IMPACT OF MILK PRODUCTION AND IMPORTANT MANAGEMENT FACTORS ON THE PROCESS OF DRY-OFF IN LACTATING DAIRY COWS

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Summary

A study of 250 cows located in Canada and the United States revealed the rate of new mammary infections was 9.9% during the dry period. Average milk production on the day prior to dry-off was 13.2 ± 7.2 kg. The odds of a cow developing a new infection was three times greater if the cow was producing more than 5 kg of milk. After 6 weeks of the dry period, 25% of the teats still remained open. This research will serve as the foundation to investigate and implement management strategies prior to dry-off that might improve the overall udder health of dairy cows.

(Key Words: Dry-Off, Mastitis, Milk Production.)

Introduction

The dry period represents a crucial phase of the lactation cycle in order to achieve optimal productivity in the next lactation. Average duration of herd dry periods is correlated significantly with herd average milk production. As days dry deviate from 60 days, average milk production is negatively affected. Therefore, dairy herd managers justifiably aim to dry cows off to achieve dry periods of adequate duration. However, as the genetic potential for milk production of cows continues to increase, it becomes a greater challenge to move cows from lactation to the dry period. It is indeed surprising that very little is known about the impact various approaches associated with this management event have on udder health.

Much is known about the relative importance of the dry period itself with respect to udder health programs. The epidemiology of new infections during this time has been well documented as has the importance of those infections that persist into the next lactation. The goal of the dry period, to have as few quarters infected at the next calving as possible, can adequately be achieved by administering dry cow antibiotic therapy at the end of lactation. Recent research towards improving the success of the dry period has focused on methods to enhance the efficacy of antibiotic treatment, protecting teat ends from bacterial contamination, manipulation of udder involution, and vaccination with gram negative core antigens.

Other than the use of blanket antibiotic dry cow therapy, recommendations on managing dairy cows during the period from 2 weeks before until 2 weeks after dry-off are not well established. This is despite the fact that the risk of new intramammary infections (IMI) has been shown to be higher in the first 2 weeks of the dry period than during any other time of the production cycle. Risk of new IMI can be reduced if: 1) milk production was decreased before dry-off; 2) mammary involution proceeds rapidly during the dry period; 3) teat canals are sealed with a keratin plug in a timely manner; and 4)

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minimal contamination of teat ends occurs. Management factors affecting the rate of udder involution and formation of the teat canal keratin plug are not well described in the literature. Causal pathways describing the interactions of these factors and their relative influence on new IMI, either alone or in combination, are not well understood. This observational study was designed to investigate the influence and importance that specific cow and teat variables have on the efficiency of the dry-off process.

Procedures

Over 300 cows from four different research herds were enrolled in this study. Enrollment occurred 2 weeks before scheduled dry-off. At enrollment, teat ends of each cow were scored, an udder involution index was assigned, and quarter milk samples collected for bacterial culture. Teats were prepared aseptically according to the National Mastitis Council's recommended procedures and samples were submitted to the university mastitis laboratory associated with each research herd. Daily milk weights were recorded from enrollment until the day of dry-off. On the day of dry-off, teat-end scores, an udder involution index, and quarter milk samples were again obtained. Teat end scores were classified on a scale of 1-5, with 0.5 increments used to allow for differentiation of teats with cracks compared to normal teats or those with only hyperkeratosis. Herd specific procedures, including dry cow antibiotic therapy and application of a teat sealant, were performed and documented. Each cow was examined weekly for the first 6 weeks of the dry period. On the same day each week, teat end scores, udder involution and closure of the teat streak canal were assessed using previously published methods. Briefly, digital pressure was applied to each teat in a downward milking action. This action created pressure in the teat sinus, which resulted in one of two events occurring. If the applied pressure resulted in a drop of secretion forming at the teat end, the teat was classified as being open. In a closed teat, when the pressure was applied, the contents of the teat would slip upwards and no drop of secretion was produced because the teat end was sealed. Within the first week of calving, a California Mastitis Test was performed and milk samples were collected to determine the udder health status of the cow. Teat ends were scored once more and daily milk weights were recorded for the first 30 days of lactation.

Results and Discussion

Data from 290 cows dried off were analyzed for descriptive statistics and teat closure rate. Complete data including fresh milk cultures from 250 cows were analyzed to determine the rate of rate of new IMI and the effect that milk production had on this rate.

The population of cows dried off had a median parity of 2, average days in milk (DIM) of 319 ± 64, and an average teat end score of 2. A teat score of 2 indicates that the majority of teat ends had mild hyperkeratosis with no cracking present. Milk production data is shown for the 13 days prior to the day of dry-off (Figure 1). The average milk production on the day prior to dry-off was 13.2 ± 7.2 kg. Considerable variation existed in the decline of milk production over this time period among herds. Assessment of teat closure during the dry period revealed that 50% of teats remained open at the end of the first week. A teat was considered to be closed when it was assessed to be closed for two consecutive weeks. A steady decline in the number of open teats occurred each week; however, after 6 weeks of the dry period, 25% of teats were still open (Figure 2).

A total of 922 quarter milk-culture results collected from cows twice before and once after the dry period were available to determine the rate of cure and development of new IMI. On the day of dry-off, 20% of quarters cultured positive for a major mastitis pathogen. The majority of these infections were caused by environmental organisms: 1) other streptococci (5.2%); 2) *Escherichia coli* (3%); 3) *Streptococcus uberis* (2%); 4) and *Streptococcus dysgalactiae* (1.5%). *Staphylococcus aureus* was present in 6.8% of the milk samples. The cure rate of pathogens based on a single sample postcalving following regular dry cow antibiotic therapy is illustrated in Table 1.

The high cure rate for *S. aureus* was most likely due to only a single sample being collected, and may indeed have been less if multiple samples were used to define cure rate. The cure rate of other streptococci is comparable to that expected for this organism. The relatively low cure rate of *S. uberis* may be partially due to the few numbers of infections identified at drying off. Bacteriology was done at each site independently and some sites routinely identified the species of streptococci, whereas others did not.

Overall, the rate of new IMI in quarters during the dry period was 9.9% (99/992). Again, environmental pathogens contributed the majority of these infections. The species isolated most frequently were other streptococci (29%), followed by *E. coli* (13%), *Klebsiella* (11%) and other coliforms (7.1%). Only 10% of the new IMI were caused by *S. aureus*. The cure rates among the five different study sites are shown in Table 2. This observed cure rate of new IMI is what has been reported typically as the rate that occurs in cultured negative quarters during the dry period. One of the main objectives of this study was to examine the effect of milk production on this rate of new IMI.

The occurrence of new IMI in cows was calculated based on differing levels of milk production recorded on the day before drying- off. Earlier research has often placed 7-10 kg of milk as the critical level. No statistical association was detected in our data at either the 7- or 10-kg level. However, based on level of production alone, a cow was four times more likely ($P<0.05$) to develop a new IMI when her yield was greater than 5 kg on the day before dry-off. This result did not account for such potential confounding variables as parity, breed, days in milk (DIM), and herd. Hence, a logisitic regression model including these variables was performed. Again, cows producing >5 kg of milk prior to dry-off had increased ($P=0.06$) probability for a new IMI occurring (Table 3). The odds of a new infection were still three times greater in cows producing >5 kg of milk. It is often thought that cows producing lots of milk at dry-off are more likely to leak milk during the dry period and be at greater risk to develop new IMI. Our results indicate that a relationship exists between milk production and the development of new IMI, even at a level as small as 5 kg.

Other variables are undoubtedly involved. For instance, is teat closure of all four teats during the dry period an important variable? Producing >5 kg of milk had a sparing effect on a cow having all teats closed. In other words, the odds of a cow having all teats closed by 6 weeks into the dry period was less ($P<0.01$) at that level of milk production. However, no association was detected with teat closure at the cow level for development of new IMI when controlling for DIM, parity, and herd. The effect of the timing of teat closure during the dry period, as well as the impact of teat-end lesions, will be further investigated at the individual quarter level.

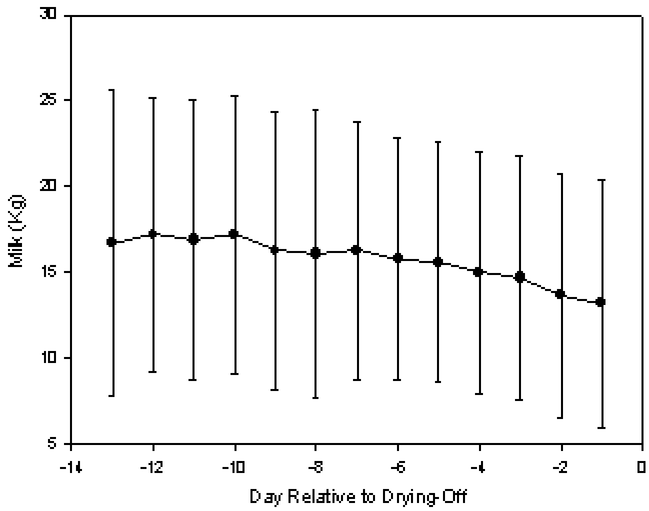

Figure 1. Daily Milk Production Relative to the Day of Dry-off.

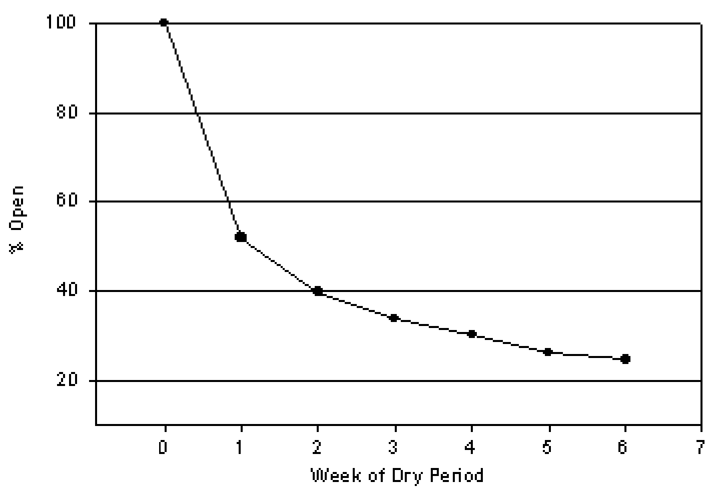

Figure 2. Percentage of Teats Closed During Each Week of the Dry Period.

Table 1. Prevalence of Major Mastitis Pathogens Cultured on the Day of Dry-Off and Cure Rate Following Dry Antibiotic Therapy

Organism	No. of quarters (% infected)	% cure rate
Other Streptococci	17 (5.0)	92.8
Streptococcus uberis	6 (2.0)	30.0
Streptococcus dysgalactiae	5 (1.5)	100.0
Escherichia coli	10 (3.0)	100.0
Klebsiella	2 (0.6)	50.0
Other coliforms	1 (0.3)	100
Staphylococcus aureus	22 (6.8)	82.0

Table 2. Rate of New Intramammary Infections (IMI) Occurring During the Dry Period in Quarters Cultured Negative at Dry-off by Research Site Involved

Site	Ontario	Ontario	KS	NY	IA	Total
No. of new	18	11	29	24	17	99
Total quarters dry	161	99	288	180	264	992
% new IMI	11.2	11.1	10.1	13.3	6.4	9.9

Table 3. Logistic Regression Model for the Probability of a Cow Developing a New Intramammary Infection (IMI) During the Dry Period

Variable	β estimate	Std. error	P value	Odds ratio (95% CI)
Intercept	−1.320	1.250	0.30	
Breed	−0.070	0.210	0.73	
Site	−0.070	0.190	0.56	
Parity	0.070	0.180	0.72	
DIM	−0.002	0.002	0.41	
Milk >5 kg	1.200	0.650	0.06	3.3 (0.9-11.8)
	Deviance:	d.f.= 239		