Commercial Dairy Calf Management

Impact on Performance and Health

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KEYWORDS

• Commercial dairy calves • Stress • Transition • Grouping • Management

KEY POINTS

- Calves in transition from a milk replacer-based diet to a grain-based diet exhibit stress, demonstrated by increased serum cortisol and α_1-acid glycoprotein levels at specific points in their lives that may influence subsequent health and performance.
- Using a "three C's" client education tool to influence calf management on the farm is an acceptable method for nutritionists and practicing veterinarians to influence calf managers' decision-making process:
  - Comfort—Consider calf comfort for every aspect of calf behavior and environment.
  - Consistency—Keeping life changes and interruptions to a minimum will yield better performance.
  - Calories—Formulating calf diets to be optimally energy dense will impact calf performance and health.

INTRODUCTION

Dairy calf production has changed over the last 30+ years, primarily due to increased population density in facility. One of the most difficult stages of production is weaning and the subsequent grouping of calves. This is a very critical life stage, as it has a direct effect on later production of both milk and meat. Understanding and reducing the intensity of sudden change in behavior and environment can reduce stress, which will improve performance.

Statistical testing in trials reviewed was not always similar. The authors of this article have listed those values in the text considered important to interpretation of outcomes, with trends being $P \leq .10$, significant being $P \leq .05$, and highly significant declared at $P \leq .01$. The significance values are reported as presented in the articles reviewed. All photographs are the property of R.M. Thornsberry D.V.M. and are reproduced with permission.

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THE "THREE C'S" OF COMMERCIAL DAIRY CALF PRODUCTION

Comfort begins with good clean dry, deep bedding. The bedding material should be wheat or barley straw, not corn stover (stalks), bean fodder, or grass hay. Straw provides a better nesting score compared with other bedding types. Research conducted by the University of Wisconsin demonstrated that deep bedding in straw reduced the incidence of bovine respiratory disease (BRD) ($P<.002$).[1] The hollow stem of straw captures air and provides an insulation impact for calves. Although this research evaluated bedding types and amounts in winter months, a University of Arkansas study evaluated bedding materials for Holstein replacement dairy heifers raised in summer and fall.[2] These researchers evaluated granite fines, sand, rice hulls, long wheat straw, and wood shavings. Growth rates and feed efficiency were not different among bedding materials from day 1 through 42. The authors noted this lack of significant difference may have been influenced by the milk replacer only providing 14.4% crude fat, possibly confounding growth and performance.[3] Calves bedded on granite fines and sand had higher rates of antibiotic treatments ($P<.05$) during the first 2 weeks on milk replacer. Wheat straw bedded calves had the lowest recorded scours scores, based on the number of days calves exhibited a liquid stool. Observations on calf cleanliness varied among bedding types ($P<.05$). Calves bedded with granite fines and sand were the dirtiest 2 groups. The calves with the wettest hair coats were bedded on sand. Although bedding types did not significantly impact final 42-day performance parameters, they did impact scours score and treatment frequency. Calf comfort is important.

This Arkansas study also measured bedding type effect on serum cortisol concentration. Serum cortisol levels were highest on day 1, but did not differ among bedding types. Higgenbotham and Stull (1997)[4] observed similar serum cortisol levels in their calf research, recording the highest levels at day 1, which gradually decreased through week 3. Serum α_1-acid glycoprotein (AGP) was also measured. AGP was highest on day 1 and gradually decreased throughout the 42-day study. Bedding types had no impact on AGP numbers. Serum APG level is recognized as a predictor of death in aging humans[5] and of stress in calves.[6]

Self-grooming is normal calf behavior for calves of all ages. A Chinese study documented individually housed calves self-groomed 40.7 minutes per day and paired housed calves self-groomed 20.6 minutes per day ($\pm$4.10 minutes per day; $P = .02$).[7] Cameras with infrared technology posted above each calf pen were used to record self-grooming behavior data points. Self-grooming time decreased when calves were grouped after weaning, indicating the increased time devoted to self-grooming activity in individually housed calves could be an indicator of mental calf stress. The Arkansas bedding materials study recorded increased self-grooming for calves housed on rice hulls and sand compared with long wheat straw. As calves self-groom, they potentially recycle intestinal pathogens from their own feces and pen mate's feces adhered to their hair coats. Clean, absorbent bedding is important to keeping calves clean and dry. A 2018 study[8] demonstrated that sick calves (those experimentally infected with *Mannheimia haemolytica*) exhibited reduced self-grooming times, feeding activity, and social interaction—spending more time lying down, especially in lateral recumbency, compared with their healthy pen mates. The authors suggested that calf managers should observe calves closely, as behavioral changes may be indicative of early onset of BRD. One- to 3-month-old calves appear to be most susceptible to BRD.[9]

Although results in feedlot cattle cannot be directly applied to raising commercial dairy calves up to 400 pounds (181.8 KG), performance improvement findings should

apply as dairy calves increase in age and weight. A North Dakota State University study[10] reported improved daily gain and total weight gain for feedlot steers double-bedded with wheat straw compared with calves lightly bedded with wheat straw or not bedded ($P<.05$). Steers receiving no bedding exhibited an average daily gain (ADG) of 2.83 lb/d (1.29 kg/d). Lightly bedded steers had an ADG of 3.69 lb/d (1.67 kg/d), whereas double-bedded steers gained 3.53 lb/d (1.60 kg/d). Gain per feed intake improved ($P = .06$) in one study period and overall for both bedded groups ($P = .06$). In a second experiment, the authors examined the impact of various bedding materials. Calves bedded on wheat straw gained fastest ($P<.01$), followed by soybean fodder, corn stover (stalks), and calves with no bedding, for pens scraped twice weekly. Wheat straw bedding is the time-honored bedding material, especially so for younger calves. Other research agrees with the finding of this study, but results from these studies were not as dramatic.[11–13] The results from these 4 studies demonstrate the economic impact of calf comfort.

There are many factors that influence the incidence and severity of respiratory disease in dairy calves. Philip J. Griebel, DVM, Vaccine and Infectious Disease Organization, University of Saskatchewan, in a recent presentation, presented data to support that a combination of psychological and nutritional stressors associated with abrupt weaning significantly enhance fatal BRD. Stressors appear to have a direct effect on the amplitude of antiviral responses. Surprisingly, stressors enhanced, rather than inhibited, innate immune responses to infection with infectious bovine rhinotracheitis virus, actually exaggerating the immune system's normal responses to infection.[14]

At the 2009 American Association of Bovine Practitioners annual convention, Griebel said functional genomic analyses suggest antiviral responses were linked to an increased capacity to respond to gram-negative bacterial respiratory infections through increased expression of TLR4 (toll-like receptor 4) and CD14 (receptor sites on the surface of macrophages). As these specific receptors are activated, the immune system in effect overreacts to the presence of certain types of pneumonia-causing bacteria, increasing the severity of disease expression. The end result is increased morbidity—disease case expression in a given population—and an increased incidence of mortality.[15,16]

As receptors respond to substances produced by infecting bacteria that have succumbed to immune system responses, the dead bacteria release chemical substances into the surrounding lung tissue. In response to these chemicals, the immune system rushes in white blood cells, causing infiltration of cellular components of the immune system, which subsequently damages the lung tissue, causing swelling and fluid accumulation. Veterinarians will often comment, while performing a postmortem examination on calves that have died of complications resulting from pneumonia, that the lungs look, and actually feel like, liver tissue rather than lung tissue. The lung tissue has become so heavy with fluid, serum, and cellular material that it literally takes on the appearance of liver tissue, both visually and tactilely. This tissue can no longer exchange oxygen from the inhaled air, nor can it release carbon dioxide with the exhaled air, and if enough lung tissue is damaged or enough bacterial toxins are absorbed, the calf dies. This immunologic knowledge provides evidence for a novel mechanism by which stress may enhance the risk of fatal BRD.[14] In addition, modulation of TLR4 expression during viral infection may be of relevance for both gram-negative and gram-positive bacterial infections. Both types of bacteria are common causes of bacterial pneumonia and bacterial mastitis. Stress, and particularly, stacking stressors, should be avoided at all costs, and the knowledge of how stress influences disease expression in calves should be used as a management tool by modern dairy calf raisers.

Although it is possible to have sudden onset of pneumonia and respiratory disease expression that is primarily caused by a bacterial infection in individual calves, the usual scenario for a severe respiratory outbreak in a group of calves involves a primary infection by a bovine respiratory virus, followed by an induced secondary bacterial pneumonia. This knowledge makes it imperative that calves be vaccinated against the most common respiratory viral causes of BRD early in life so immunity is established long before a potential stress or stressor event is to occur.

This finding also supports the gradual weaning of wet calves. An acceptable gradual weaning can be accomplished by dropping one feeding for 3 days, then feeding every other day for 3 days, and weaning the calves off milk on day 7.[17] It is recommended to leave calves in their original housing for a period of 2 weeks after weaning. This weaning process ties up housing for a 3-week period, but allows the calf to begin the process of consuming enough starter feed to survive before placing the calves in group housing where they must compete with one another for intake. It is generally recommended by dairy calf nutritionists that calves should be consuming 3 pounds (1.36 kg) of a good quality starter feed before weaning.[18] Although earlier and earlier weaning is becoming the norm in modern calf raising facilities, most practicing food animal veterinarians would caution producers on weaning too early, as adding the stress of weaning at too early an age, before the immune system becoming well established with a proper response to vaccinations, should be a consideration. Establishing immunity takes time. It is important that a proper immune response with both a sensitized cell-mediated immune system and circulating antibodies be established before weaning.

Stacking stressors should be avoided at all costs. Do not perform any management practice at weaning except weaning. Do not castrate, dehorn, vaccinate, change feed, move to different housing, or group calves at weaning. Allow the calf to accustom itself to the stress of weaning, and allow the stressful event to abate before moving to new housing or grouping with other calves. It is generally recognized that 2 weeks' time is required to deal with one stressor, much less several stacked on top of one another.[19] By following a process of gradual weaning, calves are much more capable of handling the stress of being removed from a liquid diet. Gradual weaning will also promote proper and stepped increases in starter feed intake.[20] Can calves be abruptly weaned by simply not feeding the milk or milk replacer 1 day? Yes, but there may be consequences of an increased incidence of respiratory diseases, and a slump in performance. There are data generated to support gradual weaning of wet calves off milk or milk replacer.[20] Producers should note that dairy calves increase water intake the day of weaning by about 30%.[21] Provide ample clean, fresh water at the time of weaning. Water intake directly influences dry feed intake.[22]

Grouping calves after the process of weaning, and the size of the group, contributed to the severity and the incidence of respiratory disease.[23] It was determined that calves should be grouped in no larger groups than 9 head, with better performance achieved in the smaller groups, 6 head per group pen. A study performed in Norway determined that calves housed together before 1 month of age had a greater risk of dying compared with calves housed individually.[24] Although there is debate about how many square feet there should be in a group pen, it is generally recognized that at least 40 to 50 square feet (12.19 by 15.24 m^2) per calf is needed for optimal performance[25](**Fig. 1**). A pen of 6 weaned calves would require a pen size that is at least 10 feet (3.05 m) wide by 30 feet (9.15 m) in length, and a 10 head pen would require a pen that is 20 feet (6.09 m) by 30 feet (9.15 m) (**Fig. 2**). It has been determined that if enough space is not allowed for grouped calves, there is a greater risk of developing infectious diarrhea.[26]

Fig. 1. Calves need more room than the space in a calf hutch. A hutch is fine for the first few days of life, as is the case for this newborn Jersey calf, but after a few days, calves need some exercise room.

Proper shelter is important to keep rain, snow, and sleet off calves, but it is vital that the bedded area be kept dry and clean. Bacteria and parasites need moisture to reproduce and complete their life cycle. Although deep bedding may not be required for calves grouped together after weaning, the bedding must be sufficient to maintain a dry clean environment. Frequent bedding may be necessary, particularly during times of wet weather (**Fig. 3**). Calves self-groom and socially groom throughout each day.[7] If manure and filth have accumulated on their legs, hips, and sides from lying in wet filthy bedding, the calves will simply recycle and reinfect themselves with what they lick off their hair coats while grooming (**Fig. 4**). Keep the bedding intervals close enough to secure a clean dry environment in the sheltering areas, as it may influence the incidence of intestinal disease. The shelter should be open enough to allow moisture to evaporate and to prevent poor ventilation conditions.[1]

Grouping calves after weaning is a stressful event. Cattle, like all domestic species, establish a pecking order within the group. Calves that were raised individually are not accustomed to competing with other calves for feed, space, or water. Make sure there is enough shelter for all calves in the group to comfortably lie down under the shelter, and make sure there is enough bunk space for all calves to comfortably eat at the same time. Bunk space is important at any stage of development, but especially so after weaning. Calves are social animals and desire to eat at the same time. As most calves at this point in management are limited to be fed 2.5 to 3% of their body weight in energy-dense feed, it is essential that all calves can consume their proper proportions at the same time. Water should be easy to access, and it must

Fig. 2. Keep group sizes small after weaning.

be kept clean and fresh. Make sure the waterer is not too high for a calf to reach, and not so low as to become contaminated with feces. Group housing begins the process of socialization among calves, and is considered a major animal welfare issue for today's animal husbandry practices.[27]

With a good vaccination protocol to establish immunity against common bovine respiratory pathogens, and armed with the knowledge that stress increases both the incidence and severity of respiratory disease, the calf manager can take the appropriate

Fig. 3. A filthy environment produces a filthy calf!

steps to insure the best possible environment for weaning and grouping calves after the milk or milk replacer feeding period of production. A little attention to detail will pay off in healthy replacement heifers with potential for future milk production ability. It will prepare dairy beef calves for future production efficiencies in the feedlot.

Comfort is important for accessibility to clean, fresh water and feed. The height of bunks and water sources should not be too tall. When a calf eats or drinks, there should not be more than 24 inches (61 cm) total from where the calf stands to the bottom of the bunk. To check this, take a tape measure and hold one end on the ground where the calf stands and run the tape up to the edge of the bunk and then back down to where the calf consumes the feed or water, the bottom of the feed bunk or trough. That measurement needs to be 24 inches or less (61 cm) and applies to the waterer as well. Bunks or troughs should be designed to keep feed fresh and free from contamination. Fresh feed is important to stimulate proper daily feed intake. Feed bunks should be off the ground and preferably polylined (**Fig. 5**). Polylined bunks are easy to clean and will keep the feed fresh and palatable.

Feed bunks should be cleaned of foreign material and fines weekly (**Fig. 6**). Feeding twice daily for the first 28 days in a transition facility will increase daily feed intake, as it mimics starter feed provision practices the calves were accustomed to before

Fig. 4. Weaned calves improperly managed are quite typical for the weaning transition phase of dairy calf production. Feces removal and bedding management are basic animal husbandry practices that must be observed to prevent the development of a coccidiosis or *Nematodirus spp.* outbreak.

grouping. This provides the human interaction the calves crave and stimulates feed intake. Feeding twice daily keeps the feed fresher, which also improves feed intake. This will insure the calves are checked twice a day to be able to diagnose unhealthy calves in a timelier fashion. Waterers need to be checked daily for foreign material and cleaned weekly (**Fig. 7**). It takes 4 pounds (1.82 kg) of water to digest 1 pound (0.454 kg) of feed.[22]

Consistency is important to commercial calf management. Transition is a stressful event, but keeping management and feeding times similar to the times used in the milk replacer feeding time of production, will provide the calf a familiar routine. Use the same starter feed in the transition facility for the first 2 weeks, and transition to the grower diets slowly. It takes about 2 weeks for calves to adjust to feed and environmental changes.[19] Limit the distance hauled or time required to move calves from the calf raising facility to the transition facility. Refrain from any planned veterinary intervention events a week before or 2 to 3 weeks after grouping. It is critical to keep stress manageable at transition. Do not vaccinate, castrate, debud, or dehorn until 2 to 3 weeks after grouping. Group calves as to maturity and weight to keep socialization stress to a minimum. Do not wean too early. Calves need some maturity to compete in a group housing transition facility. Calves should be 9 to 10 weeks old when they are grouped. Once calves are grouped, keep them together until 350 to 400 pounds (159–182 kg) to reduce the comingling and socialization stress.

It is best to read bunks at a similar time every day to determine when to increase intake. A good policy is when the bunk is empty for 3 straight mornings; increase

Fig. 5. A hoop structure transition facility in South Dakota. Note polylined protected feed bunks. Waterers inside each 10 head pens do result in water contamination of the pens on hot days when calves flutter the water out of the waterers into the bedded pen areas.

the intake to a maximum of 1 pound (0.454 kg) per head per day. Producers should target feed intakes to be at 3% to 4% of body weight.

A calorie is a term used in common literature that producers can understand as energy provision. Feed manufacturing and ingredients are both important to daily feed intake for calves. The starter feed will be a high-quality feed with a high net energy for gain. Producers can be tempted to reduce the cost of the transition and grower feed. A total mixed ration (TMR) containing wet feed sources, such as corn silage or haylage of some sort, is not a good option for transitioning calves. Wet feeds are 60% moisture by weight. Newly weaned calves do not have the rumen capacity to consume enough wet forage-based TMR to meet their daily energy intake requirements. Newly weaned calves should be fed the same feed they received at the calf facility for at least the first 2 to 3 weeks in a transition facility. A recommended grower transition diet would contain whole corn, pellet for protein, and macronutrient and micronutrient supplementation, with 10% to 15% oats. Using something to reduce the dust is recommended to increase intake, such as corn or soy oil, or molasses.

Fig. 6. Illinois transition facility with clean wooden feed troughs. Waterers are at the back of each 10 head pen.

Fig. 7. A modified open front transition facility in South Dakota. Note the waterers are on the outside of each 10 head pen. This keeps water contamination of the pens on hot days to a minimum.

Fig. 8. Whole corn stimulates rumen development. Chewing during eructation and rumination reduces particle size.

Fig. 9. Note the excellent rumen papilli development in this 13-week-old commercial dairy calf rumen. Whole corn diets reduce the cost of processing and provide a nutritional stimulus for rumen development.[29]

Intake should be about 3% of body weight. It is recommended to start transition calves on a 18% crude protein diet, gradually reducing the crude protein to 16% as the calves approach 400 pounds (182 kg). The use of high fiber commodity feed ingredients can greatly limit the energy content of a calf diet. Energy intake is important to immune system function.[28]

Whole corn provides good palatability and is an excellent energy source. Calves chew much of the corn during consumption and rechew it during eructation and rumination, which allows for excellent particle size for rumen fermentation (**Fig. 8**). Feeding any type of forage is not recommended until 300 pounds (159 kg). Good quality grass hay fed at 1 to 2 pounds (0.454–0.908 kg) per day is adequate at that time. Rumen capacity is limited in calves under 300 to 400 pounds (159–182 kg). Free choice access to forage will limit grain intake simply due to rumen fill, and performance will diminish due to poor rumen development (**Fig. 9**).

SUMMARY

Implementing management practices that provide the "three C's" of comfort, consistency, and calories will improve health and performance in weaned and transitioning commercial dairy calves.

DISCLOSURE

The authors have nothing to disclose.

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