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Cow- and herd-level risk factors for on-farm mortality in Midwest US dairy herds

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ABSTRACT

The objectives of this study were to describe on-farm mortality and to investigate cow- and herd-level risk factors associated with on-farm mortality in Midwest US dairy herds using lactation survival analysis. We analyzed a total of approximately 5.9 million DHIA lactation records from 10 Midwest US states from January 2006 to December 2010. The cow-level independent variables used in the models were first test-day milk yield, milk fat percent, milk protein percent, fat-to-protein ratio, milk urea nitrogen, somatic cell score, previous dry period, previous calving interval, stillbirth, calf sex, twinning, calving difficulty, season of calving, parity, and breed. The herd-level variables included herd size, calving interval, somatic cell score, 305-d mature-equivalent milk yield, and herd stillbirth percentage. Descriptive analysis showed that overall cow-level mortality rate was 6.4 per 100 cow-years and it increased from 5.9 in 2006 to 6.8 in 2010. Mortality was the primary reason of leaving the herd (19.4% of total culls) followed by reproduction (14.6%), injuries and other (14.0%), low production (12.3%), and mastitis (10.5%). Risk factor analysis showed that increased hazard for mortality was associated with higher fat-to-protein ratio (>1.6 vs. 1 to 1.6), higher milk fat percent, lower milk protein percent, cows with male calves, cows carrying multiple calves, higher milk urea nitrogen, increasing parity, longer previous calving interval, higher first test-day somatic cell score, increased calving difficulty score, and breed (Holstein vs. others). Decreased hazard for mortality was associated with higher first test-day milk yield, higher milk protein, and shorter dry period. For herd-level factors, increased hazard for mortality was associated with increased herd size, increased percentage of stillbirths, higher somatic cell score, and increased herd calving interval. Cows in herds with higher milk yield had lower mortality hazard. Results of the study indicated that first test-day records, especially those indicative of negative energy balance in cows, could be helpful to identify animals at high risk for mortality. Higher milk yield per cow did not have a negative association with mortality. In addition, the association between herd-level factors and mortality indicated that management quality could be an important factor in lowering on-farm mortality, thereby improving cow welfare.
Key words: cow mortality, risk factors

INTRODUCTION

On-farm dairy cow mortality is a growing problem in the dairy industry and has a significant effect on dairy farm profitability. It can cause economic losses due to decreased milk production, loss of income from animal sales, treatment cost during the period of illness before death, increased replacement costs, extra labor, and the cost of dead animal disposal (Thomsen et al., 2006a). In addition, an increase in herd mortality indicates suboptimal health and compromised welfare (Thomsen and Houe, 2006). Mortality is an important routinely collected herd variable associated with dairy cattle welfare and has been included in recent welfare assessment protocols for dairy cows (EFSA, 2012).

It is not known what should be considered a normal level for on-farm dairy cow mortality. Thomsen and Houe (2006) reviewed 19 studies that described dairy cow mortality from 1965 to 2006 and found that the average mortality was in the range of 1 to 5%. In the United States, dairy cow mortality remained at 1 to 2% from 1930 to 1990 (Shahid, 2013). However, recent studies indicated relatively higher mortality rates. Pinedo et al. (2010) studied 2,054 DHIA herds from 38 US states and found a 6.6% mortality rate (**MR**) for cows that calved from 2001 to 2006. Similarly, Alvåsen et al. (2012) documented that mortality in Swedish dairy herds gradually increased from 5.1% in 2002 to 2003 to 6.6% in 2009 to 2010. Mortality has become the primary reason for culling at dairy farms (20.6% of total culls; Pinedo et al., 2010), thereby increasing concerns about dairy cow welfare.

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Recent studies investigating risk factors for mortality mainly focused on herd characteristics and management style. However, very few studies examined the relationship between cow attributes and mortality risk. Cow mortality increased with larger herd size, longer herd calving interval, the use of TMR, higher herd SCC (Alvåsen et al., 2012), lower yearly culling rate, and herds with higher proportion of purchased cows (Raboisson et al., 2011). Mortality was lower in herds with higher milk yield and access to pasture for grazing (Alvåsen et al., 2012). At the cow level, higher mortality was associated with lower milk yield (Pinedo et al., 2010) and increasing parity (Raboisson et al., 2011). Conversely, Miller et al. (2008) reported that death frequency increased with greater milk yield. Considering the effect of mortality on cow welfare and profitability, further research is needed to explore the cow attributes associated with higher mortality taking into account herd characteristics. The objectives of the current study were to describe the recent trends in mortality in DHIA member herds in the Midwestern United States and to investigate cow- and herd-level risk factors associated with on-farm mortality.

MATERIALS AND METHODS

Study Data

The data consisted of 5,899,732 DHIA lactation records of cows (from January 1, 2006 to December 31, 2010) from 10 Midwest states (Minnesota, Wisconsin, Illinois, Iowa, Indiana, Michigan, Ohio, Nebraska, North Dakota, and South Dakota) and were obtained from Dairy Records Management Systems (**DRMS**, Raleigh, NC). The lactation records included information for herd code, cow registration number, breed, calving date, parity, variables related to milk yield [test day, 305-d mature equivalent (**305ME**), peak], milk composition (fat percent, protein percent, SCC), dry period length, date of removal from the herd, and removal code. Records with missing values on calving date and from herds with herd size <20 cow-years (0.02 million records) were removed from the data set before analysis.

Variables of Interest

Outcome Variable. The outcome variable was lactation ended by on-farm death, reported to DHIA, and was expressed as mortality rate (**MR**). The MR was calculated as number of cows that died during a time period divided by the total number of cow-years at risk during that duration (Pinedo et al., 2010; Raboisson et al., 2011). The number of cow-years was calculated by adding all the cow-days (1 cow-day = 1 cow on a farm for 1 d) during a specific time period divided by 365.25 d (0.25 was added to account for leap year).

Explanatory Variables. The MR for year, parity, lactation stage, and season was estimated for descriptive analysis. The years included 2006, 2007, 2008, 2009, and 2010. Parity was categorized into 1, 2, 3, 4, and ≥5. Lactation stage was categorized as ≤40, 41 to 99, 100 to 199, 200 to 305, and ≥306 DIM. Season was divided into 4 categories: spring (March to May), summer (June to August), fall (September to November), and winter (December to February).

For risk factor analysis, various cow- and herd-level explanatory variables were estimated from lactation records. The variables were related to different management areas such as milk production, transition cow management, milking management, reproductive management, and cow and herd characteristics (Table 1). These areas were considered important for our evaluation of risk factors for mortality and were available in the data set.

Cow-level explanatory variables included first test-day milk yield (**1st MY**), milk fat percent, milk protein percent, fat-to-protein ratio (**FPR**), MUN, SCS, calving difficulty, calf sex, calving with stillbirth, twinning, previous calving interval (**PCI**), previous lactation dry period length (**PDP**), parity, breed, and season of calving. The 1st MY was expressed as a relative value from the mean on a herd year-season basis and was categorized into 3 levels: low, cows producing <1 standard deviation (1 SD) below the herd-year-season average (<mean − 1 SD); middle, cows producing between 1 SD below and 1 SD above the herd year-season average (mean ± 1 SD); and high, cows producing above 1 SD of the herd year-season average (>mean + 1 SD). Similarly, milk fat and protein percent were categorized into 3 classes, low, middle, and high, on a herd year-season basis. The FPR was categorized into 3 groups: low (FPR <1), middle (FPR = 1.0–1.6), and high (FPR >1.6). To exclude the transition milk period, we only used observations for DIM >5 for fat percent, protein percent, and FPR. Milk urea N was expressed as a relative value from the mean on the herd year-season basis and divided into 3 levels: low, MUN value of 6 points below the herd-year-season average (<mean − 6); middle, MUN between 6 points below and 6 points above the herd year-season average (mean ± 6); and high, MUN value 6 points above the herd year-season average (>mean + 6). A value of 6 was used to accommodate the normal range of MUN values within the same group of cows (DRMS, 2012). Cow SCS was categorized into 5 groups based on DRMS classification: ≤ 3.0, 3.1 to 4.9, 5.0 to 5.9, 6.0 to 6.9, and ≥7.0. Calving difficulty was expressed into