J. Dairy Sci. 89:4176–4187

Milking Frequency, Estradiol Cypionate, and Somatotropin Influence Lactation and Reproduction in Dairy Cows[1]

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ABSTRACT

Our objectives were to determine lactational and reproductive outcomes in response to increased milking frequency (MF), injection of estradiol cypionate (ECP), and treatment with bovine somatotropin (bST). Lactating dairy cows (n = 144) were blocked by lactation number (1 vs. 2+) and assigned randomly to a 2 × 2 × 2 factorial experiment consisting of 8 treatment combinations: 1) MF consisting of 4× daily milking (4×) for the first 30 d in milk (DIM) vs. 2× daily milking (2×), with all cows milked 2× after 30 DIM; 2) 10 mg of ECP given postpartum at 8 ± 3 DIM versus controls that received ECP diluent (oil); and 3) biweekly bovine somatotropin (bST), starting sometime after 60 DIM, versus no bST. Ovulation before the first artificial insemination was synchronized by using Heatsynch (GnRH injection 7 d before $PGF_{2\alpha}$ followed in 24 h by ECP), and cows were artificially inseminated after detected estrus or at 48 h after ECP, whichever came first. Pregnancy was assessed by transrectal ultrasonography 28 to 30 d after artificial insemination. Daily yield and weekly components of milk were measured during the first 90 DIM. Intervals to first and second postpartum ovulation were unaffected by treatment, but cows were in estrus earlier after 2× (24 ± 4 d) than 4× (41 ± 4 d) daily MF, and sooner after ECP (25 ± 3 d) than after oil (39 ± 4 d) treatment. Pregnancy rates among 4× cows increased for ECP versus oil (52.8 vs. 27.8%) more than for cows with 2× MF treated with ECP versus oil (50.0 vs. 39.4%). Increased MF increased daily milk yields and energy-corrected milk yields during the first 30 DIM. Although milk yields were increased acutely by ECP during the 10 d after its injection, subsequent milk yields were decreased for ECP-treated cows previously milked 4× daily. Treatment with bST increased overall daily milk yields most in cows previously milked 2× daily and treated with oil and those milked 4× daily and treated with ECP. We concluded that early postpartum ECP injection increased pregnancy rates, but generally had detrimental effects on milk yields after 30 DIM for ECP-treated cows previously milked 4× daily, unless those cows also were treated with bST.
Key words: estradiol cypionate, bovine somatotropin, milking frequency, pregnancy rate

INTRODUCTION

The dairy industry must produce milk efficiently to survive economically. Milk yields can be increased by greater daily milking frequency (**MF**; Bar-Peled et al., 1995), administration of bST (McBride et al., 1988), or both (Speicher et al., 1994). The optimal number of daily milkings is between 3× and 4×, whereas no biological advantages are likely with milking more than 4× daily (Stelwagen, 2001). When cows had the freedom to choose their own MF by robotic milking processes, they chose an average of 3.9 times per day (Ipema et al., 1987).

To decrease fixed costs and justify the use of idle milking parlors, studies have examined the consequences of increased MF only during early lactation (Bar-Peled et al., 1995). Milk yields were increased by more frequent milkings during early lactation, which persisted even after switching to less frequent milking during later lactation (Bar-Peled et al., 1995). Further, bST is commonly used to increase milk yields (McBride et al., 1988).

An inverse relationship between milk yield and conception rates was detected by analyses of DHIA herd records (Lucy, 2001). Genetic emphasis is placed on selection for milk that is correlated negatively with some reproductive traits (Lucy, 2001). Conception rates (Stevenson et al., 1983) and expression of estrus (Lopez et al., 2004) are compromised by increasing milk yields. The greater the milk yield, the more apparent the compromise on reproductive performance (Harrison et al., 1990).

When administered to postpartum cows, estrogen affects ovarian activity and uterine health. Various

Received March 27, 2006.
Accepted May 30, 2006.
[1]Contribution number 06-250-J from the Kansas Agricultural Experiment Station, Manhattan. When this study was conducted, estradiol cypionate (ECP) was available in the United States. Currently, administration of any estrogen product to lactating dairy cows is not legal.
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hormone therapies are common practice in many dairy herds, and are part of fresh cow management. Researchers and veterinarians anecdotally suggest that postpartum prophylactic treatment with estradiol cypionate (**ECP**) may improve reproductive performance and uterine health. When multiparous dairy cows received ECP (10 mg) at 7 d postpartum, a delay in first postpartum ovulation and subsequent estrus was detected because of reduced circulating FSH (Haughian et al., 2002). Benefits of delayed first postpartum ovulation may include reduced services per cow, reduced interval from calving to conception, and improved conception rates.

Use of bST before AI increased conception rates in cycling cows inseminated at 1 fixed time (timed AI, **TAI**; Moreira et al., 2001) or inseminated after detected estrus (Santos et al., 2004). Results of embryo studies indicated that bST may be increasing pregnancy rates in lactating dairy cows via enhancing egg maturation, increasing fertilization rates, accelerating early embryonic development, and affecting factors within pregnant cows that enhance embryo development (Thatcher et al., 2002).

All 3 of these managerial tools (bST, ECP, and MF) affect dairy production in different ways and have been researched individually. Our objective was to determine the effects and potential interactions of bST, postpartum ECP injection, and MF (2× vs. 4×) on reproductive and lactational outcomes. We hypothesized that short-term (first 30 DIM) increased MF, forced delayed onset of the estrous cycle in response to ECP injection, and administration of bST in lactating dairy cows may increase reproductive outcomes and overall milk yields.

MATERIALS AND METHODS

Herd Management

The experiment was conducted at the Kansas State University Dairy Teaching and Research Center with cows that had calved between September 2000 and October 2001. Lactating Holstein cows (n = 144) were housed in covered free stalls bedded with sand, and twice or thrice (summer) daily were fed a TMR that met or exceeded National Research Council (1989) requirements for lactating cows. The TMR consisted of 30% chopped alfalfa hay, 19% wet corn gluten meal, 15% corn silage, 9.3% whole cottonseed, 4.4% solvent-extracted soybean meal, 3.3% expeller soybean meal, 13% corn grain, 1.3% menhaden fish meal, 1% sugar cane wet molasses, and 3.7% mineral–vitamin premix. Cows had ad libitum access to fresh water. During the summer, pens were covered with shade cloth and water was applied by sprinklers 6×/h for 1 min.

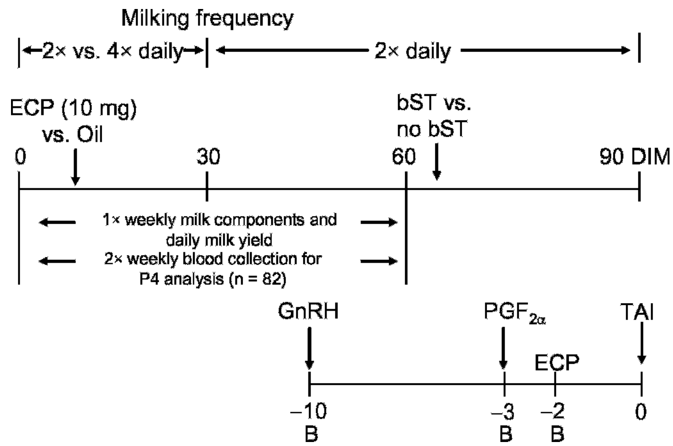

Figure 1. Experimental protocol used in lactating Holstein cows between September 2000 and October 2001. Cows were milked either 2× or 4× daily during the first 30 DIM and then milked 2× thereafter. Cows also received either 10 mg of estradiol cypionate (ECP) in oil or cottonseed oil between d 2 and 15 (8 ± 2.6 d). In addition, cows received either bST (500 mg of Posilac, Monsanto Co., St. Louis, MO) every 14 d starting at approximately 60 DIM, or did not receive bST (no bST). Ovulation was synchronized before AI by using the Heatsynch protocol starting 56 to 75 DIM. Blood was collected (B) before each injection (GnRH, $PGF_{2\alpha}$, and ECP) during ovulation synchronization to determine cycling status before the onset of the Heatsynch protocol. In the first 82 of 144 cows studied, blood also was collected twice weekly during the first 60 DIM to determine ovulatory patterns. During the first 90 DIM, milk yields were recorded daily, and milk was collected once weekly to determine milk components (fat, protein, lactose, SNF, SCC, and MUN). TAI = timed AI.

Experimental Design

Clusters (n = 22) of cows were formed as calving occurred. Within a cluster, cows were assigned to treatments. Variation associated with clusters included seasonal and other climatic differences. The experimental design consisted of a 2 × 2 × 2 factorial arrangement of 8 treatment combinations (Figure 1). The 3 main effects were MF (2× vs. 4× daily), injection of either oil or 10 mg of ECP (Pharmacia and Upjohn, Kalamazoo, MI), and either no or 500 mg of bST (Posilac; Monsanto, St. Louis, MO). Gestating heifers were paired based on their individual predicted transmitting ability for milk, and dry cows were assigned based on the previous 305-2×-ME. Pairs were allocated randomly for milking either 2× or 4× daily. Cows in the 4× treatment were milked 4× daily during the first 30 DIM (0400, 1000, 1600, and 2000 h) and subsequently were milked 2× daily (0500 and 1700 h) until the end of lactation. Remaining cows were milked 2× daily throughout lactation (2× treatment). Within each MF group, alternate cows within lactation block (1 vs. 2+) received an injection of ECP or a cottonseed oil placebo. Injection of ECP or oil was given at 8 ± 2.6 DIM (range = 2 to 15). Within each of the preceding 4 treatments,