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The Colostrum Counsel

Fostering the neonatal calf through the initial 4 weeks of life by adapting a calf rearing protocol to some of the latest nutritional, environmental and health recommendations will cater specifically to the needs of calves 1 – 4 weeks of age, and help give your calves the best start right from the start.

Delivering the Ideal Neonatal Calf Care Program

The most vulnerable period of a calf's life is immediately after he or she is born. The calf is defenseless in almost every way – An immune system awaiting antibody and calorie assimilation, delivered in a nutritiously rich and warm colostrum. Harboring less than 3-4% body energy reserves, a chill begins to set in at 13°C and regulating body temperature is not yet second nature. Calves have an unparalleled susceptibility to enteric disease in the first couple weeks; an evident trend with scouring being the #1 cause of mortality in calves (Murray, 2011). These physiological criteria make the neonatal calf a uniquely vulnerable individual, and worthy of a neonatal specific set of nutritional and management care practices.

The success of the calf in the initial 10-14 days of life has lasting effects on the performance of that animal throughout the milk fed period over to lactation (Leadley, 2004). Getting calves started off right means that you are capitalizing on the most efficient period of growth and feed utilization that you can ever achieve with that animal. Energy spent on thermoregulation and battling against scours is literally, ill spent!

Antibody Protection

Failure of passive transfer of immunoglobulins has a life-long impact on growth and production of affected calves and is surprisingly common; Among 37% in all dairy calves in Ontario and 20% in American calves identified in NAHMS 2007 data (Trotz-Williams et al., 2008). There are factors to consider when feeding colostrum that can have a large impact on how well immunity is provided and how the calf is protected. The antibodies contained in the dams' colostrum are directly related to the antibodies she has in her own body, so vaccinating her against diseases like Corona and Rota viruses and E.Coli are beneficial, as they are common enteric diseases that calves are likely to be contracted early in life.

Feeding colostrum as soon as possible after birth is best, before the calf is standing if possible (within 30 minutes of birth). Not only is this the most potent colostrum you will get from the dam, but this is also the time when the calf's gut lining is most receptive to absorbing large protective antibodies, and the calf is also most willing to suckle. Colostrum quality begins to diminish within hours after the calf is born, as more milk is constantly being produced,

the colostrum is slowly being diluted in the udder by milk, meaning the concentration of antibodies and growth factors are slowly decreasing, as are the rich fat, protein and vitamin content. By 6 hours after calving, the colostrum is reduced to 80% of its' initial concentration (Godden, 2007).

Feeding a minimum of 10% of the calf's body weight has been shown to be beneficial in the first meal with an additional 2L provided in the next 6 – 12 hours (Doepel & Bartier, 2014). In a trial, the mean risk of mortality of calves that were not fed colostrum in the initial 0-6 hours of life was 32.7%; and the odds ratio of calves having at least one respiratory event without being fed the secondary dose of colostrum in the 6 – 12 hour mark was 98.2 (Doepel & Bartier, 2014). This level of colostrum intake should provide adequate passive transfer of immunoglobulins to your calves. Bottle feeding calves 3L colostrum allows for a comfortable level of intake, promoting subsequent suckling at the next meal, and resulting in improved digestion from salivary lipase secretions and other hormonal changes invoked by suckling. If the calf is willing to suckle more than this in the first meal, allow the calf to drink until satisfied. Some calves will suckle up to 5L in this first feeding: this is great! The more the calf will drink in the first meal, the more protection and calories they are guaranteeing themselves. Take caution when feeding colostrum with an esophageal feeding tube, as calves can be over fed this way, which will discourage subsequent feedings. Tube feeding 3L of high quality colostrum or 100 g IgG of colostrum replacer is adequate in providing both calories and immunoglobulins without over filling the calf. Feeding more colostrum and up to 200 g IgG is ideal for achieving excellent passive transfer levels.

Colostrum quality and cleanliness can also be ensured by testing the quality of the colostrum the dam is producing or by feeding a dried colostrum. The added benefit of having dried colostrum on hand is the calf can be fed immediately without having to milk the dam if this is a limiting factor for timing of the first colostrum feeding, especially for off milking hour calvings.

Early Nutrition – More To It Than Immunoglobulins

Considering how fast a chill can set in and how little energy reserves the young calf has, offering clean, consistent, calorie rich nutrition is the best approach for defending the neonatal calf. Don't forget, this is the most feed efficient period your calf will ever experience, so providing the energy to utilize that feed efficiency will not be wasted. Early and substantial colostrum intake is not only essential for the absorption of antibodies, but provides large amounts of β-carotene, vitamin A and essential amino acids and calories. If calves do not receive this nutrition within the initial 24 hour period, low levels of these nutrients persist for weeks and can alter the status of plasma patterns of fatty acids, essential amino acids and glutamine/glutamate ratios (Blum & Baumrucker, 2002).

Aside from the building blocks for growth, development and energy that colostrum provides, it has bioactive hormone and regulatory factors such as insulin-like growth factors and binding proteins (IGF's and IGFBP's) which are very important for the development and regulation of neonatal tissues (Blum & Baumrucker, 2002). These bioactive components have proven to stimulate small intestinal villus proliferation and growth and are related to metabolic and endocrine pathways (Blum & Baumrucker, 2002). Feeding colostrum after the 24 hour mark of gut closure will protect the lining of the GI tract by coating the lining of the intestines with a thick solution of antibody rich and intestinal growth-promoting agents, ready to destroy any scours causing pathogens which aim to adhere to the gut lining and cause illness to the calf. Colostrum beyond the 24 hour mark also provides energy at a level that is double that provided by milk, promoting both gut health and growth to the young calf. Trials of feeding colostrum to calves for the first 14 days of life showed increased average daily gain during this period and with no digestive or metabolic disturbances, compared with the conventional feeding of colostrum (Berge et al., 2009) Similar results were obtained on farm by a member of the Attica Veterinary Associates. They noted that calves would drink a larger volume per day more quickly, had fewer bouts of scours requiring treatment in the initial 3 weeks of life, and when calves did scour, the bouts were short and less compared with only 3 days of colostrum feeding (Leadley, 2008). Other investigations into health events related to body weight gains in Holstein calves showed that mortality rates decreased by 13% for each kilogram increase in body weight gain in the first week of life (Doepel & Bartier, 2014). This helps to show that a single feeding of colostrum cannot provide the caloric, let alone the bioactive components to meet the developmental needs of the calf.

Table 1: Typical analysis of colostrum, transitional milk and whole milk from Holsteins

Composition of Colostrum				
	Milking Number			
	1	2	3	Milk
Specific Gravity	1.056	1.040	1.035	1.032
Solids	23.9	17.9	14.1	12.9
Protein %	14.0	8.4	5.1	3.1
Casein %	4.8	4.3	3.8	2.5
IgG mg/ml	48	25	15	0.6
Fat %	6.7	5.4	2.9	3.7
Lactose %	2.7	3.9	4.4	5.0
Vitamin A µg/l	2950	1900	1130	340
Calories cal/l	1520			570

Calculations done by Reny Lothrop, adjustments by Amanda Kerr of Grober Nutrition

This chart shows the natural progression of milk production in the fresh dam. The calorie difference between colostrum and whole milk is greater than double, with colostrum providing 1520cal/liter vs. whole milk providing 570cal/liter. The need to fuel the poorly insulated calf is apparent in the nutrient and caloric density of the early nutrition provided by the dam. Also note that the transition from rich colostrum to milk is gradual and prolonged over days.

Knowing that neonatal calves have a sensitive GI tract that is still developing, with high energy demands, prolonged feeding of colostrum will provide the gut with growth factors and growth promoting agents and provide the calf with much needed energy. Milk is restricted from the tank for the initial 72 hours post calving, by which time the colostrum components have diminished and whole milk is now being produced. Feeding the colostrum produced over these 3 days (7 feedings) mimics nature's nutrient profile of high calorie and nutrient needed by the calf. Practicality of collecting, cold storing and warm feeding colostrum during these 3 days may be difficult on some farms, or may be limited by disease challenges. A powdered product would work well to extend the colostrum feeding period, is bio-secure and would facilitate feeding warm, clean colostrum at any time during this critical period.

When ready to transition onto whole milk or milk replacer, take care to transition gradually, again mimicking nature with the gradual transition from colostrum to milk production in the dam. Slowly transitioning to an optimal protein/fat milk replacer, which is geared towards lean muscle and frame development (ie, 22/17 or 26/18) should be fed in adequate amounts of no less than 6L/day and ideally 9L/day or more. Feed consistency will help the neonatal calf digest their food, and avoid metabolic upset, as their gut microflora is just developing. The "good" bacteria that populate the mature calf's GI tract actually provide substantial protection against enteric disease, as they defend against pathogenic bacteria that can bind to the gut lining and cause scouring. Feeding milk replacer is a quality guarantee with a known low pathogen level. Mixing milk replacer at the correct temperatures, and using a scale to measure out milk powder is the most accurate way to ensure the nutrition will be consistent and clean, and will help provide the growing gut flora with the environment needed to build in numbers and protect the calf, while providing the calf with quality assured nutrition.

Portion size and Feeding Frequency

Calves under four weeks of age have small stomachs, which makes getting all the nutrition they need in only two meals a day challenging. Feeding 6L / day is by no means over feeding the neonatal calf. As stated earlier, this is the only time in the calf's life where the feed – gain ratio will be this efficient. If you are willing to provide calves with 7 – 10 liters per day for this early phase of life, the payoff will be in feed efficiency. To make the feedings as efficient as possible, split meals into smaller servings and feed a minimum of 3 meals per day or on an ad libitum system, which can be provided with automatic feeding machines or mob feeders. This not only makes it easier and more efficient for the calf to drink and digest larger volumes of milk, but helps the calf thermoregulate. Warm milk will help stabilize the calf's body temperature, and will also avoid large ebbs and flows in hormone releases seen when slug feeding which can swing metabolism rates. Ad libitum feeding will be most efficiently utilized in neonatal calves, and they will benefit from this feeding system. Ad libitum milk provision allows the young calf to respond to their hormone signals telling them to eat. The act of eating brings up blood energy substrate

levels and promotes nutrient tissue deposition (growth!), as opposed to a switch in metabolism causing energy substrates to be drawn from tissues to bring the blood concentrations back up to equilibrium. Forster Technik automated feeding technology have an ad libitum feeding program called 40-Fit, which allows calves to drink on demand with regulated meal sizes. Regulating the meal size ensures that calves are not over drinking at each meal, which makes for maximized feed efficiency. Feeding with an automated feeding machine has the added benefits of on demand warm milk provision, as well as individual data tracking of each calf's drinking volume and speed of drinking. Monitoring volume intakes and speed of intakes are two easy factors to look at when identifying the early onset of disease.

Feeding calves under 4 weeks of age from a nipple can influence drinking rate, saliva production, and can help avoid metabolic upsets from poor esophageal groove formation when drinking too quickly, ultimately causing wasteful rumen drinking. With rumen drinking, milk is not being directed to the abomasum, but ends up in the premature rumen, where motility is low and milk fats and proteins are altered by the developing rumen juices, resulting in loss of nutrient availability (Quigley, 2005). Symptoms usually include poor doing, soft, grey manure and reduced growth rates – not a good use of the calf's most efficient growth period! Allowing neonatal calves to suckle warm milk from a nipple is the most successful way to make sure milk will be deposited into the abomasum, where the stomach enzymes and microbe populations are designed to digest milk, making this the most efficient destination for milk once ingested by the calf. Saliva produced when suckling contains trace enzymes but mostly bicarbonates which help to buffer the calf's acidic stomach environment and help promote a healthy gut, expediting GI development and microbe population growth in the fragile innards of the neonatal calf. Slowing down intakes improves feed efficiency, as the ratio of digestive enzymes to volume of milk passing through the stomach towards the small intestines where nutrient absorption takes place is higher, meaning more of the nutrients will be available to the calf. Slower eating also helps stabilize hormone release, which can effect metabolism and nutrient utilization of the energy absorbed from each meal.

Cleanliness and Environment

The cleanliness of milk or milk replacer feeding, mixing and collecting utensils is another extremely important part of the neonatal calf care program. Warm milk is the perfect medium for bacterial growth, and with the initially open gut and immunologically sensitive calf, they are a sitting duck for milk-loving, scour causing bacteria to get access to the gut lining and cause fatal enteric disease. Washing with hot water and detergent and allowing to properly dry are a must for neonatal feeding utensils.

Cleanliness and management of the young calf environment has a direct impact on the pathogen load the calf is exposed to in this fragile stage. Frequent and generous bedding of the neonatal calf pen is an important part of neonatal care practices. The clean, dry bedding provides a barrier between diseases that may be in the calf's environment and specifically the calf's open umbilical cord. The umbilical cord contains two umbilical arteries, a vein and a urachus (a drain for the bladder), all of which retract into the abdomen at birth and gradually degenerate, leaving only the empty 2 – 6 inch umbilical sheath visible outside of the calf, which will dry up and fall off within 7 – 10 days (Leadley, 2004). Retraction of the arteries, vein or urachus into the calf's abdomen is sometimes incomplete, and the umbilical sheath can broken off directly at the calf's navel, both of which exposes the calf to much greater risk of infection (Leadley, 2004).

Dipping the navel with a 7% iodone disinfectant or a 0.5 – 2% chlorhedidine soloution (used more successfully than iodine in new born foals) 2 times in the first 48 hours of life is an easy and effective preventative step in protecting the neonate from lethal bacterial infection through the open umbilicus no matter the success of the umbilical recession and drying process (Miller et al., 2009). A study by Cornell University found that calves with un-dipped navels showed an 18% death rate compared with calves whose navels were dipped at birth with a 7% iodine solution had an average mortality rate of 7% and had gained an additional 5 ½ pounds by weaning (Leadley, 2004).

The key to housing neonatal calves is providing a microclimate suited for their sensitive needs. Starting with drying the calf off as soon as possible after birth and providing a secondary heat source to help avoid shivering

and energy wasted on thermoregulation. Heat lamps, incubators or drying boxes are all great ways to get the calf warm and dry after birth. Once they are dry, the use of a calf blanket in temperatures less than 10°C should be standard practice. The blankets can stay on the calf up to 4 weeks of age, at which time the lower end of the thermoneutral zone expands to 0°C. Switching dirty blankets for clean ones is important to keep the calf dry and clean.

Being hypothermic is quite common in young calves and does not promote good health. Ensuring constantly deep, dry, straw bedding gives calves the extra insulation that their skimpy 3-4% body fat simply can't keep the calf warm enough, especially below the thermoneutral zone of 10°C during the first 4 weeks of life. Keeping this bedding dry is of utmost importance. Wet bedding chills the calf very quickly, and moisture spawns bacterial growth. Bedding these pens "as needed" is already too little bedding for these neonates – more, and more often is best.

Provide wind breaks if the calf is kept out doors by using a screen on the front of the hutch for the first four weeks or even using a hutch indoors to provide a microclimate for the calf. Air quality is very important for housing young calves, ensuring the vents on the hutch are open or that there is fresh, clean air available to group housed calves. Minimizing interactions between calves and older cows, which are capable of harboring large amounts of disease causing pathogens without showing clinical symptoms is another way of buffering the young calf from disease exposure.

A combination of nutrition and housing management that is tailored to the needs of the delicate stage of development and growth of the neonatal calf will provide the best conditions for optimizing on the efficiency of the young animal. Reducing disease pressure and the added monetary and time costs associated with managing scouring calves will benefit both you and your calves throughout the milk fed period and as they mature. Fostering the neonatal calf through the initial 4 weeks of life by adapting some of your calf rearing protocol to some of the nutritional, environmental and health recommendations made above, will cater specifically to the needs of calves 1 – 4 weeks of age, and help give your calves the best start right from the start.

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References

Berge, A. C. et al. "Evaluation of the effects of oral colostrum supplementation during the first fourteen days on the health and performance of preweaned calves." Journal of Dairy Science; 92.1 (2009): 286-295.

Blum, J. W., and C. R. Baumrucker. "Colostral and Milk Insulin-like Growth Factors and Related Substances: Mammary Gland and Neonatal (intestinal and Systemic) Targets." Domestic Animal Endocrinology 23.1 (2002): 101-10. Science Direct. Elsevier. Web. 21 Feb. 2015.

DOI: http://dx.doi.org/10.1016/S0739-7240(02)00149-2

De Passillé, A. M. B., Christopherson, R., and J. Rushen. "Nonnutritive sucking by the calf and postprandial secretion of insulin, CCK, and gastrin." Physiology & Behavior 54.6 (1993): 1069 – 1073. Science Direct. Elsevier. Web. 21 Feb. 2015. doi:10.1016/0031-9384(93)90326-B

Doepel, L., and A. Bartier. "Colostrum Management and Factors Related to Poor Calf Immunity." WCDS Advances in Dairy Technology 26 (2014): 137 - 149. Retrieved from www.wcds.ca/proc/2014/Manuscripts/p%20137%20-%20152%20Doepel.pdf

Godden, S. "Colostrum Management for Dairy Calves" Veterinary Clinics of North America: Food Animal Practice 24.1 (2008): 19 – 39. Science Direct. Elsevier. Web. 21 Feb. 2015. doi:10.1016/j.cvfa.2007.10.005

Jasper, J., and D.M. Weary. "Effects of Ad Libitum Milk Intake on Dairy Calves." Journal of Dairy Science 85.11 (2002): 3054 – 3058. Science Direct. Elsevier. Web. 21 Feb. 2015. doi:10.3168/jds.S0022-0302(02)74391-9

Leadley, S. "Navels and Newborns." Calf Notes. May 2004. Web. 21 Feb. 2015. <www.calfnotes.com/pdffiles/CNCE0504.pdf.>.

Leadley, S. "Feeding Transition Milk and Colostrum" Calving Ease. December 2008. Web. 21 March. 2015. <http://www.atticacows.com/orgmain.asp>.

Lothrop, R., (2015, March 20th). Personal interview and provided calculations for colostrum calorie content.

Miller, S., D. Wilfong, M. Leitch, and D. Zimmel. "Foal Care - Foal Umbilical Care." AAEVT's Equine Manual for Veterinary Technicians. By D. Reeder. Ames: Wiley - Blackwell, 2009. 150. Google EBook. Web. 24 Mar. 2015. <https://books.google.ca/ :