What you need to know before, during and after transitioning to group housing of calves: Key considerations

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Take Home Messages

- Benefits of group housing for the calf: improved social skills, more adaptable animals, faster behavioral development, and improved feed intake and weight gains.
- Benefits of group housing for the farm: easy delivery of an enhanced diet of milk or milk replacer, individualized feeding behaviour data, and an improved consumer perception of the industry.
- Before beginning to group house there must be: proper colostrum management (failure of passive transfer < 5% of calves) and minimal health problems in the pre-weaning period (morbidity < 10%, and mortality < 5% of calves)
- Calves raised in a group require a high milk allowance and a gradual or step-down weaning program, ideally providing more than one teat.
- Other important factors for successful group housing include: appropriate group size, all-in-all-out grouping, regular cleaning of bedding and feeding equipment, and monitoring for illness.
- Before going big, we recommend to start small. Producers interested in trying group housing on their farm should start with pairs or triplets, using animals that are most similar in age. This can often be done by removing the partitions between individual pens or hutches. If this works well, groups can easily be expanded to 12 calves if needed.

Introduction

Most farmed mammals such as sheep, pigs, horses, and beef cattle are housed with their dam during the milk-feeding period, and the young normally

WCDS Advances in Dairy Technology (2018) Volume 30: 191-202

have contact with other young of a similar age. Dairy cattle production is the exception; standard practice in the North American dairy industry is to separate the calf and dam immediately after birth and raise calves in individual pens during the milk-feeding period, or even after weaning. This limited maternal and social contact contrasts with the evolutionary nature of cattle where young would remain with the mother and interact with other young calves in the herd.

There is a growing number of farms, however, that are moving toward housing calves in groups, in part due to the availability of automatic feeders and the potential of reducing labour requirements per head. While separation from the dam and individual housing remains the norm in the USA (78% of producers), a significant fraction of producers (22%) are converting to some form of group housing (NAHMS, 2014). Recent research has shown that group housing can provide many advantages to both the calves and the farmer if managed well. Moreover, there is recent pressure from consumers and policy-makers to transition to group housing. Here we outline the positive outcomes, but also the common pitfalls, of adopting group housing, and provide suggestions for how management practices can mitigate some of these key issues. We end with a discussion of the future of group housing, and the exciting opportunities that farmers can take advantage of now and in the future.

■ Why group house calves?

There is a growing evidence showing the negative effects of social isolation in many species, including dairy calves. These include impaired social behavior development, the ability to cope with novelty and stressors, and cognitive development (reviewed by Costa et al., 2016). A few studies have shown how these impairments carry over to adulthood, such as high reactivity to isolation and difficulty integrating into the lactating herd (Wagner et al., 2015). Therefore, it is critical to raise a calf that can effectively and successfully cope with the many management practices on a typical commercial farm.

Group housing is an alternative to individual housing that more closely resembles the natural social grouping of calves and has been shown to mitigate the negative impacts of isolation in early life. For instance, group-housed calves were shown to be less reactive toward an unfamiliar calf (De Paula Vieira et al., 2012), approached a novel object and human quicker (Meagher et al., 2015), and were more likely to consume a novel food (Costa et al., 2014) compared to calves raised individually. Group-housed calves were also more flexible when they had to re-learn a cognitive task (Gaillard et al., 2014), indicating these animals were better at adapting to changes in their environment. It is these types of calves that are best able to cope with transitions (e.g. changes in diet, feeding or lying equipment, introduction to the milking parlor) that farmers should target for their herds.

Another important benefit of housing calves in groups is an increase in weight gain and feed intake compared to calves housed individually (Costa et al., 2015). This is thought to be related to the presence of one or more social companions that facilitate attention toward and subsequently increase manipulation and intake of feed, especially when others are also feeding. Increased dry matter intake and weight gain occurs during the pre-weaning period, as early as 41 days of age, and can persist after weaning (Bernal-Rigoli et al., 2012; Jensen et al., 2015). Early onset of rumination has also been reported in group-housed compared to individually-housed calves (Babu et al., 2004).

These benefits are not just restricted to grouping with multiple calves. Many of these benefits have been seen even when calves are paired, although the age that calves are paired or grouped is important. Research has shown that there is a critical period when calves should be socially housed in order to gain the benefits of this housing system, sometime between 3 and 6 weeks of age (Costa et al., 2015). However, we recommend pairing or grouping as early as possible (at birth or shortly after) to maximize the opportunity for calves to learn from their social companions and achieve high intakes and weight gains.

■ What do farmers, consumers and policy-makers think of group housing?

Individual housing is one of the main animal welfare concerns in the dairy industry and likely one of the areas that will experience increased criticism of animal agriculture practices with respect to animal welfare, particularly the issues of cow-calf separation and extended social isolation of calves. These practices have been indicated as a key concern by consumers (Ventura et al., 2016) and thus are likely to become more and more important in driving policies that require specific standards in the dairy industry.

Group housing of calves in part addresses some of these concerns, and is likely to increase consumer acceptability and the image of the dairy industry, although this requires further research (Ventura et al., 2016). The Canadian Code of Practice for the Care and Handling of Dairy Cattle recently included a recommendation for housing calves in groups, which can become a requirement in the near future. This follows in the footsteps of several countries who have mandated that calves must be housed in a social group from an early age.

When investigating what dairy farmers think, a recent survey of dairy farmers in Canada (Medrano-Galarza et al., 2017) showed that farmers who moved from individual to group housing with automated feeders did so based on the following 4 reasons: to raise better calves, offer more milk to calves, reduce

labour, and improve working conditions. Those farmers who remained with individual housing reported that manual feeding of calves had an advantage for lowering the transmission of disease and the identification of sick calves was easier.

While the reasons to move to group housing are enticing, the transition from individual to group housing is not without its challenges. To rear calves in groups, an understanding of the practical benefits and constraints of social housing is essential. We address these issues in the following section.

■ Common pitfalls and solutions while transitioning to group housing

What is your rate of morbidity and mortality? It needs to be low.

The risk of horizontal transmission of disease in group housed calves is inevitably greater than when calves are individually housed. Thus it is not surprising that health is one of the most commonly cited concerns associated with group housing. These concerns are certainly valid given that morbidity and mortality rates of calves on farms across the globe remain high, even when calves are individually housed. For instance, yearly mortality of heifers in the United States has been reported to be 6.9% and 7.8% on calf ranches and dairy farms, respectively (Walker et al., 2012). If health is not managed well in individual housing, the problem is likely to be exacerbated in group housing.

Van Amburgh et al. (2011) suggests that dairy farms should use key targets to assess the efficacy of their calf management program. These measures include: failure of passive transfer (FPT) below 5%, calf morbidity rate under 10% (based on number of treatments) and calf mortality rate under 5%. We suggest that farms that are over these thresholds should first assess and address other aspects of management that are critically associated with illness and mortality before the transition to group-housing. Many of the problems associated with health of pre-weaned calves can be traced back to colostrum management, cleanliness of the pen and feeding equipment, or ventilation, which are issues independent of housing system. Therefore, it is critical to ensure that issues with management associated with morbidity and mortality are corrected first before changing to a group housing system.

How is your colostrum management? It needs to be measured.

Passive transfer of immunity from colostrum is one of the most important factors influencing calf health. Failure of passive transfer is highly related to increased morbidity and mortality in calves, which is associated with lower productivity and increased risk of culling later in life. Therefore, it is critical to

have a successful colostrum management program in place before moving to group housing. This includes optimal quality and quantity of colostrum and appropriate timing of delivery.

An easy cow-side test for quality of colostrum is to use a digital or optical refractometer or hydrometer (colostrometer) to ensure colostrum contains at least 50 mg/mL of immunoglobulins. When 4 L of high-quality colostrum is fed to all calves within 6 hours after birth, the producer is most likely to ensure a high rate of passive transfer in calves. To confirm passive transfer, the immunoglobulin content can be estimated by measuring the protein in the serum of the blood using a digital or optical refractometer. Calves that are under 5.2 g/dL of serum total protein are considered to have failure of passive transfer (McGuirk and Collins, 2004).

As with morbidity rate, farms that have more than 5% of FPT should not move to group housing until this issue is corrected. Farms with higher than average rates of morbidity or mortality should work with their veterinarian, consultant or extension agent to set up a colostrum management program, ensuring that colostrum quality and passive transfer are directly measured and that protocols for quantity and timing of colostrum delivery are in place. Setting proactive goals and measuring results are keys to a successful calf program, regardless of the type of housing.

How much are you feeding? More milk and gradual weaning is key.

Traditionally, calves have been fed restricted amounts of milk to encourage early consumption of grain and to accelerate rumen development so that weaning can be completed early. This milk-feeding strategy is still prevalent today, where calves are fed approximately 10% of their body weight (around 4 to 6 L of milk / day) on most farms. However, this feeding practice not only limits growth but also leaves calves experiencing prolonged hunger compared to feeding higher amounts of milk (De Paula Vieira et al., 2008; Khan et al., 2011). Consequently, calves that are fed restricted amounts of milk show more abnormal oral behaviors, such as sucking on fixtures in the pen. In group housing, this behavior can also be directed at other calves in the form of cross-sucking (Nielsen et al., 2008).

Therefore to achieve the benefits of social housing, such as higher intakes and weight gains, while minimizing abnormal behaviors, it is essential to feed higher amounts of milk. Recent research provides evidence for what may be considered a ‘high’ amount of milk. Calves that were offered 10 or 12 L of milk had the greatest weight gains, grain intakes and had the least number of visits to the milk feeder when milk was unavailable (a measure of hunger) compared to calves receiving 6 L of milk (Rosenberger et al., 2017).

When feeding higher amounts of milk, a gradual weaning program is critical to ensure calves gain familiarity with solid feeds before weaning and thereby maintain weight gains during the pre-weaning period and decrease the feeling of hunger associated with removal of milk (Khan et al., 2016). One type of gradual weaning program includes a step-down technique where milk is reduced to an intermediate level (e.g. from 12 L to 6 L/day) at about one month of age and maintained until a final milk reduction at the targeted weaning age (e.g. from 6 L to 0 L/day). This type of weaning program can be easily implemented for group housed calves using an automated milk feeder.

Can competition and cross-sucking be limited? Provide sucking opportunities.

An obvious advantage of individual housing is that competition, aggression, and cross-sucking are prevented. Nonetheless, several strategies can be employed to reduce these cases during feeding time in group housing. More than one teat should be provided when calves are housed in groups of more than 12 and free access to solid feed should be provided. Even in smaller groups, multiple teats will limit competition. Barriers that protect the calf's head and shoulders, or even the full body, are a good option that will limit or altogether prevent displacements during feeding. When milk is offered in fewer and larger portions, competition for access to teats will also be lowered. As a rule of thumb, there should not be more than 1 month of age difference between calves in a single group so that younger and smaller animals are able to access feed.

Once groups are formed, introduction or removal of individuals should be avoided since calves establish social relationships as early as 30 days of age that may negatively impact the individual if these bonds are disrupted. Therefore, to limit aggressive behavior, calves should be maintained in stable groups of a similar age.

Cross-sucking in group housed calves is another commonly cited problem but there are studies that have reported little to no cross-sucking in groups (e.g. Chua et al., 2002), suggesting that the problem can be managed. Cross-sucking often becomes a problem when the ability to engage in natural suckling behaviour is prevented or limited, which is often related to poor milk-feeding practices. Solutions include providing enough milk and teats so that the motivation to suckle can be satisfied.

Can disease transmission be minimized? Small groups, clean, and monitor.

One common reason for individually housing young calves is to limit disease transmission and to facilitate the identification of illness in individuals. On the contrary, there is little evidence of improved calf health in individual compared to small group sizes. Some studies have indeed reported more health problems in group-reared calves while others have found no health advantage of individual housing compared with small groups (reviewed in Costa et al., 2016). Furthermore, diarrhea and respiratory illness, the most common diseases in young calves, are not consistently associated with group housing (e.g. Hänninen et al., 2003). Nonetheless, we caution that many management practices can influence the risk of disease transmission and should be considered where comparing housing systems, such as the amount of milk fed and bedding management.

Group size and method of grouping are two key practices that can help to minimize disease spread. Groups of less than 12 calves are easiest to manage and reportedly have reduced respiratory illness and severe diarrhea compared to larger groups. Groups of 2 up to 8 made no difference in terms of disease incidence (Abdelfattah et al., 2013). An 'all-in-all-out' grouping system should be used whenever possible to minimize the spread of disease between groups. In this system, calves remain in a stable environment together instead of moving in and out of pens. This form of management helps to prevent the spread of infections between groups of animals raised in the same unit by allowing for cleaning and disinfection between groups.

Clean milk feeding equipment and bedding are also essential to maintaining good calf health. This includes disinfection of tubing and nipples on a regular basis to prevent bacteria build-up and soured milk. Bedding should also be changed, or at the very least topped up, regularly, and ammonia levels should be closely monitored.

We have described just a few of the important variables that must be managed to minimize health problems in group housed calves. However, there are many other factors including ventilation, bedding type, nutrition plan, stocking density, and space allowance that are related with health issues. Farms that are experiencing health problems in calves should first address and manage these factors before transitioning to group housing. However, even when each of these factors are managed well, some calves will inevitably still fall ill and thus monitoring of illness should remain a priority. Close monitoring of individuals and early detection of illness becomes easier in smaller groups.

In summary, while group housing has its benefits, it is not without its challenges, requiring careful attention and specialized management. Farms should avoid transitioning to group housing until pre-existing issues are addressed, such as high morbidity or mortality rates and poor colostrum management. Group housing is most successful when calves are fed high amounts of milk, which prevents periods of hunger and limits competition and cross-sucking. Consideration for group size and all-in-all-out group strategies will also address problems with competition and disease transmission. Finally, regular cleaning of feeding equipment and bedding is essential to minimize illness among grouped calves. Although 'reduced labour' was a top-cited reason for farmers to move to group housing, the points addressed above indicate that the time previously spent individually feeding calves should be shifted to cleaning of equipment and bedding, and monitoring grouped calves for early signs of illness.

■ The future of group housing: automated technologies

Once a farm has successfully implemented a group housing program, the dairy has another large opportunity especially when using automated milk feeders. The data recorded by these feeders can be used to identify calves that may be ill and to track overall performance and success of the pre-weaning period – all with very little additional labour. Data management and data-informed management decisions are some of the biggest opportunities for the agriculture sector, and these data management techniques and automation are expected to become more sophisticated in the near future.

The automated milk feeding system is one of the most common precision technology used to detect disease development such as bovine respiratory disease and diarrhea. For instance, the Forster Technik (Engen, Germany) software collects data on individual calf daily milk intake, drinking speed and visits to the feeder. It also can be programmed to "alarm" the farmer when a calf deviates from its normal feeding pattern or trajectory. These deviations may reflect sickness behaviours, allowing for early treatment of illness. One study reported that the automated feeder detected deviations from normal milk intake and drinking speed 2 days before diagnosis of illness, and deviations from normal unrewarded visits were noted as early as 4 days before diagnosis (Knauer et al., 2017). This example highlights a crucial opportunity for farms to utilize data collection from the feeders to identify sickness and provide treatment earlier, thus limiting the negative impacts of reduced feed intake and illness on the welfare of the individual. Calves that are detected as deviants can be placed on a 'watch' list that notifies the farmer outside of the facility, making it a convenient and efficient method for monitoring illness in grouped calves. However, we caution that the automated milk feeder should not be used as a replacement for direct assessment of calf health, but rather as a guideline for which calves may require additional attention.

In addition to using the automated milk feeder to determine which calves require further health assessments, the feeder can monitor the overall success of the pre-weaning program. The program can estimate weight gains by using the initial weight and calculating a current weight based on the calf's milk intake. These systems are thus capable of tracking the growth of individuals within groups of calves during the pre-weaning period, offering immediate feedback on the success of the milk-feeding program. Similar to feeding behaviour, deviations in growth can also be set to send an 'alarm' indicating a possible case of illness or a poor transition during weaning.

In addition, provided the calf was not sick, grain consumption can be calculated as the crude difference in weights from the automated milk feeder software and the actual weight of the calf. This can be used to calculate feed efficiency, variability in feeding patterns and many other factors that can inform culling decisions and feeding strategies. Alternatively, an automated grain feeder can be integrated with the milk feeder to report true grain intake. This option provides the opportunity to wean calves based upon individual grain consumption (de Passillé and Rushen, 2016).

In the long-term, this data has the potential to inform farmers of how the pre-weaning program is linked with later performance in the milking herd. Given that high milk consumption early in life has been associated with higher milk production and greater parenchymal mass (udder development) compared to restricted-fed calves (Geiger et al., 2016), records of a cow's early-life feeding patterns and growth will provide critical information to aid in our understanding of the long-term impacts of early-life rearing and nutrition on future productivity. Furthermore, with the advancement of technologies for monitoring other behavioural and physiological measures in calves, such as activity, rumination and body temperature, we can expect many more possibilities allowing for the automated collection, analysis and application of feeding behaviour and intake data of grouped calves.

■ Conclusions

The detrimental effects of social isolation are now recognized in a range of species, and we have highlighted newer work on dairy calves showing that individually-raised calves have deficient social skills, difficulties coping with novel situations, and poor learning abilities. Social housing for calves improves pre-weaning solid feed intake and overall weight gain during the transition from milk to solid feed. The challenges associated with group housing include disease transmission, competition at the feeder and cross-sucking, but we have presented research suggesting that calves can be grouped in good health with minimal abnormal behaviours if housing is properly managed.

Grouping calves from an early age will have returns. The long-term effects of early-life social rearing are beginning to show that adults can have improved production and reduced behavioural reactivity later in life. We encourage producers to test out group housing by starting with pairs of calves that are similar in age, and if this works well, groups can be expanded to 3 or 4, and up to 12 calves easily. We predict that producers will see the benefits within weeks of transitioning to group housing and will have the opportunity to use the data generated by the automated milk feeders to help manage their operations.

Acknowledgements

We thank Rolnei Rua Daros, Daniel M. Weary and Marina von Keyserlingk for their input and discussion about this topic throughout the years. We also thank Rebecca Wurtz for the edits and help with this document.

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