Reference Point

Management strategies to decrease calf death losses in beef herds

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Neonatal death is a major cause of decreased productivity in many beef cattle herds.[1,2] The paradigm in which a unique pathogen is solely responsible for a disease and isolation of the pathogen constitutes a diagnosis is inadequate in the case of neonatal death in calves. On farms with outbreaks of calf deaths, different pathogens are often isolated from various calves with diarrhea, and multiple potential pathogens are often identified from individual calves with diarrhea.[3] Consequently, calf diarrhea is probably best viewed as a multifactorial process caused by the combined influences of inadequate host defenses and excessive environmental exposure to pathogens. The presence of potential pathogens creates the possibility but not the assurance of clinical disease. Given this divergence from the classical paradigm in which a pathogen equals a disease, the lack of dramatic and consistent success after vaccination or pharmacologic intervention should not be viewed with surprise or chagrin.

An important concept, which must be understood and addressed in the development of plans to reduce neonatal calf death losses, is the role of the calf as a biological incubator and amplifier. Many potential pathogens are common, if not ubiquitous.[3] Infectious bacteria, viruses, and protozoa are shed not only by clinically ill calves but also by healthy adult cattle and subclinically infected calves.[4-8] Calves exposed to low concentrations of pathogens may have occult or mild clinical signs. However, these same calves may shed pathogens in large quantities, causing considerable environmental contamination.[4-6] Consequently, infectious disease control strategies for neonatal deaths will place a premium on limiting the exposure of young calves to older calves, which serve as reservoirs of infection, and dispersing young calves to maximize hygiene.

This article highlights the role of management intervention in the prevention of neonatal deaths, presenting an approach in which improved host defenses and environmental hygiene are used to prevent or ameliorate outbreaks of neonatal disease. Specific attention is focused on preventing dystocia, improving passive transfer of colostral immunoglobulins, and limiting environmental contamination. Rigorous implementation of these management strategies should reduce neonatal death losses, regardless of the specific pathogen or syndrome. In herds with high incidence of neonatal deaths, correction of underlying management deficiencies should be viewed as the practitioner's highest priority for improving neonatal health.

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Prevention of Dystocia

General considerations—The 2 major causes of dystocia are disproportionately large calves and inadequate maternal pelvic area.[9,10] Of these 2 factors, calf birth weight has a higher correlation with calving difficulty (r^2, 0.47 vs 0.07, respectively).[9,10] Dystocia can directly cause calf death. Dystocia also has an indirect role in many deaths attributed to infectious disease. Calves that survive dystocia are 2.4[11] to 6[12] times as likely to become sick soon after birth. At least a portion of this effect results from inadequate passive transfer of colostral immunoglobulin. Not only are calves less likely to stand and suckle in a timely fashion after a difficult birth, but results of some studies[13,14] also suggest that calves born from cows with dystocia are less able to absorb colostral immunoglobulins. Prevention of dystocia centers on 2 issues. First, efforts should be made to limit calf size. Second, dams should be selected for adequate size and adequate pelvic area.

Parity is an important risk factor for dystocia. Beef heifers have a much higher percentage of calves that die by 3 weeks of age than do cows (3.8% vs 1.8%, respectively).[15] This effect is primarily attributable to the higher incidence of dystocia in heifers, an expected consequence of the smaller size of first-calf heifers, compared with mature cows.

Inadequate or excessive body weight is also associated with dystocia. Thin cows may lack the energy reserves necessary for rapid parturition,[16,17] and overly fat cows may have inadequate birth canal size attributable to fat deposits in the soft tissues of the pelvis.[18]

Concerns regarding the potential for dystocia should not be restricted to first-calf heifers. Herds that are in the midst of rapid phenotypic change (shifting from small- to large-framed cattle) may have an unacceptable proportion of dystocias among mature cows because small-framed cows with small pelvic areas are being bred to bulls within the same breed or of an alternate breed with greater growth potential. Unfortunately, most growth traits, including weaning, yearling, and mature weight, are positively correlated with calf birth weight.[a] Consequently, attempts to increase calf growth rate will likely cause an increase in dystocia unless concerted efforts are made to place an upper limit on postnatal growth by simultaneously selecting for smaller birth weight. Similarly, overly aggressive and persistent selection for low birth weight may result in smaller mature size and pelvic area, leading to dystocia in subsequent generations if such cows are mated to bulls, with predilection for calves with higher growth and birth weight.

Limiting calf size—The best predictor of dystocia is a comparison of expected birth weight or calving ease of offspring by a calculation called **expected progeny difference (EPD)**. Expected progeny differences are a prediction of the transmitting ability of a parent animal or how a bull's or cow's progeny will compare with other animals' progeny for various traits.[19] All breed associations report a birth weight EPD for all cattle in their registry, which is expressed in pounds of birth weight. Several breed associations also report EPDs for direct and maternal calving ease (usually as a ratio). Sires with higher direct calving ease ratios will sire cows experiencing less dystocia than bulls with lower EPD ratios. The EPD for maternal calving ease is an indication of how easily a sire's daughters will calve. Calculation of EPDs considers the performance data of the animal, its relatives, and its offspring, compared with other members of that animal's contemporary group. As the amount of information on an animal, its ancestors, and its progeny increases, the accuracy of these predictions increases. Consequently, young bulls and bulls sired by bulls with EPDs of low accuracy have less accurate EPDs. The accuracy of EPD estimates will improve as performance data are acquired from larger numbers of progeny.

It should be noted that EPDs are valid only within a given breed and the estimated differences are calculated relative to base year, which was set several years in the past. In most cattle breeds, birth weights have increased over time. Consequently, a bull may have a positive EPD for birth weight and still produce calves that are smaller than the breed mean. When bulls are selected to breed heifers of the same breed or similar breed type, an upper percentile ranking should be established that results in an acceptable proportion of difficult births. For example, one may limit breeding heifers to bulls that rank within the lowest 30% of their breed with regard to calf size (lowest 30% of birth-weight EPD). When Continental-breed bulls are bred to English-breed heifers, a practice that we strongly discourage, a much lower percentile limit (ie, tenth percentile) should be used. Using bulls that produce exceptionally large calves should be avoided, even for use in breeding older cows.

When assisting producers in making selections based on EPDs, it is important to realize that simultaneous selection for all traits of economic importance in beef production is not feasible because some combinations of positive traits are genetically antagonistic. The antagonism between growth rate and calving ease is noteworthy[20]; however, sires that produce progeny with both acceptable calving ease and acceptable pre- and postweaning growth do exist.

Ensuring adequate maternal pelvic area—Although of less importance than calf weight, insufficient pelvic area can also explain dystocia in some herds. The use of pelvic measurement at 1 year of age as a tool to decrease the incidence of dystocia has been described extensively since the middle 1970s.[21,22] The ratio between yearling pelvic area and pelvic area at 2 years old is 0.70; therefore, measuring yearling pelvic area is beneficial for predicting pelvic size at the time of parturition.[22] Pelvic area is moderately to highly heritable (h^2, 0.44 to 0.61), so after a few years of measuring replacement heifers and bulls used to produce replacements, producers can increase mean pelvic size of the herd.[23]

Critics of using pelvic area measurements to decrease dystocia point out that pelvic area is positively correlated with mature cow size and calf birth weight.[21] If producers select for larger pelvic area, calf birth weight will increase and the proportion of dystocia may remain static.[24] This hypothesis has been confirmed by results of several studies.[25,26] Rather than using pelvic area measurement to select for maximum pelvic size, pelvic area measurement should be used to set a minimum pelvic size as a culling criterion (eg, 140 to 170 cm^2 at 1 year of age, depending on breed and other factors) without assigning a preference for heifers that exceed the minimum. On the basis of available data, pelvic area measurements have limited usefulness in predicting dystocia on an individual basis but can be used to predict herd problems.[23-26]

It should be noted that prebreeding body weight is superior to pelvic area in the prediction of dystocia.[9,24,26] Some producers choose to screen or cull the lower 10% to 30% of available replacement heifers by use of body weight. Replacements should weigh 65% to 70% of mature body weight at the time of breeding and should reach 85% to 90% of mature body weight by the time they calve.

Ensuring Adequate Transfer of Colostral Immunoglobulins

The importance of early colostrum intake with regard to calf health is well documented.[27-29] Among calves that die from infectious diseases, 50% have lower serum IgG concentrations than 2 SDs less than the mean; 35% have serum IgG concentrations between 1 and 2 SDs less than the mean; and only 15% have IgG concentrations > 1 SD below the mean.[30] Observational studies suggest that calf serum IgG concentrations < 1,000 mg/dL are associated with increased morbidity, increased death losses, and decreased performance.[29,31]

Failure of passive transfer is common and estimated at 10% to 40% in beef calves.[30,32,33] Affected calves are more likely to become sick during the first 28 days after birth (20.4% vs 7.5%) and to die before weaning (8.3% vs 1.6%).[12] Calves that become sick during the first 28 days after birth weigh 16 kg (35.2 lb) less at weaning than calves that remain healthy.[12]

For a beef calf to consume adequate amounts of colostrum, it must be able to stand, walk, find the dam's teats, and suckle. The dam must stand, have a good maternal bond with the calf, produce colostrum with adequate concentrations of immunoglobulin, and have teats that can be grasped by the calf. Problems in any of these areas can lead to delayed or inadequate colostrum intake and low calf serum immunoglobulin concentrations. Delayed suckling appears to be the most common cause of failure of passive transfer of antibodies.[34,35] Calves should stand and suckle within 2 hours of calving; if not, the dam should be restrained and the calf should be assisted. If the calf is unable or unwilling to suckle, the cow should be milked out by hand and the calf fed colostrum with a nipple bottle or tube feeder. Fractious or excitable dams may be sedated with a long-acting sedative such as acepromazine.

Calves born unassisted (ie, without the need of human intervention) have a substantially shorter interval from birth to standing, decreased risk of poor bonding with their dams, and greater antibody absorption, compared with calves from cows that required assistance during birth.[36] Furthermore, results of 1 study indicate that calves from cows that required minimal assistance during delivery are at a substantial advantage for these factors, compared with calves from cows that required more assistance during delivery.[36] A difficult birth that does not result in calf death but prevents either the cow or calf from standing in a timely manner is an additional negative event. Even when fresh colostrum is obtained from the dam and administered by bottle to calves that survive a difficult birth, the amount of absorbed antibodies may be less than for calves that had a normal delivery.[36]

Commercially available colostral supplement products are less effective in providing a calf with a readily absorbed source of immunoglobulins, compared with natural colostrum.[37,38] Commercially available colostral supplements are less efficient for immunoglobulin transfer and disease protection, compared with bovine colostrum, even when fed at equal volumes and similar immunoglobulin concentrations.[37,38]

Dairy cow colostrum should be avoided because its use constitutes a break in herd biosecurity. Many agents of chronic diseases, such as bovine leukemia virus and *Mycobacterium avium* subsp *paratuberculosis*, are readily transmitted to a neonatal calf by ingestion of colostrum.[39,40] Additionally, many common pathogens that cause diarrhea are either shed in colostrum or can be transmitted as a result of fecal contamination. Consequently, use of colostrum derived from another farm should be strongly discouraged. Ideally, excess colostrum should be collected and stored frozen from a cow within the herd. Use of frozen colostrum has no deleterious effect on IgG concentration of calf serum.[41]

A variety of procedures have been proposed to assess passive transfer status in calves. Serum protein concentrations ≥ 5.2 g/dL are indicative of adequate passive transfer of colostral immunoglobulin in overtly healthy calves,[42,43] and serum protein concentrations > 5.5 g/dL are indicative of adequate passive transfer in sick calves.[44] The **sodium sulfite turbidity test (SST)** should be performed as a 1-dilution procedure with an 18% test solution.[42] Alternative test procedures, such as the zinc sulfate turbidity test, glutaraldehyde coagulation, and serum γ-glutamyl transferase activity, are less accurate than either refractometry or the SST procedure.[42,45-47] The accepted gold standard for determination of passive transfer status is radial immunodiffussion; however, it should be noted that this procedure is more costly than refractometry or the SST procedure and is not available or readily adapted to most practices. Furthermore, results from radial immunodiffussion procedures are not immediately available, which is clearly an impediment when investigating a disease outbreak. Recently, a competitive ELISA kit has been developed and marketed that assesses passive transfer status by use of blood rather than serum. This test performs well under practice conditions and is a viable alternative to refractometry or the SST.[48]

During disease outbreaks, adequacy of passive transfer should be assessed via refractometry or the SST. Ideally, serum samples should be collected from a representative sample of sick and overtly healthy calves < 2 weeks of age. If the proportion of calves with failure of passive transfer (< 1,000 mg of IgG/dL of serum) exceeds 15%, failure of passive transfer may be an important contributing factor to a calf health problem. Under these circumstances, 3 causes of failure of passive transfer are possible. Cows may be producing colostrum with an inadequate IgG concentration, calves may not be ingesting a sufficient volume of colostrum in a timely manner, or calves may have inadequate absorption of antibodies from consumed colostrum. Although poor colostrum quality can be investigated by measuring colostral concentrations of IgG, inadequate colostral intake is more likely and common in beef cattle.[34,35]

In large herds, the proportion of calf death losses attributable to failure of passive transfer can be readily calculated with simple mathematical procedures.[49] These calculations require adequate sample size, knowledge of passive transfer status, and accurate determination of the percentage of death losses. Results of these calculations can be used to focus management intervention efforts on the areas of most importance.

The amount of IgG available for absorption by the calf is determined by the quality and amount of colostrum produced by the dam, which are affected by age of the dam and its nutritional plane. Older cows may produce colostrum that contains higher concentrations of IgG than that of younger cows.[50] Calves born to heifers have significantly lower mean serum IgG concentrations at 1 to 7 days of age, compared with calves born to cows.[51] However, it should be noted that the magnitude of this difference may not be great. In a recent study, Holstein cows in their first and second lactation produced colostrum with mean IgG concentrations of 66 and 75 g/L, respectively, whereas older cows produced colostrum with mean IgG concentration of 97 g/L.[50] The authors concluded that colostrum from first-calf heifers was acceptable if an adequate volume was ingested in a timely manner.

In general, heifers and cows that are in good body condition at parturition are more likely to have calves with adequate passive transfer than are thin or obese heifers or cows. If a dam's diet is deficient in protein before parturition, it will result in a selective decrease in the absorption of IgG_1 and IgG_2 by the calf.[52]

Calving Site Selection and Design

Another important factor that affects morbidity and death losses is the amount of exposure to pathogens. Sanitation, protection from inclement weather and other stressors, and separation from sick calves will decrease the risk of sickness and death in calves.

The most common system of calving is pasture calving. Alternatives include more intensive systems such as barn or dry lot calving. Any procedure that concentrates large numbers of cattle in a small area increases environmental contamination and, consequently, increases the potential for fulminant outbreaks of neonatal disease. Consequently, extensive systems in which calving cows are dispersed in large calving pastures are generally considered optimal from the perspective of reduced disease transmission among neonatal calves. The single factor that most often forces farmers and ranchers to opt for intensive calving systems is the perceived need to assist cows that have dystocia. Proper heifer development with particular attention to heifer size at breeding and calving and judicious sire selection will generally reduce the need for veterinary intervention at the time of parturition.

Size of calving pasture is not a direct measure of cow concentration and, hence, environmental contamination. Cows will tend to congregate around feed and water sources, and these areas may become heavily contaminated. If supplemental hay and grain are fed, these should be provided at locations that are both separate and distant from water sources. This practice will encourage cow dispersal and minimize contamination. If feed bunks or bale feeders are used, they should be moved frequently. Alternatively, bales can be spread over the calving pasture and the feeding location changed daily. In areas of the country with minimal snowfall, winter pasture can be stockpiled. Cool season grasses such as tall fescue are permitted to grow in the fall, and access to these pastures is restricted until calving season. Use of pasture grasses encourages cow dispersal and minimizes contamination. If the herd forage plan includes feeding hay, consider feeding hay in early to mid gestation and saving stockpiled pasture for the actual calving season.

In many areas, calving pastures are nearly devoid of natural cover or windbreaks. Under harsh, cold, and windy conditions, cows will congregate downwind from available windbreaks. At an ambient temperature of –12.2°C (10°F) and a wind speed of 25 miles/h (wind chill, –34°C [–29 °F]), a beef cow's maintenance energy requirement increases by > 45%, compared with that at the critical temperature of –8°C (18°F). Provision of an adequate windbreak will reduce this increased energy demand by half.[53] If calving pastures are devoid of natural cover, cows will either gravitate into protected valleys or gullies or concentrate near windbreaks, bale feeders, and barns. This behavior concentrates cows and their calves in small, wet, heavily contaminated areas. The calving area should be free of mud and protected from the wind. A large pasture with good drainage, southern exposure, and a natural windbreak that will block prevailing winds is probably adequate for many mature herds. Inexpensive windbreaks can be constructed when natural protection is lacking. Windbreaks should be sufficiently large to avoid concentrating cattle. In addition, it would be reasonable to have an area that is sheltered from the weather and that has a chute, stall, or other restraint area so that dystocia can be corrected.

Feed and water sources should be located distant from windbreaks to promote cow dispersion throughout calving and nursery pastures. Sites within the calving and nursery pasture where cows are fed or provided bedding should be moved frequently. If small square hay bales are used, cattle should be fed at a different location each day. If large round bales are used as forage, unrolling bales is preferable to the use of a bale ring or other hay feeder when cattle groups include calves. Both of these practices will promote cow dispersion and avoid creation of unsanitary, muddy congregation sites within the pasture.

Because of the high percentage of dystocia and poor maternal bonding associated with heifers and their first calves, the calving pasture should be designed so that the entire area can be checked frequently and heifers can be moved to an area in which assistance can be provided with relative ease.

When producers schedule a calving season to avoid periods of low ambient temperatures and inclement weather and parturition takes place on pastures, deaths and disease are greatly reduced. However, should the calving season be scheduled for late winter or early spring, additional facilities may be required. The ability to dry and warm calves that have been born during inclement weather becomes critical during snowstorms or rainstorms accompanied by low temperatures.

Only heifers and, less frequently, cows that require assistance during parturition or establish a bond with their calf should be confined to a calving barn or small pen; all other cattle should be housed in a calving pasture. During a disease outbreak, the most powerful intervention strategy is often to move cows that have yet to calve to a distant, clean pasture. In herds with a low percentage of dystocia, this decision has few obvious drawbacks. In herds with a moderate percentage of dystocia, the potential costs associated with calf deaths must be weighed against the potential for cow and calf losses associated with dystocia. Accurate records will permit practitioners and producers to base these decisions on fact rather than perception.

Plan for Heifers to Calve Early

Beef producers should plan for heifers to give birth 2 or more weeks earlier than mature cows. Limiting the breeding and therefore the calving season to 45 days or less for heifers also offers several advantages. From a labor standpoint, an early, short calving season prevents overlap between increased labor needed to monitor and assist heifers and labor needed to monitor and assist mature cows. Also, this labor extends to the care of neonatal calves. From a nutritional and reproductive management standpoint, scheduling heifers to calve earlier than cows allows the heifers to have additional time before the start of the breeding season to regain body condition while nursing a calf. This additional time is often necessary to maintain a high pregnancy percentage for heifers after their first calf.

Scheduling parturition of heifers earlier than mature cows should result in less exposure of their calves to pathogens that cause infectious disease. The primary reservoirs for pathogens that cause diarrhea in young calves are calves with diarrhea, clinically normal calves that have subclinical infection, and adult cattle.[54] Calves that recover from diarrhea may continue to shed pathogens for several months.[5-7] Cattle (calves or adults) that become infected with diarrhea-causing pathogens will shed a large number of the pathogens, regardless of whether or not they become ill.[4-8] Because of this multiplication effect, exposure to infectious agents increases as the calving season progresses. By limiting the period during which heifers are scheduled to give birth to the early part of the calving season, the less-protected calves do not come into contact with as many pathogens as calves from mature cows that are born later during the calving season.

Shorten the Calving Season

Controlling the timing and length of the calving season is critical in the development of an integrated approach to prevent neonatal disease in beef calves. Ensuring that cows calve in adequate body condition is necessary for them to be successfully bred in a tightly controlled breeding season (ie, 60 days). Higher body condition scores or greater levels of supplemental energy during late gestation improve the percentage of heifers and cows in estrus by 60 days after calving and subsequent pregnancy percentage.[16,55,56] Females that calve in poor body condition (< 5 on a 9-point body condition scale) have lighter calves, a longer postpartum interval to return to estrus, and a lower pregnancy rate during the following breeding season.[16,55,56]

It is clear that energy and protein requirements after calving greatly exceed that of mid gestation and even late gestation. These higher demands make it difficult to add body condition to cows and heifers once they begin lactation.[56] Because high postcalving condition score and energy balance control ovulation and are required for a high rate of conception, body condition at calving and level of nutrition after calving are critical control points.[16,55,56]

Breeding records, particularly in herds in which artificial insemination is used, permit accurate prediction of calving dates, facilitating timely movement of cows from gestation to calving pastures. In naturally serviced herds, practitioners should consider adopting herd health programs that incorporate early pregnancy diagnosis to improve accuracy of predicting calving date. Most traditional herd health programs schedule pregnancy diagnosis of cows to coincide with weaning. In these circumstances, some cows may be as much as 6 months pregnant. A more accurate prediction of stage of pregnancy can be attained if cows are examined earlier in gestation; pregnancy diagnosis should be scheduled 35 to 45 days after the termination of the breeding season.

Even greater concentration of the calving season can be attained if estrus synchronization programs are used. A feed-grade progestogen, an intravaginal progesterone device, and an injectable prostaglandin have all been used successfully.[57,58] A herd with synchronization of estrus for 80% of the breeding females and that achieves a 60% conception rate could conceivably have nearly 50% of the breeding herd give birth within 2 to 3 weeks of the start of the calving season, thereby achieving a high percentage of calves that are not exposed to older calves.

Inclusion of an ionophore, either monensin or lasalocid, in the pregnant cows' diet should be considered to improve nutrient utilization and decrease shedding of coccidial oocysts by mature cows, decreasing the potential for contamination of calving pastures.[59,60] This procedure will decrease exposure of calves to oocysts and decrease the incidence of coccidiosis in nursing calves.

Animal Flow and Group Assortment Strategies

The incidence and severity of neonatal disease will typically increase, and the age at disease onset will decrease as the calving season progresses.[51] This phenomenon is common in beef herds because of the effect of the calf as a biological amplifier. The more the calving season is shortened, the more this biological amplification effect is negated.

For beef herds, it is necessary to have a plan for cattle movement throughout the calving season. Such a plan generally requires a minimum of 4 or 5 separate pastures. These include a gestation pasture, a calving pasture, and a series of nursery pastures. To ensure that beef calves are born in a sanitary environment, the herd should not be fed throughout the winter in the same pasture or area in which calves will be born or to which neonatal calves will be moved. Cattle should be moved from the gestation pasture to the calving pasture 1 to 2 weeks prior to calving. One day after parturition, a cow or heifer and its calf should be moved from the calving pasture to a nursery pasture. Cow-calf pairs should be added to a single nursery pasture until the appropriate number of pairs has been reached. Thereafter, the farmer or rancher should begin adding pairs to a second pasture. The difference in age between the oldest and youngest calf in a nursery pasture should never exceed 30 days, and smaller differences are preferable. This effectively negates the biological amplification effect. The longer the calving season, the greater the need for a large number of nursery pastures. Calves that develop diarrhea should be moved immediately to an area away from healthy calves and treated and not returned until all the calves in the group are at low risk for developing diarrhea (ie, > 30 days of age or at time of summer turnout).

Dam Nutrition

The nutritional demands of pregnancy increase as gestation progresses. These demands occur not only because of fetal growth but also because of uterine and placental growth and metabolism involved with the fetal-maternal interaction and exchange of nutrients and waste. Heifers that calved in a body condition score of 4, 5, or 6 had calves with progressively heavier birth weights, respectively, but the percentage with dystocia was not influenced by body condition score at calving.[55] Heifers with greater weight gains before calving had calves with actual heavier and 205-day adjusted weaning weights than did heifers with moderate weight gains.[55] Thin females should be fed during the last third of pregnancy to achieve a targeted body condition score of 5 to 6 at calving, whereas those in moderate-high to high body condition at 90 days before calving should be fed levels to maintain body reserves. Although fat cows can have dystocia attributable to fatty infiltration of soft tissues of the birth canal, rapid weight loss before calving is not recommended. Inadequate feed intake during late pregnancy is associated with weak labor, increased dystocia, reduced milk production, reduced calf growth, and lowered rebreeding performance.[16,55,56] Poor dam nutrition can have negative impacts on calf health in the subsequent calving year because a prolonged calving season without a concentrated number of parturitions early in the calving season creates an undesirable animal flow in that a high percentage of the calves are born after a period of pathogen multiplication in the herd.

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