

How to Minimize the Impacts of Dystocia on the Health and Survival of Dairy Calves

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■ Take Home Messages

- ▶ The most dramatic physiological changes occur during birth and death.
- ▶ Calves born without assistance experience hypoxia (low arterial blood oxygen), acidosis, and frequently hypothermia. Dystocia calves experience the same changes but to a greater degree.
- ▶ Dystocia has an immediate and prolonged effect on the health and productivity of calves.
- ▶ Perinatal mortality due to dystocia accounts for about half of all calf deaths through weaning and is not due to infectious disease.
- ▶ Simple interventions such as providing calves with mechanical breathing assistance, oxygen, colostrum, and a warm environment for the first few hours after birth can make the difference between life and death.
- ▶ Dystocia monitoring should be implemented on every dairy farm.
- ▶ Dystocia and subsequent perinatal mortality are major animal-welfare issues for the dairy industry.

■ Prevalence and Effects of Dystocia

Dystocia is defined as delayed or difficult parturition. There are three general categories of dystocia: fetal-maternal size mismatch (e.g. oversized calf or small maternal pelvis), fetal malpresentation (e.g. breech presentation), and maternal causes (e.g. hypocalcemia) (Arthur et al., 1989).

The prevalence and effects of dystocia can be reduced in three ways:

- Prebreeding management: select sires for calving ease and dams for adequate pelvic size (dam selection has never been done in the dairy industry), breed heifers of recommended height and weight, and provide optimal nutrition during pregnancy.
- Calving time: ensure that calving areas are comfortable and as stress free as possible, and provide assistance when needed using proper techniques and procedures.
- Neonatal assistance: provide maternal and additional care as needed.

While all three of these methods are important, this paper focuses on neonatal assistance.

Most dairy farms likely don't know the impact of dystocia because it isn't well monitored. The first step in reducing dystocia and improving the outcome for calves is to implement a monitoring plan. The plan can be relatively simple. For instance, the first step would be recording the number of calvings using a three-point dystocia scale in which '1' is an unassisted birth, '2' is a relatively easy pull, and '3' is a hard pull or surgical extraction. Each calving should be assigned a dystocia score using the above criteria. In addition, record live and dead births, gender, time to stand, time to colostrum, and time to suckle. Specific interventions are discussed later in this paper and can also be recorded.

These basic measures can be used to evaluate the effect of dystocia and suggest interventions to decrease its impact. Evaluated over time, these measures can indicate whether or not management changes have reduced the occurrence and impact of dystocia. For instance, a comparison could be made between the incidence of dystocia and the number of stillbirths by the level of dystocia before and after the implementation of specific practices, such as using a new sire, worker training, or additional care provided to dystocical calves.

The prevalence of dystocia varies based on the type of cattle (beef versus dairy breeds), parity, and across studies. Data collected from U.S. dairy farms participating in the Dairy Herd Improvement Association indicated that 28.6% of primiparous (first-calf heifers) and 10.7% of multiparous cows experienced dystocia (Meyer et al., 2001). Other producer-collected data suggest a much lower rate or, more likely, reduced recognition of dystocia. These data indicate that only 4.6% of cows experienced reproductive problems, including dystocia (NAHMS 2007). A study involving three large U.S. dairies reported an overall dystocia rate of 36.6% (Lombard et al., 2007), with 48.8% of primiparous dams experiencing dystocia compared with 29.4% of multiparous dams. Holsteins, the predominant dairy breed in the United States, have a higher prevalence of dystocia than Jerseys or Jersey crosses (Dhakal et al.,

2013). Regardless of breed, twins, bull calves, and heavier calves have an increased risk of experiencing dystocia (Johanson and Berger, 2003; Dhakal et al., 2013).

Multiple studies have demonstrated the adverse effect dystocia has on the survival, health, and production of calves and dams (Lombard et al., 2007; Barrier et al., 2012a, b; Tenhagen et al., 2007). A 13-month study evaluating 7,380 calvings on three Colorado Holstein dairy farms (Lombard et al., 2007) used a three-level dystocia scoring system with 1 indicating a normal, unassisted delivery; 2 indicating assistance by one person not using mechanical means; and 3 indicating that two or more people were required, and mechanical or surgical assistance was required. In this study, the percentage of stillbirth calves (more correctly perinatal mortality, or calves dying at or immediately near calving) increased as the dystocia score increased. Only 3.2% of unassisted calves (score of 1) were stillborn compared with 8.4% of calves with a score of 2, and 37.2% of calves with a score of 3. Overall, 8.2% of calves were stillborn, which is similar to a review of perinatal mortality reported by Mee (WCDS, 2012).

Studies of both dairy and beef calves have also shown increased morbidity and mortality through the preweaning period for calves experiencing dystocia (Lombard et al., 2007; Wittum et al., 1994). Dystocical calves in the Lombard study had significantly increased odds of experiencing respiratory or digestive disease compared with calves born unassisted. A similar finding of increased odds for general morbidity was reported in beef calves experiencing dystocia in the Wittum study. Based on the findings from these studies, dystocia has both an immediate and prolonged effect on the health and survival of calves. Obviously, based on the frequency of occurrence and the impact, dystocia should be an area of great concern for the dairy industry.

To address the impact of dystocia on calves, it is helpful to understand the complex and dramatic physiological changes that must occur for calves to successfully adapt to extrauterine life.

■ Normal Fetal Physiology

During normal extrauterine circulation in calves, the right side of the heart receives deoxygenated (relatively low oxygen and high carbon dioxide) blood from the body and pumps it to the lungs where oxygen is taken up by hemoglobin in the red blood cells and carbon dioxide is removed. The oxygenated (relatively high oxygen and low carbon dioxide) blood then flows to the left side of the heart where it is pumped to the rest of the body. Blood pressure in the right side of the heart is lower than in the left side (Cunningham and Klein, 2007).

The lungs of the fetus *in utero* are not functional. Until birth, the placenta serves as 'fetal lungs,' providing gas exchange and acting as the source of nutrients. The placenta also eliminates waste products such as carbon dioxide from fetal blood. In turn, diseases or disorders affecting the placenta can have serious consequences for calves. Fetal blood circulation bypasses the lungs, for the most part, since blood is not oxygenated *in utero*. Fetal blood travels through two structures (referred to as fetal shunts) to bypass the lungs. The foramen ovale is a connection between the right and left atria of the heart and prevents some blood from being pushed through the lungs. The ductus arteriosus connects the pulmonary artery to the aorta and also shunts blood away from the pulmonary circulation (Kasari, 1994).

During pregnancy and immediately after birth, calves have low blood oxygen levels and relatively high carbon dioxide levels compared with calves just a few hours old. Fetuses do fine at lower oxygen levels *in utero* because of the reduced oxygen consumption associated with low physical activity and living in a controlled environment in which the dam is responsible for providing nutrients and removing waste products.

■ Changes at Parturition

Parturition results in dramatic physiological changes and has a negative impact on fetal oxygen concentration. As delivery progresses, uterine and abdominal contractions can impede or stop blood flow through the placenta. Bluel et al. (2008) showed that during delivery a fetus's blood oxygen saturation drops from about 20% to less than 5%. During the calving process, the fetus experiences neonatal asphyxia: low blood oxygen levels and areas of decreased blood flow, or ischemia. Hypoxia can progress to anoxia (no oxygen in the blood). Prolonged anoxia, such as occurs during continuous uterine contractions, will result in fetal death within six minutes.

After delivery, the calf must begin breathing by inflating the lungs and initiating gas exchange. Lung expansion reduces blood pressure on the right side of the heart, causing a reversal of blood flow through fetal shunts, and functionally occludes the foramen ovale, usually within 5 to 20 minutes after birth. Due to respiration, oxygen tension in the blood going to the left side of the heart increases, causing the ductus arteriosus to close, usually within 5 minutes after birth (Kasari, 1994). If the foramen ovale or ductus arteriosus do not close normally, the resulting turbulent blood flow may be detected as a heart murmur.

Increased blood levels of carbon dioxide result in a respiratory acidosis and play a critical role in stimulating respiration. During dystocia, a more pronounced respiratory acidosis may occur. In addition to respiratory acidosis, the reduced oxygen content of the blood leads to anaerobic metabolism within tissues, resulting in a metabolic acidosis (lactic acidosis). The major clinical

effect of acidosis is central nervous system depression, sometimes referred to as 'weak calf syndrome' or 'dummy calf syndrome'. Maximizing lung function is key to resolving respiratory acidosis in newborn calves. Once the lungs are expanded, carbon dioxide is quickly removed via respiration. Resolution of the metabolic acidosis usually occurs within 2 hours of birth, while respiratory acidosis may persist for 24 to 48 hours (Ravary-Plumioën, RMV 2009).

After parturition, the neonate moves from the controlled environment of the uterus to the ambient environment which always results in heat loss. Minimizing heat loss by drying the hair coat and placing calves in a protected and warmed environment will increase the calves' body temperature. Calves also begin to generate body heat after birth. Heat is generated by three mechanisms: shivering thermogenesis, non-shivering thermogenesis, and physical activity. Shivering thermogenesis involves involuntary, periodic skeletal muscle contractions, while non-shivering thermogenesis involves the metabolism of brown adipose tissue (brown fat). Physical activity is the voluntary movements of skeletal muscles and is responsible for the greatest heat generation (Carstens, 1994). All of these mechanisms require good blood oxygen levels; hypoxemic calves have reduced ability to generate heat.

■ **Effects of Dystocia**

Dystocia results in a more severe acidosis than a normal, unassisted birth due to the increased time of hypoxia and anoxia during parturition. The longer the calves are in the transition between the uterine and extrauterine environment, the greater the probability of anoxia, resulting in a more severe acidosis. The acidosis starts a cascade of events that make the successful transition to extrauterine life much more difficult. Dystocical calves frequently have a depressed central nervous system, which reduces the stimulation for respiration. This depression also results in decreased physical activity and might prevent calves from standing or taking longer than normal to stand. In addition, decreased physical activity and reduced shivering results in more heat loss and hypothermia. In this case, suckling and the consumption of colostrum may not occur and, if it does, calves may not efficiently absorb the immunoglobulins necessary to protect against disease. Hypothermia and the lack of activity result in not only a failure to resolve the acidosis, but it commonly gets more severe and these calves frequently die (Kasari, 1994).

■ **Calving Assistance**

Assistance should always be provided by a trained, competent person. Information on diagnosing and treating dystocia has been published elsewhere (Roberts, 1986). In addition to knowing the techniques involved in delivery, it is important to implement the proper use of hygienic procedures, lubrication, chains, and other extraction equipment, which should result in a

successful outcome for calves and dams. Farms should have guidelines available that provide specific instructions on when and how to proceed during a dystocia event. In addition, dystocia training for employees can help decrease the effects of dystocia. Improper or aggressive methods used by untrained personnel are likely to cause physical harm to calves, including fractures and crushing injuries (Nagy, 2009). In a study by Schuenemann et al. (2011), employees underwent a comprehensive educational program designed to improve calving management, practices of calving personnel, and communication within the farm team. One herd was evaluated for stillbirths before and after the training; the stillbirth percentage on this farm dropped from 15.5 to 6.5% after training, representing a 60% decrease in stillbirths. Similar reductions due to employee training have been observed by the authors.

In order to know when and when not to intervene, the calving process must be thoroughly understood. Although the normal calving process is classified into three stages, the process is continuous and proceeds gradually from one stage to the next. Stage 1 is characterized by cervical dilation and uterine contractions that are usually not evident as abdominal contractions. During this stage, cattle might be restless/off feed because of the discomfort caused by uterine contractions. Stage 1 usually lasts 2 to 6 hours but may be longer in heifers. During stage 2, uterine contractions continue and abdominal contractions become evident. Stage 2 ends in the delivery of the fetus(es) and usually takes less than 2 hours for mature cows but up to 4 hours for heifers. In stage 3, the fetal membranes (placenta) are expelled as the uterus continues to contract. The duration of stage 3 can be minutes, even days if the placenta is retained (Arthur et al., 1989).

Frequently observing cows close to calving is the key in determining how labor is progressing, how much time has elapsed since labor began, and whether or not intervention is necessary. About half of U.S. dairy producers reported observing cattle close to calving about every 3 hours during the day but only about every 5 hours during the night (NAHMS, 2007). When calving was imminent and the heifer or cow was restless/off feed but not straining, about half of producers would examine heifers and cows within 3 to 5 hours; however, more than one-fourth of producers waited 7 or more hours before examining cattle in labor. Once heifers or cows began straining, almost 90% of producers examined the animals within 3 hours if labor was not progressing. Producers that call a veterinarian for assistance should consider the time it takes the veterinarian to arrive on site to avoid increasing the time to delivery and the possibility of a dystocia-related stillbirth. The results of the NAHMS study indicate that many producers should observe cattle in labor more frequently and potentially intervene earlier in the calving process.

■ Neonate Assistance

Based on the many physiological changes that occur during and after birth, most neonates (newborns), especially those experiencing dystocia, can benefit from relatively simple interventions. The three goals of intervention are to:

- Stimulate respiration
- Maintain body temperature (thermoregulation)
- Increase blood volume via colostrum

Stimulate Respiration

As mentioned earlier, calves are born with increased levels of carbon dioxide in their blood, which stimulate respiration; however, sometimes calves still need assistance breathing. To help calves breathe, mucus in the upper airway should be removed via suction or positive pressure ventilation. Some farms suspend calves from their rear legs immediately after birth to help clear fluid from the upper airway and lungs. Research has shown that calves delivered by caesarean section have improved gas exchange and acidosis correction when they are suspended for 90 seconds or less or placed in sternal recumbency compared with calves placed in lateral recumbency (Uysterpruyst et al., 2002). Although suspending newly born calves might be beneficial if done for a very short period, research has shown that most of the expelled fluids originate in the calves' abomasum, not in the lungs. Additionally, the weight of the digestive tract on the diaphragm when calves are suspended makes it more difficult for calves to breathe. Rather than suspending calves upside down, we prefer to place calves in sternal recumbency immediately after birth.

Lungs must inflate with air and expand in order for respiration to occur. The initial expansion of the lungs is similar to blowing up a balloon; expansion is difficult initially but gets easier as more air enters the lungs. Increased blood levels of carbon dioxide and the additional stimuli of the extrauterine environment, including temperature changes, promotes respiration in calves. Additional stimulation and respiration assistance can be performed in multiple ways, including stimulating the nostril with a piece of straw or similar material, vigorously rubbing the calves, pouring cold water on the calves' head or in their ears, using an Ambu bag (a trademark, self-inflating ventilation bag) or similar device, or endotracheal tube for positive pressure ventilation, drugs such as doxopram, and the administration of oxygen. We recommend stimulation, positive pressure ventilation, and the administration of oxygen, for calves experiencing dystocia. We don't recommend pouring cold water on newborn calves because of hypothermia concerns.

Positive pressure ventilation forces air through the upper airway or trachea and into the lungs using mechanical means. Devices such as the Ambu bag have pressure relief valves that prevent over inflation and damage to the lungs. When using an Ambu bag with a mask for positive pressure ventilation, the esophagus must be occluded to prevent inflation of the abomasum (Kasari, 1994). Occluding the esophagus can usually be accomplished by extending the neck and applying pressure around the trachea. Some calves may need only a few “mechanical” breaths to inflate their lungs, while others may need more prolonged assistance. Endotracheal tubes can also be used, but they frequently require a laryngoscope to place within the trachea and are not as simple and convenient to use as the Ambu bag with a mask.

The direct administration of oxygen via nasal insufflation can be accomplished using a small rubber catheter placed in the nose or integrated into the ventilation provided with the Ambu bag. The recommended oxygen flow rate varies, but 2 to 4 L/min is probably adequate for most calves (Bleul 2008; Nagy 2009). The length of time that oxygen should be administered is based on the response of the individual calf. If the calf appears to be doing well, oxygen administration can be discontinued and the calf monitored to determine if oxygen therapy should be reinstated.

Thermoregulation

Newborn calves regulate their body temperature (i.e. generate heat) by the catabolism of brown fat and by activity. Hypothermia, or body temperatures below 37°C, occurs in up to 25% of calves at birth (Mee, 2008). Calves that can thermoregulate shouldn't have a body temperature less than 38.3°C. Heat loss in calves occurs in multiple ways. In most instances, the ambient temperature is lower than the calf's body temperature, resulting in heat loss through convection. Calves will also lose body heat when lying on cold surfaces via conduction. The other common form of heat loss occurs via evaporation from wet calves. Dystocial calves have increased heat loss and lower body temperatures due to their acidosis and decreased activity. It is relatively easy to assist calves in thermoregulation by drying them immediately after birth. Drying calves not only stimulates respiration but also reduces evaporative heat losses. Providing straw or other bedding also reduces conductive heat loss. Increasing the ambient temperature using a heater, providing heat via a hot water bottle, or immersing the calves in hot water helps prevent and treat hypothermia. Calves may need heat sources for up to 24 hours after birth.

Administer Colostrum

Once calves are breathing normally, administering high quality colostrum is one of the most important practices to increase calves' survival and

productivity. There are numerous papers on the importance of colostrum administration for preventing failure of passive transfer and subsequent health and productivity of heifers. Colostrum also provides essential fluids that are absorbed by the calves, increasing blood volume, thereby improving circulation and resolution of acidosis. Colostrum is also an important source of energy. This energy and the fact that colostrum is given to calves at 37.8°C helps calves regulate their body temperature.

■ Conclusion

There have been large field studies evaluating the negative effects of dystocia. These effects are numerous, consistent, and have a negative impact on the health and welfare of calves and dams. Since dystocia is associated with 50% of preweaned calf losses, every dairy should implement a dystocia monitoring program and employ management practices that limit the occurrence and impact of dystocia.

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