IMPORTANCE OF MONITORING CALVING TO DECREASE STILLBIRTH RATE IN HOLSTEIN-FRIESIAN DAIRY FARMS

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Abstract

The successful genetic selection for higher milk production caused a dramatic decline in the reproductive performance of dairy cows all over the world during the last decades. Achievement of optimum herd reproductive performance (calving interval of 12 or 13 months with the first calf born at 24 months of age) requires concentrated management activities especially during calving and during the first 100 days following calving. The following management activities are needed to pursue during the early postpartum period to reach or approach the optimal reproductive performance such as careful surveillance and assistance at calving, prevention of post parturient metabolic diseases, early diagnosis and treatment of post parturient uterine diseases, accurate detection of oestrus, correct timing of insemination, reducing the effect of heat stress and early pregnancy diagnosis. Among these main activities only careful surveillance and assistance at calving and their effects on milk production, reproductive performance as well as on newborn calves are discussed. Due to the fact that the cause of stillbirth with a non-infectious aetiology is likely to be multifactorial and difficult calving may explain only about half of them therefore it is very important to examine the risk factors of stillbirth especially in large-scale dairy farms.

Key words: dairy cow, eutocia, dystocia, stillbirth, obstetrical assistance

The successful genetic selection for higher milk production in Holstein cows has nearly doubled the average milk production in the United States since 1960, to over 11.000 kg/year. Over the same time period, there has been a dramatic decline in the reproductive performance of dairy cows. The average number of days open (interval from calving to conception) and the number of services per conception have increased substantially. In order to decrease the longer lactations and the number of cows culled for reproductive reasons it is very important to improve our reproductive management practices (Silva, 2003). Achievement of optimum herd reproductive performance (calving interval of 12 or 13 months with the first calf born at 24 months of age) requires concentrated management activities especially during the first 100 days following calving. Early postpartum breeding of dairy cows results in more calves, and higher milk production per lactation (Britt, 1975). Poor reproductive performance can reduce the number of calves born and milk production and may increase the cost of therapy and semen.

The following management activities such as careful surveillance and assistance at calving, prevention of post parturient metabolic diseases, early diagnosis and treatment of post parturient uterine diseases, accurate detection of oestrus, correct timing of insemination, reducing the effect of summer heat stress and early pregnancy diagnosis are needed to pursue during the early postpartum period to reach or approach the optimal calving interval (Szenci, 2008).

Among these main activities only careful surveillance and assistance at calving and their effects on milk production, reproductive performance as well as on newborn calves will be discussed in the present review. However, this topic has also a great importance because it is generally accepted that the type of obstetrical assistance can predominantly negatively affect reproductive performance of dairy cows.

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Prevalence of stillbirth rate and risk factors

The profitability of cattle breeding is also influenced by the rate of calves being born alive and reared to adulthood. In spite of the speedy developments of animal breeding, perinatal mortality (stillbirth) is still very high (4 to 7%) and constitutes approximately half of the total calf losses (Szenci and B.Kiss, 1982; Mee, 1991; Vestweber, 1997). Perinatal mortality may be defined as a calf death before, during or within 24 to 48 hours of calving (Szenci and B.Kiss, 1982), following a normal gestation period of > 260 days (Mee, 1999).

The prevalence of stillbirth rate reported for Holstein-Friesian heifers and cows in loose-housing based dairy herds (5.7 to 8.2% /7.7% in average/ based on normal farm operation between 2001 and 2005) was similar to those recently have been reported for Holstein-Friesians in pasture-based dairy herds (5.1 to 7.4%) or in confinement (5.0 to 9.6%) rearing systems worldwide (McGuirk et al., 1999; Fourichon et al., 2001; McClintock, 2004 vs. Harbers et al., 2000; Bar and Ezra, 2005; Jamrozik et al., 2005; Silva del Rio et al., 2007). In French dairy herds the prevalence of perinatal mortality changed between 5.3% and 7.6%, and it was about twice as frequent in heifers as in cows (Chassagne et al., 1999). The prevalence of stillbirth (294 out of 4103) in a large-scale Hungarian Holstein-Friesian dairy farm between 1973 and 1978 was 8.3% for heifer calvings and 6.5% for cow calvings, respectively (Szenci et al., 1981). In the same farm the stillbirth rate was 8.7% for heifer calvings and 5.9% for cow calvings in 2003, respectively. All together 124 of 1733 newborn calves were lost (7.2%) in the perinatal period. Comparing the two periods there were no increase in perinatal mortality, however it is still very high. Somewhat lower stillbirth rate (2.8% and 4.3%) has been recently reported in Ireland (Mee et al., 2008) and Switzerland (Bleul, 2011) in small dairy farms. According to Mee et al. (2008), the herd-size (small: 20 to 39 calvings, medium: 40 to 59 calvings and large: > 59 calvings) has no significant effect on the prevalence of stillbirth rate, which is in agreement with our previous findings (Szenci and B. Kiss, 1982) observed at larger dairy farms (between >100 and >901 calvings).

It is important to emphasize that during the last decades there has been a trend of increasing stillbirth rate (perinatal mortality), especially in Holstein-Friesian heifers. In the Swedish Holstein-Friesian heifer population stillbirth rate has recently increased from 4 to 11% (Gustafsson et al., 2007) or 10.3% in 2002 (Berglund et al., 2003). In the Netherlands stillbirth rate for heifers was reported to be 12.2% in 1999 (Harbers et al., 2000), and in the USA it was 13.2% in 1996 (Meyer et al., 2001). At a dairy farm in Iowa, USA, perinatal mortality was 7.1% between 1968 and 1999 for all parities, and odds of perinatal mortality was increased by 2.1% annually (Johanson and Berger, 2003). Similarly increased stillbirth rate (12.3%) in heifers has been reported in a Hungarian Holstein-Friesian dairy farm recently (Báder et al., 2009).

The cause of stillbirth with a non-infectious aetiology is likely to be multifactorial and difficult calving may explain only about half of them (Berglund et al., 2003; Szenci et al., 2010). The majority of calves might die due to direct and indirect asphyxia because in 73 to 75% of the calves that died in the perinatal period no pathological changes were detected (Hahnsdorf, 1967; Greene, 1979). In another study, prevalence of asphyxia in calves dying perinataly was 58.3% (Schuijt, 1990).

Often it is difficult to determine what causes a calf to be stillborn. One or more factors (e.g. parity, gender, gestation length) may contribute to a complex combination of events when the final outcome is a stillborn calf (Meyer et al., 2000) therefore it is very important to examine the risk factors on a dairy farm which may contribute to stillbirth.

A path model of risk factors for common causes of bovine perinatal mortality in all types of calvings, difficult calvings (dystocia) and easy calvings (eutocia) has recently been suggested by Mee (2009). Regarding all calvings risk factors, genetic and non-genetic variables can be distinguished:

- Genetic risk factors include sire breed, dam breed, trait heritability, inbreeding, and gestation length.

- Non-genetic risk factors are herd, year, season, precalving nutrition and calving environment.

The basic risk factors influencing stillbirth following *dystocia*, can be sorted according to parity, calf birth weight, gender, age at first calving, foeto-pelvic incompatibility, foetal malpresentation, uterine inertia or environmental stress.

In case of *eutocia*, the important risk factors include prematurity, dysmaturity, infections, congenital defects, precalving nutrition, prolonged calving, twins and toxicities.

In addition to these, herd-level risk factors may include herd, year, season, larger herd size, short dry period, intensive herd management, calving management and nutritional management however some of these variables have already been discussed under the non-genetic risk factors (Mee, 2009).

It is also important to emphasize that none of the aforementioned risk factors focused on the importance of farm personnel, especially at large-scale farms. At the same time, qualifications of employed calving assistants (Szenci and B.Kiss, 1982), changes in the calving supervision at working shifts (8.1% vs. 16.2%: Hoedemacker et al., 2008) or low level surveillance of calvings especially during nights (Szenci and B. Kiss, 1982; Vasseur et al., 2010) and week-ends or bank holidays especially in loose housing systems (Szenci and B. Kiss, 1982) may contribute to the significant increase of stillbirth rate. In contrast, it was reported that farm personnel had no effect on stillbirth rate at small dairy farms (<120 vs. >120 cows per farm) in Virginia, USA, however calf mortality until weaning was related to the persons taking care for the calves (James et al., 1984). It was similarly emphasized that calf management personnel (Losinger and Heinrichs, 1997) and herd-management policies (restraining, bedding, milk and water supply) directly and indirectly influence the cumulative prevalence of calf hood morbidity and mortality (Curtis et al., 1993).

It has been confirmed that farm personnel related to management changes (introduction of a camera surveillance system, motivating wages and expressed focus on stillbirth rate by the general management) could significantly decrease the prevalence of stillbirths at two of the three examined dairy farms (Farm B: 7.6% vs. 5.0% and Farm C: 8.2% vs. 6.1%) and the total prevalence (7.7% vs. 5.5%), respectively. At the third farm (Farm A) the prevalence of stillbirths did not change significantly (5.7% vs. 4.9%), however it became somewhat lower as well. The lower prevalence rate might be explained by the lower density on Farm C (n=458) comparing with the other two dairy farms (Farms B /n=1016/ and C /n=1446/), respectively. These results clearly confirmed the effect of farm personnel on the prevalence of stillbirth rate, because on average 28.6% improvement could be reached at the examined three dairy farms by improving farm personnel related management during a three-year period (Szenci et al., 2012).

According to Drew (1988) in Ireland the differences in stillbirth rates among herds were primarily due to the herdsman's ability to calve heifers with large newborns. The importance of farm personnel was clearly suggested by Heinrichs and Radostits (2001) who emphasized that "regardless of herd size, housing pen construction, calving site and many other factors that have been associated with calf mortality, calf rearers and their motivations (owner vs. employee) to raise healthy calves have the greatest influence on calf survival".

On the other hand, other management controlled risk factors, such as age at first calving, sire genetic merit for direct stillbirth, extent of calving supervision and the degree of assistance have also to be focused to reduce the prevalence of perinatal mortality and improve perinatal welfare (Mee et al., 2008; Steinbock et al., 2003).

Calving assistance

According to Mee et al. (2011) calving assistance can be scored on a scale of 1-4 as follows:

1. no assistance
2. slight assistance (assistance by one person without needing to use a calf puller)
3. considerable assistance (assistance by one person needing to use a calf

puller or more than one person)
4. veterinary assistance (including Caesarean operations)

Mee et al. (2011) examined 152,641 records of full-term calvings from pasture-based Holstein–Friesian dams in Ireland and the overall prevalence of no, slight, considerable and veterinary calving assistance was 68.9%, 24.3%, 4.3% and 2.5%, respectively. The calving assistance rate was 31.1% while the dystocia (considerable and veterinary assistance) rate was 6.8%. The prevalence in primiparae and pluriparae was 40.0% and 28.2% for assistance and 9.3% and 5.8% for dystocia, respectively.

We have recently followed up 296 calvings in a Holstein Friesian dairy farm in Hungary (unpublished data) and the overall prevalence of no and slight calving assistance was 35.8% and 38.9%, respectively which was altogether 74.7%. Considerable assistances were sorted into two groups as follows: assistance with 2 persons (19.3%) and assistance with $\geq$3 persons or a calf puller (6.1%). There was a need only for one Caesarean section (0.3%). Comparing with the Irish data it seems that in loose-housing based farm conditions we used more assistances however prevalence of dystocia was similar (6.8% vs. 6.1%).

Effect of eutocia on the dam and newborn calf

We examined 205 neonatal calves from eutocic calvings in a large-scale dairy farm in Hungary with around 900 lactating Holstein-Friesian cows (Kovács et al., 2017).

Eutocic calving was considered as a combination of 'no assistance' and 'slight assistance' (where assistance/traction was brief, slight and the cow may otherwise have calved unassisted) by one person (Mee et al., 2011).

Assessment of vitality immediately after birth revealed that 137 calves were normal (vitality score > 7.5), 60 calves exhibited slight (vitality score = 5.0–7.5) and 8 severe depression (vitality score < 5.0). In agreement with previous findings (Szenci, 2003) and recent reports (Kovács et al., 2016), vitality score tended to increase over time.

Linear mixed models were used to determine the effects of season, time of sampling relative to birth (factors), duration of the delivery process, duration of maternal grooming, calf birth weight (BW) at birth and time of day (covariates) on values of venous blood gas, acid-base and electrolyte parameters and lactate concentrations in dairy calves born to eutocic dams. Neonatal vitality was assessed at 0, 1 and 24 h after delivery in a linear scoring system using muscle tone, erection of the head, muscle reflexes, heart rate and sucking drive as criteria. Simultaneously with vitality scoring, venous blood samples were collected by jugular venipuncture. Blood was tested for pH, pCO_2 (mmHg) and pO_2 (mmHg), L-lactate (mmol/L), hemoglobin (Hb; g/L), ionized calcium (Ca^{2+}; mmol/L), sodium (Na^{+}; mmol/L), potassium (K^{+}; mmol/L) and chloride (Cl^{-}; mmol/L). Bicarbonate (HCO_3^{-}; mmol/L), base excess (BE; mmol/L), total carbon dioxide (TCO_2; mmol/L) and anion gap (mmol/L) were calculated. Electrolyte parameters were affected by none of the factors and covariates. Time of day at birth did not affect any of the parameters of interest. Vitality score tended to increase over time. Blood pH, concentrations of pO_2, HCO_3^{-}, and BE decreased, whereas lactate concentrations, values of pCO_2, TCO_2 and anion gap increased with longer duration of delivery. Shift in acid-base balance was also linked to the BW of the calf at birth with lower values of blood pH, HCO_3^{-} and BE in calves with higher BW compared to those with lower BW at birth, whereas TCO_2 and lactate concentrations increased with higher calf BW at birth. Values of pO_2 increased, whereas pCO_2 decreased with longer duration of maternal grooming. Blood pH, HCO_3^{-} and BE increased, whereas lactate concentrations and anion gap decreased with longer duration of licking the calf. Our results indicate that prolonged delivery can impair acid-base status and can cause slight lactic acidosis even in calves born from spontaneous or eutocic calvings and high BW at birth predisposes calves to acidosis. The positive effect of maternal grooming on neonatal acid-base status should be considered in parturition management. Season, duration of the delivery process, calf BW at birth and duration of maternal grooming are recommended to be considered in future studies on blood-gas and acid-base parameters in dairy calves in the immediate neonatal period (Kovács et al., 2017).

Welfare aspects of obstetrical assistance were also studied in multiparous Holstein-Friesian cows (n = 176) as follows (Kovács et al., 2016):

Group 1: unassisted calving in an individual pen (n = 42),

Group 2: unassisted calving in a group pen (n = 48),

Group 3: assisted calving with appropriately timed obstetrical assistance (n = 50),

Group 4: assisted calving with inappropriately timed (premature) obstetrical assistance (n = 36).

Duration of the stages of calving, the prevalence and the degree of dystocia, stillbirth ratio, newborn calf vitality, and the occurrence of postpartum health problems (i.e., retained placenta and vulvovaginal laceration) were recorded. The time from amniotic sac and hooves appearance to birth and the total duration of calving (from the onset of calving restlessness to delivery) were shorter for Group 2 cows (unassisted calving in a group pen) than for any other groups. The overall prevalence of dystocia was 31.3% in the calvings studied. The prevalence of dystocia was below 10% in cases of unassisted calvings. The proportion of severe dystocia was higher in Group 4 cows (premature obstetrical assistance) than in Group 3 cows with appropriately timed obstetrical assistance (47.2% vs. 12.0%, respectively). The prevalence of stillbirths was the highest in Group 4 calvings (22.2%), followed by Group 3, Group 1, and Group 2 cows (8.0, 4.8, and 0.0%, respectively). The Group 4 calves had lower vitality scores than calves born from Group 3, Group 2 and Group 1 dams immediately after delivery and 24 h after birth. Although Group 3 calves had lower vitality scores than Groups 2 and 1 calves at birth, a delayed recovery of vitality was mirrored by satisfactory vitality scores 24 h after birth. Retained placenta and vulvovaginal laceration occurred more often with assisted dams (i.e., Groups 3 and 4 animals) compared with Group 1 cows with the highest prevalence in Group 4 cows. In Group 2 cows, no injuries occurred in the vulva or vagina, and we noted only 4 cases of retained placenta (8.3%), proportions lower than in cows with unassisted calving in the maternity pen. Our results suggest that calving in a group might have benefits over calving in an individual pen in terms of calving ease, duration of the delivery process, and postpartum health of the dam as well as vitality of her offspring. Premature obstetrical assistance leads to a high prevalence of dystocia, impairs postpartum health of the dam, and poses a potential risk to calf survival (Kovács et al., 2016).

Effect of dystocia on the dam and newborn calf

Dystocia may increase the risk of calf morbidity and mortality (Bicalho et al., 2007; Lombard et al., 2007), reduce fertility (Fourichon et al., 2001; Tenhagen et al., 2007), and milk production (Fourichon et al., 1999; McGuirk et al., 2007) as well as cow survival (McClintock, 2004; Bicalho et al., 2007). The total economic cost due to a severe case of dystocia has recently been estimated at up to €500 per cow (McGuirk et al., 2007). According to Mee (2008), the dystocia rate in dairy cows in Ireland varies between 2% and 14%.

According to our investigation dystocia (considerable assistance) significantly increased the prevalence of retained foetal membranes, development of clinical metritis between days 0 to 10 after calving and the prevalence of recurrent clinical metritis (unpublished data).

Prediction the onset of calving

Predicting the onset of calving allows determining if there is a need for human intervention, thereby enables the rescue of newborn calves and dams (Gundelach et al., 2009; Vasseur et al., 2010). Environmental disturbance at calving, caused by continuous presence of an observer, confinement or overcrowded calving pen can lead to prolonged calving and dystocia (Dufty, 1981). Moreover, Mee (2004) hypothesized that good supervision during stage 2 of calving might reduce dystocia due to prolonged calving and thus stillbirth rate.

Many protocols have been suggested to

predict the exact time of calving, including changing in body temperature (Fujomoto et al., 1988; Burfeind et al., 2011), controlling the degree of relaxation of pelvic ligaments (Dufty, 1971) and/or swelling of the vulva as well as mammary gland expansion and teat feeling (Streyl et al., 2011), performing ultrasound examinations (Wright et al., 1988), measuring blood oestrone sulphate and 17-β-oestradiol (Shah et al., 2007), or progesterone concentrations (Matsas et al., 1992; Streyl et al., 2011), determining the electrolyte concentrations in mammary gland secretion (Bleul et al., 2006), monitoring the animals by cameras (Cangar et al., 2008), using electronic data loggers attached to legs (Titler et al., 2015), or measuring rumination time (Kovács et al., 2017) or heart rate and heart rate variability (Kovács et al., 2015). Although these methods may help predict the exact time of calving, however inaccuracy and difficulty of some methods may limit their use in the field.

Recently an electronic system (C6 birth control), originally used for mares, has been introduced for monitoring calving in dairy cows, previously a sensor device was sutured to the vulva labia of the pregnant cows being close to calving, which was activated by the physical separation of the vulva lips generating a radio wave signal sent to a receiver installed in the calving barn, then through the Global System for Mobile Communication (GSM) technology, sent a short SMS text message to the farmer's mobile phone informing about the beginning of calving (Paolucci et al., 2010). Due to the prevalence of false alarms caused by those cows scratching in response to the suture and the requirement of the presence of a veterinary practitioner, these sensor devices were developed into intra-vaginal GSM devices inserted into the cranial portion of the vagina 3±1 days before expected time of calving (Palombi et al., 2013). The use of this system in dairy cows showed a reduction in the prevalence of puerperal diseases and improved the neonatal viability.

In our recent experiment, 257 calvings have been monitored by using vaginal thermometers (Vel'Phone, Medria, Châteaugiron, France) and the prevalence of stillbirth rate was 3.1% (unpublished data). Similar results were reported by others (Paolucci et al., 2010). It is also very important to avoid birth injuries (Kovács et al., 2016) and infection of the reproductive tract during assistance, which is more likely to occur in cows with dystocia.

CONCLUSION

The general trend worldwide is to continuously improve our reproductive management in order to get an animal pregnant as soon as possible after calving (Szenci, 2008). On the other hand, when an animal becomes pregnant, less attention is provided and not the correct assistance used to be chosen during calving in several cases. This may be the main reason why the rate of perinatal mortality is still very high comparing with human data. Therefore

one of the most important breeding objectives is to reduce the number of calving assistance required. This is even more important, since calving assistance in itself may negatively affect the newborn calves' acid-base balance and subsequent fertility of the dam. Therefore, the main emphasis should be paid on the prevention of asphyxia of calves at birth, since instruments suitable for a reliable clearing of respiratory passages and artificial respiration of newborn calves under practical conditions are not yet widely used (Szenci, 2003).

In case of dystocia, the mode and time of calving assistance should be chosen with regard to profitability factors and in a manner which would allow the least possible shift of the newborn calf's acid-base balance towards acidosis. Before applying traction, measurements of the soft birth canal should always be considered when dilatation of the soft maternal passages is not sufficient they must be expanded non-surgically or surgically (episiotomy lateralis) and obstetric lubricants should be used to avoid tractions longer than 2 to 3 minutes (Szenci et al., 1988) and rib and/or vertebral fractures due to excessive traction (Schuijt, 1990). If a prolonged traction is expected, Caesarean section should be carried out to save the calf and to prevent injuries of the maternal birth canal. Recent studies have shown that before selecting the mode of calving assistance in an animal hospital, the results of acid-base balance measurements from blood samples should be considered. The routine use of complex treatment of newborn calves born with severe asphyxia may reduce the postnatal calf losses (Szenci, 2003). In addition to an adequate therapy, particular attention in the case of calves with asphyxia should be paid to the ingestion of sufficient amounts of colostrum, since the lack of colostrum uptake is accompanied by an increased susceptibility to E. coli infections (Besser et al., 1990).

While it is not possible to eliminate dystocia, adequate management of heifers during their development (adequate feeding, selection of a sire with a negative expected progeny difference for birth weight) and close observation of cows and heifers during calving are essential for reducing calf losses (Szenci, 2003). Since in many cases there are no visible clinical signs of the onset of calving, therefore especially in large dairy farm it is difficult to recognize it. Insertion a vaginal thermometer into the vagina (Vel'Phone) may contribute to the decrease of stillbirth, delayed calving assistance and its consequences by alarming via SMS about the day-to-day changes in temperature, of the imminence of calving, and breaking of the allantoic sac (Choukeir et al., 2013).

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