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Does clinical mastitis in the first 100 days of lactation 1 predict increased mastitis occurrence and shorter herd life in dairy cows?

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ABSTRACT

The objectives of this study were to estimate the direct effects of clinical mastitis (CM) occurring in early productive life (defined as the first 100 d of the first lactation) of Holstein dairy cows on the future rate of CM occurrence and on the length of total productive lifetime. Information on CM cases and other data occurring in 55,144 lactations in 24,831 cows in 5 New York State Holstein herds was collected from January 2004 until February 2014. For the first objective, a generalized linear mixed model with a Poisson distribution was used to study the effects of CM cases occurring in the first 100 d of a cow's first lactation, as well as farm indicator and number of days in the cow's lifetime, on the future lifetime rate of CM. Only cows that had completed their productive life [i.e., all had been culled (or sold) or had died; $n = 14,440$ cows] were included in this analysis. For the second objective, a Cox proportional hazards model was used to study the effects of CM cases occurring in the first 100 d of a cow's first lactation on the length of total productive lifetime. The model was stratified by farm. All 24,831 cows were included in this analysis with right censoring. Cows experienced between 0 and 4 CM cases in the first 100 d of lactation 1. Over their lifetime, cows experienced between 0 and 25 CM cases. During the study period, 10% of all cows died and nearly half of all cows were culled. The average length of productive life, including censored observations, was 2.0 yr after first calving. Compared with cows having no CM cases in the first 100 d of lactation 1, cows with 1 CM case in that time period had a 1.5 times higher rate of total number of CM cases over their lifetime. Cows with 2 (or 3 or more)

CM cases in the first 100 d of lactation 1 had a 1.7 times (or 2.6 times) higher rate of total number of CM cases over their lifetime. For each additional CM case occurring in the first 100 d of lactation 1, the hazard rate of culling increased by 34%. Given economic conditions for preferentially culling mastitic cows, the study findings may help farmers make optimal decisions with regard to culling of such cows.

Key words: mastitis, herd life, generalized linear mixed models, survival analysis

INTRODUCTION

Clinical mastitis (CM) is an important disease in the dairy industry worldwide. It may cause discomfort to the cow (Fitzpatrick et al., 2013; Fogsgaard et al., 2015) and is costly to the farmer in multiple ways. It can occur multiple times in a lactation and may result in lower milk production (Houben et al., 1993; Hertl et al., 2014a), with lower reproductive performance (Herath et al., 2009; Hertl et al., 2014b), increased veterinary costs (Kossaibati and Esslemont, 1997; van Soest et al., 2016), and increased mortality and culling (Thomsen et al., 2004; Cha et al., 2013). Clinical mastitis occurring at any time in productive life is detrimental, but may be particularly so if it occurs early in productive life. Our interest in the present study was to evaluate whether CM cases occurring in early productive life, which we defined as the first 100 d of a cow's first lactation, would be predictive for future cases and potentially for the rate of survival in the herd.

Houben et al. (1993) estimated the probability of CM cases occurring in the following month of Dutch Black and White cows' current lactation as a function of several factors, including number of CM cases occurring in the previous lactation, number of CM cases occurring in the previous months of the current lactation, and whether or not CM occurred in the current month of

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the current lactation. Having CM in any of these 3 time periods increased a cow's probability of having CM in the next month of her lactation.

Faye et al. (1996) developed a method to identify disease patterns associated with cows' life spans using data collected over 10 to 20 yr in 3 French farms. They found that a very high incidence of mastitis was associated with shorter life spans, although the timing of mastitis cases was not detailed. In contrast, cows with both mastitis and milk fever were more likely to have longer life spans.

Using survival analysis, Neerhof et al. (2000) compared several models estimating the effect of mastitis on risk of culling. These models differed in how long an episode of mastitis was assumed to affect the risk of culling. The highest risk occurred when the effect of mastitis was assumed to persist until the end of lactation, where the risk of culling for a mastitic cow was 1.7 times higher than that of a healthy cow. Their other models assumed the effect of mastitis to last only 10, 100, 200, 400, and 800 d after occurrence; the risk ratios varied from 1.2 for the shortest time period (10 d) to 1.6 (for 400 d).

Although some studies have investigated the recurrence of CM, few studies have researched the effects of CM occurring early in productive life on later likelihood of CM occurrence or on total length of productive lifetime (Bar et al., 2008a), which were motivations for the current study. In the Netherlands, Barkema et al. (1998) found that 30% of CM cases in first-lactation cows occurred in the first 14 DIM; similar findings were reported in Canada by Olde Riekerink et al. (2008). In first-lactation Iranian Holsteins, Moosavi et al. (2014) found that although more CM cases occurred in the first 74 DIM of lactation than later on, the duration of CM was shorter when it occurred during this time period. Those authors also found that early occurrence of CM in lactation 1 was more likely in winter and spring, possibly due to environmental conditions favoring pathogen growth.

Heravi Moussavi et al. (2012) found that CM occurring between first calving and conception tended to shorten productive life in Holsteins in Iran. The sooner the first mastitis case occurred after calving, the shorter the cow's productive life. Furthermore, the more mastitis cases a cow had, the shorter her productive life. Similarly, among French Holstein cows diagnosed with mastitis in the first 45 d of lactation 1, 81% were still alive at the end of lactation 2 (Beaudeau et al., 1995); their median lifetime was 13 d less than cows not having mastitis in the first 45 d of lactation 1.

Although the risk of repeated cases of mastitis in the same lactation has been studied in much detail (Barkema et al., 1998; Piepers et al., 2010), the car-

ryover of risk from one lactation to the next has not been studied in detail. Furthermore, the specific risk of mastitis in early productive life on subsequent cases throughout a cow's full lifetime has not been studied in recent literature. Such studies are inherently difficult, as long-term follow-up of a large number of animals is necessary to obtain reliable results. The value of early lifetime mastitis experience as a predictor of future cases lies in obtaining an early indication of the cow's ability to remain healthy. Such information may be valuable with regard to management of high-risk cows, eventual culling or keeping decisions that are being made by the dairy producer, and a general interest in the pathobiology of repeated cases of CM in dairy cows. We have repeatedly shown that, unlike many other infectious diseases, a case of CM does not protect against a subsequent case in the same lactation (Schukken et al., 2009; Cha et al., 2016). A further understanding on the risk of repeated cases of CM throughout the cow's productive life will be of value to better study the mechanisms behind this somewhat unexpected finding from observational studies.

In the current study, the focus was on the effects of CM occurring early in a cow's productive life, namely in the first 100 d of a cow's first lactation, on future CM occurrence and on length of total productive life. Productive lifetime (lifetime days) was defined as the number of days between lactation 1 calving date and culling or death either in lactation 1 or a subsequent lactation or, if still alive, end-of-study date (February 4, 2014). The objectives of our study were to examine the effects of CM cases occurring in the first 100 d in a cow's first lactation on (1) future rate of lifetime CM and (2) total productive lifetime in New York Holstein cows.

MATERIALS AND METHODS

Herd Descriptions

Five Holstein herds, 3 from central New York State, 1 from northern New York, and 1 from western New York, participated in the study. Average herd size was approximately 1,260 cows. These were well-managed, high-producing farms, with 305-d rolling herd average milk production ranging from 11,260 to 13,123 kg/cow per year. Monthly mean SCC ranged from 137,000 to 262,000 cells/mL. Cows were housed in freestalls in covered barns and were managed in groups according to lactation month, production, and reproduction status. They were fed a balanced TMR and were milked 3 times a day. DairyComp305 herd management software (Valley Agricultural Software, Tulare, CA) was used to record information on calving, milk production, milk

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