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REVIEW ARTICLE

Newborn calf welfare: A review focusing on mortality rates

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ABSTRACT

Calf mortality control is vitally important for farmers, not only to improve animal welfare, but also to increase productivity. High calf mortality rates can be related to larger numbers of calves in a herd, employee performance, severe weather, and the neonatal period covering the first 4 weeks of life. Although the basic premise of preventing newborn calf mortality is early detection and treatment of calves at risk for failure of passive transfer of immunoglobulins, calf mortality due to infectious diseases such as acute diarrhea increases in the presence of these physical and psychological stressors. This suggests that farmers should not ignore the effects of secondary environmental factors. For prevention rather than cure, the quality of the environment should be improved, which will improve not only animal welfare but also productivity. This paper presents a review of the literature on newborn calf mortality and discusses its productivity implications.

Key words: *animal welfare, mortality rate, newborn calf, prevention, productivity.*

INTRODUCTION

While more and more farmers as well as researchers around the world are now concerned with animal welfare, historically the idea has been dealt with from a different perspective. For instance, although animal mortality is now considered the most crucial indicator of welfare level (Sato 1997; Scientific Committee on Animal Health and Animal Welfare 2001), it was traditionally investigated on farms as an important indicator of management quality. The caretaking activities of capable farmers are considered to keep mortality rates low in all seasons.

The mortality rate is considered one of the practical indicators on welfare assessment surveys. This is particularly common in the poultry industry (Meluzzi *et al*. 2008), mainly because of the large number of birds per flock. However, we cannot overlook the existence of cattle farms that have mortality rates of newborn calves over 30% (Martin *et al*. 1975a,b), even if their herd sizes are one-tenth or one-hundredth that of poultry farms. Mortality in the cattle industry is not only relevant with regard to animal health and welfare but also to economic losses.

This paper reviews the literature on newborn calf mortality, focusing on the factors and causes of mortality. The industrial implications are also discussed.

FACTORS INFLUENCING NEWBORN CALF MORTALITY

Immunological factor

Passive transfer of colostral immunoglobulins from dam to neonate is of paramount importance (Godden 2008) because calves less than 5 weeks of age do not have active immunity, and colostral antibodies are the only source of immunoglobulins to protect calves from infectious disease immediately after birth (Weaver *et al*. 2000). Therefore, for instance, the UK Code of Recommendations for the Welfare of Livestock: Cattle (DEFRA 2003) states that 'Ideally calves should be left with their dam for at least 12 and preferably 24 h after birth Allowing the calf to suckle naturally may be the best way to make sure that it gets enough colostrum.' In spite of this, it is reported that a significant proportion of dairy calves suffer from failure of passive transfer (FPT) of antibodies from colostrum (Godden 2008). For instance, 30–40% of dairy calves are estimated to suffer from FPT even when they were left with their dams for 12 to 26 h following birth (Brignole & Stott 1980).

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Lower serum immunoglobulin G1 (IgG1) concentrations are associated with higher morbidity and mortality rates (Dewell *et al*. 2006), and calves classified as having FPT have substantial increases in mortality, with a relative risk of 2.0 in the first week of life (Weaver *et al*. 2000). Calves with FPT also suffer from a possibility of poor productivity that lasts until the first lactation in dairy heifers (Robison *et al*. 1988; DeNise *et al*. 1989) and the feed lot in beef cattle (Wittum & Perino 1995). It includes relatively higher morbidity and mortality rates, lower daily weight gain during the pre- and post-weaning periods, and lower milk production during the first lactation.

Primiparous cows are known to produce low-quality colostrum (Weaver *et al*. 2000; Fukushima *et al*. 2004); thus, the mortality rate for calves from primiparous dams is higher than that for calves from multiparous dams (Nix *et al*. 1998). Cows suffering from various infections produce lower levels of colostral immunoglobulins and a higher calf mortality rate (Dardillat *et al*. 1978). In addition, many factors, including the timing of colostrum ingestion, method and volume of colostrum administration, and immunoglobulin concentration in the colostrum ingested have been implicated in immunoglobulin absorption by suckling in calves (Weaver *et al*. 2000). In cases where there are suspicions of possible FPT, prophylactic administration of freeze or spray-dried colostrum just after a calf is born efficaciously increases blood immunoglobulins (Fukushima *et al*. 2004). Additionally, the nutrition of a dam in the periparturient period can play a vital role in the early development of immunity in a neonate (Wilde 2009).

Nonimmunological factors

Analyses of data on newborn calf mortality in epidemiological investigations show that the inter-farm variation in mortality rate is notably large, ranging from a few percent to over 20% (Martin *et al*. 1975a,b; Bendali *et al*. 1999; Razzaque *et al*. 2009). The mortality rate is considerably lower on farms where the owner takes care of his/her calves him/herself than on farms where employees perform these duties (Martin *et al*. 1975b). Calf mortality rate tends to increase with increasing herd size (Gulliksen *et al*. 2009). On some farms, an increase in the number of calves born each year seems to be related to a concomitant increase in calf deaths (Martin *et al*. 1975b). Other farm factors concerning calving site and calf housing do not seem to be related to calf mortality rate (Martin *et al*. 1975b).

The estimated heritability of newborn calf mortality during the first 30 days of life is reported to be 0.082, suggesting a possibility for genetic improvement (Fuerst-Waltl & Sørensen 2010). In the buffalo, female calves are more prone to death than their male counterparts (Khatun *et al*. 2009).

Seasonal variation of the mortality rate is also found to be large, with increased rates during midsummer (June, July and August) and midwinter (November, December and January) (Martin *et al*. 1975a). In general, calf mortality rate is higher in winter than in summer (Wittum *et al*. 1990; Bendali *et al*. 1999; Gulliksen *et al*. 2009). Increases in the mortality rate in winter would be closely related to cold, wet, windy weather (Martin *et al*. 1975c). These climatic conditions are especially severe for dystocial calves because they have a lower basal metabolic rate and heat production (Vermorel *et al*. 1983; Wittum *et al*. 1990). Heat stress in summer can reduce calf resistance to disease as a result of increased corticoid levels, inhibiting immunoglobulin absorption from colostrum (Wiersma *et al*. 1976).

The induction of premature parturition puts fetuses and calves at risk of stillbirth and death before 4 weeks of age (Allen & Herring 1976). Furthermore, calf mortality within 24 h of birth increases as the severity of dystocia increases (Nix *et al*. 1998; Tarrés *et al*. 2005). Even in calves from normal parturitions, the mortality is higher in bull calves than in heifer calves (Nix *et al*. 1998). Yet this is the opposite of the buffalo previously described. The risk of death is greatest during the first week of life, accounting for more than half of all deaths (Martin *et al*. 1975a). However, the mortality rate of calves 5 weeks old and over decreases significantly (Martin *et al*. 1975a; Rogers *et al*. 1985). Apart from the neonatal period, it is demonstrated that dairy calves fed nonsaleable pasteurized milk have a higher growth rate and lower morbidity and mortality rates than do calves fed commercial milk replacer until they are weaned (Godden *et al*. 2005).

CAUSES OF NEWBORN CALF MORTALITY

One of the most common causes of calf death is acute neonatal diarrhea due to pathogenic agents such as rotavirus, coronavirus, and *Escherichia coli* bacteria (Acres & Radostits 1976; Thurber *et al*. 1977; Holland 1990; Bendali *et al*. 1999; Abd-Elrahman 2011). More than 50% of all neonatal diarrheas appear during the first week, and only 15% occur after the second week of life (Bendali *et al*. 1999), although, exceptionally, the highest prevalence of rotavirus is seen at 2–4 weeks of age (Nourmohammadzadeh *et al*. 2011). Bacteremia in neonatal calves increases the risk for severe diarrhea and death (Fecteau *et al*. 1997). A second principal cause of calf death is respiratory disorders, including pneumonia, but colostral immunity normally protects the calf from developing pneumonia early in life (Donovan *et al*. 1998). Diarrhea and respiratory disease increase the risk of newborn calf death (Gulliksen *et al*. 2009). The former accounts for more

than 50% of all deaths and the latter for about 15% (Azizzadeh *et al*. 2012).

Vaccination of pregnant cows reduces calf morbidity and mortality rates (Razzaque *et al*. 2009). Vaccination of pregnant cows even at early stages of pregnancy (6 months before calving) can provide passive protection in neonatal calves against etiologic agents such as enterotoxigenic *E. coli* (Jayappa *et al*. 2008). A sequential course of vaccines after birth can be an effective method to reduce the morbidity and mortality of calves from severe infectious diseases (Thurber *et al*. 1977; Selim *et al*. 1995; Wildman *et al*. 2008), but its efficacy depends on various conditions (Waltner-Toews *et al*. 1985). Congenital infection with bovine viral diarrhea virus (BVDV) may have a negative impact on calf health, with a higher risk of a severe illness (Muñoz-Zanzi *et al*. 2003). In particular, type-1 BVDV infections and the presence of persistently infected calves appear to contribute to higher mortality rates (Booker *et al*. 2008). Therapeutic and prophylactic effects of all sorts of antibiotics have been demonstrated (Grimshaw *et al*. 1987). The advantage of anthelmintic treatments first at 3 weeks of age is seen as a reduction in the combined morbidity/mortality rate in buffalo calves (Srikitjakarn *et al*. 1987). Oral administration of antibodies (Razzaque *et al*. 2009) and probiotic supplements (Abd-Elrahman 2011) to newborn calves can reduce calf morbidity and mortality rates. Administration of an oral solution of dried oregano leaves (Bampidis *et al*. 2006) and fluid therapy with an oral glucose-glycine electrolyte solution (Greene 1983) were also shown to be effective to minimize calf deaths from diarrhea after the appearance of symptoms. However, improvement of the quality of calf rearing conditions is the key to success in the prevention of neonatal calf diarrhea. Prevention is better than cure from the viewpoint of not only productivity but also animal welfare.

Inappropriate or unnatural rearing methods increase the risk of morbidity and mortality from diarrhea in calves. For instance, brief intensive artificial suckling from buckets is known be associated with frequent occurrences of cross-suckling in group-reared calves and self-grooming in singly penned calves after milk ingestion (Phillips 2002). These abnormal oral behaviors due to incomplete release of sucking motivation might lead to the formation of hairballs within the abomasum of a calf (Terosky *et al*. 1997). Hairballs can be a potential agent of noninfectious diarrhea. Profuse infectious diarrhea often arises as a complication of noninfectious diarrhea induced by this kind of digestive disorder due to decreased immune strength (JLIA 2010). The same pathogenic mechanism can apply to other types of noninfectious diarrhea induced by dietary, psychological and environmental stresses (Zenkokukachikuchikusanbutsueiseishidoukyoukai 1999).

These clinical phenomena encourage farmers with a high calf mortality rate to reduce the incidence of noninfectious diarrhea by improving their rearing methods and environment for calves less than 5 weeks of age. However, it will not be as easy in practice as in theory for farmers to perceive hidden problems without help from outside specialists such as veterinarians (Mee 2008).

Conclusions and implications

Although the basic premise of prevention of newborn calf mortality is early detection and treatment of calves at risk for failure of passive transfer, higher mortality rates seem to be related to the larger number of calves in a larger herd, employee performance, cold weather, and conditions during the neonatal period, especially the first week of life. Although the direct cause of calf death is infectious diseases such as acute neonatal diarrhea, the morbidity and mortality from the disease increases in the presence of physical and psychological stressors in the calf-rearing environment. This suggests that a calf should be treated with the utmost care and attention even concerning the above secondary influencing factors. In addition to protection by passive immunization and preventive vaccinations for infectious diseases, environmental quality improvement should be performed from the point of view of not only animal welfare but also increasing productivity.

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