The Effects of Poor Calf Health on the Future of Dairy Heifer Replacements

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Take Home Messages

- Reproductive performance, metabolic function and milk production of dairy replacement heifers are affected by genetic selection, nutrition of the dam, the metabolic environment during their fetal development and the way they were fed as pre-weaned calves.
- Reduce calf mortality in the first 24 hours of life.
- Maximize performance, health, welfare and profitability of replacement heifers by focusing on the first 60 days of the calf's life: newborn survival, colostrum, nutrition, optimizing the calf environment and regularly screening for health problems.

Dairy Calf Problems that Affect Future Performance

Some calf health events are limited to immediate consequences; others have immediate and future impact.

Nutrition and Management of the Dam

Precalving nutrition has been associated with strength of labor, birthing ease, calf vigor, colostrum production, and calf growth. While emphasis is typically given to nutrition in the last trimester of pregnancy and its effect on calf morbidity and mortality, nutrition around the time of fetal implantation and during rapid placental development are also important. Prenatal nutrition may program calves for adult life as well as fetal growth and development (Greenwood, 2007; Martin, 2007; Hammon, 2014). Maternal nutrient restriction, including protein, energy or micronutrients such as arginine, methionine, vitamin B12 and folate, may increase the risk of perinatal calf mortality (PCM), reduce colostral immunoglobulin absorption in calves, adversely effect perinatal calf vigor, delay age at puberty and negatively impact health (Bach, 2012; Mee, 2013)

Dystocia

Dystocia is associated with poor calf performance, often attributed to poor colostrum ingestion and absorption and susceptibility to disease, especially diarrhea.

Perinatal Calf Mortality/Stillbirth

Pre-calving nutrition that results in micronutrient deficiency and fetal over or under sizing are risks for PCM (Mee, 2013).

Colostrum

Colostrum contains antibodies, immune cells (neutrophils, macrophages, T cells and B cells), complement, lactoferrin, insulin-like growth factor-1, transforming growth factor, interferon and other soluble factors and nutrients such as sugars and fat soluble vitamins. Its importance for immunity is always emphasized but colostrum has added value, affecting nutrition and neonatal programming.

Body condition scores of 3.0 to 3.5 at the time of calving are associated with production of more colostrum, and higher quality colostrum and calf serum immunoglobulin concentrations. Selenium supplementation of pregnant cows has been associated with improved colostrum and calf serum immunoglobulin concentrations. Colostrum improves glucose absorption by the neonatal calf and systemic effects of colostral hormones and growth factor constituents such as IGF-I, IGF-II, insulin, growth hormone, epidermal growth factor, leptin and prolactin support the development and maturation of the gastrointestinal tract and are linked to enhanced immunity (summarized in Bach, 2012).

Early Nutrition of the Calf

Recent literature provides evidence that milk feeding of calves has an imprinting effect on growth and lactation performance (Bach, 2012; Soberon, 2012). Several studies indicate that calves receiving whole milk during the first 1.5 to 2 months of life tend to produce more milk than calves fed milk replacer (Bach, 2012). Increasing the allowance of milk replacer may have a positive effect on future milk production but one that is less significant than feeding more whole milk. Growth rate due to calf starter intake is correlated with future milk yield and survivability to second lactation. It is suggested that for every 100 g of average daily gain during the first 2 months of the calf's life, an additional 225 kg of first lactation milk yield could be expected. While the effect is achieved primarily from milk replacer or milk consumption, starter consumption is important (Bach, 2012). The critical time for imprinting mammary gland capacity is limited to the first 8 to 10 weeks of life.

Health events

Diarrhea

Incidence risks for diarrhea range from 10 to 35% and producers report that 57% of preweaned calf mortality is due to diarrhea (USDA, 2008). Diarrhea can be due to infectious (viruses, bacteria, and protozoa) and non-infectious factors. Co-infection is common. Ten different pathogens are recognized as either major (rotavirus, coronavirus, Bovine Virus Diarrhea virus, *Salmonella* spp, *E.coli, Clostridium perfringens* and *Cryptosporidium parvum*) or emerging (bovine caliciviruses and bovine torovirus) (Cho, 2014). BVDV, not typically considered a cause of calf diarrhea, can be a problem in persistently infected calves (damaged intestinal cells or co-infection) or in transiently infected calves with intestinal crypt enterocyte damage. *Salmonella* is particularly pathogenic to calves because it invades the intestinal mucosa, multiplies in lymphoid tissue and evades host defenses, leading to systemic disease. Newborn calves, which produce a low level of trypsin in the gastrointestinal tract, are more susceptible to *Clostridium perfringens* type C than are older calves. There are approximately 24 species of *Cryptosporidium* but *C. parvum* is considered the primary cause of calf diarrhea and a zoonotic agent. Severe diarrhea such as that caused by *Cryptosporidium* can result in considerable economic loss due to malnutrition-induced reduced growth in affected calves, lost revenue and high treatment cost. Although there are many different potential pathogens, there is not much difference between the agents in pattern of development, clinical signs, treatment and prevention.

Respiratory Disease

Producers report treating 12.4% of preweaned calves and blame 22.5% of preweaned dairy calf deaths on respiratory disease (USDA, 2008). The incidence and prevalence of respiratory disease in calves is higher than producers report because detection is difficult. The economic toll from treatment expense, mortality, premature culling, reduced growth, fertility and milk production in first lactation survivors of respiratory disease is reported to range from $15 to $36.

▪ Making the Most of the First 60 Days to Maximize Future Performance

Reduce Mortality in the First 24-Hours of Life

Most calves that die within the first 24 hours of life are alive at birth and simple strategies that do not rely on drugs or oxygen delivery may prevent death. Of foremost importance to improved survival in the first 24 hours is unassisted vaginal delivery of calves. With a normal presentation and sustained progress, observe calving from a distance and provide no assistance. For calving cows that are moved during second stage labor, expect labor to stop temporarily and allow time (65 minutes from the time of appearance of feet outside the vulva to intervention) for labor to resume before providing assistance.

After delivery, calving attendants should watch closely for behavior indicative of normal adaptation to life outside the uterus.

- Head righting begins within minutes.
- The calf is sitting in a sternal position within 5 minutes.
- The calf makes standing attempts within 15 minutes.
- Shivering begins within 30 minutes of delivery.
- The calf is standing by 1 hour.
- The calf is suckling within 2 hours of delivery.

Without appropriate movement and reflex activity, the newborn calf's body temperature declines from an elevated level at birth to 38.3-38.9°C within an hour. It will continue to decline if the calf is not active and shivering. Death due to hypothermia can occur within 1 to 2 hours, especially when the environmental temperature is below 14°C, the low end of a calf's thermal neutral zone.

For calves that have flaccid muscles, are unresponsive to stimulation, have blue membrane color or are breathing irregularly, simple techniques may be used to revive the calf and stimulate regular breathing. Place the calf on a low platform, cart or table to facilitate the following procedures.

- Place the calf's head over the edge of the raised platform for 10 to 15 seconds to get postural fluid drainage from the mouth and nose.
- Place the calf in a sitting position if possible. Take a clean, dry towel and rub the topline of the calf from the tailhead to the poll.
- Use the towel to stimulate the ears, eyelids and nose of the calf.
- Ice water can be poured onto the head or into the ear of the calf to stimulate breathing.
- Compress and then shake the trachea (wind pipe) high up in the neck to stimulate a cough reflex.
- Place pinpoint pressure right in the center of the muzzle between the nostrils or place finger pressure across the nasal septum where nose tongs would be placed to further stimulate breathing.

Colostrum

Failure of passive transfer of immunity (FPT) is recognized as a major problem that has negative short- and long-term consequences for the health and productivity of herd replacements. Many dairy calf raisers routinely monitor serum total protein (STP) concentration of calves but use the results in a limited way. Results can be used to classify individuals as high risk calves when STP concentration is $\leq$ 5.0 gm/dl. High-risk calves can be marked so that intensified health screening procedures are used on these individuals.

To classify a herd as an FPT herd, a minimum of 10 to 12 STP results from calves less than 7 days of age are needed. When more than 20% have STP < 5.5 gm/dl or more than 10% have STP < 5.2 gm/dl, the colostrum program needs attention. When using STP data from refractometer readings, it is imperative that the refractometer is calibrated. The simplest calibration step is to verify that the specific gravity scale of the refractometer reads 1.000 after application of distilled water. Adjust as necessary. At least every 6 months, split serum samples and correlate STP concentrations between an accredited laboratory and the refractometer. Perform serum testing at room temperature.

A systematic review of colostrum protocols on the dairy is necessary to find the reason for herd based FPT. Colostrum volume, quality, cleanliness and absorption factors should be reviewed to find potential problems. Potential problems are listed:

- Inadequate volume of colostrum is administered.
  - Less than 4-quarts of colostrum is administered with an esophageal feeder.
  - Less than 3-qt of colostrum is given to calves that suckle.
- The colostrum quality is inadequate. Common reasons for reduced quality include:
  - High producing cows – colostrum dilution occurs soon after calving.
  - Delayed milking – time between calving and milking exceeds 4 hours.
  - Calving cows are suckled before colostrum collection (Note: calves that remain with the cow for 30 to 60 minutes after birth frequently have suckled before they are removed from the pen.)
  - Calving cow has leaked milk or been pre-milked before calving.
  - The dry period length was less than 30 days.
  - There are significant nutritional problems with the close-up dry cows (Note: this problem usually results in reduced colostrum volume rather than the quality)
  - There are significant health problems in the calving cows (Note: the effect is usually reduced volume rather than the quality).
  - Limited or poor vaccination program (Note: Vaccination of the dry cows is important for immunity to specific diseases of calves.

Vaccination does not have a quantitative impact that can be measured by colostrometer or Brix refractometer)

- Colostrum immunoglobulin absorption is impaired.
  - Colostrum feeding is delayed $\geq$ 4-hours after birth.
  - There is excessive bacterial contamination (> 100,000 cfu/ml) of colostrum (Note: probiotics should not be added to colostrum)
  - Colostrum supplement or replacement powder is added to colostrum.
  - There is a high level of calving assistance

Comfort with proper use of the esophageal feeder amongst calf workers will improve herd FPT problems and reduce mortality due to diarrhea-induced dehydration. For colostrum administration, use a 4 L capacity esophageal feeder. In contrast, use a 2 L esophageal feeder for the administration of an oral electrolyte solution. Never use the esophageal feeder in a calf that cannot maintain sternal recumbency (standing position is preferred), in a calf that is having respiratory difficulty, or one that has abdominal distension. While passing the esophageal feeder, maintain the head of the calf in a neutral position so that the nose is below the plane of the ears during passage.

Esophageal feeders should be cleaned and soaked in a disinfectant between uses. Therefore, have as many esophageal feeders as will be used (maximum use) in a day. Do not use the esophageal feeder to force feed milk or milk replacer without a discussion with and a protocol from your veterinarian. Limit the number of successive forced feedings.

Nutrition

Have a nutritional plan that will allow calves to double birth weight by 60 days of age. Whether the diet is whole milk or milk replacer, use the Nutrient Requirements of Dairy Cattle (NRC) to make the feeding plan. Implement a winter-feeding program when the temperature falls below 13°C and determine what milk or milk replacer intake is needed to meet weekly goals for average daily gain (ADG). A winter feeding plan for calves on whole milk in Wisconsin may look like the one shown in Table 1.

Table 1. Whole Milk Winter Feeding Plan for Holstein Calves in Wisconsin

Age	Whole Milk Volume
0-3 days	2 quarts twice daily
3-10 days	3 quarts twice daily
10-49 days	4 quarts twice daily
49-56 days	4 quarts once daily
56-63 days	No milk

Table 2. As fed, this 45 kg birth weight Holstein calf will not meet expected ADG for weeks 1 and 2.

	Milk replacer intake (kg/day)	Estimated starter intake (kg/day)	Energy Allowable ADG (kg/day)	Protein Allowable ADG (kg/day)	Goal met/Limiter	MR needed to meet goal (kg/day)
Week 1 - 29°C	0.57	0.1	0.43	0.40	No/Protein	0.63
Week 1 - 0°C	0.57	0.1	0.11	0.40	No/Energy	0.8
Week 2 – 50 kg; 29°C	0.59	0.2	0.48	0.45	No/Protein	0.8
Week 2 – 50 kg; 0°C	0.59	0.2	0.17	0.15	No/Energy	0.94

Understand what milk or milk replacer and starter intakes are needed to meet weekly goals for gain to double birth weight by 60 days. In Table 2, the NRC calculator was used to estimate the protein and energy allowable ADG for a 45 kg birth weight Holstein calf at two different temperatures. Looking for an ADG of 0.45 and 0.54 kg for weeks 1 and 2, respectively, current feeding rates of a 22:20 milk replacer do not meet ADG goals.

Monitor feeding consistency on a regular basis. Calculate and measure total solids delivered in each batch of liquid feed. Consistency of the liquid feed (less than 1% difference) from the first calf fed to the last, from one feeding to the next and between feeders will reduce the risk for nutritional diarrhea, bloat, ulcers and abomasitis. Total solids should never be greater than 18%. Brix readings can be used to monitor liquid feed consistency.

Monitor the bacterial quality of the milk or milk replacer being fed to calves. Standard plate counts and selective bacterial counts can find post-pasteurization contamination of milk or contaminated nipples at automatic feeder stations. Bacterial contamination of milk or milk replacer puts calves at high risk for infection and may affect the nutritional value of the feed. Table 3 shows the effect of dirty nipples at automatic feeding stations on the bacterial quality of pasteurized whole milk.

Table 3. Milk replacer culture results

Select Microorganisms Counts (CFU/ml)	**Pen 1-2**	**Pen 2-1**	**Goal Levels**
Total Plate Count (CFU/ml)	6,250,000	5,150,000	**< 10,000**
Coliforms (lactose-positive)	150,000	2,550,000	**< 100**
Gram negative rods (lactose-negative)	3,400,000	350,000	**< 5,000**
Streptococci (non-agalactiae)	2,600,000	2,000,000	**< 5,000**
Staphylococci (coagulase-negative)	100,000	200,000	**< 5,000**
Comments	Probable *Pseudo-monas spp*	*Pseudo-monas* and many lac + morpholo-gies	

Environment

Environmental management starts with removing the newborn calf from the calving area before standing attempts are initiated (< 10 minutes after birth). Neonatal calves are limited in their ability to regulate body temperature so environmental conditions that minimize hypothermia (may occur at temperatures < 13°C) must be insured in newborn calf housing. Clean, dry, draft free facilities bedded with deep straw should provide calves in individual pens at least 2.4 sq meters and calves in group pens at least 2.8 sq meters. Calf jackets are helpful. When housing calves in individual calf pens, have 15% more pens than calves at maximum occupancy. For group pens, small, stable groups are ideal. Shared contact amongst calves with more than a one week age difference almost inevitably results in high morbidity from scours and respiratory disease. Managing calf facilities with an all in-all out strategy reduces pathogen survival in the environment thus limiting calf exposure. Remove all liquid and solid feed refusals from the calf housing area.

Housing factors associated with the lowest respiratory disease amongst preweaned dairy calves housed in individual pens are having solid panels between calves, provide deep nesting in clean, dry bedding and take measures to lower airborne bacteria counts (Lago, 2006). Airborne bacterial counts are reduced in large pens, with fewer solid pen sides (solid side panels but open front and back panels), cold temperatures and ventilation enhancements that bring in fresh outside air to dilute stale pen air (Lago, 2006).

Housing factors that may reduce calf diarrhea are increased time between occupants of the same calf pen or hutch and increased bedding depth using clean, dry bedding to distance the sleeping calf from the excreta in the bedding pack underneath it.

Health Screening

Early detection of disease is critical to making appropriate decisions regarding interventions that minimize short and long term adverse health, production and profitability outcomes of dairy replacements.

One of the biggest challenges of raising calves is early detection of health problems. Instituting regular health screening exercises will facilitate early detection. Provided that there is an appropriate intervention (examination and a treatment plan), a regular screening plan will reduce mortality, shorten disease duration and improve treatment outcomes. In the absence of activity, appetite, or fever monitoring technology, a daily chore is to find abnormal calves, calves that remain standing after feeding when 90% of the calves are sleeping, or calves with diarrhea, sunken eyes, eye or nasal discharge, abnormal head posture (tilted or star-gazing) or coughing frequently. This daily observation can be coordinated with the pick up of refused feed. The abnormal calves, the pen or the calf hutch of the abnormal calves are marked, indicating that these calves need a complete examination by the trained individual(s) assigned to that duty. The components of the basic exam are:

- Head position (tilted, star-gazing)
- Eye or nasal discharge – color, consistency and amount
- Temperature
- Fecal consistency
- Breathing pattern (abdomen vs. chest) and effort (inspiration vs. expiration)
- Navel exam (diameter, temperature, exudate)
- Fecal consistency
- Lameness, joint swelling
- Abdominal size and contour

Examination findings can sort calves into an intervention plan, which may be diagnostic testing, supportive care, antibiotic administration or simply, a planned recheck examination the next day. On a twice a week basis, a more detailed respiratory disease screening is recommended (http://www.vetmed.wisc.edu/dms/fapm/fapmtools/8calf/calf_respiratory_scoring_chart.pdf) for all calves between 3 weeks of age and weaning. For health screening, it is estimated that an additional 0.5 full time equivalent (FTE) is needed for each 150 to 200 calves. For all calves that die, a post mortem examination is recommended. Farm staff can be trained to open, examine and take pictures of lesions that can be routinely reviewed by the farm's veterinarian. Samples from dead calves can be a valuable tool to refine protocols, identify training needs or diagnose herd problems.

In general, diagnostic testing for diarrhea or respiratory disease pathogens is most useful when performed on several affected but untreated animals from the population at risk. Selection of the population of animals to test, the test specimens that are collected, the type of test requested, laboratory selection and shipping method should be determined by working with your veterinarian. As an example, on a dairy farm with diarrhea affecting more than 25% of calves at 5 to 7 days of age, fecal specimens (regardless of consistency) from 6 untreated calves within that age group can be submitted for culture and polymerase chain reaction (PCR) testing to determine a fecal shedding pattern of the potential pathogens (McGuirk, 2008). When more than 20% of tested calves have positive tests for rotavirus, coronavirus, or *C. parvum* or any single calf has a positive *Salmonella spp.* culture, a plan to reduce exposure should be constructed. Similarly, on a dairy farm that finds that more than 10% of the preweaned calves develop respiratory disease starting at 3 or 4 weeks of age, deep nasopharyngeal swab samples from 6 or more untreated, affected 3 to 4 week old calves for bacterial culture and PCR analysis can be used to determine an appropriate antibiotic treatment strategy.

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