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On-farm deaths of dairy cows are associated with features of freestall barns

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ABSTRACT

On-farm death (OFD) of a dairy cow is always a financial loss for a farmer, and potentially a welfare issue that has to be addressed within the dairy industry. The aim of this study was to explore the associations between OFD of dairy cows, housing, and herd management in freestall barns. To achieve the goal, we followed 10,837 cows calving in 2011 in 82 herds. Data were gathered with observations and a structured interview during farm visits and from a national dairy herd improvement database. The hazard of OFD was modeled with a shared frailty survival model, with SAS 9.3 PHREG procedure (SAS Institute Inc., Cary, NC). The study population was 58% Ayrshire and 42% Holstein cows. The median herd size and mean milk yield in the study herds were 116 cows and 9,151 kg of milk per cow per year. The overall probability of OFD was 6.0%; 1.8% of the cows died unassisted and 4.2% were euthanized. Variation in OFD percentage between individual herds was large, from 0 to 16%, accounting for 0 to 58% of all removals in the herds. Keeping close-up dry cows in an own group was associated with higher hazard of OFD [hazard ratio (HR) = 1.37] compared with keeping them in the same pen with far-off dry cows. Higher hazard on OFD was observed when barns had only one kind of calving pens; single (HR = 2.09) or group pens (HR = 1.72), compared with having both of those types. The hazard of OFD was lower if the whole herd was housed in barns or pens that had only 1 type of feed barrier at the feed bunk, namely post-and-rail (HR = 0.51) or a type with barriers between the cow's heads (HR = 0.49), compared with having 2 types. Lower OFD hazard was observed with wider than 340 cm of walking alley next to the feeding table (HR = 0.75), and with housing a whole herd in pens with only 1 type of walking alley surface, specifically slatted (HR = 0.53) or solid (HR = 0.48), compared with having both types. The hazard of OFD was higher with stalls wider than 120 cm (HR = 1.38) compared with narrower stalls. The hazard of OFD was also associated with breed, parity, and calving season. This study identified many factors that contribute to the incidence of OFD of dairy cows. The solutions for reducing on-farm mortality include housing, management, and breeding choices that are most probably herd specific.
Key words: dairy cow, adult cattle mortality, death, euthanasia

INTRODUCTION

On-farm death (**OFD**) of a dairy cow is always a loss for a dairy producer. It occurs mostly in early lactation (Hertl et al., 2011; Alvåsen et al., 2014; Shahid et al., 2015), leading to a markedly lower than potential profit for the cow. Often, veterinary and medicinal costs are incurred before death or euthanasia, the sale price of the carcass is lost, and the cadaver has to be destroyed, which all contribute to the total costs. In addition, a lactating replacement animal is usually not available immediately, and some of the production potential of the farm is lost. Many of the cows that die or need to be euthanized on farm would not have been yet culled voluntarily; therefore, the farmer loses some of the herd's genetic potential.

Dairy herds are increasing in size as a reflection of the greater demands for efficiency. Intensification of production has been suggested to affect cow mortality (Nørgaard et al., 1999); it has been reported being higher in larger herds (Raboisson et al., 2011; Alvåsen et al., 2012, 2014) and in herds with a higher cow to employee ratio (McConnel et al., 2015). High on-farm mortality is an ethical issue of public concern and a potential indicator of poor cow welfare (de Vries et al., 2011; Nielsen et al., 2014).

On-farm death has increased in many countries during the last decades: from 2 to 3.5% in Denmark during 1990 to 2001 (Thomsen et al., 2004), from 2 to 4.6%

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during 1995 to 2005 in the United States (Miller et al., 2008), and from 5.1 to 6.6 events per 100 cow-years in Sweden during 2002 to 2010 (Alvåsen et al., 2012). In Finland, at herd level, a median of 5% of the dairy cows died on farm in 2016. The percentage was slightly higher, 6%, for herds with 100 or more cows (Finnish DHI database). Other authors have reported similar mortalities, at 6.1% in Sweden (Alvåsen et al., 2014) and 6.8 in the United States (Shahid et al., 2015).

Previous studies have reported several cow- and herd-level risk factors (Alvåsen et al., 2012; Maia et al., 2014; Shahid et al., 2015), seasonal effects (Stull et al., 2008; Vitali et al., 2009, 2015), and diseases (McConnel et al., 2008; Alvåsen et al., 2014) associated with on-farm mortality of dairy cows. Ten years ago, a review reported 19 studies on this topic (Thomsen and Houe, 2006); however, we could not find any published studies that focused especially on the associations of housing on OFD. We hypothesized that management factors in freestall barns would have an effect on OFD. Therefore, the goal of our study was to identify those factors that are directly related to housing and have the potential to contribute to better cow survival.

MATERIALS AND METHODS

Sampling, Inclusion, and Exclusion Criteria

Study herds were selected from the herds in the Finnish DHI database, operated by ProAgria Agricultural Data Processing Centre (http://www.mloy.fi), previously described and used by other authors (Gröhn et al., 1984; Olsson et al., 2001; Kyntäjä and Niskanen, 2007). All herds in the database with a mean herd size greater than 80 in 2010 (n = 184) were invited to participate in the project.

A total of 82 herds volunteered and met the inclusion criteria. The criteria were (1) using a conventional production system (not organic), (2) housing in an insulated freestall barn at least for 2 yr before the time of the farm visit, and continuing to be housed there during the survey, and (3) herds with an automatic milking system used at least 2 milking robots with a reasonable stocking capacity (at least 45 cows per robot in 2010).

The study herds were visited once between January and April in 2012. The herd owners were interviewed about the herd management with a predesigned questionnaire and barns and animals were observed by 1 of the 3 veterinarians that were equally trained for the visits, with oral and written instructions and 3 training herd visits. The cow-level data on breed, parity, calving date, milk yield, removal method, and reason were received from DHI database.

Statistical Analysis

Descriptive statistics were first calculated for the data. The percentages were calculated based on the total number of study cows 10,907. Cows of breeds other than Ayrshire or Holstein were then excluded (n = 69), and the hazard of OFD was statistically modeled with a survival model, where clustering of cows within herds was taken into account by animals in the same herd sharing a random, frailty effect. In the analysis, a total of 10,837 cows were followed for 305 d, starting from their first calving day of the year 2011.

A shared frailty survival model is an extension of the standard semiparametric Cox model. The model can be written as

$$\lambda(t) = Z_i \lambda_{0j}(t) e^{\beta^T X_{ij}},$$

where $\lambda_{0j}(t) e^{\beta^T X_{ij}}$ is the same as the model for standard semiparametric Cox model [$\lambda_{0j}(t)$ are the baseline hazard functions and β is a vector of fixed effect parameters to be estimated] and the frailties Z_i are assumed to be identically and independently distributed random variables with a common density function (Wienke, 2011).

The study period was between January 1, 2011, and October 31, 2012. Only 1 lactation period per cow was included. The modeled outcome was time from calving until unassisted death or euthanasia on farm. The observations were censored if a cow left the herd for any other removal reason or if the study period ended before the outcome of interest occurred. Noncompleted lactations were also included, which is possible in using survival analysis.

The potential explanatory variables were grouped into cow-level characteristics and herd-level attributes or practices. The first step of the modeling process was univariable screening, and cow-level features were introduced into a model individually in addition to the herd frailty. Next, cow-level variables with $P < 0.25$ in the univariable models were added into a joint model, and variables with $P > 0.1$ were removed one by one from this model. The examined cow-level characteristics were breed, animal born at farm or bought, age at arrival to herd, age at first calving, parity of the study lactation, calving season, and milk yield relative to time from calving.

The herd-level variables were then added individually to the model built during the previous step,. The herd-level variables with $P < 0.25$ in univariable screening were then added in the model jointly and the model was again reduced until all variables were statistically significant ($P \leq 0.05$).

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