

The 5 C's of Calf Raising

Lance S. Fox¹

Alpharma, Inc.

Abstract

Originally introduced to the dairy industry by Dr. Sheila McGuirk, University of Wisconsin School of Veterinary Medicine, the 5 C's include the following: Colostrum, Calories, Comfort, Cleanliness, and Consistency. While both the alphabet itself and various anagrams have been used to highlight certain components of dairy calf-rearing, the 5 C's are unique in that they quickly point out 5 key management factors necessary to promote optimum health and production of dairy calves on today's modern operations, regardless of type and/or size.

It is obvious that the dairy heifer calf is the foundation of our future milking herd. It is this foundation, however, that still struggles with health issues, such as digestive disorders (i.e. scours), which account for approximately 62% of pre-weaning mortality (NAHMS, 2002). Heifer calves are expected to consume enough maternal antibodies (**IgG**) to achieve adequate passive transfer. Colostrum, the very first meal a newborn calf should ingest, is still not being directly administered in roughly 30% of our dairy heifers (NAHMS, 2002). As a result, approximately 40% of heifer calves have failure of passive transfer (**FPT**) (NAHMS, 2002). On average, a calf will nurse naturally 6 to 8 times in a 24-hour period, which translates into small multiple meals. Previously, 24 hours of age was the timeframe the industry advocated for allowing adequate IgG absorption

through the gastrointestinal tract; a process known as pinocytosis. Continued research is now telling us that the ideal 'window of opportunity' for antibody absorption may be half as long, if not less.

Calories, how we feed them and why, is the only other technical "C" listed of the five. Whether discussing winter feeding practices or rumen development, how we supply the necessary groceries to a calf in part dictates how successful growth, weaning, transition, pregnancy, and ultimately milk production will be. The 3 remaining "C's;" comfort, cleanliness, and consistency are not technical in nature. If a calf is housed in a wet, dirty environment with poor ventilation and inconsistent feeding practices, one would not expect optimal health and performance to occur. While the topic of calf and heifer management may seem rudimentary, there clearly exists a need to address the various parameters involved to insure a successful calf-rearing program.

Colostrum

Another way to view colostrum is as liquid gold. The word gold is synonymous with value. The topic of feeding sufficient amounts of good quality colostrum to newborn calves in a timely matter has been a topic of industry discussion for many years. Yet we still read reports indicating significant levels of FPT. Why? Is it because calves are not being fed enough? Is it because the quality is suboptimal? Or is it due to delayed timing of

¹Contact at: N2989 County Road W, New London, WI 54961, (920) 982-1797, FAX: (920) 982-1798, Email: lance.fox@alpharma.com

administration? The answer is that one or a combination of these issues is likely. Feeding colostrum is similar to putting a puzzle together. Without all the necessary pieces, the puzzle is incomplete. Without colostrum, the calf is at significant risk of increased morbidity, death, and substandard performance, both as a growing heifer and eventually a mature lactating cow. In regards to disease, it is similar to the age old question, “Which came first, the chicken or the egg?” In calves we must ask, “Which comes first, immunity or the pathogen(s)?” In other words, we would like the immune system prepped and ready to go prior to being exposed to harmful pathogens.

In addition to colostrum management, other areas of opportunity exist on the first day of the calf’s life. Maternity pen management is one such opportunity. When a calf is born into a communal maternity pen, it is subsequently being introduced to a variety of pathogens shed from mature cows waiting to share that common ‘birthing center.’ It is not realistic to expect every dairy operation to have individual maternity pens that are thoroughly cleaned between calvings. Yet, if the maternity pen area is cleaned infrequently, the newborn calf is at risk of ingesting its first manure meal well before colostrum. After about an hour, the newborn calf tries to stand. The process of standing normally takes several attempts to achieve upright success, and with each dive into the bedding pack, the possibility of consuming a small amount of manure increases. Many potential pathogens may lie in waiting inside the bedding pack. Salmonella, a species of bacteria that has plagued the dairy industry for years, is a great example. If present, a calf need only ingest about 1/5th of a teaspoon of manure, about the size of a pea, to become infected. Other pathogens, such as *E. coli* or *Cryptosporidium*, may be waiting for their chance to strike as well. Removing the newborn calf from the maternity pen immediately after birth is ideal. However, some producers prefer to have the cow lick the calf off. If this is the case, I encourage those producers to make what I call a

calf landing zone (**CLZ**) where the newborn calf can be immediately placed within the confines of the maternity pen. Straw bales to partition off a corner of the maternity pen work great. It should be a small area, perhaps 15 to 20 square feet. Cows typically do not like to step over the bales. In the northeast part of the U.S. where straw bales are less commonly used, I recommend a 100 to 200 gallon black poly water tank with clean bedding (i.e. shavings). The CLZ will not only allow the cow to lick the calf off, but it will also help reduce the chances of a calf consuming a manure meal or two. Realistically, producers are more likely to clean a small area, like the CLZ, between calvings.

Another portal of entry for pathogens from the environment is the umbilicus. If not sanitized properly, calves are at risk of both navel ill and joint ill; the latter a result of septicemia. Dipping is preferred to spraying, primarily because of adequate contact. Seven percent tincture of iodine has been the disinfectant of choice for years. Disposing of the disinfectant between each dipping is advised and using a designated navel dip cup or disposable device such as a Dixie® cup or large syringe case is warranted.

It has been said that one gallon or 4 quarts (i.e. 4 L) of colostrum is important, especially in Holstein calves. Why not 2 or even 3 quarts? In smaller breeds, such as Jersey calves, smaller amounts should be given and repeated as needed. For larger breeds, however, recent research from the University of Arizona (Faber et al., 2005) has reinforced the idea that 4 is better than 2. Brown Swiss calves were used to evaluate colostrum feeding and subsequent milk production in this study. Only maternal colostrum that was reported to have a “green” reading by way of a colostrometer was fed. Calves were randomly assigned to either a 2 or 4 liter feeding at birth. Calves receiving 4 liters had fewer health problems, lower veterinary costs, and improved average daily gain (**ADG**). Heifers were then tracked through 2 lactations with the data

suggesting that cows fed more colostrum at birth produced more milk during both lactation periods (Table 1).

What about quality? The quality of colostrum relative to quantity has an inverse relationship. That is, the poorer the quality, the more volume that needs to be given. That statement alone answers in part why more is better. The goal for passive transfer is 10 g/L IgG in serum. Calves unfortunately are not very efficient at absorbing IgG. Efficiency of absorption is at its highest immediately after birth and quickly falls to zero by 24 hours of age. Research estimates vary widely with the average efficiency of absorption reported to be approximately 35 to 50% at birth. Producers also need to take into account that the average Holstein cow produces 50 g of IgG/L of colostrum. Jerseys tend to produce close to 75 g/L. Yet, not every cow reads the textbook. Without testing colostrum, whether via a colostrometer or direct measurement of antibodies (e.g. Midland Bovine Colostrum IgG test kit; Midland BioProducts Corporation, Boone, IA), we assume the average. Another important fact is that a calf's body contains a plasma volume equal to 9% of its bodyweight. Example math for a 90-lb calf:

A 41 kg (91 lb) calf x 9% = 3.7 L of plasma volume

3.7 L x 10 g/L (passive transfer goal) = 37 g of IgG needed to be absorbed

Assume 50 g/L IgG colostrum quality unless testing
 x 2 L fed = 100 g of IgG x 50% efficiency of absorption = 50 grams absorbed = passive transfer achieved

What if the quality of colostrum is 25 g/L?

25 g/L x 2 L fed = 50 g x 50% = 25 g absorbed = FPT

What if the efficiency of absorption is only 35%?

50 g/L x 2 L fed = 100 g x 35% = 35 g absorbed = FPT

Utilizing similar variables, yet increasing the volume of colostrum fed, reveals the following:

25 g/L x 4 L fed = 100 g x 50% = 50 g absorbed = adequate passive transfer

50 g/L x 4 L fed = 200 g x 35% = 70 g absorbed = adequate passive transfer

Without routinely measuring the antibody content of colostrum, as well as knowing that the calf's efficiency of absorption of antibodies rapidly decreases over the first 24 hours of life, feeding 4 quarts in large breeds immediately after birth (or alternatively splitting between two feedings within the first 12 hours in smaller breeds) is crucial to get the calf's immune system off to the correct start.

Calories

There are a variety of calf milk replacers as well as calf starter and grower diets available from which producers can choose. Whether choosing a traditional versus intensified (i.e. accelerated) milk replacer program, a pelleted versus textured calf starter, or tackling the question of when forages should be introduced, producers rely on the expert advice of their local nutritionist for providing a sound nutritional program that yields healthy growing calves. This section covers the very basics of feeding calves and does not reflect any one particular program.

Some of the most significant challenges of nutrition management in calves are cold weather feeding and adequate rumen development, the latter of course which defines, in part, how successful weaning and transition will be. The thermo neutral zone (TNZ) for calves under one month of age is

approximately 50 to 75° F of ambient temperature. For every 1°F drop in ambient temperature below the TNZ, *maintenance* energy increases by 1%. In other words, at 0°F, a calf should receive 50% more energy (i.e. calories) just for maintenance.

Providing good quality water to calves is crucial, not only for maintaining hydration status but also for adequate rumen development. Research has demonstrated that free-choice water vs. no water available promoted better starter intake, improved ADG, and reduced the incidence of scours (Table 2; Kertz et al., 1984). During the cold winter months, ice is not considered free choice water. Operations in cold climates have learned to adapt to this type of weather. Some producers offer warm water for about an hour after the morning and evening feedings. The water is then removed to prevent freezing in the buckets. An additional feeding of warm water at mid-day is ideal to ensure that calves have enough water available.

Whether an operation is feeding milk replacer or pasteurized waste milk, the calf's esophageal groove is responsible for shunting milk towards the abomasum and away from the rumen. This functional tube closes as a result of nervous stimulation. It is a conditioned reflex and takes place regardless of whether feeding with buckets or nipple bottles (Ørskov, 1972). Although there is no exact timeframe, it is recommended that water be offered to calves no sooner than 15 to 20 minutes after milk feeding. The idea is that this will allow the esophageal groove time to relax, thereby allowing water to enter the rumen. It is not realistic to expect milk buckets to be adequately sanitized between feedings. Rather, these same buckets are often used right after feeding for free-choice water. Inadequate rinsing will result in the mixing of water with left over milk residues, creating a cloudy liquid that may continue to stimulate the esophageal groove, shunting the liquid to the abomasum. Think of the rumen as a vat for making bread. Will brewer's yeast ferment dry? Clean water pails, timing of water

administration, and water quality can have a tremendous impact on rumen development.

When dealing with bloat in milk-fed calves, I like to review several things before blaming a pathogen like *Clostridium* as the primary cause. Whether feeding with buckets or nipple bottles, making sure the temperature of the milk is approximately 100 to 105° F is crucial. Coffee typically measures around 125° F, which in most cases is too hot for calves to want to consume their milk. More crucial, however, is feeding milk that is too cold. Calves that are hungry will often still consume their milk as it dips below 95° F. Lower temperatures, however, seem to increase the likelihood of bloat. Although research is lacking, it has been theorized that a lower milk temperature may cause an abrupt change in the pH of the abomasum. This abrupt change may in fact allow pathogens, such as *Clostridium*, which normally resides further down the intestinal tract, a chance to populate the abomasum, resulting in an abomasal bloat. Worn out nipples, or alternatively nipples that have been cut too deep with a knife, are sometimes the culprit on bottle fed operations. On bucket fed facilities, those calves that are 'gulpers' versus 'sippers' may have an increased chance of bloating.

While some milk that finds its way into the rumen is not harmful, a large amount may contribute to bloat. Worn out nipples need to be replaced and gulper calves need to be retrained to drink more slowly. The latter can be accomplished in two ways: 1) by placing the calf back onto a bottle and nipple or 2) by using a floating nipple or similar object in the bucket during milk feeding time. I sometimes recommend using a children's bath toy, such as a rubber duck. The idea is that this will draw the calf's attention such that it will slow down its drinking during milk feeding. Lastly, I review the producer's health records. In older calves with a history of pneumonia, the risk for ruminal bloat increases. It is a condition known as vagal indigestion. When a

calf has had pneumonia, the lymph nodes inside the chest cavity located in an area known as the mediastinum can sometimes become enlarged. This enlargement can place pressure on the vagus nerve as it passes from the brainstem down to the rumen. The pressure on the vagus nerve can interrupt normal nervous stimulation to the musculature found within the walls of the rumen. The outcome is a rumen that cannot contract properly, thereby not allowing the animal to eructate and resulting in rumen bloat.

Volatile fatty acids (**VFA**) produced in the rumen as a result microbial fermentation of the carbohydrate and proteins in the diet have been shown to stimulate papillae development (Brownlee, 1956). Butyric and propionic acids are the primary VFA that drive this tissue growth. Grain is the ideal source for these VFA while hay contributes to volume expansion and musculature development in the forestomach tissues. Good quality hay should be offered after weaning and not before (Stobo et al., 1966).

Most experts agree that calves consuming approximately 2 lb/day of starter for several consecutive days are ready for the weaning process. Weaning should therefore not be dictated by age of the calf or housing constraints. Weaning calves is not dissimilar to the ‘freshman slumps’ of students. Avoid multiple stressful events during the weaning and transition process to reduce the chances of such slumps. Examples include, but are not limited to: dehorning, castration or removal of extra teats, vaccination(s), and change of grain (i.e. starter to grower). Relocating calves to group pens is in itself stressful; not to mention an overcrowded pen. Calves removed from individual housing are now required to not only find their feed and water in a new place, but they must also now compete with other animals for that feed and water.

The weaning/transitioning pen can often make or break a successful calf-rearing program. This is a prime time for problems, such as bovine

respiratory disease (**BRD**), and coccidiosis outbreaks to occur. Keep in mind that calves are creatures of habit. That is, they like consistency and need time to adapt to change. The ideal number of calves per pen is 6 to 8. Pens should provide at least 25 to 50 sq. ft. of resting area and 18 inches of bunk space per head. Avoiding headlocks in the first transition pen is warranted unless calves were previously raised in headlock-adapted individual pens. Feeding curbs should be less than 14 inches in height and the feeding area should be raised 4 to 6 inches above the standing area. If elevated feeding troughs are used, they should be no more than 18 inches high and approximately 6 to 8 inches deep (adapted from Raising Dairy Replacements, 2003).

Comfort, Cleanliness, and Consistency

As indicated earlier, comfort starts on day one of the calf’s life and continues throughout its lifetime. A calf that is kept dry with adequate shelter, proper ventilation, and offered a sound nutritional program starting with colostrum will not only perform well early in life but can go on to provide a positive economic return for the producer throughout her lactation years. From the time a newborn heifer calf ‘hits the ground’ at birth to the time she is resting in a free-stall chewing her cud waiting patiently for her turn to be milked again, the bedding she lays on should be as clean and dry as possible. A great way to examine bedding is by the “Wet Knee Test.” In other words, if you kneel down and your knee gets wet, it is time to change the bedding. At only 60° F, pathogens like *E. coli* can double in count every 20 minutes! In between calves, all bedding should be removed and disposed; hutches should be cleaned, sanitized, and ultimately placed on new ground for the next resident. To date, there are no known effective disinfectants against cryptosporidium, a common pathogenic protozoa found on most dairy farms. Ultraviolet light can be highly effective against not only this pathogen but others as well. Placing hutches so that UV light can penetrate inside is certainly recommended.

Aside from manure, blood and milk proteins provide the best growth media for bacterial pathogens. Milk mixing and feeding equipment should be thoroughly rinsed and disinfected between meals. When contemplating how to sanitize the equipment, think of the milk pipeline and what happens to it after each milking: warm water rinse, soapy disinfectant, acid rinse, and followed by a final hot water rinse. The first rinse should not be extremely hot water because this may actually cause the milk proteins to ‘bake’ or scald onto the equipment, leaving a substrate available on which bacteria can feed.

Adequate drying of mixing and feeding equipment is essential. Stacking buckets inside one another may take up less space in the mixing room, but this leaves the possibility of moisture being trapped inside. Desiccation ensures that pathogens cannot survive. Stacking pails in a pyramid effect will allow for adequate draining. Another option, especially when bottles and nipples are used, is to place these items on shelving purchased from the local hardware store. Soaking equipment is a common practice, yet if milk residues remain, the opportunity for pathogen survival is real. Drying equipment is a great “pathogen insurance plan.”

Don’t forget about proper ventilation. The number one limiting nutrient in all species is air. We can all live longer without water and energy, but without oxygen, we will not survive. Calves up to 2 months of age require 50 cubic feet per minute (CFM) of air exchange when temperatures are in their TNZ. From 2 to 12 months of age, this number increases to 60 CFM in TNZ temperatures (Table 3; adapted from Raising Dairy Replacements, 2003).

As mentioned earlier, calves are creatures of habit that like consistency. Sudden changes can be stressful on calves. Minimizing the stress placed on calves not only benefits them but will also benefit the producer in that calves typically will perform

better and require less individual attention due to medical issues.

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Table 1. Calves fed 2.1 versus 4.2 quarts of colostrum (Faber et al., 2005).

	2.1 Quarts	4.2 Quarts
Veterinary cost per calf	\$24.51	\$14.77
Average daily gain	1.76 lb	2.27 lb
First-lactation yield	19,739 lb	21,845 lb
Second-lactation yield	21,261 lb	24,903 lb

Table 2. Impact of free-choice versus no water on calf performance (Kertz et al., 1984).

	Free-Choice Water	No Water
Average daily gain (increased)	0.678 lb	0.399 lb
Starter intake (increased)	0.927 lb	0.643 lb
Scour Days	4.5 days	5.4 days

Table 3. Ventilation rates needed (cubic feet per minute; CFM) based on ambient temperature and age change of calves (Raising Dairy Replacements, 2003).

Age (months)	Cold	Mild	Hot
0 to 2	15	50	100
2 to 12	20	60	130
12 to 24	30	80	180