

Strategies for Controlling Neonatal Diarrhea in Cow-Calf Herds — The Sandhills Calving System

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Abstract

Undifferentiated neonatal diarrhea is an economically important cause of morbidity and mortality in beef calves. Understanding the multifactorial nature of neonatal calf diarrhea in cattle populations is the basis for developing strategies for prevention. The common pathogens of neonatal calf diarrhea are endemic, and it is unlikely that cattle populations could be made biosecure from these agents. Managers of extensive beef cattle systems have limited practical opportunities to improve rates of passive transfer, and vaccines have not always been protective. Lactogenic immunity wanes, making calves age-susceptible and age-infective. For these reasons a biocontainment approach to control neonatal calf diarrhea seems prudent. The Sandhills Calving System is a biocontainment strategy to protect calves from effective contact with the agents of neonatal diarrhea by: 1) segregating calves by age to prevent direct and indirect transmission of pathogens from older to younger calves; and 2) scheduled movement of pregnant cows to clean calving pastures to minimize pathogen dose-load in the environment and contact time between calves and the larger portion of the cow herd. The effect of the system is to re-create the more ideal conditions that exist at the start of the calving season during each subsequent week of the season. The Sandhills Calving System has been tested over six and five calving seasons, respectively, in two privately-owned ranch herds. We have observed important and statistically significant reductions in morbidity and mortality due to neonatal calf diarrhea, and greatly reduced use of medications on these operations. Although the system has been tested and adopted in ranches typical of the Nebraska Sandhills, it should be useful elsewhere because the principles on which it is based are widely applicable.

Résumé

La diarrhée néonatale non spécifique, cause importante de morbidité et de mortalité des veaux, a de graves conséquences économiques chez les bovins de boucherie. La compréhension de la nature multifactorielle de la diarrhée néonatale dans le cheptel bovin servira de base aux stratégies de prévention. Les agents pathogènes couramment impliqués dans cette maladie sont présents de façon endémique et il est donc peu probable que l'on parvienne à assurer la biosécurité du cheptel bovin à leur égard. D'autre part, il est techniquement difficile pour les éleveurs des grands troupeaux de bovins de boucherie d'améliorer le transfert passif et les vaccins ne sont pas toujours efficaces. L'immunité lactogénique finit par décliner, ce qui rend les veaux sensibles et infectieux avec l'âge. Pour toutes ces raisons, le bio-confinement semble une approche plus prudente pour combattre la diarrhée néonatale des veaux. Le système de vêlage Sandhills est un bio-confinement visant à empêcher les veaux d'entrer en contact avec les agents responsables de la diarrhée néonatale en : 1) séparant les veaux en groupes d'âge pour prévenir la transmission directe et indirecte des agents pathogènes des veaux plus âgés aux plus jeunes, et 2) en programmant le transfert des vaches gestantes dans des pâturages propres pour minimiser la charge pathogène dans l'environnement et la durée du contact entre les veaux et la plus grande partie du troupeau des vaches. Ce système recrée les conditions presque idéales qui existent au début de la saison des vêlages et cela, chaque semaine pendant le reste de la saison. Nous avons testé le système Sandhills durant six et cinq saisons de vêlage, respectivement, dans deux ranchs privés. Nous avons observé une réduction importante et statistiquement significative de la morbidité et de la mortalité dues à la diarrhée néonatale des veaux, et

avons fortement réduit l'usage des médicaments dans ces deux fermes. Bien que ce système ait été testé et adopté dans les ranchs typiques des Sandhills du Nebraska, on pourrait l'implanter ailleurs puisqu'il se base sur des principes d'application très générale.

Introduction

Diarrhea is an important cause of illness and death of young beef calves.⁴⁴ The economic effects to beef cattle producers from neonatal diarrhea can be profound.^{3,40} Economic costs of the disease include loss of performance, mortality, and the expense of medication and labor to treat sick calves. In addition, herd owners and their employees often become disheartened after investing long hours to treat scouring calves during an already exhausting calving season. Neonatal calf diarrhea is a multifactorial disease.^{1,2,36} Agent, host and environmental factors play important roles in the occurrence of undifferentiated neonatal calf diarrhea; and knowledge of these factors become the basis for management intervention to control the disease.⁶

Agent factors

A number of infectious agents have been recovered from calves with neonatal diarrhea.^{1,2,4,6,10,21,23,24,26,42} Common agents of neonatal calf diarrhea include bacteria such as *Escherichia coli* and *Salmonella*, viruses such as rotavirus and coronavirus, and protozoa such as cryptosporidia. Bovine rotavirus, bovine coronavirus and cryptosporidia are ubiquitous to most cattle populations and can be recovered from calves in herds not experiencing calf diarrhea.⁶ Multiple agents can be recovered from herds experiencing outbreaks of calf diarrhea, suggesting that even during outbreaks more than one agent may be involved. The cow herd commonly serves as the reservoir of pathogens from one year to the next.^{12-14, 22, 34, 46}

Host factors

The important protective effect of maternal antibodies obtained from colostrum has been recognized for some time.⁴⁵ Calves obtain passive immunity against the common agents of calf diarrhea after absorbing antibodies from colostrum or colostrum supplements.⁷⁻⁹ The quality and quantity of colostrum ingested largely influences the level of passive protection. The presence of antibodies in colostrum directed against specific agents requires prior exposure of the dam to the agent. Vaccines are often used to immunize the dam against specific agents, and some commercially available colostrum supplements contain polyclonal or monoclonal antibodies directed against specific agents. Unfortu-

nately, vaccination or the use of colostrum supplements has not been universally successful for controlling undifferentiated neonatal calf diarrhea.

Calves become ill or die from neonatal diarrhea within a narrow range in age (Figure 1).^{1,10,11,42} The age-specificity of undifferentiated neonatal calf diarrhea may not be explained solely by the incubation period of the agents, because disease is observed in colostrum-deprived and gnotobiotic calves within a few days of virus challenge regardless of age.^{16,17,35} It is possible that calves have an age-specific susceptibility to neonatal diarrhea disease as lactogenic immunity wanes and before the calf is fully capable of developing an active immune response.⁷

Regardless of the reason for the age specificity of undifferentiated neonatal calf diarrhea, this period defines the age of susceptibility and the ages of those calves most likely to become infective and shed the agents of neonatal calf diarrhea in feces.^{18,25,28,29,34,43} The age specificity of susceptibility and infectivity has important implications for controlling transmission of the pathogens of neonatal diarrhea, because in some calving systems the number of susceptible and infective calves can change dynamically over the course of time.

The age of the dam also explains a calf's risk for undifferentiated neonatal diarrhea. Calves born to heifers are at higher risk for neonatal diarrhea and have lower maternal antibody levels than calves born to older cows.³⁸ Increased susceptibility to disease of calves born to heifers is probably because heifers produce a lower volume of colostrum, although decreased calf vigor due to dystocia may also contribute.^{30,31}

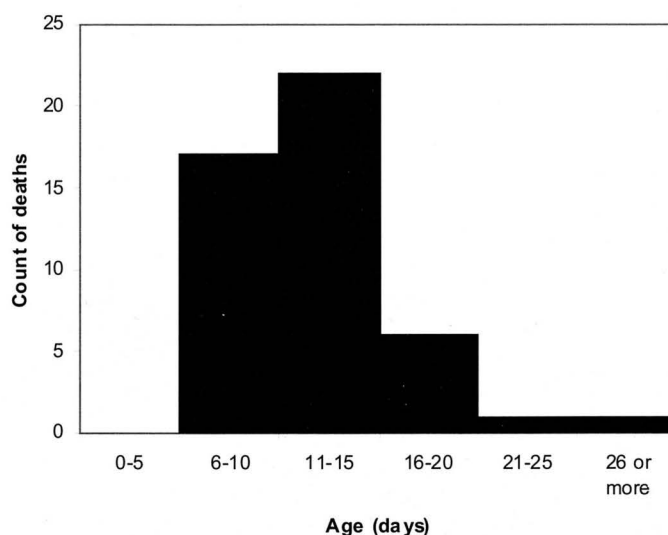


Figure 1. Frequency distribution of the age of beef calves from a ranch that died from undifferentiated neonatal diarrhea (Smith *et al*, unpublished). Most calves died between six and 15 days of age.

Environmental factors

The environment may influence both the level of pathogen exposure and the ability of the calf to resist disease. Environmental exposure to pathogens may occur through direct contact with other cattle or via contact with contaminated environmental surfaces. Crowded conditions facilitate the number of effective contacts with infected animals or contaminated surfaces. Ambient temperature (e.g. excessive heat or cold) and moisture (e.g. mud or snow) are important stressors that impair the ability of the calf to resist disease and may influence pathogen numbers and opportunities for oral ingestion.

Although we have long understood the importance of environmental hygiene in the control of neonatal calf diarrhea,^{19,45} our understanding of the population dynamics of host susceptibility, pathogen exposure and pathogen transmission is still incomplete.⁶ Within a calving season the average dose-load of pathogen exposure to calves is likely to increase over time because calves infected earlier serve as pathogen multipliers. This multiplier-effect results in widespread pathogen contamination of the environment.⁵ Each calf serves as culture media for pathogen production, amplifying the dose-load of pathogen it received.^{18,35,43} Therefore, calves born later in the calving season may receive a larger dose-load of pathogen, and, in turn, may become relatively more infective by growing even greater numbers of agents. Eventually the dose-load of exposure may exceed the calf's ability to resist disease. These factors alone or in combination may explain observations that calves born later in the calving season are at greater risk for disease or death (Figure 2, Smith *et al*, unpublished).¹¹

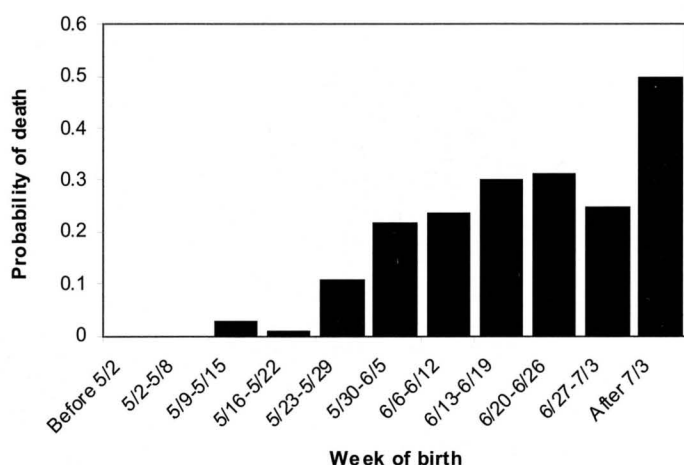


Figure 2. The proportion of calves born each week that subsequently died due to undifferentiated neonatal diarrhea (Smith *et al*, unpublished). Calves born later in the calving season had increasingly greater risk of death.

Biocontainment of undifferentiated neonatal calf diarrhea

In theory one could prevent outbreaks of undifferentiated neonatal calf diarrhea by eliminating the presence of the pathogens, decreasing calf susceptibility, or altering the production system to reduce opportunities for pathogen exposure and transmission. However, the endemic nature of the common pathogens of neonatal calf diarrhea makes it unlikely that cattle populations could be made biosecure from these agents. Also, maternal immunity is clearly important to calf susceptibility to these agents,^{27,36} but lactogenic immunity wanes with time⁷ and managers of extensive beef cattle systems have limited practical opportunities to improve rates of passive transfer. In addition, vaccines are not available against all pathogens of calf diarrhea, may not be sufficiently cross-protective,²⁵ and pathogens may evade the protection afforded by vaccination by evolving away from vaccine strains.²⁰ For these reasons a biocontainment approach to control neonatal calf diarrhea seems prudent.¹⁵ Various biocontainment systems have been proposed to prevent neonatal calf diarrhea by minimizing pathogen exposure and transmission.^{32,33,37,41}

Sandhills Calving System

An effective contact is an exposure to pathogens of a dose-load or duration sufficient to cause disease. Effective contacts can be prevented by physically separating animals, reducing the level of exposure (e.g. through the use of sanitation or dilution over space), or minimizing contact time. These principles have been successfully applied in calf hutch systems to control neonatal diseases in dairy calves.³⁷ The management actions we defined as the Sandhills Calving System prevent effective contacts among beef calves by: 1) segregating calves by age to prevent direct and indirect transmission of pathogens from older to younger calves, and 2) scheduled movement of pregnant cows to clean calving pastures to minimize pathogen dose-load in the environment and contact time between calves and the larger portion of the cow herd. The effect of the system is to re-create the more ideal conditions that exist at the start of the calving season during each subsequent week of the season. Those more ideal conditions are that cows are calving on ground that has been previously unoccupied by cattle (for at least some months), and older, infective calves are not present.

The Sandhills Calving System uses larger, contiguous, pastures for calving rather than high animal-density calving lots (Figure 3). Cows are turned into the first calving pasture (Pasture 1) as soon as the first calves are born. Calving continues in Pasture 1 for two weeks. After two weeks the cows that have not yet calved

Week 5

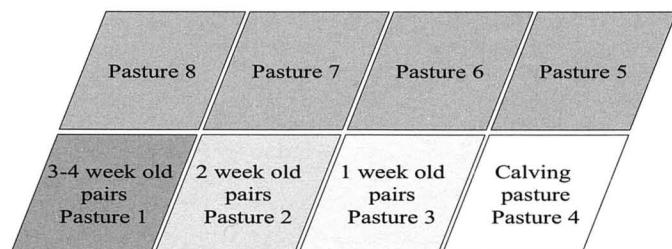


Figure 3. Schematic of the Sandhills Calving System in the fifth week of the calving season. During Week 5 cows are calving in the 4th pasture and calves born in the previous pastures remain behind in age-related groups. The goal is to prevent exposure of calves to high dose-loads of pathogens by re-creating the favorable conditions of the first weeks of the calving season each subsequent week of the season.

are moved to Pasture 2. Existing cow-calf pairs remain in Pasture 1. After a week of calving in Pasture 2, cows that have not calved are moved to Pasture 3 and cow-calf pairs born in Pasture 2 remain in Pasture 2. Each subsequent week cows that have not yet calved are moved to a new pasture and pairs remain in their pasture of birth. The result is cow-calf pairs distributed over multiple pastures, each containing calves within one week of age of each other. Cattle from different pastures may be commingled after the youngest calf is four weeks of age and is considered low-risk for neonatal diarrhea.

It can be difficult to manage many cattle groups in intensive grass management systems; therefore, the Sandhills Calving System in these herds is modified slightly to reduce the number of groups. Cattle are moved to different pastures throughout the calving season as appropriate for forage utilization; however, every 10 days, or whenever 100 calves are born, the herd is divided by sorting cows that had not calved from the cow-calf pairs of the preceding group. In this manner, fewer cattle groups are required, although the number of calves within any pasture group never exceeds 100, and all calves within a group are within 10 days of age of each other.

The Sandhills Calving System was designed to prevent effective contacts by using clean calving pastures, preventing direct contact between younger calves and older calves, and preventing later born calves from being exposed to an accumulation of pathogens in the environment. The specific actions to implement the system may need to differ slightly between herds to meet the specific needs of each production system. Key components of the systems are age segregation of calves and

the frequent movement of gravid “heavy” cows to clean calving pastures. Age segregation prevents the serial passage of pathogens from older calves to younger calves. The routine movement (every seven to 10 days) of gravid cows to new calving pastures prevents the build up of pathogens in the calving environment over the course of the calving season and prevents exposure of the latest born calves to an overwhelming dose load of pathogens.

Development of a ranch-specific plan for implementing the Sandhills Calving System must take place well in advance of the calving season. Available pastures must be identified and their use coordinated with the calving schedule. Water, feed, shelter and anticipated weather conditions must be considered. The size of the pastures should be matched to the number of calves expected to be born in a given week. Use of the pastures must not be damaging to later grazing. The plans should be developed and mapped in consultation with a veterinarian and, in some circumstances, a range specialist.

The Sandhills Calving System may offer additional benefits to management. For example, there may be some efficiency because cattle movement could be scheduled once a week as labor is available. Moving cows without calves to a new pasture is often easier than moving individual cow-calf pairs. Also, the workload is partitioned between pasture groups such that cows at risk for dystocia are together in one pasture while calves at risk for diarrhea are in another. Information from pregnancy examination, when available, enables sorting cows into early and later calving groups. Cows expected to calve later in the season can be maintained elsewhere and added to the calving pasture as appropriate, thereby reducing the number of cattle moving through the initial series of pastures.

We have tested the Sandhills Calving System in two privately-owned ranch herds and observed important and statistically significant reductions in morbidity and mortality due to neonatal calf diarrhea, and greatly reduced use of medications on these operations.³⁹ The prevention of illness and death in these herds has been observed consistently over six and five calving seasons, respectively. Although the system has been tested and adopted in ranches typical of the Nebraska Sandhills, it should be useful elsewhere because the principles on which it is based are widely applicable.

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