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Akbar Nikkhah *

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Review Article

Preventing Diarrhea to Reduce Calf Morbidity and Mortality: A Pragmatic Outlook

Akbar Nikkhah[1*] and Masoud Alimirzaei[2]

[1]Highly Distinguished Professor and Nutritional Scientist, Iran

[2]Behroozi Dairy Complex, Tehran, Iran

***Corresponding Author:** Akbar Nikkhah, Highly Distinguished Professor and Nutritional Scientist, Iran

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Abstract

The objective of this article was to highlight and describe the role of management practices in preventing diarrhea in dairy calves. To reduce diarrhea outbreak and improve calf health and welfare, selected empirical protocols were presented. Pre-weaning dairy calf health and well-being are associated with herd longevity and subsequent milk production. The first weeks of age are considered as a high-risk phase of calf life because the immune system is not fully developed. Meanwhile, newborns are exposed to pathogens and environmental stresses, predisposing them to infectious diseases. Diarrhea is the most prevalent disease infecting new born calves in early stage of life, causing morbidity, mortality, and economic loss. According to the NAHMS report (2007) diarrhea comprises a half of calf death rate in the pre-weaning period. In the 2014 report, 59.9% of sick calve exhibited clinical signs of digestive tract disorders. Despite advances in pathophysiology and diarrhea treatment, it remains a major threat to pre-weaned calves worldwide. Treatment is just a part of the problem. The response to treatment widely varies amongst calves and depends on disease severity, individual resistance to diseases, immune function, and environmental conditions. As such, treatment may not be successful in all cases of diarrhea, especially in those with septicemia. Treatment is a coercion not a choice. The problem can be more complicated if diarrhea pandemic occurs in large scaled herds because it is difficult to treat large numbers of diarrhetic calves. Reducing the severity and number of diarrhetic calves by performing key management practices provides opportunities to decrease calf morbidity and mortality.

Key words: calf; management; diarrhea; prevention; economics

Review, Innovation, and Discussion

This article aimed to discuss and emphasize important management practices to prevent and control diarrhea in dairy calves. Despite advances in veterinary drug industry and treatment methods, diarrhea remains as a main cause of mortality and economic loss in dairy settings worldwide. Neonatal calf diarrhea is a multifactorial disease which makes it difficult to control or treat [1]. Diarrhea occurs frequently in almost all farms with different severities. The rate of mortality is closely related to the severity and number of infected calves. In severe cases, mostly caused by enterotoxigenic *E. coli* (ETEC); lethargy, anorexia, and suckling disability are common which can be followed by septicemia, coma, and finally death [2]. In severe or sepsis circumstances, calves are less able to respond properly to treatment. However, it seems that mild cases with moderate signs of dehydration or even acidosis could be efficiently treated by correcting dehydration and appropriate antibiotics therapy. If the number of diarrhetic calves increases, the mortality rate rises as a result of fatigue and decreased labor performance in treating ill calves. Thus, decreasing the number and severity of neonatal calf diarrhea (NCD) by improving management practices should be considered as a main goal in any calf rearing program [3].

Recently, with the discovery of gut-brain bidirectional communication, the gut microbiome has attracted more attention [4]. In human studies, alteration in gut microbiota may result in long-term health effects. Likewise, the importance of gut microbiota on immunity, growth and longevity of dairy heifers has been reported [5]. In light of to-date evidence, it can be suggested that having a healthy gut with minor interference of invading pathogens would be an ideal framework for rearing healthy calves.

Prevention is much more important than treatment. There are many management factors influencing the susceptibility of newborn calves to diseases. The management of pre-parturient cows, calving environment, calving status, colostrum feeding, and milk feeding and sanitation protocols are all important in optimizing the health and performance of dairy calves. Fetal development in the late gestation is closely related to

maternal nutrition and may possess long-lasting effects on health and growth of infants [6]. For instance, greater energy intake in the prepartum period could result in greater calf birth weight and immunocompetence [7]. In addition to maternal nutrition, it is believed that exposure to environmental stressors such as heat stress during late gestation affects fetal development quality which can determine health and performance of calves in postnatal period and likely later in their productive life cycle [8]. Impaired intestinal development of calves born to dams exposed to hyperthermia in late gestation may lead to the failure of passives immunity regardless of colostrum quality (FPT) [9,10]. It has been reported that colostrum quality declines in hot seasons, although, it is controversial [10]. Decreased colostrum quality accompanied by reduced intestinal capacity to absorb adequate IgG may increase the number of FPT calves, predisposing them to diarrhea and septicemia. Presumably, the incidence of diarrhea not only depends on infectious factors but also is closely related to non-infectious factors such as maternal and environmental stressors affecting calves indirectly. Consequently, spreading diarrhea in mid-summer can be partly attributed to the management of cows in prepartum period. Other stressors influencing pre-fresh cow welfare include density in pre-fresh group, insufficient feed bunk space, and nutrient imbalance. All of these stressors could negatively affect postnatal health and performance of neonatal calves. As noted, diarrhea could be a consequence of the late-gestation stresses on newborn calves. As such, the prevention of diarrhea should start from late gestation.

Calving environment is another important factor affecting diarrhea incidence in newborn calves. Single and multiple cow calving pens are two types of maternity pens commonly used in dairy farms both of which have their own proponents. In single cow calving pens, contaminated bedding materials are removed and renewed after each parturition, causing higher hygiene score in this system. Instead, the multiple cow calving pens are used for multiple parturitions with violated cleanliness. Although some studies reported no significant differences between the two systems with respect to disease incidence [11], it seems that single maternity pens are preferable systems [12]. It has been demonstrated that calves born in single maternity pens had lower risk of *salmonella* shedding during the pre-weaning period [13]. Moreover, calves born in filthy or contaminated calving pens may be easily infected by pathogenic *E.coli*, predisposing them to infectious diarrhea in the first day of life [14]. It is believed that the prevention of pathogenic load in maternity pens by regular disinfection can be a logical way to reduce the risk of pathogens transmission. Other management practices in the case of individual calving pens including provision of dry bedding, good ventilation, and enough space for calving are also recommended. Overall, individual calving pens can be a perfect environment for standing against diarrhea. It is notable that the time during which the calf stays with the dam is important because of the increased risk of infection over time [14]. Besides calving pen management, the calving status (i.e., natural delivery vs. dystocia) plays a role in calf survival and health. Naturally delivered calves are fresh, stand soon after birth, and consume colostrum with more craving. However, following dystocia, the time to achieve sternal recumbency and standing seems to be longer than in normal calves, leading to decreased colostrum intake and efficiency of IgG absorption [15]. Such calves are at higher risk of infectious diarrhea because they might suffer from FPT. Therefore, cows should be allowed to expel the calf normally and excess forces to pull the calf out must be avoided. After birth, when the umbilical cord is cut off, the navel must be dipped in an iodine solution (7%) for about 15 seconds. It is notable that disinfected navel may be licked by dam so the navel should be disinfected again 12 hours later.

Colostrum feeding management plays a key role in newborns susceptibility to infectious diarrhea. Providing 4 lit of quality colostrum immediately after birth and 2 lit 12 hours later is a suitable management practice to prevent infectious diseases. Because of the importance of colostrum management in the prevention of infectious diseases, it is discussed with more details. Newborn calves are deficient in serum immunoglobulin levels (agammaglobulinemic), thus, they totally depend on Ig uptake from the maternal colostrum. Feeding high quality colostrum (IgG $\geq$ 50 g/L) within the first 2 hours of life is necessary for the efficient transfer of passive immunity. Decreased IgG concentrations of blood serum after 24 h of life is referred to as failure of passive transfer (FPT). Calves with IgG levels lower than 10 g/L are classified as FPT calves [16]. Failure of passive transfer is associated with higher morbidity, mortality and longevity [17]. It has been reported that 20-40% of calves suffer from FPT [17]. As the FPT rate is surprisingly high in dairy herds, it is crucial to decrease the number of FPT calves. Determining the quality of colostrum by a refractometer is a useful method to ensure calves receives enough IgG. In addition to colostrum quality, quantity and time of feeding, the temperature, and microbial count of allocated colostrum should be checked carefully. In cold seasons, colostrum should be warmed indirectly (i.e., using hot water) to reach 37˚C before feeding. Cold colostrum feeding can lead to diarrhea itself. Feeding of colostrum with high microbial count (> 100000 cfu/ml) must be avoided. To prevent microbial load, surplus colostrum must be kept in refrigerator for the next meal. Timing of feeding colostrum should be carefully managed, with 12 hours intervals being recommended. Recently, prolonged feeding of colostrum with advantages for preventing diarrhea and optimizing gut health has been discussed [18].

Colostrum feeding management is not all we can do to prevent diarrhea in neonatal calves. Regardless of passive immunity status, the risk of diarrhea would increase in filthy environments where pathogenic load is high [14]. As a general rule, disease incidence is a function of host immunity and environment interactions. As a result, in heavily infected ambience, diarrhea would be expected. To reduce pathogens load in the calf environment, calf pens, hutches, and barns must be disinfected routinely particularly when calves are moved to group or other individual pens. Pens with concrete floor or walls are recommended because washing and disinfecting is easy in concrete buildings. Absolutely, there are many options to house newborn calves, but cleaning and sanitation are the most important factors that should be considered when we a housing system is chosen. In addition to calf pen disinfection, feeding facilities such as milk tank, buckets, and bottles must be washed with a detergent after each meal to remove fat and other milk residues. Then, milk containers should be immersed in a disinfectant solution for the next meal. In our experience, sanitation and practicing proper hygiene protocols could be very helpful in reducing the pathogenic load in the calf environment and in preventing the outbreak of infectious diseases such as diarrhea.

Early diagnosis and treatment of diarrhetic calves is a critical practice that needs more experience and care. Diarrhetic calves shed infectious agents increasingly to the surrounding environment that can be a major source of contamination. For instance, calves infected by low number of cryptosporidia oocysts sheds large number of oocysts to the environment, indicating that higher rates of replication occur inside the host body [19]. Some pathogenic microorganisms like *salmonella* spp. survive in the environment for about 2 years and can be transmitted by staff via boots and clothes [20]. Consequently, early diagnosis and treatment of infected calves and blockage of pathogens entry to the calf environment provide opportunities to minimize microbial loads in the calf ambience. Installation of a disinfectant bath in front of the entrance gate of calf barns would be useful in eliminating foreign microorganisms before they can enter to calf rearing facilities.

Conclusion

Calf rearing is a package of management practices which work together. Diarrhea is a threat to calf survivability and herd longevity worldwide,

but it can be controlled by impactful on-farm management practices. Reducing stress in pre-fresh cows, calving in a hygiene environment, feeding high quality colostrum, and regular sanitation of calf ambience are important factors that impact on calf susceptibility to infectious diseases, especially diarrhea. Rapid identification and treatment of sick calves can be useful in minimizing pathogen loads in the calf environment.

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Nature for its inspirational nature.

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