality hay if the amount of palatable grass in the pasture declines significantly
- also provide good quality hay during the spring, when the new grass may not meet the horse's minimum daily requirement for roughage (see page 60)

Preventing Specific Types of Colic

Most of the following recommendations for preventing specific types of colic, or preventing colic in particular types of horses or situations, are based more on practical experience and extrapolation from clinical studies than on 'hard data' from scientific research. Hopefully, in the next few years studies into particular types of colic will allow more specific recommendations.

Spasmodic or 'gas' colic

Spasmodic colic is the most common type of colic in adult horses. Probably the two most frequently incriminated factors are high-carbohydrate diets (*e.g.*, grain, lush pasture) and internal parasites. Implementing the ten management strategies discussed in the first part of this chapter can substantially reduce the incidence of spasmodic colic. The following recommendations are especially important:

- keep the amount of concentrates (grain and grain-based sweet feed or pellets) to a minimum
 - limit the total amount fed in each meal, and feed roughage (*e.g.*, chopped or pelleted hay) with the concentrates
- avoid suddenly turning horses out onto lush spring pasture full-time; instead, gradually increase their grazing time over 1–2 weeks
- feed hay to pastured horses during the spring flush, even though there may be plenty of grass
 - most horses on lush pasture will eat a surprising amount of hay; in fact, they may need it to meet their daily roughage requirements (see page 60)
 - if necessary, limit the time spent on lush pasture until the grass matures a little
- provide daily exercise — every day, in some form
- maintain a regular deworming program
 - in some horses, daily Strongid C can reduce the incidence of repeated bouts of colic

Large colon impactions

Most large colon impactions can be prevented by following the ten strategies discussed earlier. Particularly important are providing:

- good quality roughage, especially hay that is not too mature
 - poor quality roughage is one of the key factors in most impactions, whether of the large colon, the small colon, or the ileum
 - selecting good quality hay is discussed on page 66
- access to fresh, clean water at all times

- many large colon impactions occur when water intake is reduced for some reason
- if necessary, add salt to the diet or provide a salt block to encourage the horse to drink more
- daily exercise
- as much pasture turnout as available and advisable (*e.g.*, limit turnout time or use a grazing muzzle in horses and ponies at risk for pasture-associated laminitis)

Avoiding colic at shows and competitions

The most common types of colic in horses at shows or other competitions away from home are spasmodic colic and large colon impaction. The most likely factors are the stress of transport and strange surroundings, a change of water and routine (feeding, exercise, and turnout schedules), and in some cases a change of bedding. Thus, the most effective preventive strategy involves minimizing changes:

- feed the same ration as fed at home, including hay, and keep to the horse's regular feeding schedule as much as possible
- make sure the horse has good quality hay at all times
- make sure the horse has fresh, clean water at all times
 - with horses that are reluctant to drink 'strange' water, take water from home or flavor the water with something the horse likes, such as molasses or peppermint
 - add salt or electrolytes to the ration or provide a salt block to encourage the horse to drink
- exercise the horse each day; longe, ride, or drive the horse on days when you are not competing
- hand-graze the horse for at least 30 minutes every day, if there is a suitable area; otherwise, hand-walk the horse around the grounds
- if possible, use the same type of bedding as used at home
 - horses bedded on shavings at home will often eat straw bedding if there is insufficient hay available, and sometimes just for novelty or out of curiosity
 - to avoid impaction colic in horses that must be bedded on straw, feed plenty of good quality hay; a small amount of straw, eaten out of curiosity, is unlikely to cause impaction
- if possible, make sure the horse has compatible company nearby

Large colon displacements

Most large colon displacements can be prevented by following the ten strategies discussed in this chapter. Of particular importance are these:

- keep the amount of concentrates to a minimum
 - high-grain diets are a common factor in horses with large colon displacements
- feed plenty of high-quality roughage
- provide regular exercise and as much turnout as possible
- maintain an effective deworming program

Large colon twists in broodmares

The reason large colon twists (volvulus) are most common in broodmares, especially after foaling, is not completely known. But it is conceivable that in recently foaled mares it is a combination of two factors: abdominal fill and altered bowel motility.

Abdominal fill. During pregnancy, the growing fetus occupies progressively more of the abdomen, such that in late pregnancy much of the abdomen is taken up by the fetus. After the mare has foaled, but before the abdominal wall has regained its nonpregnant tone, there is suddenly a lot of extra room in the abdomen.

Altered bowel motility. With the large colon so mobile (see Chapter 1), it is perhaps surprising that displacements and twists are not more common after foaling. This suggests that abnormal bowel motility is a key player. The energy requirements of late pregnancy and in the first few weeks of lactation are high and most often are met by increasing the amount of concentrates fed. This is an appropriate nutritional strategy for broodmares. However, as discussed in Chapter 2, feeding large carbohydrate meals causes an increase in colon gas, so a cycle of rapid inflation and gradual deflation may be set up in the colon in horses fed large amounts of grain.

This effect, together with altered bowel motility caused by the products of carbohydrate fermentation, could make displacement more likely. It also explains how displacements and twists can occur before foaling and in nonpregnant mares and male horses. There has also been some suggestion that marginally low calcium levels (which can also affect bowel motility) could be involved in the first few weeks after foaling, when milk production is highest.

Recommendations. Based on these assumptions, recommendations for preventing large colon displacements and twists in broodmares include these:

- feed plenty of good quality roughage, particularly in the first few weeks after foaling
 - in late-pregnant mares, roughage intake may be limited by the size of the fetus, so forage quality is particularly important
- feed a high-fat balanced ration, in place of traditional grain-based concentrates, to meet the mare's increased energy needs
 - a mare's nutritional needs increase in late pregnancy and are highest during the first 2 to 3 months of lactation
- ensure adequate calcium intake in recently foaled mares

Ileal impactions

Ileal impactions can occur for a variety of reasons, although the big two are tapeworms and poor-quality hay, especially coastal Bermuda grass hay. Treatment for tapeworm infestation is discussed on pages 68 and 69. Given that there is some evidence for an association between ileal impaction and feeding coastal hay, at least in the southeastern US, it may be wise for owners in this part of the country to do one or other of the following:

- if the coastal hay that is available is not of good quality (green, soft, and fragrant), buy another type of hay instead, and transition the horse from the current batch of coastal hay to the new hay

- if lower-quality coastal hay must be fed, then mix it with *good quality* hay of another type, either a grass or a legume hay; the goal is to feed less of the coastal hay without reducing the horse's overall roughage intake

Mixing coastal hay with a legume hay, such as alfalfa, is a good strategy anyway. Legume hays are a little higher in digestible energy and other nutrients than grass hays, which could make up for the lower quality of the coastal hay. Table 3.3 on page 83 lists the average nutrient composition of common hays.

(Note: Ileal impaction does not appear to be a problem when horses graze coastal Bermuda grass pastures.)

Small colon impactions in Miniature Horses

Three factors appear to be important in preventing small colon and other impactions in Minis:

- feed only high-quality roughage
 - when buying hay, choose the leafiest, least stemmy hay available
- continue regular dental care
 - because of the shape of their heads, Minis are prone to dental problems throughout their lives
 - dental care is particularly important in young Minis
- keep the horse's environment free of swallowable foreign materials, especially with young Minis

Miniature horses are also susceptible to the various types of colic that occur in larger breeds, so the ten management strategies discussed in this chapter are worthwhile when keeping these little horses.

Sand colic

The most common means of preventing sand colic is by regularly feeding psyllium (Metamucil® or its equine or generic equivalent). However, veterinary opinions are divided on the effectiveness of psyllium in ridding the large colon of sand. A couple of well designed studies have shown that adding psyllium to the diet, or even directly into the digestive tract during surgery, does not increase sand removal from the large colon. But some veterinarians, particularly those who practice in sandy areas, firmly believe that feeding psyllium or administering it by stomach tube does aid in elimination of sand from the bowel and in prevention of sand colic.

Some veterinarians recommend feeding psyllium on a daily basis to horses on sandy pastures. Others suggest periodic treatments (*e.g.*, once or twice a month). Mineral oil and bran are of little or no benefit in ridding the bowel of accumulated sand. Mineral oil may, however, be of some use when treating sand impactions. (Although, if the impaction is not relieved and the horse must go to surgery, mineral oil in the colon can make the surgery more difficult and compromise bowel healing.)

Researchers at the University of Florida⁸ recently conducted a study on sand intake and removal in horses, with the following results:

- significant amounts of sand may be consumed when grain is fed in contact with sand, or when horses retrieve grain dropped onto sand
- very little sand is consumed when grass hay is fed on sand; but because of its small leaf size and high palatability, more sand may be taken in when alfalfa hay is fed on sand

- feeding grass hay at a rate of 1.5% of body weight per day (15 lb/day for a 1,000-lb horse) was just as effective in ridding the bowel of sand as feeding psyllium (either as a single treatment or twice a day in feed)
- feeding grass hay at a rate of 2.5% of body weight per day (25 lb/day for a 1,000-lb horse) was even more effective

The authors concluded, “hay may be primarily responsible for movement of sand through the gut and that the larger the hay intake (2.5% vs. 1.5%), the quicker the sand moves through.”

Management. Regardless of whether psyllium is used, *it is important to minimize the horse’s opportunity to eat more sand:*

- when feeding horses outside, minimize sand intake with one of the following methods
 - raise outside feeders off the ground and feed hay in a hay net or rack
 - use feeders and hay nets/racks that minimize spillage
 - lay a large sheet of plywood, carpet, or rubber matting beneath the feeder and keep it swept clean of sand
 - feed the horses inside, then turn them out afterward
- practice good pasture management to minimize sand intake during grazing
 - avoid overstocking and overgrazing
 - improve the pastures as needed
 - provide good quality hay when the pasture quality declines or is inherently poor

Enteroliths

Recommendations for preventing enteroliths in at-risk horses center on limiting the amount of protein, magnesium, and phosphorus in the diet to only what is recommended for the horse’s size and life stage. At-risk horses include Arabians in ‘enterolith territory’ (see Chapter 2, page 36) and horses that have had enteroliths removed or have been seen to pass small stones in their manure.

Mineral intake

Enteroliths are primarily composed of magnesium, ammonium, and phosphorus. Horses with enteroliths reportedly have higher concentrations of these (and other) minerals in their colons. So, it may be worth having the mineral content of the horse’s diet (grain, hay, pasture, and supplements) and water analyzed.

Dietary adjustments can then be made to reduce the horse’s intake of magnesium, protein, and phosphorus to levels more in line with the NRC recommendations for that horse’s age, size, and activity level. Daily protein and phosphorus requirements for adult horses are listed in Table 3.2 on page 82. Daily magnesium requirements for horses weighing 400 to 500 kilograms (900 to 1,100 pounds) are 6 to 7.5 grams (g) per day for maintenance; 7.5 to 9.5 g/day for horses in light work; and 12 to 15 g/day for horses in very heavy work.*

[*2016 Note: These values are from the 6th revised edition of *Nutrient Requirements of Horses*, published by the NRC in 2007.]

Common feeding recommendations include the following:

- eliminate alfalfa from the diet or feed it 'diluted' with some other roughage source, such as grass hay
 - note: the horse's overall roughage intake should not be decreased in the process
- limit the amount of grain and bran in the diet
 - compared with most forages, grains are high in phosphorus (see Table 3.3 on page 83)
 - as it is a grain byproduct, bran is also high in phosphorus

Nidus

Most enteroliths form around a central core, or nidus, most often some type of foreign material such as a piece of wire, a pebble, or baling twine. So, keeping the horse's feed and environment clean and free of 'potential niduses' may be important in preventing enterolith formation. Fibrous plant material can also act as a nidus, so once again, roughage quality is important.

Acidifiers

Enteroliths form more readily when the contents of the colon are less acidic than normal. In fact, outside the body the outer few millimeters of an enterolith can be dissolved by placing the stone in a mildly acidic solution such as vinegar. This fact has led some people to recommend feeding vinegar (*e.g.*, 1 cup apple cider vinegar twice a day) to at-risk horses.

But although one study⁹ showed that feeding vinegar twice daily to ponies increased the acidity in the colon, existing enteroliths were dissolved extremely slowly and only partially. This strategy is not effective with large enteroliths, and there is no evidence that feeding vinegar prevents enteroliths from forming.

Gastric ulcers

There are two separate regions in the lining, or mucosa, of the horse's stomach where ulcers can form: the glandular mucosa and the squamous mucosa. The glandular mucosa is in the lower part of the stomach and is the 'active' area; it is the site of acid and enzyme production. Protective substances such as bicarbonate and mucus are also secreted by the glandular mucosa. The squamous mucosa is in the upper part of the stomach; it does not secrete acid, enzymes, or protective substances.

Although gastric ulcer disease is not fully understood in horses, it is known that the site of ulceration (glandular vs. squamous mucosa) depends on the cause. Nonsteroidal anti-inflammatory drug (NSAID) induced ulcers occur in the glandular mucosa. These drugs cause ulceration by inhibiting production of prostaglandins — substances that have a role in protecting the mucosa from erosion by gastric acid. Stress-induced ulcers occur in the 'unprotected' squamous mucosa.

Preventing NSAID-induced ulcers

As discussed in Chapter 2, any NSAID can cause ulceration, although phenylbutazone ("bute") and flunixin (Banamine®) are most often incriminated. Preventing NSAID-induced ulcers involves the following:

- use these drugs only when necessary
- keep the dosage and frequency as low as possible and the duration of treatment as short as possible
- do not combine two or more NSAIDs, a practice known as ‘stacking’; for example, do not give bute and Banamine together
- make sure the horse always has plenty of fresh water

Vegetable oil. Vegetable oils are relatively high in linoleic acid, which the body can use to produce the prostaglandins that help protect the gastric mucosa from acid erosion. It has been suggested that adding ½ to 1 cup of vegetable oil to the feed twice a day may help protect the stomach from ulceration. But whether or not this strategy is effective remains to be seen.

Preventing stress-induced ulcers

Most horses with stress-induced ulcers respond to the ten simple management strategies discussed in this chapter. Of most important are the following:

- make sure the horse has good quality forage available at all times
 - food buffers the gastric acid, so keeping food in the stomach helps protect the mucosa from acid damage
 - unlike grains and processed feeds, hay remains in the stomach for several hours, which may help limit acid damage
- minimize the amount of concentrates in the diet, and feed the concentrates mixed with roughage
 - some fermentation of carbohydrates occurs in the stomach, so feeding grain may add to the acid load in the stomach
 - when a high-energy diet must be fed, use a high-fat balanced ration and feed it in several small meals per day
- provide as much pasture turnout as possible, for exercise, grazing, and social interaction
- keep to regular feeding and exercise schedules

As suggested by one recent study,¹⁰ feeding alfalfa may reduce the incidence and severity of gastric ulcers. Adding vegetable oil to the diet may also be of benefit, both to help prevent ulcers and as a supplemental energy source.

Acid suppressors. Histamine type 2 (H₂) blockers, such as cimetidine (Tagamet®) and ranitidine (Zantac®), are the mainstay of ulcer therapy in foals and adult horses. But whether they are effective for ulcer prevention is not clear.

Recently, omeprazole, a potent acid suppressor used to treat gastric ulcers in humans, has become available in paste-form for use in horses (GastroGard®). Studies indicate that this drug speeds ulcer healing and can prevent new ulcers from forming in horses in high-stress occupations such as race training. But whether this strategy will be cost-effective and safe long-term needs further evaluation.

[2016 Note: Since *Preventing Colic in Horses* was published in 1999, omeprazole has become the most commonly used drug for the treatment and prevention of gastric ulcers in horses. However, while its long-term safety appears to be confirmed, it is not always cost-effective.]

Right dorsal colitis

Inflammation and ulceration of the right dorsal colon is most often associated with NSAID use, particularly phenylbutazone and flunixin (bute and Banamine). Thus, preventing right dorsal colitis involves avoiding NSAID use unless absolutely necessary; keeping the dose, frequency, and duration of treatment low when these drugs are needed; and making sure the horse has access to fresh, clean water at all times. The harmful effects of NSAIDs are more likely in horses that become even mildly dehydrated.

Other less common causes of right dorsal colitis are Potomac horse fever and internal parasites. Vaccinating against Potomac horse fever, preventing access to natural water courses (rivers and streams) in areas where the disease is common, and using an effective deworming program help prevent colitis from these agents.

Dietary management. Horses recovering from right dorsal colitis are often kept on diets low in long-stem roughage (*i.e.*, hay). Complete pelleted feeds are recommended, both in the recovery period and long-term. However, good quality hay may actually be beneficial in these horses because the proportion of volatile fatty acids produced during its microbial digestion in the large colon favors repair of ulcerated areas.

Verminous arteritis (*Strongylus vulgaris* infestation)

Preventing colic caused by *Strongylus vulgaris* (redworms or bloodworms) is a simple matter of regularly using a dewormer that is effective against the larval stages of this parasite. Suitable products include ivermectin, moxidectin (Quest®), fenbendazole (Panacur® at double the standard dose, daily for 5 days), and daily pyrantel tartrate (Strongid C®). Consult with your veterinarian to devise a suitable deworming program for your horses. Good pasture management is also important, regardless of how effective a particular deworming product or program claims to be.

Meconium impaction in newborn foals

Some breeders and veterinarians give enemas to all newborn foals, simply to prevent meconium impaction. This approach has merit in that the foals that may have developed meconium impaction have been spared the stress and pain of impaction. However, others feel that this approach is excessive and prefer simply to observe all newborn foals closely, given enemas only to those having difficulty passing their meconium. In most foals, nursing from the mare and moving around are sufficient to stimulate bowel activity for meconium passage.

All foals strain a little when passing their meconium; this is normal. If the foal has been straining for more than an hour without passing anything, it is usually safe to give a mild enema. But if the foal still does not pass its meconium or continues to strain after passing some meconium, call a veterinarian rather than giving another enema.

Roundworm (ascarid) impactions

The horses most at risk for roundworm impaction are foals, weanlings, and yearlings that:

- have never been dewormed or that have an unknown or questionable deworming history,
- look obviously parasitized (*e.g.*, pot-belly with a long, scruffy, dull haircoat), even if they have been dewormed, or

- have large, white worms in their manure or protruding from their anus

To prevent roundworm impaction in heavily parasitized foals, it is best to deworm the foal with a moderately effective product, such as fenbendazole or thiabendazole at the standard dosage. This approach reduces worm numbers without killing all the adult worms at once and creating an obstruction. After 1 to 2 weeks, the foal can be dewormed at a higher dosage or with a more effective product, such as ivermectin. Some veterinarians administer mineral oil by stomach tube to prevent roundworm impaction after deworming in these foals.

The most effective way of preventing roundworm impaction is by preventing roundworm infestation. This is as simple as maintaining an effective deworming program for all horses on the farm, especially broodmares and foals, and maintaining good pasture management. Roundworm eggs are particularly resilient, so each new foal crop is at risk. Most veterinarians recommend beginning the foal's deworming program at 6 to 8 weeks of age, with deworming every 2 months or daily pyrantel tartrate (Strongid C).

Colic in senior horses

Horses older than about 15 years of age are prone to certain types of colic that are not preventable (*e.g.*, strangulating lipoma, epiploic foramen entrapment, tumors; see Chapter 1). But like any other adult horse, older horses are also prone to spasmodic colic, large colon impactions, sand colic, *etc.*

The ten strategies outlined in this chapter should minimize the incidence and impact of these preventable types of colic in senior horses. Of particular importance are these:

- feed plenty of high-quality roughage
- feed a high-fat balanced ration if the horse's weight cannot be maintained on roughage alone
 - feed a ration that is specifically formulated for senior horses
 - old horses may be less competitive in a group-feeding situation, so it is best to feed them separately
- dental examination every 6 months, or as often as recommended by your veterinarian
- monitor pastured horses at least once a day

It is often said that 'old age is not a disease'. With good management (and a little good fortune), it is possible to keep most horses healthy and active well into their 20s.

[2016 Note: Where applicable, the nutritional tables on the following pages have been updated with data from the 6th revised edition of *Nutrient Requirements of Horses*, published by the National Research Council (NRC) in 2007. The original tables in *Preventing Colic in Horses* (1999) used data from the current edition at the time, the 5th edition, published in 1989.]

Table 3.1 Dietary proportions for specific types of horse or activity

Type of Horse & Activity Level	Roughage, minimum (% of diet)	Concentrates, maximum (% of diet)
Maintenance	100%	0%
Working Horses		
light work	65%	35%
moderate work	50%	50%
intense work	35%	65%
Breeding Horses		
stallion	70%	30%
pregnant mare (9–10 months)	80%	20%
pregnant mare (11 months)	70%	30%
lactating mare (first 3 months)	50%	50%
lactating mare (4+ months)	65%	35%
Growing Horses		
weanling	30%	70%
yearling	40%	60%
2-year-old (not in training)	65%	35%
2-year-old (in training)	50%	50%

Maintenance requirements are those needed to maintain body weight in an adult horse that does little or no regular work.

Light work is that performed by a show horse training for and participating in English or Western Pleasure classes, equitation, etc.

Moderate work is that performed by a working ranch horse, or a horse performing more athletic activities than showing (roping, cutting, barrel racing, jumping, etc.).

Intense work includes race training, polo, and 3-day eventing.

Note: Regardless of the ratio of hay to grain, all horses should be fed at least 1% of their body weight per day of good quality roughage (pasture and/or hay), and preferably at least 2% of body weight/day.

Table 3.2 Daily nutrient requirements for adult horses of various sizes and activity levels

Body Weight & Activity Level	Calories (Mcal/day)	Crude Protein (grams/day)	Calcium (grams/day)	Phosphorus (grams/day)
400 kg (880 lb)				
maintenance	13.3 (12.1–14.5)*	504 (432–576)*	16.0	11.2
light work	16.0	559	24.0	14.4
moderate work	18.6	614	28.0	16.8
heavy work	21.3	689	32.0	23.2
very heavy work	27.6	804	32.0	23.2
500 kg (1,100 lb)				
maintenance	16.7 (15.2–18.2)*	630 (540–720)*	20.0	14.0
light work	20.0	699	30.0	18.0
moderate work	23.3	768	35.0	21.0
heavy work	26.6	862	40.0	29.0
very heavy work	34.5	1,004	40.0	29.0
600 kg (1,320 lb)				
maintenance	20.0 (18.2–21.8)*	756 (648–864)*	24.0	16.8
light work	24.0	839	36.0	21.6
moderate work	28.0	921	42.0	25.2
heavy work	32.0	1,034	48.0	34.8
very heavy work	41.4	1,205	48.0	34.8

Calories = digestible energy, measured in megacalories (Mcal)

* The 2007 NRC guidelines list *minimum*, *average*, and *elevated* categories for maintenance requirements. *Minimum* applies to adult horses with a sedentary lifestyle, due either to confinement or a docile temperament. *Average* applies to adult horses with alert temperaments and moderate voluntary activity. *Elevated* applies to adult horses with nervous temperaments or high levels of voluntary activity. In this table, the *average* maintenance requirement is given, with the *minimum* and *elevated* requirements in parentheses below it.

Updated definitions for work (exercise) categories in the 2007 NRC guidelines:

Light work includes recreational riding, beginning of training programs, and showing (occasional).

Moderate work includes school horses, recreational riding, beginning of training, showing (frequent), polo, and ranch work.

Heavy work includes ranch work, polo, showing (frequently, in strenuous events), eventing (low to medium level), and race training (middle stages).

Very heavy work includes racing (Quarter Horse, Thoroughbred, Standardbred, or endurance) and elite 3-day eventing.

Table 3.3 Average nutrient composition of some common feedstuffs

Feed	Calories (Mcal/lb)	Crude Protein (grams/lb)	Calcium (grams/lb)	Phosphorus (grams/lb)
Forages				
Alfalfa meal or pellets (17% crude protein)	1.10	87.3	6.7	1.3
Bermuda grass hay, coastal	0.85	47.3	2.2	1.2
Bermuda grass hay, Tifton	0.85	62.3	1.8	1.0
Cool season grass hay*				
immature (before bloom)	1.07	81.8	3.3	1.5
mid-mature (midbloom)	0.99	60.5	3.0	1.3
mature (late bloom)	0.93	49.1	2.1	1.2
Cool season grass pasture	1.09	75.0	2.5	2.0
Cool season grass silage (‘haylage’; mid-mature)	0.98	76.4	2.7	1.6
Legume hay (e.g., alfalfa) mid-mature	1.10	94.5	6.2	1.4
Concentrates				
Barley, rolled	1.67	56.4	0.3	1.8
Beet pulp	1.27	45.5	4.1	0.4
Corn, cracked	1.76	42.7	0.2	1.4
Oats, rolled	1.49	60.0	0.5	1.8
Rice bran	1.52	70.5	0.3	8.1
Wheat bran	1.46	78.6	0.6	5.4
Wheat, rolled	1.74	64.5	0.2	2.0
Wheat middlings	1.55	84.1	0.7	4.6

Calories = digestible energy, measured in megacalories (Mcal)

Nutrient values are given as Mcal or grams *per pound of feed* (all converted to 100% dry matter for side-by-side comparison).

*Cool season grasses include Kentucky bluegrass, ryegrass, fescue, orchardgrass, bromegrass, and timothy.

These values are taken from the 6th revised edition of *Nutrient Requirements of Horses* (2007). Growing conditions can dramatically affect the nutrient content of feedstuffs, so the values in this table are general guidelines only. Feed analysis is recommended to determine the exact nutrient content of a particular batch of feed. Another useful resource is the Common Feed Profiles database kept by Equi-Analytical Laboratories (www.equi-analytical.com).

Bibliography

1. Jackson SG, Pagan JD (1996) Nutrition and productivity: practical problems related to nutrition. *Proceedings of the 18th Bain-Fallon Memorial Lectures*, Australian Equine Veterinary Association 18: 139–140.
2. Argenzio RA (1999) Comparative pathophysiology of nonglandular ulcer disease: a review of experimental studies. *Equine Veterinary Journal Supplement 29*: 19–23.
3. Berschneider HM, Blikslager AT, Roberts MC (1999) Role of duodenal reflux in nonglandular gastric ulcer disease of the mature horse. *Equine Veterinary Journal Supplement 29*: 24–29.
4. Cohen ND, Gibbs PG, Woods AM (1999) Dietary and other management factors associated with colic in horses. *Journal of the American Veterinary Medical Association 215*: 53–60.
5. de Fombelle A, Jacotot E, Drogoul C, *et al.* (1999) Effect of the hay:grain ratio on digestive physiology and microbial ecosystem in ponies. *Proceedings of the 16th Equine Nutrition and Physiology Symposium 16*: 151–154.
6. Steinbach T, Bauer C, Sasse H, *et al.* (2006) Small strongyle infection: consequences of larvicidal treatment of horses with fenbendazole and moxidectin. *Veterinary Parasitology 139*: 115–131.
7. Betancourt A, Lyons ET, Horohov DW (2015) Characterisation of the inflammatory cytokine response to anthelmintic treatment in ponies. *Equine Veterinary Journal 47*: 240–244.
8. Lieb S, Weise J (1999) A group of experiments on the management of sand intake and removal in equine. *Proceedings of the 16th Equine Nutrition and Physiology Symposium 16*: 257.
9. Hintz HF, Hernandez T, Soderholm V, *et al.* (1989) Effect of vinegar supplementation on pH of colonic fluid. *Proceedings of the 6th Equine Nutrition and Physiology Symposium 6*: 116–118.
10. Nadeau JA, Andrews FM, Mathew AG, *et al.* (1999) Implications of diet in the cause of gastric ulcer disease in horses. *Proceedings of the 16th Equine Nutrition and Physiology Symposium 16*: 20–21.