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INTRODUCTION

There are numerous causes of disease and death in nursing beef calves. Within the first several days of life, the leading causes of beef calf disease are metabolic and behavioral problems, many of which are the direct or indirect result of dystocia.[11] Thereafter, the most common calfhood problems are infectious diseases. Infections of the respiratory and gastrointestinal system account for the overwhelming majority of calf disease and death in the United States.[5] Gastrointestinal diseases tend to be most common within the first month of life, while the respiratory diseases tend to be more important after that time.[2,12]

There are numerous causes of gastrointestinal infection in calves and is very important to distinguish between them, because they can have very different modes of prevention and treatment.[1,2] Calf scours is the most common type of gastrointestinal infection. Scours is caused by microbes that affect the lining cells of the gut but do not invade further into the body. These agents cause disease and death by increasing fluid and electrolyte losses via diarrhea. Affected calves can routinely be saved if treatment includes sufficient fluid and electrolyte to counterbalance the diarrheic losses.[9]

A considerable amount of research effort has been directed toward understanding, treating and preventing calf scours. Although our best attempts at prevention cannot eliminate calf scours, we have numerous methods of limiting the disease. Importantly, we have very effective means for limiting calf death when the disease does occur. Most of the treatment and prevention methods are readily available to the cow/calf producer.

CAUSES AND EFFECTS OF CALF SCOURS

The direct cause of calf scours is exposure to and infection by specific infectious agents. Indirect causes include the many factors that increase calf exposure to the microorganisms or decrease calf resistance to infection.[6,7] The microbes may act individually to cause diarrhea but frequently when a scours outbreak is found in a herd, two or more of these agents can be identified in affected individuals or in the group of scouring calves. Although each of these agents is unique, and they can cause disease in several different ways, the end effect of the infection in the calf is strikingly similar for all of the major scours-causing agents. The four agents that cause the majority of calf scours are rotavirus, coronavirus, cryptosporidia and K-99 *E. coli*.[2] Rotavirus and coronavirus have a very similar mechanism of action in the calf. Both viruses infect the lining cells of the intestinal tract and destroy the cells responsible for digestion

and absorption of milk. Damage to the gut can be repaired if the calf survives. The usual cause of death in animals affected by these viruses is tremendous fluid and electrolyte losses that result from the diarrhea and lead to severe dehydration and acidosis.[2]

Cryptosporidia is a protozoan parasite similar to coccidia. Like rota- and coronaviruses, it affects the intestinal lining cells, resulting in damage to the cells and subsequent decreased absorption and digestion. Cryptosporidia typically does not kill calves except by causing severe dehydration, electrolyte imbalance and acidosis.[2]

There are numerous different types of the bacteria *Escherichia coli* (*E. coli*) that can be distinguished by their cellular antigens and their ability to cause different effects during their infection and invasion of the body. Many types of *E. coli* are normal inhabitants of the gastrointestinal tract and do not cause disease.[2] On the other end of the spectrum, some *E. coli* have characteristics that allow invasion through the gut wall and spread to many different organs. This causes septicemia and severe toxic changes that are frequently lethal in the infected animal. These are known as the invasive *E. coli*.[1,14] In calves, the characteristic *E. coli* that causes simple scours is termed K-99. The K-99 designation identifies an antigen that enables the *E. coli* to attach to the gut wall and secrete a toxin that affects the intestinal lining cells. The effects of this toxin are to stimulate hypersecretion of water and electrolytes from the cells.[2,14] The end effect of this activity is like that of the other scours causing organisms to produce severe diarrhea and electrolyte and fluid loss. It is important to realize that K-99 *E. coli* does not invade the intestine or kill calves directly, rather it kills calves via production of dehydration and severe acidosis. The loss of fluid can be so rapid and extreme that calves affected by this strain of *E. coli* can die within 24 hours from the onset of the disease. On the other hand, if calves are supported with sufficient fluid and electrolyte replacement, they are very efficient at clearing this organism from the intestinal tract, thus can effectively cure themselves.

The four microbes just described are the leading causes of calf scours but they are not the only causes of diarrhea. An important distinction needs to be made between calf scours and other types of infections that may produce diarrhea but also other organ problems. The prevention, treatment and eventual prognosis of these diseases are quite different. In calf scours, the primary problem is diarrhea leading to electrolyte and fluid losses as the major disease effect. The diarrhea seen in calves with some other infections is only one of many problems caused by the infecting organism and in such cases calves usually die because of damage to other tissues besides the gut. Calf scours primarily affects calves within the first three weeks of life. The more aggressive diseases that affect multiple organ systems can occur early in the calf's life but can and frequently do affect calves older than three weeks of age.[2,12,14]

Bovine viral diarrhea (BVD), in addition to diarrhea, tends to produce weak calves or calves with congenital birth deformities and when an outbreak of BVD occurs in a herd, older animals are also usually affected. The virus can also cause reproductive problems, abortion, and can predispose to pneumonia via suppression of the immune system. Clostridial enteritis is a sporadic disease of neonatal calves with very high mortality and is caused by *Clostridium perfringens*. These bacteria can proliferate rapidly in the intestine of some calves and then secrete a very potent exotoxin. Affected calves usually die rapidly before the onset of diarrhea

due to the profound effects of the toxin on the vascular system.

The invasive types of *E. coli* are capable of invading beyond the gastrointestinal tract to cause septicemia (microorganisms in the blood). In this instance, the infectious bacteria can spread to any organ in the body, including lungs, brain tissue, kidneys, and joints and can cause severe damage at these infected sites. The *Salmonella* species of bacteria have been associated with calf enteritis but like the septicemic *E. coli*, *Salmonella* has a strong tendency to spread beyond the gut and cause widespread disease.[8]

A good diagnostic workup can and should distinguish between these different causes of diarrhea in calves. Again, making this distinction is important because successful treatment and prevention measures will depend on being appropriately directed at the right disease. The following discussion of prevention and treatment measures is aimed at calf scours and not at the more severe, but also more sporadic, systemic calf diseases.

Aside from the infectious causes of diarrhea, there are also occasional cases caused by excessive feeding of milk. These cases are known as nutritional scours and occur because of fermentation of excess milk in the intestinal tract. The same problem can occur with calves fed certain types of milk replacer. Generally this is the least severe form of diarrhea. While affected calves may show loose or watery feces, they rarely become dehydrated and generally maintain a very good appetite. The most common cause of nutritional scours is feeding of large quantities of milk at certain times with long time intervals between feedings. Therefore, nutritional scours are commonly seen in dairy calves fed only two times per day but is much less a problem in beef calves left to nurse naturally from the dam.

As discussed above, the infectious calf scours problems result primarily from excessive loss of water and electrolyte from the intestines. In severe cases, the diarrhea is so fluid that it contains little particulate matter and is mostly water, electrolytes and mucus. After a few days, blood may be present in the feces, as the severity of the enteritis increases. The end result is development of varying degrees of dehydration associated with severe electrolyte imbalance and acidosis. In mild states of dehydration, the calf will show dryness of the mucous membranes, loss of elasticity in the skin, concentrated urine and beginning retraction of the eye into the orbit. The extremities (legs, tail, ears) are usually cooler than the body due to constriction of peripheral blood vessels to counteract the decreased blood volume. The worse the dehydration and electrolyte loss, the more severely affected will be the calf. Mildly affected calves will be somewhat weak and depressed. With increasing severity, calves will show more severe depression, may be unable to stand, will lose their nursing reflex and will drop to subnormal body temperature. In even more severe cases, dehydration will lead to a calf that is unable to rise and will become comatose. When fluid and electrolyte losses are severe enough, affected calves will die.[2,9]

TREATMENT OF THE SCOURING CALF

With this understanding of the causes and effects of calf scours, we can devise very effective treatment measures. Since the leading cause of disease signs and death in the scouring

calf are dehydration, electrolyte loss and acidosis caused by the outpouring of fluid into the gastrointestinal tract, by far the most important treatment measure is replenishment of these vital fluids and electrolytes.[9] Numerous formulas are now commercially available for this purpose.

The loss of fluids that occurs with calf scours is a progressive problem. In the initial or mild stages of the disease, calves are still standing and orally administered fluids will be effectively used. As the disease progresses, however, and dehydration worsens, calves become more lethargic and decrease their own voluntary intake of fluids, whether via milk from the dam or oral electrolyte replacement fluids. The most common mistakes made in the use of commercially available electrolyte replacement fluids are waiting too long before administering these formulas or administering them too infrequently to affected calves. Administered early and frequently, these fluids help the calf maintain vigor and normal body temperature and allow it to continue sucking. Administering fluids too late, so that the calf is already depressed and down, or administering too little so that the calf continues to lose more fluid than it is receiving orally, allows the progressive fluid loss to continue and the calf's condition to deteriorate.[8]

When dehydration and acidosis are severe enough, normal intestinal function declines and orally administered fluids are not appropriately absorbed. In such cases, oral fluids do little to enhance calf survival. At this stage, the only effective means of preventing death is to administer intravenous fluid therapy. For severe cases with extremely rapid onset of dehydration, intravenous fluid administration may be the only effective treatment. For most cases, however, the progression of the disease is not nearly so rapid and the problem lies only in the missed opportunity to administer oral fluids at an earlier stage of the problem. Since calves with normal hydration can rapidly excrete excess water and electrolyte, it is usually better to administer oral electrolytes when in doubt than to wait until the calf is more significantly dehydrated.[2,8,9]

Other treatments besides fluids have been tried. Intestinal protectants such as Kaolin and pectin are favored by some but their efficacy in stopping fluid and electrolyte loss is highly questionable.[8] They may act to absorb toxins and thus help clear them from the intestinal tract but this again is very debatable. The intestinal protectants are at least not harmful. In contrast, numerous treatments have been devised to affect intestinal motility. At one time it was popular to use drugs that decreased intestinal motility with the assumption that hypermotility of the intestine was the cause of the diarrhea. We now know that most of the diarrhea causing organisms decrease intestinal motility and the use of such types of drugs is, in fact, contraindicated.[8]

Antibiotics have been extensively used in the treatment of calves with scours. These drugs can be given orally or systemically. The overall effect of oral antibiotics, however, is detrimental. A quick review of the organisms that cause calf scours shows that the major causes of calfhood diarrhea are resistant to antibiotics. Rota- and coronavirus are not affected by antibiotics at all, while cryptosporidia, like most coccidia, respond poorly or not at all to antibiotics. The K-99 serotype of *E. coli* that classically causes calf scours is routinely cleared by the calf as long as fluid therapy is provided to keep the calf alive. The invasive forms of *E. coli* and *Salmonella* that penetrate the intestine and cause septicemia will generally respond better to antibiotics administered systemically. Since these organisms typically cause a deterioration of

normal gut function, it is highly questionable how much orally administered antibiotic is appropriately absorbed to fight the infection. Furthermore, orally administered antibiotics have some deleterious effects on the calf.[8] Oral antibiotics alter the normal intestinal flora and in some cases can predispose to superinfections or infections with fungal organisms. Some of the antibiotics commonly used for scours actually inhibit glucose absorption from the intestine and alter the intestinal lining cells. In these cases, the continued use of oral antibiotics can actually lead to a prolongation of diarrhea.[8]

In summary, oral antibiotics are rarely effective in treating scours and sometimes can produce an adverse result. By contrast, when septicemia is suspected, antibiotic use is critical in the treatment of the disease but in such cases the type of antibiotic used should be based on accurate identification of the disease causing organism and the antibiotic is best administered systemically.[8]

Recently the use of natural biologic products to reestablish a normal balance of intestinal microorganisms has been suggested as a useful treatment for calf scours. Products containing either *Lactobacillus* or *Streptococcus faecium* are commercially available. It is debatable how effective they are, but it is likely that they are useful in cases where scours are very prolonged or when oral antibiotics have been used extensively.[8]

Electrolyte fluid administration is by far the most effective treatment for calves with scours. Because affected calves are typically weak and chilled, additional nursing care can be very important. In this regard, provision of warmth, dryness, protection from the elements and adequate nutritional support are all critical. Fluid therapy is most effective when it is administered aggressively and early in the course of the disease. The most critical factor may be the early recognition of affected calves. Caught early, most calves will respond very favorably to oral fluid therapy. Once the calf becomes more severely dehydrated so that it is weak and unable to rise, other routes of fluid administration such as intravenous fluid therapy may be the only way to save the calf's life. Other treatments may be beneficial but they are far less important than fluid and electrolyte replacement.[8,9]

PREVENTION OF SCOURS

For any infectious disease outbreak, the avoidance of losses can involve both the treatment of affected animals and the prevention of further cases. In the case of calf scours, we have very effective treatment measures that can limit the loss of affected calves in the majority of cases. Unfortunately, our ability to prevent the disease is not as good as we would really like. In witness to this, there are very few cow/calf operations that do not experience occasional outbreaks of calf scours. Part of the explanation of this problem lies in the complexity of the predisposing causes of calf scours and the fact that some of these factors are difficult to control or are adversely influenced by other positive management changes.

The most direct way to evaluate the likelihood of development of calf scours is to balance the factors that increase the likelihood of calf infection against those factors that increase the resistance of the calf to the infection. It has long been known that the absorption of

immunoglobulins by the calf from the dam's colostrum helps the calf ward off infectious disease.[6] Because of this important concept, a great bulk of our efforts to prevent calf scours have been directed at maternal vaccination and assurance of colostral ingestion by the calf. Assuring consumption of adequate volumes of high quality colostrum, preferably from the herd of origin, remains our best single method of enhancing calf health. Unfortunately, for the immunoglobulin to be effective in preventing the disease, it must be present in sufficient quantity at a site where it can neutralize the microorganism. It appears that colostral immunoglobulin is not as effective at preventing scours organisms from invading the gut lining cells as we had formerly hoped. Furthermore, colostral immunoglobulin protection is only one aspect of the infectious disease equation. It is clear that colostral transfer alone will not prevent scours unless other steps are taken to maximize calf resistance to disease and to minimize calf exposure to the infecting agents.[6,7]

Calves born in dystocia are more susceptible to disease and death. Immediately following delivery, calves from dystocia birth are more susceptible to metabolic and behavioral abnormalities that may lead to death within the first couple of days.[11] Dystocia also leads to increased occurrence of infectious disease. This is likely a reflection of decreased calf vigor, decreased heat production, and decreased immunoglobulin absorption.[4,11] All of these factors and others that are more poorly documented decrease the calf's resistance to disease. Deficient protein, energy or micronutrient nutrition of the dam prior to calving may also produce some of the same negative effects on calf vigor and disease resistance as does dystocia.[4,10] Management practices that enhance precalving maternal health and that decrease the incidence of dystocia or that minimize the impacts of dystocia on calves can all be expected to positively influence calf resistance to disease and eventual survival.

Management efforts directed at decreasing exposure to infectious agents will also be beneficial in minimizing calf scours problems.[6,7] Unfortunately, some of the efforts made to improve monitoring of delivery and thus to decrease dystocia also increase confinement of pregnant cattle and therefore enhance crowding and spread of infectious disease. To assist calving in first-calf heifers, they are frequently maintained in relatively confined environments. Calves from heifers are therefore subjected both to the effects of increased dystocia and to increased exposure to scours-causing organisms.[3,13] Maintaining a clean area for assisted delivery, washing the teats of heifers following an assisted delivery, cleaning the utensils used for administration of colostrum, cleaning and maintenance of dry maternity pens and movement of pairs out to a clean pasture as soon as possible after calving can all be useful in decreasing calf exposure to infection.

Inclement weather is a prime factor in encouraging the spread of calf scours. Cold wet weather not only stresses calves, but also increases exposure to scours-causing organisms that spread via fecal contamination of muddy areas. Shelters designed to afford protection for calves may contribute to the problem if insufficient space is provided or the shelters are not cleaned or moved periodically. While providing protection from the elements, such shelters also increase crowding and spread of infectious disease among calves.[7]

Prolongation of the calving period may also encourage spread of scours. Some of the

scours-causing organisms are shed in the feces of the dams and so increasing the period of calving can also increase the contamination of the calving area. Calving first-calf heifers before the older cows may improve the detection and management of dystocia in the younger animals and can provide a longer postcalving interval to breeding in these heifers but it also leads to a prolongation of the calving period. It has been recently documented that calving heifers early increases the risk of calf scours problems.[3,13]

Timing the calving period to coincide with the most likely good weather could also be useful in decreasing calf scours problems. Besides the effects of inclement weather on calf disease resistance and increased spread of infectious disease via mud contamination, poor weather can also increase crowding of animals. For many producers, the determination of optimum calving time is made based on factors that influence timing of sale, timing of the breeding season, etc. When calf scours problems are severe and linked to common weather problems, there may be good reason to more strongly consider the influence of calving time on calf health and consider changing the calving time.

In conclusion, precalving vaccination of the dam and adequate provision of colostrum to the calf remain important aspects of scours prevention. Alone, however, these management practices will not adequately prevent calf scours outbreaks. Other practices that are aimed at enhancing calf disease resistance and minimizing calf disease exposure are also of major importance. Programs to improve calf scours prevention should include evaluation of as many of these factors as possible.

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