Developing Quality Dairy Replacement Heifers

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A lot of work and care is required to develop newborn calves into productive, lactating cows. When managed properly, replacement heifers should grow at a rate that allows them to calve at 24 months of age or less. However, a recent report indicated that the average age of Holsteins at first calving was 26.9 months (Hare et al., 2006), so there are opportunities for improvement. Also, the mortality rate on many farms is higher than desired reducing the number of potential replacement heifers. Much of the success, or failure, of the replacement heifer program is related to care provided during the first two months of life. “Thirty-one percent of all dairy heifer mortality during the first 21 days could be prevented with improved colostrum management” (Dr. Sandra Godden, Univ. of Minn.). Providing a clean calving environment and timely feeding of good colostrum is essential for getting calves off to a good start. After weaning, providing balanced diets along with adoption of good preventive health programs will ensure that calves are ready to breed by 13 months of age so they can calve at 24 months of age or less and produce up to their potential.

Calving Environment

Successful heifer replacement programs begin with providing the cow a clean environment to calve in. The calving area should be easy to monitor so assistance can be provided when needed as outlined by Drost (2005). Ideally, each dairy would have calving pens that provide easy access, are easy to clean, and provide a means of providing any assistance required to the cow and calf. After birth and the calf is breathing normally, the naval should be dipped with a 7% tincture of iodine and immediately removed from the damn to minimize exposure to pathogens that may be present. As outlined in Table 1, a large number of disease organisms are transmitted through fecal contamination and direct contact with the damn or other cows in the calving area. Removing the calf from the calving area into a clean environment reduces exposure to these pathogens and reduces the potential for sickness. After the calf has been removed to a clean area, high quality colostrum should be fed as quickly as possible.

Colostrum Feeding and Management

Calves are born without any natural immunity to disease and depend on colostrum intake to provide immunoglobulins (IgG) for protection against diseases and nutrients in support of life. Absorption of IgG in the small intestine decreases approximately 5% per hour so that essentially no absorption occurs after 24 hours of birth. In addition to providing IgG, colostrum also binds pathogens preventing them from colonizing in the small intestine and causing sickness. To achieve successful passive

transfer of immunity, it is recommended that calves be fed 2 to 4 quarts of high quality colostrum within 2 hours of birth and another 2 quarts 12 hours later to provide the calf adequate immunity and nutrients to get it off to a good start.

Table 1. Methods of disease transmission to calves.

Fecal/Oral	Fecal/Naval	Milk	Nasal/Saliva	In Utero
E. coli	E. coli	Johne's	Salmonella	Johne's
Clostridium		Salmonella	BVD	Salmonella
Rota virus		BVD		BVD
Corona virus		BLV		BLV
Coccidia				
Cryptosporidia				
Johne's				
Salmonella				
BVD				

According to the 2002 National Animal Health Monitoring Survey (USDA, 2002), 56.1% of calves were removed from the cow immediately and fed colostrum, but the remaining calves had the opportunity to nurse the damn (Appendix I). The mortality rate of calves left with their damn for 12 to 24-hour was twice that of calves removed from their damn within 4 hours of birth (Jenny et al., 1981). The reason for the higher mortality rate is related to increased exposure to disease pathogens and failure of passive transfer of immunity (FPT). Calves left with their damn do not always consume adequate amounts of colostrum or colostrum quality is low or poor. Field data from a wet calf grower in Florida indicated that approximately 30% of calves with FPT died. Those that did not die required more antibiotic treatments increasing rearing cost. Calves that are sick early in live and recover do not grow as well or produce as much milk as calves that do not get sick.

Colostrum Quality

Not all colostrum provides adequate amounts of IgG to ensure successful passive transfer of immunity. The IgG quality is affected by vaccination status, nutrition, stress, age, breed and other factors. A good preventive health program is the first step in stimulating the production of high IgG concentrations in the colostrum. Choice of vaccine, time of administered, and route of administration all affect the effectiveness of a vaccine to stimulate an effective immune response. Diets should be balanced to provide adequate protein, energy, macro minerals, trace minerals and vitamins using palatable ingredients that are readily consumed and free of mycotoxins. During times of heat stress, supplemental cooling should be provided to minimize heat stress and maintain intake. Even when all steps are taken to provide each cow with the opportunity to produce high quality colostrum, so do not.

The quality of colostrum should be measured and only high quality colostrum from cows tested free of Johne's, BLV, and BVD fed. Colostrum quality can be

measured quickly on farm using a colostrometer. The colostrometer works on the specific gravity of the colostrum, so the higher it floats the better the colostrum quality. The colostrometer is marked with green, yellow, and red indicators. Green indicates high concentrations of IgG, yellow intermediate, and red poor IgG concentrations. Colostrum that measures green can be fed without any problems. Colostrum that measures green can be frozen for later use when high quality colostrum is not available. When colostrum has a lower quality (yellow), a colostrum supplement or replacement should be mixed with the colostrum to provide adequate IgG. Poor quality colostrum (red) should only be fed after the first day of life as it will result in FTP.

The colostrometer readings are sensitive to the temperature of colostrum. Cooler temperatures overestimate IgG concentrations whereas warmer temperatures underestimate IgG concentrations. Colostrum should be cooled (or warmed when feeding frozen colostrum) to approximately 68 to 74 F before testing. Scientists at Penn State University have developed a spread sheet that allows the reading to be adjusted for temperature if time or conditions do not allow the temperature to be adjusted completely (Table 2).

Pooled Colostrum

The NAHMS survey indicated that many producers (70.6%) feed pooled colostrum. Many producers feed pooled colostrum to reduce the risk of FPT, but feeding pooled colostrum spreads diseases such as Johne's, BLV, or BVD to a large number of calves. These diseases reduce milk yield and reproductive performance, increase culling rates, and increase mortality rates. For successful control of diseases such as Johne's, pooled colostrum should not be fed.

Another problem associated with feeding pooled colostrum is bacterial contamination. If a strict sanitation protocol is not used to keep containers clean, pooled colostrum is quickly contaminated with bacterial that can cause a severe disease outbreak can occur resulting in high death losses. Calves fed contaminated colostrum frequently die within 1 to 3 days after birth. If pooled colostrum is used, a sample should be collected routinely for analysis of bacterial concentrations to monitor sanitation. A strict sanitation protocol must be used for cleaning containers used for handling colostrum (individual or pooled).

Amount of Colostrum Fed

As indicated earlier, most recommend feeding at least 4 quarts of colostrum within 2 hours of birth plus an additional 2 quarts 12 hours later. A recent report suggest that there are long term benefits of feeding 4 quarts of high quality colostrum immediately after birth (Faber et al., 2005). The researchers fed either 2 or 4 quarts of good colostrum immediately after birth plus an additional 2 quarts 12 hours later. Calves were fed whole milk until weaning. The results of the trial are summarized in Table 3. Calves fed 4 quarts of colostrum at birth had fewer health disorders and lower veterinary cost which is consistent with previous research. Because calves

Table 2. Corrected Ig values (mg/ml) for colostrum tested with a colostrometer at various temperatures.

Ig as measured (mg/ml)	Colostrum temperature		
	°C	4.4	18.3	32.2
	°F	40	65	90
10		0.4	11.5	22.6
20		10.4	21.5	32.6
30		20.4	31.5	42.6
40		30.4	41.5	52.6
50		40.4	51.5	62.6
60		50.4	61.5	72.6
70		60.4	71.5	82.6
80		70.4	81.5	92.6
90		80.4	91.5	102.6
100		90.4	101.5	112.6
110		100.4	111.5	122.6
120		110.4	121.5	132.6
130		120.4	131.5	142.6

Based on equations from Mechor et al., 1991. Journal of Dairy Science. 74:3940-3943
Source: http://www.das.psu.edu/dairynutrition/documents/tempcorrect.xls

have fewer health disorders and possibly because of positive effects on nutrient absorption, these calves also had a higher estimated average daily gain (ADG) and were bred at an earlier age. The authors suggested that there was possibly a positive effect on mammary development because 305 d ME lactation records for both first and second lactation were approximately two to three thousand pounds higher than for calves fed only 2 quarts of colostrum at birth. The number of animals culled before completing the second lactation was almost twice as high for the group fed 2 quarts of colostrum compared with that of the group fed 4 quarts of colostrum at birth. Although these data represent the results of only one trial, they do suggest that good colostrum management not only reduces health disorders in calves, but may improve nutrient digestion and metabolism in the young calf allowing it to grow more efficiently. There is additional research supporting these observations and suggest that the positive nutrient balance positively influences endocrine function related to mammary development. These improvements may also promote other positive changes that support improved milk production and improve the odds of the animal staying in the herd longer.

Table 3. Performance of calves fed either 2 or 4 quarts of colostrum immediately after birth.

	0.53 gallon	1.0 gallon
Number of calves	37	31
Health disorders	8	5
Medical cost, $/calf	$24.51	$14.77
Estimated ADG, lb/d	1.76	2.27
Age at conception, month	13.97	13.54
305 d ME		
First lactation	19,736	21,841
Second lactation	21,257	24,899
Culled, %	24.3	12.9

Source: Faber et al., 2005. Prof. Anim. Sci. 21:420-425.

endocrine function related to mammary development. These improvements may also promote other positive changes that support improved milk production and improve the odds of the animal staying in the herd longer

Colostrum Supplements and Replacements

There are numerous colostrum supplements and replacers on the market and are regulated by the USDA Center for Veterinary Biologics. These products were developed to provide a means of suppling IgG to the newborn calf when high quality colostrum is not available or to provide an alternative to disease control. Colostrum supplements are produced from bovine colostrum or other milk products or bovine serum and are designed to be mixed with lower quality colostrum to increase IgG intake. Colostrum supplements contain less than 100 grams of IgG per dose and cannot be used to effectively replace good colostrum. These products are intended to be used as a supplement to lower quality colostrum to increase IgG intake and prevent FTP. However, IgG absorption is low for most of these products resulting in higher than desired rates of FTP. Egg-based supplements are poorly absorbed whereas products based on colostrum or whey have variable IgG absorption efficiencies.

Colostrum replacements are produced from bovine serum-based products and provide 100 g or more of IgG per dose. These products also contain fat, protein, vitamins and minerals and can be fed in place of colostrum. Research indicates that the IgG in colostrum replacements is absorbed as effectively as IgG provided by colostrum to supports successful passive transfer when fed in adequate amounts (Jones et al., 2003). The success rate of colostrum replacements is related to feeding adequate amounts to insure successful passive transfer of immunity. The effect

Table 4. Predicted plasma IgG in 88 lb. calf with 9% plasma volume.

	Apparent efficiency of IgG absorption			
IgG intake, g	20%	25%	30%	35%
50	2.8	3.5	4.2	4.9
100	5.6	6.9	8.3	9.7
150	8.3	10.4	12.5	14.6
200	11.1	13.9	16.7	19.4

Quigley, J. D. 2002. Calf Note #81. Colostrum supplements vs. colostrum replacers. http://www.CalfNotes.com

of the amount of IgG fed and absorption efficiency is outlined in Table 4. The amount of IgG that must be fed to provide 100 g of IgG, which is considered the minimum for successful passive transfer, varies with absorption efficiency. These data indicate that at least 150 to 200 g of IgG must be fed to prevent FPT. Producers should check products to see that they will provide adequate amounts of IgG when fed according to directions and that the product is based on bovine serum.

Measuring IgG Status

Failure of passive transfer is generally defined as blood IgG concentrations less than 10 mg/ml at 24 to 48 hours of age. The success or failure of passive transfer can be determined using commercial IgG test kits or by measuring blood protein concentrations. Many of the IgG test kits are more complicated to run, so most producers use a refractometer to measure blood or serum protein concentrations. Total serum protein concentrations are directly related to IgG concentrations in the blood are easier to measure. The procedure consist of collecting a whole blood sample from a calf anytime between 24 and 48 hours after birth. The sample is allowed to clot or spun in a centrifuge to separate the serum. The serum is collected and placed on a refractometer which directly measures the total protein. Total serum protein concentrations greater than 5.5 mg/dl are considered to indicated successful passive transfer. Concentrations of 5.0 to 5.4 mg/dl indicate moderately successful passive transfer and concentrations less than 5.0 indicate a failure of passive transfer. This simple method can be helpful in trouble shooting health problems related to colostrum management.

Whole Milk or Milk Replacer

Calves can be successfully raised on either whole milk or milk replacers. Whole milk provides more nutrients which should support faster gains, but feeding raw whole milk can transmit diseases such as Johne's or BLV, spread mastitis causing organisms to young calves, and can result in antibiotic residues if a young calf were sold for meat. If whole milk is fed to replacement heifers, it should pasteurized. Feeding properly pasteurized milk improves growth rates and reduces the number of days calves have diarrhea or pneumonia. It is essential that pasteurization be done consistently from day-

to-day and that the equipment be throughly cleaned to prevent bacterial contamination. Milk that is batch pasteurized should be heated to 145 oF for 30 minutes whereas milk that is flash pasteurized should be heated to 162 oF for 15 seconds. All employees should be trained on the importance of following operating procedures for pasteurization and sanitation. Producers should keep a daily log that records who pasteurized milk, pasteurization temperatures and times, and cleaning routines.

Traditionally, producers have had good results feeding all-milk milk replacers containing 20% protein and 20% fat. Although milk replacers can be made using plant proteins to reduce cost, calf performance is not as good. More recently, higher protein milk replacers (28% protein and 15 to 20% fat) that are fed at rates of 2.5 lb/d have been used. These products have been shown to increase growth rates and promote greater muscle and frame development, but increase milk replacer and labor cost although cost per pound of gain is equal or lower to traditional programs. These programs are though to enhance mammary development as well. However, these products may not be as effective when colostrum management is not adequate or if there is increased disease potential. A recent trial with calves that did not have adequate transfer of immunity and were challenged with coronavirus had greater mortality and incidence of scours although they gained more weight throughout the trial (Quigley et al., 2006).

Weaning

Age at weaning varies from farm to farm with a range of 4 to 8 weeks of age. Calves can be successfully weaned from milk or milk replacer when starter intake exceeds 2 lb/d for two consecutive days. The amount of stress the calf is subjected to increases at weaning as diets change, calves are moved out of hutches or individual pens into a group housing environment, and they are exposed to other calves and have social changes. Intake often drops reducing nutrients needed for growth and immune function increasing their susceptibility to respiratory disease. To minimize stress, calves should remain in the same environment for an additional week. When moved to group hosing, calves should be grouped by body size and keep groups small (less than 7 head). Adequate feed bunk space should be provided feed should be changed gradually. Other activities that increase stress (vaccinations, dehorning, etc.) should be spread out rather than done at weaning. Reducing stress will make the transition for the calf go more smoothly and keep them healthier.

Summary

Getting calves off to a good start in life will allow the calf the opportunity to grow into a productive cow. Colostrum management is critical for minimizing disease and optimizing growth. At least one gallon of high quality colostrum should be fed within the first 2 hours of life with an additional 2 quarts 12 hours later to provide successful passive immunity. When high quality colostrum is not available or there is a question about the disease status of a cow, 150 to 200 grams of a colostrum replacer can be fed

to provide successful passive transfer of immunity. Serum protein concentrations can be measured to determine the success (or failure) of passive transfer of immunity.

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Appendix 1. Summary of information on dairy heifers from the 2002 NAHMS survey of dairy health and management in the United States (USDA, 2002).

Time of when newborn calves were removed from their damn
- 56.1 % of calves were removed immediately and hand fed colostrum
- 22.4 % of calves remained with the damn for up to 12 hour after birth
- 15.9% of calves remained with their damn for 12 to 24 hour
- 8.7% of calves remained with their damn for more than 24 hour

Method of colostrum feeding
- 23.1 % of calves nursed their damn
- 63.5 % of calves were hand fed using a bucket or bottle
- 12.7 % of calves were hand fed using an esophageal feeder
- 0.7% of calves were not fed colostrum

How much colostrum was fed at the first feeding
- 16.5 % of calves received ≤ 2 quarts
- 45.3 % of calves received 2 to 4 quarts
- 38.2 % of calves received ≥ 4 quarts

28.6 % of large dairies measured colostrum quality

70.6 % of large dairies feed pooled colostrum
Of dairies feeding waste milk to calves
- 13.2 % pasteurized waste milk
- 86.8 % did not pasteurize waste milk

Notes