Does Milking Frequency Affect Feeding Behavior?

Geoffrey E. Dahl[1]
Department of Animal Sciences, University of Illinois

Abstract
Increased milking frequency is a common management practice to improve overall yield and production efficiency in dairy cattle, but it is typically imposed throughout lactation. Recent studies support the concept that cows milked at higher frequency in early lactation, for example 4 to 6 times daily, continue to produce more milk than contemporaries milked only 2 to 3 times daily, even after frequency is reduced. In addition to the production response, other positive effects may result from high frequency milking in early lactation cows. Limited data suggests that dry matter intake increases with milking frequency as cows attempt to match greater energetic demand in regard to milk output. The mechanism that drives the greater feed consumption is unknown, but its potential impact is considered. Regardless of the mechanism, higher milking frequency in early lactation increases milk yield and dry matter intake and thus serves as a method to improve overall animal performance.

Introduction

Although milk production is influenced by numerous physiological and management factors, total milk yield is a direct function of the frequency of milk removal. Stelwagen (2000) summarized the relationship of milking frequency to yield and reported that total milk output was increased ~20 % when the milk removal frequency increased to 3 times daily (3X) from the usual twice daily (2X) approach. Thus, milking cows more frequently is clearly an approach to improving overall efficiency of milk production.

Though a number of theories have been put forth to explain the increased milk yield noted with greater milk frequency (reviewed in Stelwagen, 2000), it is likely that any increase is associated with greater numbers of mammary epithelial cells, greater metabolic activity of those cells, or a combination of both processes. Comparing those two processes, it is reasonable to consider the expected persistency of metabolic versus cell number mediated responses. Any factor that directly impacts mammary cell metabolism would be expected to exert its action and result in greater milk yield only when that factor was administered to the cow. In contrast, an increase in the number of mammary epithelial cells would be expected to produce responses that would persist because mammary epithelial cell numbers are generally thought to diminish at a constant rate following the peak of lactation (Capuco et al., 2003; Tucker, 1981).

As it is commonly implemented in the field, cows are milked 3X throughout lactation. This precludes the ability to distinguish between the two theories described above, i.e. cell number vs. metabolism, because the stimulus is present throughout lactation. But recent studies (Bar-Peled et al., 1995; Dahl et al., 2004a; Hale et al., 2003) support the

---

[1] Presented at the 2004 TriState Dairy Nutrition Conference, 27 April 2004, Fort Wayne, IN. Contact at: 230 Animal Sciences Laboratory, MC-630, 1207 W. Gregory Dr., Urbana, IL., 61801; 217-244-3152, FAX 217-333-7088, gdahl@uiuc.edu.

concept that at least a portion of the response to increased milking frequency has a persistent impact, especially during a window of time in early lactation. In addition there is evidence that high frequency milk removal in early lactation has other beneficial actions, including promotion of dry matter intake (DMI) and udder health (Dahl et al., 2004a).

Because depressed DMI has been implicated with numerous periparturient dysfunctions, it follows that every attempt should be made to stimulate DMI as soon as possible after calving (Hayirli et al. 2003). Yet studies comparing DMI of 2X with 3X cows indicate that there is no overall increase in DMI as milking frequency increases (discussed below). However, limited evidence from early lactation milking frequency studies indicates that DMI improves during the immediate postpartum period when milking frequency is increased. It is best to begin with a brief review of the impact of milking frequency on milk production, and then consider the effects on DMI.

Milking Frequency and Yield

Traditional implementation of higher milking frequency (i.e. 3X vs. 2X) is made throughout lactation. Relative to 2X, continuous 3X milking throughout lactation increases yields by 3.5 kg/d and parity does not affect the response (Erdman and Varner, 1995). The effect of 3X on components is characterized by reductions in fat and protein percentage, yet overall yield of fat and protein improves compared with 2X. Similar incremental patterns of response are reported for 4X but data sets are limited for the comparison of 2X to 4X. Collectively the studies suggest that total milk and component yields increase as frequency of removal increases.

Higher milking frequency in fresh cows causes immediate increases in milk and component yield, but greater milk yield persists after cows return to a lower frequency of milk removal. For example, Bar-Peled et al. (1995) reported that cows milked 6X for the first 6 weeks of lactation produced more milk than control cows milked 3X over the same period. After 6 weeks the 6X cows were milked 3X, yet they continued to produce more milk than those milked 3X from parturition. Under field conditions we found similar effects of early lactation milking frequency, but also noted that 21 rather than 42 days was sufficient time to produce the persistency effect on milk yield (Table 1 and Dahl et al., 2004a).

In the first study designed to compare milk yields of cows milked 4X for the first 21 days of lactation to the typical 2X approach, Hale et al. (2003) reported that 4X caused significant increases in yield relative to 2X, and the greater yields persisted until week 36 of lactation when milk yields of the groups converged. Similar responses were noted in Jersey cows milked 4X or 2X for the initial 3 weeks of lactation (Dahl et al., 2002). Cows milked 4X had higher yields of milk (Figure 1) for the first 21 days in milk and this persisted through 100 days in milk (though only results through day 42 are presented in Figure 1).

Milking Frequency and Dry Matter Intake

A number of studies have examined the effect of higher milking frequency throughout lactation on DMI. Despite greater milk yields in 3X versus 2X cows, DMI was not affected in any of the studies that reported data on DMI (Amos et al., 1985; Andersen et al., 2001; Barnes et al., 1990; DePeters et al., 1985). Indeed, Pearson et al. (1979) reported that 2X cows consumed DM relative to 3X cows. The consistency of the lack of effect of milking frequency across studies suggests that cows accommodate the greater energetic requirement of milk yield increases by mobilizing body reserves. Consistent with that hypothesis is the observation in many studies that 3X cows did not gain bodyweight to the extent that 2X cows gained during lactation. Further, 3X cows had lower milk fat percentage compared with 2X cows in the studies cited above.

In contrast to 3X milking effects on DMI, it appears frequent milking in early lactation produces a significant, though perhaps transient, increase in DMI. Bar-Peled et al. (1995) observed that cows milked 6X for the initial 6 weeks of lactation consumed 2.6 kg more DM/d than those milked 3X during that period, and the 6X cows ate 2.3 kg DM/d more than the 3X cows from week 7 to 18 of lactation. Also, the 6X cows took longer to recover postpartum bodyweight and body condition compared with those milked 3X, and had lower milk fat percentages. Bar-Peled et al. (1998) later reported that 6X cows had greater DM digestibility compared with 3X cows, but that observation was made in only week 5 of lactation, when the cows were still being milked 6X. Therefore, whether or not the improved diet digestibility persisted as lactation advanced remains unknown.

Relative to cows milked 2X, 4X milking frequency increased DMI in Jersey cows during the initial 3 weeks of lactation (Figure 2). Of interest, DMI of both groups converged to a peak by 6 weeks in milk, suggesting that other factors, perhaps physical or other limitations, were causing a plateau of DMI. There was no effect of milking frequency on NEFA concentrations during the initial 21 days in milk (2X = 414$\pm$69 vs. 4X = 386$\pm$64 ueq/L), though some variation in milk fat fatty acid profiles suggest that 4X cows may have been mobilizing greater tissue reserves relative to 2X cows. Overall the responses of 4X cows support the concept of an earlier postpartum increase in DMI when compared with 2X cows, which should be a benefit to cows as they transition into lactation.

Implementing Early Lactation Frequent Milking

Realizing the benefits of early lactation frequent milking requires more than just milking fresh cows more often. Consideration must be made for the time cows spend away from feed, water and stalls, when they are being milked or moving to milking. The milkings need not be equally spaced throughout the day, as a minimum of 2 hours between milkings has been shown to produce the persistency effect (Dahl et al., 2004a; Hale et al., 2003). Many producers implement a system whereby fresh cows are milked first, followed by the remaining cows in the herd, and then fresh cows are milked again before the milking system is cleaned. Ideally cows should return rapidly to pens where feed, water and stalls are available after each milking, rather than remaining in a holding pen between milkings.

With regard to other management issues, reports thus far give no indication that reproductive competence suffers with greater milking frequency, and therefore milk yield, in early lactation. No dietary adjustment has been made in any of the studies cited above to accommodate the higher milk yields, though cows must be provided feed ad libitum. We have shown that cows milked 6X in early lactation respond to bST when it is provided according to label directions (Dahl et al., 2004b), further supporting the concept that properly managed cows can adapt to and respond to multiple stimulators of milk yield.

Conclusions

In summary, increased milking frequency in early lactation cause persistent increases in milk yield. Greater milking frequency per se does not stimulate increases in DMI, although high frequency milking in early lactation does appear to stimulate intake from the onset of lactation. This improvement in DMI is expected to ameliorate many of the metabolic and digestive diseases observed in the peripartum period, and therefore positively impact transition cow health. Increased milking frequency is easily integrated into dairy production systems that have high level management, and can be combined with other stimulators of yield.

References

Amos, H. E., T. Kiser, and M. Loewenstein. 1985. Influence of milking frequency on productive and reproductive efficiencies of dairy cows. J. Dairy Sci. 1985 68:732-739.

Andersen, J. B., T. Larsen, M. O. Nielsen, and K. L. Ingvartsen. 2002. Effect of energy density in the diet and milking frequency on hepatic long chain fatty acid oxidation in early lactating dairy cows. J. Vet. Med. A Physiol. Pathol. Clin. Med. 49:177-183.

Barnes, M. A., R. E. Pearson, and A. J. Lukes-Wilson. 1990. Effects of milking frequency and selection for milk yield on productive efficiency of Holstein cows. J. Dairy Sci. 73:1603-1611.

Bar-Peled, U., Y. Aharoni, B. Robinzon, I. Bruckental, R. Lehrer, E. Maltz, C. Knight, J. Kali, Y. Folman, H. Voet, H. Gacitua, and H. Tagari. 1998. The effect of enhanced milk yield of dairy cows by frequent milking or suckling on intake and digestibility of the diet. J. Dairy Sci. 81:1420-1427.

Bar-Peled, U., E. Maltz, I. Bruckental, Y. Folman, Y. Kali, H. Gacitua, A. R. Lehrer, C. H. Knight, B. Robinzon, H. Voet, and H. Tagari. 1995. Relationship between frequent milking or suckling in early lactation and milk production of high producing dairy cows. J. Dairy Sci. 78:2726-2736.

Capuco, A. V., S. E. Ellis, S. A. Hale, E. Long, R. A. Erdman, X. Zhao, and M. J. Paape. 2003. Lactation persistency: insights from mammary cell proliferation studies. J. Anim. Sci. 81(Suppl 3):18-31.

Dahl, G. E., R. L. Wallace, R. D. Shanks, D. Lueking. 2004a. Hot topic: frequent milking in early lactation: effects on milk yield and udder health. J. Dairy Sci. 87:882-885.

Dahl, G. E., T. L. Auchtung, and E. D. Reid. 2004b. Manipulating milk production in early lactation through photoperiod changes and milking frequency. In Press in *The Veterinary Clinics of North America: Update on Transition Cow Management*, eds. N. Cook and K. Nordlund.

Dahl, G. E., T. L. Auchtung, J. P. Underwood, and J. K. Drackley. 2002. Frequent milking in early lactation that increases milk yield also increases prolactin receptor mRNA expression. J. Anim. Sci. 80(Suppl. 1):53. Abstract # 207.

DePeters, E. J., N. E. Smith, J. Acedo-Rico. 1985. Three or two times daily milking of older cows and first lactation cows for entire lactations. J. Dairy Sci. 68:123-132.

Erdman, R. A., and M. A. Varner. 1995. Fixed yield responses to increased milking frequency. J. Dairy Sci. 78:1199-1203.

Hale, S. A., A. V. Capuco, and R. A. Erdman. 2003. Milk yield and mammary growth effects due to increased milking frequency during early lactation. J. Dairy Sci. 86: 2061-2071.

Hayirli, A., R. R. Grummer, E. V. Nordheim, and P. M. Crump. 2003. Models for predicting dry matter intake of Holsteins during the prefresh transition period. J. Dairy Sci. 86:1771-1779.

Stelwagen K. 2001. Effect of milking frequency on mammary functioning and shape of the lactation curve. J. Dairy Sci. 84(E. Suppl.):E204-211.

Tucker, H. A. 1981. Physiological control of mammary growth, lactogenesis and lactation. J. Dairy Sci. 64:1403-1421.

Table 1. ANOVA, including mean comparisons of various production traits of cows milked 3 (3X) or 6 times each day (6X) for the initial 21 days of lactation. Adapted from Dahl et al., 2004.

Trait	3X	6X	P
Summit milk, lb	103.0 ± 4.2	121.5 ± 4.0	0.017
Peak milk, lb	112.7 ± 4.0	125.7 ± 4.0	0.071
DIM at peak	101.0 ± 12	56.4 ± 11	0.020
Actual milk, 305 d, lb	27,022 ± 803	29,487 ± 1,019	0.078
ME milk, 305 d, lb	29,183 ± 959	33,064 ± 1,021	0.015
Actual corrected milk, 305d, lb	27,580 ± 820	29,719 ± 961	0.051

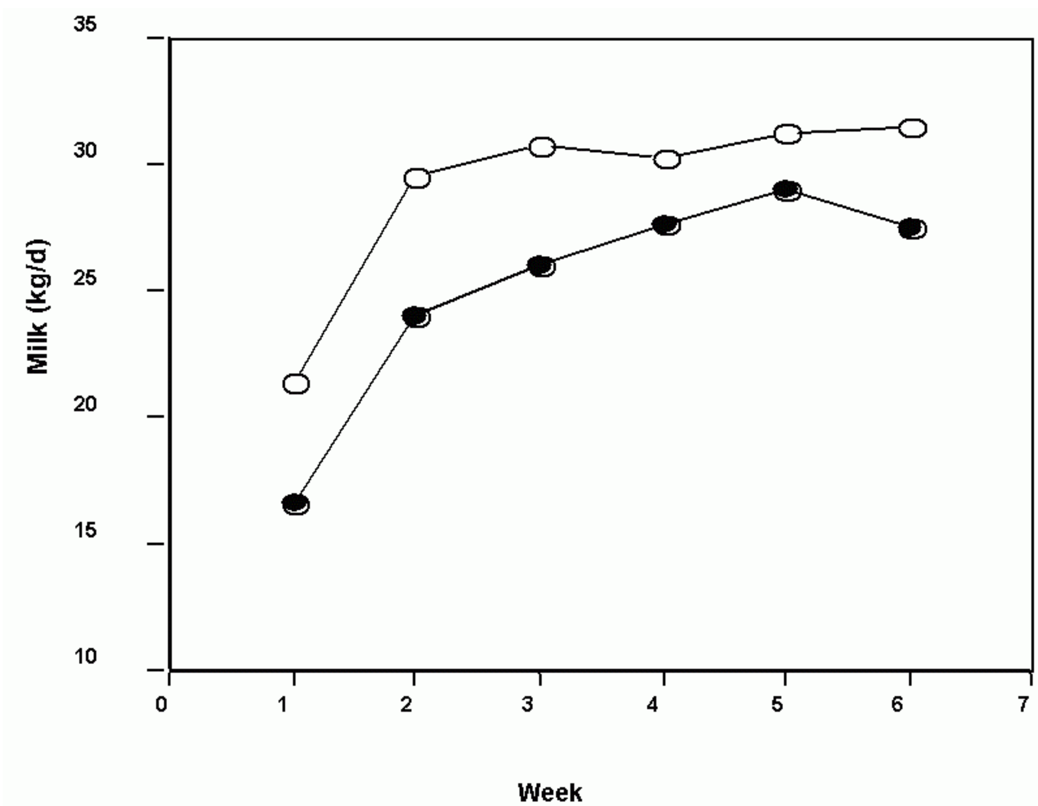

Figure 1. Milk yield of cows milked 2 (2X; solid circles) or 4 (4X; open circles) times daily for the initial 21 days of lactation. Each symbol represents the average daily yield in kg for that group (n = 8/group) by week of lactation. Pooled standard error = 1.4 kg/d. After 3 weeks in milk all cows were milked 2X. The 4X cows had greater milk yields throughout the study (P < .05).

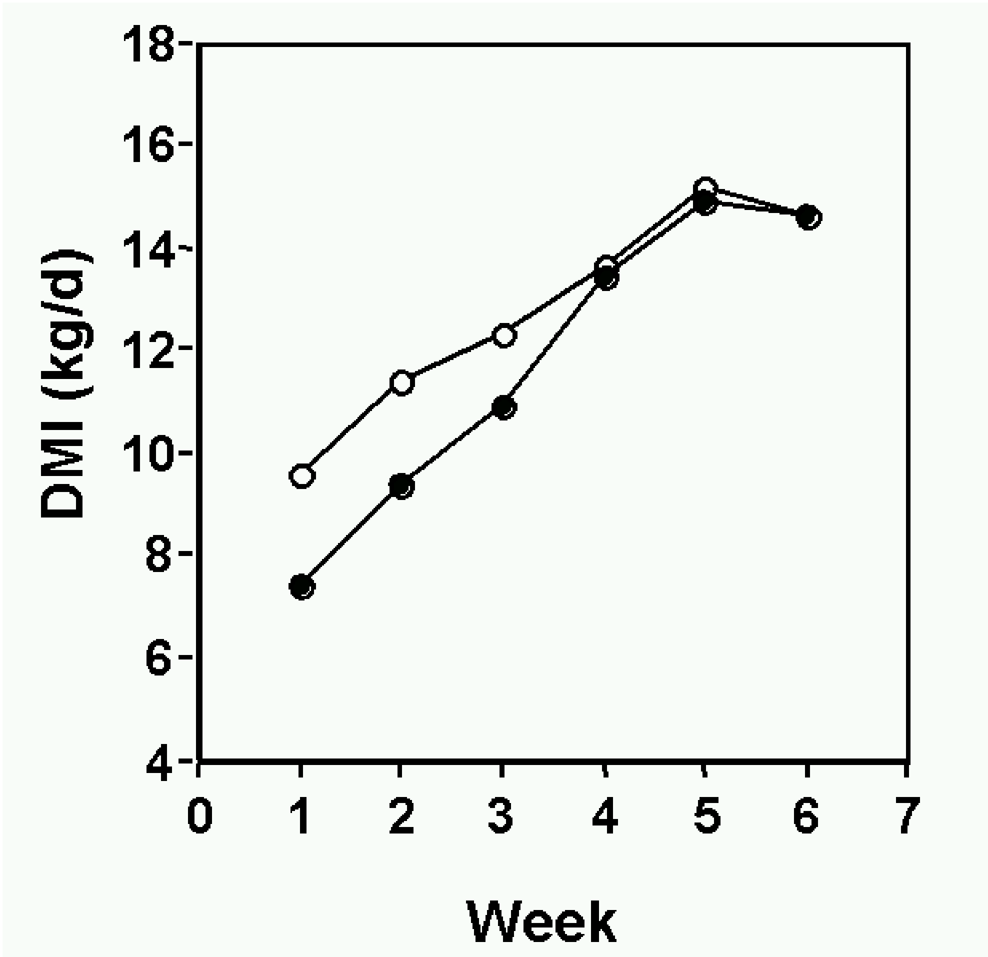

Figure 2. Dry matter intake (DMI) of cows milked 2 (2X; solid circles) or 4 (4X; open circles) times daily for the initial 21 days of lactation. Each symbol represents the average daily DMI in kg for that group (n = 8/group) by week of lactation. Pooled standard error = 1.4 kg/d. After 3 weeks in milk all cows were milked 2X. The 4X cows had greater DMI for the first 3 weeks the study ($P < .05$).