New insights into health of dairy calves during the pre-weaning period

Vinicius Machado, DVM, PhD
Department of Veterinary Sciences
Texas Tech University, Lubbock, TX

Optimal growth during the pre-weaning period is crucial for the post-weaning performance of dairy heifers. It was reported that for every 1 kg of pre-weaning average daily gain (ADG), heifers produce, on average, 850 kg to 1,113 kg more milk in their first lactation (Soberon et al., 2012). Growth during the pre-weaning period is impacted by many factors, including nutrition, management, environment, and incidence of diseases. Bovine respiratory disease (BRD) and diarrhea are the two most common disorders during the pre-weaned life of dairy calves. In addition to the economic losses due to delayed growth, BRD and diarrhea are the two most common causes of calf mortality during the pre-weaning period (USDA-NAHMS, 2007).

Both diseases have multifactorial nature. Diarrhea can be caused by infectious and non-infectious agents. Management (e.g., colostrum, housing), nutritional state, immunity, and pathogen exposure are risk factors associated with both diarrhea and BRD (Al Mawly et al., 2015; Dubrovsky et al., 2019). *E. coli*, *Salmonella spp*., *Cryptosporidium*, and rotaviruses are among the most common enteropathogens that causes diarrhea in pre-weaned dairy calves (Gulliksen et al., 2009). In addition to a complex of viruses, the major bacterial etiological agents of BRD are *Mannheimia haemolytica*, *Pasteurella multocida*, *Histophilus somni* and *Mycoplasma spp.* (Angen et al., 2009).

Metagenomics studies have been conducted in the last decade to investigate the bacterial diversity and abundance associated with diarrhea and BRD. It has been established that the fecal microbiome of dairy calves significantly changes as the calf ages. Additionally, the relative abundance of some bacteria in the feces is associated with diarrhea incidence and growth, in particular *Faecalibacterium prausnitzii.*, a butyrate producing organism (Oikonomou et al., 2013). Higher relative abundance of *Faecalibacterium prausnitzii* in the feces during the first week of life is associated with lower incidence of diarrhea, and with increased ADG. The impact of *Faecalibacterium prausnitzii* on the gut of other species have also been studied. It has been associated with obesity in children, and it was decreased in the gut of dogs with acute diarrhea, suggesting that it has anti-inflammatory roles as well as energy harvesting properties. In a subsequent study, *Faecalibacterium prausnitzii* live cultures were administered orally to dairy calves in their first week of life (Foditsch et al., 2015). Oral administration of *Faecalibacterium prausnitzii* lowered the incidence of severe diarrhea, decreased the mortality due to severe diarrhea, and accelerated the growth of dairy calves over the pre-weaning period. These are encouraging results regarding the use of this commensal bacterium as a probiotic that will promote health and growth of dairy calves.

High-throughput sequencing of the 16S rRNA gene was used to characterize the upper respiratory tract of dairy calves over the first 35 days of life, and to compare the microbiome of healthy and unhealthy calves (Lima et al., 2016). It was observed that the microbiome of the

upper respiratory tract of dairy calves during the pre-weaning period is highly diverse. Calves diagnosed with BRD had a greater bacterial load in their upper respiratory tract. Results from this study supports the previous knowledge that Mannheimia and Mycoplasma are important in the pathogenesis of BRD, while suggests that Moraxella can also be an important etiological agent. Hence, it is likely that strategies that decrease the bacterial load in the respiratory tract of dairy calves, especially Mannheimia and Mycoplasma, will decrease the incidence of BRD during the pre-weaning period. In fact, it was reported that tildipirosin metaphylaxis on pre-weaned dairy calves housed in group pens decreases the combined incidence of pneumonia and otitis (Teixeira et al., 2017), but this strategy did not have any impact on growth or survival.

About 10% of dairy heifers in the United States are transported within the first 2 days of age to specialized calf raising facilities. Similarly to commingling, transportation is a known stressor of cattle that causes immunosuppression and can potentially impact the health of pre-weaned heifers. Recently, we evaluated the impact of a non-specific immune stimulant (mycobacterium cell wall fraction) on the health of calves that were transported (~18h from Minnesota to New Mexico) within the first 3 days of life to a calf raising facility. We observed that treating calves immediately before transportation decreased the hazard of BRD during the first 35 days of life, while treating immediately after transportation did not have a impact on disease incidence (Omontese et al., 2019).

It is known that after long-distance transportation, circulating levels of inflammatory and stress biomarkers are elevated. We have evaluated the association of serum levels of haptoglobin, cortisol, and l-lactate measured at time of arrival with health and growth of dairy calves transported to a grower facility within the first 4 days of life (Celestino et al., 2019). We hypothesized that high concentration of these biomarkers would be associated with greater disease incidence and delayed growth. However, we observed that calves categorized in the high haptoglobin group were less likely to develop BRD and had higher ADG compared to calves in the low haptoglobin group. Additionally, we did not observe any association of cortisol and l-lactate with health or weight gain. Because serum concentration of haptoglobin in our study animals were generally low in comparison to reported concentrations associated with pathological processes, we speculate that high haptoglobin in our study was suggestive of a more activated and protective immune system. More research is needed to better understand the interactions between early life transportation of calves, stress, immunity, and health.

Angen, Ø., J. Thomsen, L.E. Larsen, J. Larsen, B. Kokotovic, P.M.H. Heegaard, and J.M.D. Enemark. 2009. Respiratory disease in calves: Microbiological investigations on trans-tracheally aspirated bronchoalveolar fluid and acute phase protein response. Vet. Microbiol. 137:165–171. doi:10.1016/J.VETMIC.2008.12.024.

Celestino, M., P.R. Menta, L. Fernandes, D. Poit, R.C. Neves, Caixeta L S, and V.S. Machado. 2019. Associations of Serum Biomarkers of Stress and Inflammation Measured at Arrival with Bovine Respiratory Disease Incidence, Mortality, and Growth of Calves Transported within the First 4 Days of Life. Accessed July 12, 2019. https://aabp.org/meeting/display_research.asp?recnum=81.

Dubrovsky, S.A., A.L. Van Eenennaam, B.M. Karle, P.V. Rossitto, T.W. Lehenbauer, and S.S. Aly. 2019. Epidemiology of bovine respiratory disease (BRD) in preweaned calves on California dairies: The BRD 10K study. J. Dairy Sci.. doi:10.3168/jds.2018-14774.

Foditsch, C., R.V.V. Pereira, E.K. Ganda, M.S. Gomez, E.C. Marques, T. Santin, and R.C. Bicalho. 2015. Oral Administration of Faecalibacterium prausnitzii Decreased the Incidence of Severe Diarrhea and Related Mortality Rate and Increased Weight Gain in Preweaned Dairy Heifers. PLoS One 10:e0145485. doi:10.1371/journal.pone.0145485.

Gulliksen, S.M., E. Jor, K.I. Lie, I.S. Hamnes, T. Løken, J. Åkerstedt, and O. Østerås. 2009. Enteropathogens and risk factors for diarrhea in Norwegian dairy calves. J. Dairy Sci. 92:5057–5066. doi:10.3168/JDS.2009-2080.

Lima, S.F., A.G. V. Teixeira, C.H. Higgins, F.S. Lima, and R.C. Bicalho. 2016. The upper respiratory tract microbiome and its potential role in bovine respiratory disease and otitis media. Sci. Rep. 6:29050. doi:10.1038/srep29050.

Al Mawly, J., A. Grinberg, D. Prattley, J. Moffat, J. Marshall, and N. French. 2015. Risk factors for neonatal calf diarrhoea and enteropathogen shedding in New Zealand dairy farms. Vet. J. 203:155–160. doi:10.1016/J.TVJL.2015.01.010.

Oikonomou, G., A.G.V. Teixeira, C. Foditsch, M.L. Bicalho, V.S. Machado, and R.C. Bicalho. 2013. Fecal Microbial Diversity in Pre-Weaned Dairy Calves as Described by Pyrosequencing of Metagenomic 16S rDNA. Associations of Faecalibacterium Species with Health and Growth. PLoS One 8. doi:10.1371/journal.pone.0063157.

Omontese, B., M. Celestino, D. Paiva, A. Garcia-Munoz, A. Masic, V. Machado, and L. Caixeta. 2019. Effects of a Bovine Nonspecific Immune Stimulant on Health of Jersey and Jersey-Cross Heifer Calves in the First Month of Life. Accessed July 12, 2019. https://m.adsa.org/2019/abs/t/78582.

Soberon, F., E. Raffrenato, R.W. Everett, and M.E. Van Amburgh. 2012. Preweaning milk replacer intake and effects on long-term productivity of dairy calves. J. Dairy Sci. 95:783–793. doi:10.3168/jds.2011-4391.

Teixeira, A.G.V., J.A.A. McArt, and R.C. Bicalho. 2017. Efficacy of tildipirosin metaphylaxis for the prevention of respiratory disease, otitis and mortality in pre-weaned Holstein calves. Vet. J. 219:44–48. doi:10.1016/J.TVJL.2016.12.004.

USDA-NAHMS. 2007. Dairy 2007: Heifer Calf Health and Management Practices on U.S. Dairy Operations.