REVIEW ARTICLE

Newborn calf welfare: A review focusing on mortality rates

Katsuji UETAKE

School of Veterinary Medicine, Azabu University, Sagamihara, Japan

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).

Correspondence: Katsuji Uetake, School of Veterinary Medicine, Azabu University, Chuo, Sagamihara, Kanagawa 252-5201, Japan. (Email: uetake@azabu-u.ac.jp)

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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-qualitycolostrum (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 collostrum immunoglobulins and a higher calf mortality rate (Dardillat et al. 1978). In addition, many factors, including the timing ofcolostrum ingestion, method and volume ofcolostrum administration, and immunoglobulin concentration in thecolostrum ingested have been implicated in immunoglobulin absorption bysuckling in calves (Weaver et al. 2000). In cases where there are suspicions of possibleFPT, 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 notable 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 fromcolostrum (Wiersma et al. 1976).

The induction of premature parturition puts letuses 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 to 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 (Zenkokukakuchikuschinanbutseiseishidoukyoukai 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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REFERENCES

Abd-Elrahman AH. 2011. Colibacillosis in newly born buffalo calves and role of Lacteol Fort in preventing recurrence of calf diarrhea. Life Science Journal 8, 497–502.

Acres SD, Radostits OM. 1976. The efficacy of a modified live reo-like virus vaccine and an E. coli bacterin for prevention of acute undifferentiated neonatal diarrhea of beef calves. Canadian Veterinary Journal 17, 197–212.

Allen JG, Herring J. 1976. The induction of parturition using dexamethasone in dairy cattle. Australian Veterinary Journal 52, 442–445.

Azizzadeh M, Shooroki HF, Kamalabadi AS, Stevenson MA. 2012. Factors affecting calf mortality in Iranian Holstein dairy herds. Preventive Veterinary Medicine 104, 335–340.

Bampidis VA, Christodoulou V, Florou-Paneri P, Christaki E. 2006. Effect of dried oregano leaves versus neomycin in treating newborn calves with colibacillosis. Journal of Veterinary Medicine Series A: Physiology Pathology Clinical Medicine 53, 154–156.

Bendi F, Bichet H, Schelcher F, Sanaa M. 1999. Pattern of diarrhoea in newborn beef calves in south-west France. Veterinary Research 30, 61–74.
Booker CW, Abutarbush SA, Morley PS, Guichon PT, Wildman BK, Jin GK, Schunicht OC, Pittman TJ, Perrett T, Ellis JA, Appleyard G, Haines D. 2008. The effect of bovine viral diarrhea virus infections on health and performance of feedlot cattle. *Canadian Veterinary Journal* 49, 253–260.

Brigone TJ, Stott GH. 1980. Effect of suckling followed by bottle feeding colostrums on immunoglobulin absorption and calf survival. *Journal of Dairy Science* 63, 451–456.

Dardillat J, Trillat G, Larvor P. 1978. Colostrum immunoglobulin concentration in cows: relationship with their calf mortality and with the colostrum quality of their female offspring. *Annales de Recherches Veterinaires* 9, 375–384.

DeNise SK, Robison JD, Stott GH, Armstrong DV. 1989. Effects of passive immunity on subsequent production in dairy heifers. *Journal of Dairy Science* 72, 552–554.

Department for Environment Food and Rural Affairs (DEFRA). 2003. *Code of Recommendations for the Welfare of Livestock*. DEFRA Publications, London.

Dewell RD, Hungerford LL, Keen JE, Laegreid WW, Griffin DD, Rupp GP, Grotelueschen DM. 2006. Association of neonatal serum immunoglobulin G1 concentration with health and performance in beef calves. *Journal of the American Veterinary Medical Association* 228, 914–921.

Donovan GA, Dohoo IR, Montgomery DM, Bennett FL. 1998. Associations between passive immunity and morbidity and mortality in dairy heifers in Florida, USA. *Preventive Veterinary Medicine* 34, 31–46.

Fecteau G, Van Metre DC, Paré J, Smith BP, Higgins R, Holmberg CA, Jang S, Guterbock W. 1997. Bacteriological culture of blood from critically ill neonatal calves. *Canadian Veterinary Journal* 38, 95–100.

Fuerst-Wall B, Sørensen MK. 2010. Genetic analysis of calf and heifer losses in Danish Holstein. *Journal of Dairy Science* 93, 5436–5442.

Fukushima M, Kibushi M, Sakase M, Noda M, Takeda K. 2008. Colostrum management for dairy calves. *Veterinary Clinics of North America - Food Animal Practice* 24, 1–17.

Godden SM, Fetrow JP, Feitrag JM, Green IR, Wells SJ. 2005. Economic analysis of feeding pasteurized nonsaleable milk versus conventional milk replacer to dairy calves. *Journal of the American Veterinary Medical Association* 226, 1547–1554.

Greene HJ. 1983. Minimise calf diarrhoea by good husbandry: treat sick calves by fluid therapy. *Annales de Recherches Veterinaires* 14, 548–555.

Grimshaw WT, Colman PJ, Petrie L. 1987. Efficacy of sulbactam-ampicillin in the treatment of neonatal calf diarrhoea. *Veterinary Record* 121, 162–166.

Gulliksen SM, Lie KI, Løken T, Østérås O. 2009. Calf mortality in Norwegian dairy herds. *Journal of Dairy Science* 92, 2782–2795.

Holland RE. 1990. Some infectious causes of diarrhoea in young farm animals. *Clinical Microbiology Reviews* 3, 345–375.

Japan Livestock Industry Association: (JLIA). 2010. Nyuuwuosyoukoushoushiyokumisirijoushanyou [homepage on the Internet]. JLIA, Tokyo; [cited 29 Aug 2012]. Available from URL: http://jlia.lin.gr.jp/hi_wakaushi/ (In Japanese)

Jayappa H, Davis R, Dierks L, Sweeney D, Wasmoen T. 2008. Demonstration of passive protection in neonatal calves against colibacillosis following immunization of pregnant heifers at 3 months of gestation. *Veterinary Therapeutics* 9, 283–289.

Khatun MR, Arifulazzaman M, Ashraf A. 2009. A comparative analysis on factors affecting calf mortality of buffalo in a breeding farm. *Pakistan Journal of Biological Sciences* 12, 1535–1538.

Martin SW, Schwabe CW, Franti CE. 1975a. Dairy calf mortality rate: characteristics of calf mortality rates in Tulare County, California. *American Journal of Veterinary Research* 36, 1099–1104.

Martin SW, Schwabe CW, Franti CE. 1975b. Dairy calf mortality rate: influence of management and housing factors on calf mortality rate in Tulare County, California. *American Journal of Veterinary Research* 36, 1111–1114.

Martin SW, Schwabe CW, Franti CE. 1975c. Dairy calf mortality rate: influence of meteorologic factors on calf mortality rate in Tulare County, California. *American Journal of Veterinary Research* 36, 1105–1109.

Mee JF. 2008. Newborn dairy calf management. *Veterinary Clinics of North America – Food Animal Practice* 24, 1–17.

Meluuzzi A, Fabbri C, Folegatti E, Sirri F. 2008. Survey of chicken rearing conditions in Italy: effects of litter quality and stocking density on productivity, foot dermatitis and carcas injuries. *British Poultry Science* 49, 257–264.

Muñoz-Zanzi CA, Hietala SK, Thurmond MC, Johnson WO. 2003. Quantification, risk factors, and health impact of natural congenital infection with bovine viral diarrhea virus in dairy calves. *American Journal of Veterinary Research* 64, 358–365.

Nix JM, Spitzer JC, Grimes LW, Burns GL, Pyler BB. 1998. A retrospective analysis of factors contributing to calf mortality and dystocia in beef cattle. *Theriogenology* 49, 1515–1523.

Nourmohammadzadeh F, Davoudi Y, Abdollahpour G, Nouri A. 2011. The prevalence of rotavirus in neonatal calf diarrhoea, using electron microscopic examination. *Comparative Clinical Pathology* (DOI 10.1007/s00580-011-1270-z).

Phillips C. 2002. *Cattle Behaviour & Welfare*, 2nd edn. Blackwell Science Ltd, Oxford, UK.

Razzazque MA, Al-Mutawa T, Abbas S, Bedair M. 2009. Performance of pre-weaned dairy calves under hot arid environment: effects of immunoglobulins and age on diseases and mortality. *American Journal of Applied Science* 6, 1885–1891.

Robison JD, Stott GH, DeNise SK. 1988. Effects of passive immunity on growth and survival in the dairy heifer. *Journal of Dairy Science* 71, 1283–1287.

Rogers RW, Martin SW, Meek AH. 1985. Reproductive efficiency and calf survival in Ontario beef cow-calf herds: a cross-sectional mail survey. *Canadian Journal of Comparative Medicine* 49, 27–33.

Sato S. 1997. Shitsugikoutoutokachikunofukushi [unnatural behavior and domestic animal welfare]. In: Mimura K (ed.), *Kachikukoudougaku*, pp. 98–121. Yokendo Ltd., Tokyo. (In Japanese)
Scientific Committee on Animal Health and Animal Welfare. 2001. *The Welfare of Cattle Kept for Beef Production*. European Commission, Brussels.

Selim SA, Cullor JS, Smith BP, Blanchard P, Farver TB, Hoffman R, Dilling G, Da Roden L, Wilgenburg B. 1995. The effect of *Escherichia coli* J5 and modified live *Salmonella dublin* vaccines in artificially reared neonatal calves. *Vaccine* 13, 381–390.

Srikitjakarn L, Löhr KF, Leidl K, Hörchner F. 1987. Meta-phyllactic deworming program for buffalo calves (*Bubalis bubalis*) in North-East Thailand. *Tropical Medicine and Parasitology* 38, 191–193.

Tarrés J, Casellas J, Piedrafita J. 2005. Genetic and environmental factors influencing mortality up to weaning of Bruna dels Pirineus beef calves in mountain areas. A survival analysis. *Journal of Animal Science* 83, 543–551.

Terosky TL, Wilson LL, Stull CL, Stricklin WR. 1997. Effects of individual housing design and size on special-fed Holstein veal calf growth performance, hematology, and carcass characteristics. *Journal of Animal Science* 75, 1697–1703.

Thurber ET, Base EP, Beckenhauer WH. 1977. Field trial evaluation of a reocoronavirus calf diarrhea vaccine. *Canadian Journal of Comparative Medicine* 41, 131–136.

Vermorel M, Dardillat C, Vernet J, Saido, Demigne C. 1983. Energy metabolism and thermoregulation in the newborn calf. *Annales de Recherches Veterinaires* 14, 382–389.

Waltner-Toews D, Martin SW, Meek AH. 1985. A field trial to evaluate the efficacy of a combined rotavirus-*Escherichia coli* vaccine in dairy cattle. *Canadian Journal of Comparative Medicine* 49, 1–9.

Weaver DM, Tyler JW, VanMetre DC, Hostetler DE, Barrington GM. 2000. Passive transfer of colostral immunoglobulins in calves. *Journal of Veterinary Internal Medicine* 14, 569–577.

Wiersma F, Stott GH, Menefee BE. 1976. Improved environmental housing to enhance calf survival. *Paper – American Society of Agricultural Engineers* 11.

Wilde D. 2009. Nutrition and immunity in the newborn calf: new advances from yeast based technologies. *Revue de Medecine Veterinaire* 160, 425–428.

Wildman BK, Perrett T, Abutarbush SM, Guichon PT, Pittman TJ, Booker CW, Schunicht OC, Fenton RK, Jim GK. 2008. A comparison of 2 vaccination programs in feedlot calves at ultra-high risk of developing undifferentiated fever/bovine respiratory disease. *Canadian Veterinary Journal* 49, 463–472.

Wittum TE, Curtis CR, Salman MD, King ME, Odde KG, Mortimer RG. 1990. Management practices and their association with reproductive health and performance in Colorado beef herds. *Journal of Animal Science* 68, 2642–2649.

Wittum TE, Perino LJ. 1995. Passive immune status at post-partum hour 24 and long-term health and performance of calves. *American Journal of Veterinary Research* 56, 1149–1154.

Zenkokukachikuchikusanbutsuieishidoukyoukai. 1999. *Seisanjyuiryoushisutemu*. Nousangyosonbunkakyoukai, Tokyo. (In Japanese)