Management Practices for Successful Calving

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Take Home Messages

- Dairy herds should have written calving SOPs describing the imminent signs of birth (what to look for and why is that important), hygiene and newborn care practices (e.g., colostrum), and record-keeping. The SOPs should be revised, and adjusted if necessary, at least twice annually.
- The time a cow or heifer spends "in labor" (straining) and the estimated times from the appearance of the amniotic sac or feet of the calf outside the vulva should be used as guidelines to determine the appropriate time for intervention. Early intervention has the potential to prevent stillbirth, but also has the potential for injury to the dam because of lack of soft tissue dilation.
- Although limited science-based information is available in the literature, providing sufficient close-up and maternity pens is key to improve the survival and performance of dams and calves. The following guidelines apply to the maternity pen: (1) an area of at least 175 ft^2 (16 m^2) per cow; (2) flooring of sand, dirt, or clay covered with straw bedding (6-10 inches deep, changed frequently to keep it dry and clean); (3) the area or pen should be well-ventilated with adequate lighting; and (4) chute or head gate available to restrain animals and water (hose) for sanitation.
- The overall (pregnant heifers and cows) prevalence of stillbirth (calf born dead at term or dies within 24 h after birth) should be less than 2%. If the prevalence is higher (especially over 8%), provide training to personnel as well as revise the pre-fresh management (e.g., overstocking, calcium status), heifer replacement program (e.g., nutrition management, breeding records), and colostrum program (e.g., septicemia due to bacterial load).

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Introduction

The three largest expenses of the dairy business are: 1) feeding lactating dairy cows, 2) raising replacement heifers, and 3) labor. However, personnel performance (labor) is directly associated with the success of lactating cows and replacement heifers. Dystocia directly influences the survival and performance of both calves (which affects the number of replacement heifers available) and lactating dairy cows (due to reproductive failure and reduced milk yield). Dystocia has been defined as a difficult birth resulting in prolonged calving or severe assisted extraction of the calf at birth (Mee, 2004; Schuenemann et al., 2011a). When referring to problems at calving, it is important to note the difference between dystocia and assisted births. Assisted birth is defined as a birth in which assistance is required (e.g., only one foot of the calf is visible outside the vulva), but this may not necessarily result in dystocia (Mee, 2004). In practice, as soon as the malpositions are corrected the cow may complete the delivery normally or with minimal assistance. Dystocia increases the prevalence of stillbirth and calf mortality within 30 days postpartum (Mee, 2004; Lombard et al., 2007; Schuenemann et al., 2011b). In addition, dystocia increases the likelihood of trauma on the dam (i.e., paresis), uterine disorders, and decreased milk yield (Dematawewa and Berger, 1997; Sheldon et al., 2009). Incidence of dystocia (assistance required during parturition) varies between studies (Mee, 2004; Meyer et al., 2001), but it is generally greater in primiparous cows compared with multiparous cows in the US (Figure 1; USDA, 2010; Hunter et al., 2013).

Comprehensive training on calving management for dairy personnel has been reported as a top priority to mitigate the negative effects of dystocia, especially to reduce the prevalence of stillbirth, injury to the dam, and metritis (Lombard et al., 2007; Schuenemann et al., 2011a). The training program should provide clear information on the imminent signs of parturition and delivery times for normal and dystocic births (Schuenemann et al., 2013). This article will present information on: 1) the imminent signs of birth and calving progress (normal versus dystocia); 2) how to determine if dairy heifers or cows need assistance at calving; and 3) management practices to reduce risks of calving-related losses (e.g., stillbirth) and improve overall herd performance under field conditions. Our studies were conducted using Holstein heifers or cows; however, the information provided can serve as a guideline for all dairy cows.

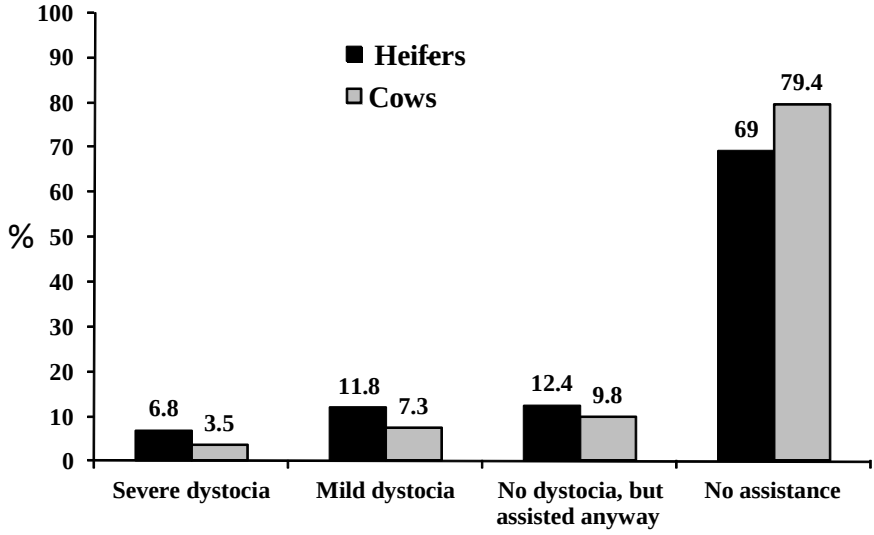

Figure 1. Frequency of dystocia according to the degree of assistance provided during parturition in dairy heifers and cows in the US (adapted from USDA, 2010).

▪ Signs of Parturition, Calving Progress, and Reference Times for Intervention

Normal or Eutocic Births

Recognizing the signs of imminent birth (normal or abnormal) and the behavior of the cow or heifer before or during parturition is critical to identify those needing assistance (difficult births) and determine the appropriate time for intervention. Calving or birth of the calf is a natural process that is divided into three stages (I, II, and III) and under normal conditions it progresses gradually from one stage to the next. Stage I is characterized by dilation of the soft tissues of the birth canal, including ligaments of the pelvis, cervix, and vulva. Enlargement of the mammary gland, distension of the vulva and perineum region, and vaginal fluid discharge are signs of imminent parturition in cows or heifers. Regarding the behavioral signs, variation exists between cows and heifers as time of calving approaches and thereafter (Titler et al., 2013b). In general, stage I is characterized by frequent sniffing of the ground, licking of the cow's body parts such as hind legs or back; frequent discharges of urine and feces; and frequent transition between walking, lying down, and

standing (typical signs of discomfort before delivery) with frequent vocalizations and raised tail (Miedema et al., 2011; Schuenemann et al., 2011a). It is noteworthy that many of the behavioral signs described previously can be repeated in stage II and stage III. Stage I ends with full dilation of the cervix and appearance of the allantochorion or amniotic sac (AS) outside the vulva.

Stage II (expulsion of the calf) is characterized by appearance of the AS or "water bag" outside the vulva, onset of abdominal contractions, and progress of the calf through the birth canal (USDA, 2010; Schuenemann et al., 2011a). Under normal conditions, the calving progress is characterized by appearance of the feet of the calf outside the vulva, followed by the nose and head (front presentation) or by the tail and pelvis of the calf in posterior presentation (backward). Stage II ends with the delivery of the calf or multiple calves such as twin or triplet births (USDA, 2010; Schuenemann et al., 2011a; Hunter et al., 2013). In multiparous cows, stage II is characterized by lying down at the onset of abdominal contractions and remaining in the same position until birth (Schuenemann et al., 2011a). The AS appears immediately before or after the onset of abdominal contractions and the calving progress (showing feet of the calf followed by the nose, head, shoulder and birth) is evident every 15 to 20 min (Schuenemann et al., 2011a). Abdominal contractions are frequent (between 3 and 9 abdominal contractions every 3 min) as calving progresses (Schuenemann et al., 2011a). Under normal conditions, when the head and shoulder of the calf are outside the vulva, 2 or 3 intense abdominal contractions complete the birth (Schuenemann et al., 2011a). Distribution of births at calving (forward or backward presentation, single or multiple calves, breech, and stillbirth) in Holstein dairy cows is provided in Table 1.

Table 1. Distribution of birthing conditions at the time of calving in Holstein dairy cows[1]

Item	Proportion of 3,870 births (%)
Forward (or anterior)	96. 0
Backward (or posterior)	4. 0
Single calf	94. 9
Multiple calves	5. 1
Breech	1. 0
Stillbirth[†]	8. 0

[1]Adapted from Hunter et al. (2013).
[†]Stillbirth was defined as a calf born dead at term or died within 24 h after birth.

For Holstein heifers, stage II of labor is characterized by frequent changes of position (from standing to lying), mainly at the beginning of stage II or even at the end of stage I. When the calf is positioned into the birth canal and the feet or head are outside the vulva, the heifer usually remains recumbent with abdominal contractions and clear calving progress every 15 to 20 min. At the time of parturition, abdominal contractions in Holstein heifers are more numerous than in multiparous cows. In cows or heifers experiencing normal or eutocic births, mean times from the onset of AS or feet of the calf outside the vulva to birth was estimated to be 70 to 65 min, respectively (Table 2; Schuenemann et al., 2011a).

Finally, stage III covers the period from birth until the expulsion of the fetal membranes. Immediately after birth, the cow or heifer will stand up (if previously lying down) and start sniffing and licking the calf. Normal expulsion of fetal membranes should occur before 24 h after birth in both cows and heifers (Kelton et al., 1998; LeBlanc, 2008). It is common that some animals eat the fetal membranes. To avoid any inconvenience (choking or suffocation), fetal membranes should be removed from the maternity or fresh pen immediately after expulsion.

Table 2. Signs and reference values for normal births in Holstein heifers or cows[1]

Signs of normal birth	Description[2]	References
Appearance of the AS or feet of the calf outside the vulva	Landmark references	Noakes et al. (2001) Schuenemann et al. (2011b)
Signs of calving progress	Evident every 15 to 20 min	Schuenemann et al. (2011b)
Average time since appearance of the AS outside the vulva to birth	70 min*	Noakes et al. (2001) Schuenemann et al. (2011b)
Average time since appearance of the feet of the calf outside the vulva to birth	65 min*	Schuenemann et al. (2011b)
Time that a cow or heifer is in labor (abdominal contractions)	≤2 h	Gundelach et al. (2009) Schuenemann et al. (2011b)
Frequency of observation	At least every hour	Schuenemann et al. (2011b)

[1]These recommendations work best if dairy personnel monitor cows every hour because frequency of observation is critical to determine the onset of the amniotic sac or feet of the calf outside the vulva.

[2] Mean times were estimated using the mean ± 2 SD.

Assisted or Dystocic Births

Recognizing the characteristics and behavioral signs of normal birth in cows or heifers is critical to correctly identify the signs of dystocia. A recent study examined the characteristics of difficult births under field conditions in Holstein cows and heifers (Schuenemann et al., 2011a). During stage II of difficult births, appearance of AS outside the vulva was observed about 18 min after the onset of abdominal contractions (Schuenemann et al., 2011a). Appearance of the feet and nose of the calf and clear signs of calving progress was observed between 36 and 48 min after appearance of AS (Schuenemann et al., 2011a). For normal births, calving progress is evident every 15 to 20 min as opposed to dystocic births in which progress is slow or appearance of only feet and nose of the calf occurs without progress despite constant abdominal contractions (Schuenemann et al., 2011a).

Although the frequent change of position (transition between standing and lying down) is a clear sign of discomfort in heifers with dystocia, it is also occasionally observed in heifers with normal deliveries (Schuenemann et al., 2011a). When heifers experience difficult births, the number of abdominal contractions often decreases significantly (as well as their intensity) after 2 h of intense labor (Gundelach et al., 2009; Schuenemann et al., 2011a). Decreased contractions are a clear sign of fatigue and should be taken into account when determining the appropriate time for intervention in heifers (Table 2). Calving personnel should constantly monitor the calving progress and the time that a cow or heifer is in “labor”. Generally, the time in labor (abdominal contractions and progress of the calf through the birth canal) starts at the onset of stage II with the appearance of the AS outside the vulva (Schuenemann et al., 2011a). In practice, the appearance of the AS should be the time “zero” and used as the reference landmark to determine whether the cow or heifer might experience dystocia or require assistance (Table 2).

Appearance of the AS, feet of the calf, or both, outside the vulva, combined with signs of calving progress, are clear landmarks that calving personnel can easily identify under field conditions. The time a cow or heifer spends “in labor” (straining) and the estimated times from the appearance of the AS or feet of the calf outside the vulva should be used as guidelines to determine the appropriate time for intervention during dystocic births (Table 2). It is noteworthy that if malpositions are evident (e.g., only one foot of the calf is visible outside the vulva) after appearance of AS or for uterine torsion (where nothing is visible outside the vulva; Frazer et al., 1996), the cow or heifer must be assisted. Immediately after delivery, it is important to examine the cow or heifer to determine the presence of a second calf in case of multiple births (twins or triplets). Early intervention has the potential to prevent stillbirth, but also has the potential for injury to the dam because of lack of soft tissue dilation. To implement these obstetric concepts under field conditions, calving personnel should receive appropriate training to correctly interpret these signs

and reference values described above and determine whether the cow or heifer needs assistance.

■ Management Practices and Calving-Related Losses

Economic losses associated with dystocia can have severe consequences in dairy herds. After dystocia, increased risk for stillbirth and maternal injury and the subsequent negative effects on productive and reproductive performance of lactating dairy cows can occur resulting from increased risk for uterine disease (metritis) and ovarian dysfunction (Williams et. al., 2007). The percentage contribution of the total costs of dystocia was loss of production (41%) and fertility (33.4%) followed by cow-calf losses (25%); without considering medical and replacement costs (Dematawewa and Berger, 1997). Furthermore, reproductive failure increases the risk for premature cow removal from dairy herds (USDA, 2002). Once the cow or heifer is pregnant, risks associated with subsequent parturition must be overcome to support the next lactation. Prevention of diseases at the herd level requires an ongoing and constant effort with effective coordination of the whole system (animals, environment, facilities, and personnel). Substantial knowledge exists to prevent many diseases or conditions; however, it must be translated into on-farm applications or practices to have a measurable effect at the herd level. Appropriate calving management is key to reduce health-culling risks and improve milk yield and reproductive performance. Considering the diversity of production systems, adoption of herd-specific management practices is critical to prevent calving-related losses (e.g., stillbirth, dam injury, and uterine diseases) without neglecting animal welfare and profitability.

Animals having excessive body condition or body weight loss during the last trimester of pregnancy are prone to dystocia (Gearhart et al., 1990; Noakes et al., 2001). Therefore, appropriate nutrition management of cows during pregnancy and use of proven calving-ease sires have the potential to significantly reduce the prevalence of dystocia. To avoid these negative effects, some dairy herds provide early obstetrical assistance (once the feet of the calf is outside the vulva) to all periparturient cows; however, the effects of this practice on cow-calf survival and health have not been fully investigated. A recent study showed that cows experiencing normal calving have similar postpartum health (metritis) and reproductive performance as cows with early obstetrical intervention (Villettaz Robichaud et al., 2013). Although cows with dystocia are more restless 24 h before calving than cows with normal calving (Titler et al., 2013c), cows with early obstetrical intervention spent more time (1 h ± 26 min) standing per day during the 10 d after calving compared with unassisted cows (Villettaz Robichaud et al., 2013). Because dairy cows that experienced dystocia might have altered activity patterns (e.g., resting and feeding time; Huzzey et al., 2007), and consequently are less active (Titler et al., 2013a; 2013b), development of electronic systems to accurately monitor cow activity (on real-time around the clock) provides a clear opportunity to

identify individual animals in need of attention and reduce the risks of culling and mortality that are the consequence of late interventions.

When designing calving management practices within-herd, it is important to keep in mind the risk factors associated with stillbirth. Difficult birth, backward presentations, calf gender (male), parity (primiparous cows), season (winter and spring), and the time around the shift change (calves born 1 h before and after) of herd personnel significantly increased the proportion of stillbirth (Lombard et al., 2007; Schuenemann et al., 2011a; Hunter et al., 2013). Distribution of births with respect to season (daily or weekly birth rate) and the same number of calving personnel might increase the risk for stillbirth because of increased number of cows calving per unit of time and the real possibility of late intervention (unable to assist multiple cows with dystocia at the same time).

■ Calving Management Training

Training of calving personnel (oral presentation, group discussion, and hands-on demonstrations) is a key management tool to significantly reduce calving-related losses in dairy herds. The following topics are critical components of educational programs for calving personnel (e.g., dairy personnel school; Schuenemann et al., 2013):

- Description of behavioral signs of the cow or heifer before and during labor;
- When and how it is appropriate to assist the cow or heifer;
- Strategies to correct abnormal presentation, position, or posture;
- Hygiene practices during assisted births;
- Accurate record-keeping of birth events;
- Best communication practices within the farm team (i.e., when to call for help); and
- Best newborn care practices (e.g., timing and amount of colostrum to be fed).

After training and hands-on demonstration, personnel should be able to recognize the landmarks and reference times for normal births (i.e., calving progress) as well as for difficult births to determine the appropriate time for intervention under field conditions (Table 2). Using these learning methodologies, calving personnel significantly increased their knowledge (Schuenemann et al., 2013) and reduced the proportion of stillbirths by 9 percentage points (from 15.5% to 6.5%; Schuenemann et al., 2011c). Furthermore, use of tests of knowledge (e.g., 5 multiple choice questions) and

hands-on demonstrations may serve as valuable instruments to identify those workers that are skilled and able to follow the on-farm standard operating procedures (SOPs; Schuenemann et al., 2013). It is critical that herd managers or owners spend time finding the right task for the right worker. Calving management is a critical task with significant implications on cow-calf survival and health, which requires well-trained workers and established SOPs.

A comprehensive training program must be able to: (1) provide new knowledge for immediate field application; (2) encourage discussion; (3) collect feedback; and (4) allow follow-up with participants after program delivery (Schuenemann et al., 2013). According to feedback provided by dairy personnel, communication within the farm team (especially between workers or family members), need for new obstetric chains or additional manual help, written calving protocols, unknown anticipated calving dates, and maintenance of calving or maternity pens were ranked as the top priorities to effectively identify and assist cows with dystocia (Schuenemann et al., 2013). Human resources play a critical role in the application of best management practices within herds. In previous training and hands-on demonstrations, dairy personnel shared examples of unclear recommendations such as “wait 2 h and assist cows experiencing difficult births” or “if there is no calving progress call for help.” The SOP for calving management must provide clear reference landmarks for time zero (when to start counting) and signs of the normal progression of calving (Table 2); otherwise, most calving personnel would not be able to follow the above recommendations. For more information on personnel training, assessment tools, and calving management practices to prevent stillbirth, visit the following web site: http://vet.osu.edu/extension/dairy-personnel-school.

In addition to personnel training and having established SOPs, dairy managers should maintain their calving facilities and working conditions; monitor pre-fresh cows to prevent hypocalcemia at calving (Curtis et al., 1983; Reinhardt et al., 2011); monitor the duration of stay in the dry pen (shorter [<30 days] or longer [>70 days] dry periods, which increased the prevalence of stillbirth; Norman and Hutchinson, 2011); and keep accurate breeding (AI date) and pregnancy diagnosis records to be able to estimate calving date. In confinement systems, moving periparturient cows or heifers during stage I or II (appearance of AS or showing feet outside the vulva) from group pens (e.g., close-up) to a contiguous maternity pen is a common practice in many dairy herds. For herds that group cows according to expected calving date (close-up pen) and to avoid cows calving in the stalls, moving periparturient cows to a contiguous maternity pen before or at the onset of labor (appearance of AS outside the vulva) did not increase the risk for stillbirth compared with cows moved in an earlier stage (presence of only mucus or blood at the vulva; Carrier et al., 2006). Frequency of observation (calving personnel walking the pen and actually observing cows every hour) is critical to determine the onset

of the AS outside the vulva. Although the effect on stillbirth was not assessed, a recent study showed that moving cows to a contiguous maternity pen during the later portion of stage I delayed stage II of labor, probably because movement altered lying behavior (Proudfoot et al., 2013). Further research is needed to assess the effect of movement with respect to stages of parturition on stillbirth and health, taking into account facility design and personnel.

The following elements should be considered when designing management practices to reduce calving-related losses:

Intervention

Knowing when to intervene and recognize imminent signs of calving is critical for positive outcomes. Usually, once the AS or "water bag" appears outside the vulva, birth should occur within 70 min. Call for help if there is no progress 30 min after your intervention. For heifers, once the nose/feet of the calf are outside the vulva, assist to finish the process. For backward presentations in cows or heifers, assist to finish the process. Establish calving protocols (including the frequency of observations, how and when it is appropriate to intervene) and have them available. The appearance of the AS or feet of the calf outside the vulva should be used as a reference landmark to determine the calving progress and when to intervene. Regularly monitor hypocalcemia (clinical or subclinical; Curtis et al., 1983) at calving and adjust dietary cation anion difference (if used), ration, and/or management (e.g., stocking) in close-up pens.

Adoption of Hygiene Practices

Cleanliness of the perineal region (presence of feces or dirt) in cows at calving is significantly associated with metritis (Schuenemann et al., 2011b). If intervention is required: (1) wash the perineum region with disinfectant soap and water; (2) disinfect obstetric chains before and after use; and (3) use abundant lubricant and disposable long sleeve gloves. The maternity pen should be kept clean and dry, and free of placentas. Maximize the comfort of cows in the close-up pen.

The following link provides helpful information on disinfectants available for dairy herds: http://www.cfsph.iastate.edu/Infection_Control/disinfectant-resources-for-veterinarians.php (Center for Food Security and Public Health at Iowa State University).

Establish Calving SOPs

Dairy herds should have written calving SOPs and they should be revised (and adjusted if necessary) twice annually. Calving personnel should be able

to follow the established SOP, know what to look for or monitor before and during calving, understand the process (Table 2), and communicate calving records. Use of photo images in the SOP can greatly enhance understanding of concepts. If the prevalence of stillbirth is approximately 8 to 15%, provide training to calving personnel. Keep prevalence of stillbirth below 2%. The following link provides helpful information (e.g., visual guide of parturition) to develop the SOP: http://www.drostproject.org/en_bovrep/guide.html.

Colostrum Program

Dairy herds should have written colostrum SOPs (from harvesting to feeding and monitoring quality) and they should be revised (and adjusted if necessary) twice annually. Feeding quality (≥50 mg/mL IgG) and quantity (at least 4 L) of colostrum in a timely manner (within 3 hours after birth) without bacterial contamination is critical for calf survival, health and performance. Colostrum quality, passive transfer of immunoglobulins (total calf serum proteins assessed at 48 hours after feeding colostrum), as well as milk solids can all be measured using a Brix refractometer (Moore et al., 2009; Bielman et al., 2010; Deelen et al., 2014).

Record Keeping

Keeping complete and accurate records of calving-related events is key to reduce the prevalence of stillbirth. At a minimum, personnel should record the degree of calving difficulty (Table 3), newborn gender, accurate identification (ID) of the mother and calf, birth date, start (appearance of AS outside the vulva) and end time of calving, stillbirth (or abortion), personnel ID, and hygiene of the cow perineum at calving (1 to 3 scale; Schuenemann et al., 2011b). This information will assist veterinarians, consultants, and dairy producers in trouble-shooting calving-related losses. For more information on calving records, visit the following web site: http://vet.osu.edu/extension/dairy-personnel-school. The degree of assistance (force) that is provided during assisted births determines the difficulty at birth (dystocia) and several scales have been described (Table 3).

Table 3. Description of scales used to determine the degree of calving difficulty according to the degree of assistance provided during parturition in Holstein herds

Scale	Description of calving difficulty	References
1 to 3 scale	1 = no assistance 2 = slight assistance 3 = needed assistance	Meyer et al. (2001)
1 to 5 scale	1 = no assistance 2 = assistance by one person without use of mechanical traction 3 = assistance by 2 or more people 4 = assistance with mechanical traction 5 = surgical procedure	Dematawewa and Berger, (1997) Lombard et al. (2007) Schuenemann et al. (2011b)
Combination of both	Description is based on degree of assistance	Mangurkar et al. (1984) Schuenemann et al. (2011b)

Proven Calving-ease Sires

Use of calving-ease sires (calves with low birth weight) in breeding programs, especially when inseminating replacement heifers is an essential management tool to prevent calving-related losses (Gearhart et al., 1990). This strategy combined with proactive management at the farm level should significantly reduce the prevalence of dystocia and stillbirth.

Sufficient Close-up and Maternity Pens

Although limited information is available regarding proper sizing in the literature, this is a key area to improve cow-calf survival and performance. The following guidelines apply to the maternity pen: (1) an area of at least 175 ft^2 (16 m^2) per cow; (2) flooring of sand, dirt, or clay covered with straw bedding (6-10 inches deep, changed frequently to keep it dry and clean); (3) the area or pen should be well-ventilated with adequate lighting; and (4) chute or head gate available to restrain animals and water (hose) for sanitation. In addition, sizing the close-up pen(s) in free-stall barns is a critical task to avoid overstocking and subsequent negative effects.

The following example illustrates the steps for a 2,000-cow herd: (1) estimate the average daily births: 2,000 cows per 365 d = average 5.5 births per day; (2) then estimate the number of calvings per week: 5.5 births per day x 7 d = ~38 births per wk; and (3) finally estimate the number of stalls according to the length of the close-up period and births per week: ~38 births x 3 wk = ~115 births for the 3-wk period. Although the "average" births per week is a valuable metric, most producers are faced with ranges of 4 to 56 births per week). Therefore, plan for 162 stalls for the 3-wk close-up period based on the maximum births per week (54 births per week x 3 wk = 162 stalls) to avoid overstocking. These calculations assume that cows are grouped at dry-off based on their estimated calving dates (far-off and close-up pens). Because the weekly rate of calving varies from season to season, animals with no calving dates (e.g., bull-bred replacement heifers or cows, missing records, or unknown pregnancy status) may overcrowd the close-up pens.

Conclusions

Evaluating calving management success only on the basis of calf survival substantially underestimates the opportunities for superior management. Substantial knowledge exists to prevent many calving-related diseases or conditions; however, it must be translated into on-farm applications or practices to have a measurable effect at the herd level. Every farm is an integrated system; decisions made on one area of the farm will impact other areas of the farm. Unlike other experts in the dairy industry, practicing veterinarians and consultants regularly visit their clients. They are ideally placed to identify at-risk dairy herds likely to benefit from calving management training, which may significantly reduce calving-related losses, improve overall performance (milk yield and reproduction), and increase profitability.

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References

Bielman, V., J. Gillan, N. R. Perkins, A. L. Skidmore, S. Godden, and K. E. Leslie. 2010. An evaluation of Brix refractometry instruments for measurement of colostrum quality in dairy cattle. J. Dairy Sci. 93:3713-3721.

Carrier, J., S. Godden, J. Fetrow, S. Stewart, and P. Rapnicki. 2006. Predictors of stillbirth for cows moved to calving pens when calving is imminent. J. Dairy Sci. 89(E-Suppl. 1):195. (Abstr.)

Curtis, C. R., H. N. Erb, C. J. Sniffen, R. D. Smith, P. A. Powers, M. C. Smith, M. E. White, R. B. Hilman, and E. J. Pearson. 1983. Association of parturient hypocalcaemia with eight periparturient disorders in Holstein cows. J. Am. Vet. Assoc. 183:559-561.

Deelen, S. M., T. L. Olivett, D. M. Haines, and K. E. Leslie. 2014. Evaluation of a Brix refractometer to estimate serum immunoglobulin G concentration in neonatal dairy calves. J. Dairy Sci. 97:3838-3844.

Dematawewa, C. B. M., and P. J. Berger. 1997. Effect of dystocia on yield, fertility, and cow losses and an economic evaluation of dystocia scores for Holsteins. J. Dairy Sci. 80:754-761.

Frazer, G., M. Perkins, and P. Constable. 1996. Bovine uterine torsion: 164 hospital referral cases. Theriogenology 46:739-758.

Gearhart, M. A., C. R. Curtis, H. N. Erb, R. D. Smith, C. J. Sniffen, L. E Chase, and M. D. Cooper. 1990. Relationship of changes in condition score to cow health in Holsteins. J Dairy Sci. 73:3132-3140.

Gundelach, Y., K. Essmeyer, M. K. Teltscher, and M. Hoedemaker. 2009. Risk factors for perinatal mortality in dairy cattle: Cow and foetal factors, calving process. Theriogenology 71:901-909.

Hunter, A., M. G. Maquivar, S. Bas, J. D. Workman, and G. M. Schuenemann. 2013. Assessment of work shift transition of calving personnel on stillbirth in Holstein dairy cows. J. Dairy Sci. 96(E-Suppl. 1):383. (Abstr.)

Huzzey, J. M., D. M. Veira, D. M. Weary, and M. A. G. von Keyserlingk. 2007. Prepartum behavior and dry matter intake identify dairy cows at risk for metritis. J. Dairy Sci. 90:3220-3233.

Kelton, D. F., K. D. Lissemore, and R. E. Martin. 1998. Recommendations for recording and calculating the incidence of selected clinical diseases of dairy cattle. J. Dairy Sci. 81:2502-2509.

LeBlanc, S. J. 2008. Postpartum uterine disease and dairy herd reproductive performance: A review. Vet. J. 176:102-114.

Lombard, J. E., F. B. Garry, S. M. Tomlinson, and L. P. Garber. 2007. Impacts of dystocia on health and survival of dairy calves. J. Dairy Sci. 90:1751-1760.

Mangurkar, B. R., J. F. Hayes, and J. E. Moxley. 1984. Effects of calving ease-calf survival on production and reproduction in Holsteins. J. Dairy Sci. 67:1496-1509.

Mee, J. F. 2004. Managing the dairy cow at calving time. Vet. Clin. North Am. Food Anim. Pract. 20:521-546.

Meijering, A. 1984. Dystocia and stillbirths in cattle - A review of causes, relations and implications. Livest. Prod. Sci. 11:143-.

Meyer, C. L., P. J. Berger, K. J. Koehler, J. R. Thompson, and C. G. Sattler. 2001. Phenotypic trends in incidence of stillbirth for Holsteins in the United States. J. Dairy Sci. 84:515-523.

Miedema, H. M., M. S. Cockram, C. M. Dwyer, and A. I. Macrae. 2011. Behavioural predictors of the start of normal and dystocic calving in dairy cows and heifers. Appl. Anim. Behav. Sci. 131:14-19.

Moore, D. A., J. Taylor, M. L. Hartman, and W. M. Sischo. 2009. Quality assessments of waste milk at a calf ranch. J. Dairy Sci. 92:3503-3509.

Noakes, D. E., T. J. Parkinson, and G. C. W. England. 2001. Dystocia and other disorders associated with parturition, 8th ed. Arthur's Veterinary Reproduction and Obstetrics, Saunders.

Norman, H. D. and J. L. Hutchison. 2011. Effects of dam's dry period length on heifer development. J. Dairy Sci. 94(E-Suppl. 1):27. (Abstr)

Proudfoot, K. L., M. B. Jensen, P. M. H. Heegaard, and M. A. G. von Keyserlingk. 2013. Effect of moving dairy cows at different stages of labor on behavior during parturition. J. Dairy Sci. 96:1638-1646.

Reinhardt, T. A., J. D. Lippolis, B. J. McCluskey, J. P. Goff, and R. L. Horst. 2011. Prevalence of subclinical hypocalcemia in dairy herds. Vet. J. 188:122-124.

Schuenemann, G. M., I. Nieto, S. Bas, K. N. Galvão, and J. Workman. 2011a. Assessment of calving progress and reference times for obstetric intervention during dystocia in Holstein dairy cows. J. Dairy Sci. 94:5494-5501.

Schuenemann, G. M., I. Nieto, S. Bas, K. N. Galvão, and J. Workman. 2011b. II. Dairy calving management: Effect of perineal hygiene scores on metritis. J. Dairy Sci. 94(E-Suppl. 1):744. (Abstr.)

Schuenemann, G. M., S. Bas, E. Gordon, and J. Workman. 2011c. Dairy calving management: Assessment of a comprehensive program for dairy personnel. J. Dairy Sci. 94(E-Suppl. 1) 1):483. (Abstr.)

Schuenemann, G. M., S. Bas, E. Gordon, and J. D. Workman. 2013. Dairy calving management: Description and assessment of a training program for dairy personnel. J. Dairy Sci. 96:2671-2680.

Sheldon, I. M., J. Cronin, L. Goetze, G. Donofrio, and H-J. Schuberth. 2009. Defining postpartum uterine disease and the mechanisms of infection and immunity in the female reproductive tract in cattle. Biol. Reprod. 81:1025-1032.

Titler, M., M. G. Maquivar, S. Bas, E. Gordon, P. J. Rajala-Schultz, K. McCullough, and G. M. Schuenemann. 2013a. Effect of metritis on daily activity patterns in lactating Holstein dairy cows. J. Dairy Sci. 96(E-Suppl. 1):647. (Abstr.)

Titler, M., M. G. Maquivar, S. Bas, E. Gordon, P. J. Rajala-Schultz, K. McCullough, and G. M. Schuenemann. 2013b. Effect of parity on daily activity patterns prior to parturition in Holstein dairy cows. J. Dairy Sci. 96(E-Suppl. 1):431. (Abstr.)

Titler, M., M. G. Maquivar, S. Bas, E. Gordon, P. J. Rajala-Schultz, K. McCullough, and G. M. Schuenemann. 2013c. Effect of dystocia on daily activity patterns prior to parturition in Holstein dairy cows. J. Dairy Sci. 96(E-Suppl. 1):646. (Abstr.)

USDA. 2010. Dairy 2007, Heifer Calf Health and Management Practices on U. S. Dairy Operations, 2007. USDA:APHIS:VS, CEAH. Fort Collins, CO.

USDA. 2002. Part I: Reference of Dairy Health and Management in the United States, 2002.

Villettaz Robichaud, M., D. L. Pearl, J. Rushen, A. M. de Passillé, S. M. Godden, S. J. LeBlanc, and D. B. Haley. 2013. The effects of calving assistance on health, reproduction, and survival of Holstein dairy cows. J. Dairy Sci. 96(E-Suppl. 1):383. (Abstr.)

Williams, E. J., D. P. Fischer, D. E. Noakes, G. C. W. England, A. Rycroft, H. Dobson, and I. M. Sheldon. 2007. The relationship between uterine pathogen growth density and ovarian function in the postpartum dairy cow. Theriogenology 68:549-559.