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Short Communication: Association Between Milk Yield at Dry-Off and Probability of Intramammary Infections at Calving

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ABSTRACT

The association between milk yield at dry-off and intramammary infections at calving was evaluated from 116 lactations in one herd. Duplicate quarter samples were collected within 3 d after calving to estimate prevalence of intramammary infection at calving; information on cows' parity, daily milk yields, weekly somatic cell counts, and dry-off and calving dates were available for the data analyses. Generalized linear models with logit link were used to model the probability of a cow or a quarter being infected at calving, accounting for the clustered data. Increasing milk production at dry-off was a significant risk factor for both a cow and a quarter being infected with environmental pathogens at calving, but infections caused by coagulase-negative staphylococci at calving were not associated with milk yield at dry-off. For every 5-kg increase in milk yield at dry-off above 12.5 kg, the odds of a cow having an environmental intramammary infection at calving increased at least by 77%.
(**Key words:** milk yield, dry-off, intramammary infection)

From the udder health perspective, the goal of dry cow management is to have cows starting a new lactation with a healthy, uninfected mammary gland (Eberhart, 1986; Dingwell et al., 2003; Leslie and Dingwell, 2003). The rate of new IMI is higher during the dry period than during the lactation; 2 highly susceptible times for cows getting an IMI during the dry period are soon after cessation of milking and during lactogenesis (Cousins et al., 1980; Smith et al., 1985). Even though the epidemiology of mastitis during the dry period has been intensively studied, milk yield at dry-off as a risk factor for IMI has not received much attention, especially with the current high production levels. The objective of this study was to assess the association between milk yield at dry-off and the probability of an IMI at calving.

Duplicate quarter milk samples were obtained within 3 d after calving from 116 lactations of 96 multiparous cows in one study herd over a 16-mo study period to estimate the prevalence of IMI at calving (IDF, 1987). Milk samples were examined microbiologically according to the guidelines of National Mastitis Council (NMC, 1999). A quarter was diagnosed as infected when the same pathogen was isolated from both of the duplicate milk samples from that quarter (Hogan et al., 1995). More specifically, a quarter was classified as infected with environmental pathogens if *Escherichia coli*, *Klebsiella* spp., *Citrobacter* spp., *Enterobacter* spp., *Serratia* spp., or species of streptococci other than *Streptococcus agalactiae* were isolated from that quarter. A quarter was classified as infected with CNS if only CNS were isolated. A cow was classified as infected if it had at least one quarter infected at calving based on the above criteria.

Generalized estimation equations (GEE) in SAS version 8.2 (SAS Institute, Inc., Cary, NC) with a logit link and binomial error distribution were used to model the probability of a cow or a quarter being infected at calving, separately for CNS and environmental organisms. Mixed infections with CNS and environmental organisms were included in the analyses for both types of infections, however, additional analyses were also run by omitting mixed infections. Comparison was with the noninfected cows (quarters). Compound-symmetry correlation structure was used to account for the clustering of quarters within cows and lactations within cows (Littell et al., 1996). The milk yield used in the analyses was the actual daily milk weight of a cow on the day before dry-off. Milk yield was centered at 12.5 kg (median in the data) and scaled to reflect a 5-kg change. Somatic cell count at the end of lactation, parity of a cow, calving season, DIM at dry-off, and dry period length were considered potential confounding variables (Dohoo et al., 2003).

A total of 29 of the 116 lactations (25%) started with a cow being infected with environmental pathogens (gram-negative organisms or streptococci), 14 of which

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Table 1. The final logistic regression model for the probability of a cow being infected with environmental pathogens at calving (mixed infections with CNS included in the analysis).

Variable	Estimate (SE)	P	OR (95% CI)[1]
Intercept	–0.9331 (0.3254)	0.004	—
Milk yield at dry-off[2]	0.5691 (0.2141)	0.008	1.77 (1.2–2.7)
SCC ≥200,000[3]	0.9439 (0.5467)	0.084	2.57 (0.9–7.5)
SCC <200,000[3]	0 (Ref.)	—	—

[1]Odds ratio (OR) and its 95% confidence interval (CI).

[2]Milk yield was centered at 12.5 kg and divided by 5 to reflect a 5-kg change in milk yield.

[3]The arithmetic mean of the last 4 weekly SCC counts before dry-off was used in the model and dichotomized using 200,000 cell/mL as the cut-off (Dohoo and Leslie, 1991).

were mixed infections with CNS. Thirty-nine (39) quarters were infected either with streptococci or gram-negative bacteria. The gram-negative isolates included *E. coli*, *Klebsiella* spp., *Citrobacter* spp., and *Serratia* spp. Thirty-eight (38/116, 32.8%) cows and 76 quarters were infected with CNS only. One cow had one quarter infected with *Staph. aureus*, however, this was omitted from the analyses. No cows in this herd were infected with *Strep. agalactiae*.

Milk yield at dry-off was significantly associated with environmental infections at calving, both on a quarter and a cow level. The results from the quarter- and cow-level analyses were very similar and because milk yield at dry-off was the main risk factor of interest in this study and is typically measured on a cow level, only results from the cow-level analysis are presented. With mixed infections included in the analysis, for every 5-kg increase in milk production at dry-off above 12.5 kg, the odds of a cow having an IMI caused by environmental organisms at calving increased by 77%, odds ratio = 1.77 (Table 1). None of the potential confounders were significantly associated with environmental IMI at calving ($P > 0.05$). However, including SCC in the model meaningfully changed (>20%) the parameter estimates for milk yield at dry-off, suggesting a confounding effect (Dohoo et al., 2003) and thus, SCC was kept in the model. When mixed infections with CNS were omitted from the analysis for environmental infections, the negative effect of high milk yield at dry-off became even more pronounced (odds ratio = 2.13, $P < 0.001$, results not shown). Association between milk yield at dry-off and CNS infections at calving was not significant, regardless of whether mixed infections were included in the analyses or not and whether analyses were done on a quarter or cow level. Parity of a cow was the only factor significantly associated with CNS infections at calving (results not shown).

All quarters of all cows in the study herd are routinely treated with dry cow preparations at the end of lactation (penicillin-streptomycin or cephalothin preparations used in alternate years). This study was not intended to measure the incidence of new infections or the cure rate of existing infections during the dry period. Assuming that antibiotic treatment of all cows at dry-off effectively eliminates existing infections and prevents new infections (reasons for the recommended use of blanket dry cow therapy), our objective was simply to evaluate the association between milk yield at dry-off and infection status at calving. The results suggest that increasing milk yield at dry-off can be a significant risk factor for environmental infections at calving, even in cows receiving antibiotic dry treatment. This observation is in agreement with the results of Dingwell et al. (2004), who evaluated quarter- and cow-level risk factors associated with new IMI during the dry period. Their study showed that formation of the keratin plug, a major natural defense mechanism against new infections during the dry period, was compromised by the high milk yield of modern dairy cows as portion of the teats remained open far into the dry period in high-producing cows, increasing the likelihood of infections (Dingwell et al., 2004). Also, Williamson et al. (1995) reported that clinical infections during the dry period were most prevalent in quarters identified as having open teat canals. Cows leaking milk following dry-off were 4 times more likely to develop clinical mastitis during the dry period than cows that did not leak (Schukken et al., 1993). These studies suggest that high milk yield at dry-off may induce leakage of milk and slower formation of the protective keratin plug, thus allowing an open bacterial entry to the udder and predisposing cows to environmental organisms for a longer period. Increasing milk yield at dry-off increased the risk of environmental IMI at calving in the present study.

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