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# Management factors associated with mortality of dairy calves in Finland: A cross sectional study

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ABSTRACT

Mortality at herd level is an indicator of overall calf welfare on dairy farms. The aim of this cross sectional study was to identify management factors associated with calf mortality on dairy farms in Finland. Calf mortality data and information on management practices collected during farm visits and farmer interviews were analysed using linear models. The average size of 82 herds enrolled in the study was 125 ± 41 cows. The mortality risk of calves <7 days of age was 5 (or 5.2) ± 2.3% and was associated with larger herd size and the practice of not separating sick calves from other calves (6.0 ± 0.4 vs. 4.7 ± 0.3%; $P < 0.05$). The mortality risk of calves aged 7–180 days was 6 (or 5.7) ± 6.2% and increased with a shorter whole milk feeding period, longer period in the calving pen and lower average herd production level ($P < 0.05$). The mortality risk of calves was lower on farms where a veterinarian disbudded calves instead of farmer. Longer milk feeding and improved management of sick calves are recommended to reduce calf mortality. Specific management practices associated with lower mortality risk should be emphasised when advising farmers on how to enhance calf welfare.



## Introduction

Infectious diseases are often considered to be the primary reasons for calf mortality, particularly digestive disorders (Svensson et al., 2006; Torsein et al., 2011; Bähler et al., 2012; Hötzel et al., 2014) and respiratory diseases (Gulliksen et al., 2009). Mortality is a coarse measure of welfare, but when considered in a large number of animals it may reveal the state of animal welfare at group level (Winckler et al., 2003). In addition, death seldom occurs without periods of disease of various lengths, and unassisted death often prolongs suffering (Mellor and Stafford, 2004), thus reaffirming the independent status of dying at young age among welfare indicators. Moreover, farms having higher calf mortality were suggested to have poorer welfare at the herd level (Ortiz-Pelaez et al., 2008; Kelly et al., 2013). Calf mortality is a sensitive indicator of overall cattle welfare, when evaluated according to animal-based on-farm measures (Sandgren et al., 2009). An unnecessarily high death rate also represents an economic burden that needs to be addressed.

Small scale farming is in decline in some regions and it is important to adopt new management cultures that are adjusted to increasing herd sizes (Barkema et al., 2015). Certain characteristics of intensified farming were associated with increased on-farm mortality of dairy cows (Alvåsen et al., 2014). Torsein et al. (2014) analysed the management choices most beneficial for calf survival in Swedish herds. Designing controlled experiments to establish management practices that benefit calf survival is difficult. Therefore, recognising favourable management practices on-farm is of practical relevance. The aim of this study was to investigate associations between management practices and calf mortality risks in dairy farms in Finland using interviews, evaluation of facilities and herd records.

### Materials and methods

Data for this cross sectional study were gathered during farm visits and retrieved from the Finnish Agricultural Data Processing Centre.[1] Letters inviting participation in the study were sent to all Finnish dairy farmers with >70 cows according to the records ($n = 293$), with the aim of recruiting 100 farms. No sample size calculations were undertaken and this level was determined based on practicality. Consent for the study was obtained through a letter with a related pre-structured initial questionnaire to determine if the free-stall barn met the initial eligibility criteria requirements. No organic farms or barns with uninsulated walls were included to limit variation in management. Barns that were <2 years old were excluded to ensure stabilised management practices (routines and animal numbers). Farms with an automated milking system had to have at least two milking units to meet the eligibility criteria, since one milking unit usually serves only 60 cows. A follow-up phone call was made for all the herds larger than 80 cows in the case of non-responders ($n = 149$). Finally, 82 farms that fulfilled the eligibility criteria were visited.

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[1] See: http://www.mloy.fi.

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**Table 1**
Univariable results from herd records and from management practices derived from interviews that were used in the analysis of mortality of newborn calves or calves aged 7–180 days on Finnish dairy farms.

| | Source of data | *n* | Mean ± SD[c] | *P* | |
|---|---|---|---|---|---|
| | | | | 0–6 days | 7–180 days |
| Herd size | Record | 82 | 125 ± 41 | 0.01 | 0.58 |
| Herd average milk yield (kg/year) | Record | 82 | 9193 ± 871 | 0.13 | 0.00 |
| Percentage of calves sold | Record | 82 | 48 ± 19 | 0.33 | 0.00 |
| Herd average parity | Record | 82 | 2.2 ± 0.2 | 0.03 | 0.30 |
| Percentage of other breeds[a] | Record | 82 | 0.6 ± 1.5 | 0.07 | 0.84 |
| Total breeding value | Record | 82 | 0.08 ± 0.05 | 0.02 | 0.05 |
| Number of caretakers | Interview | 82 | 3.4 ± 1.5 | 0.13 | 0.70 |
| Latency until colostrum intake (h) | Interview | 79 | 5.4 ± 3.0 | 0.06 | 0.38 |
| Colostrum fed first time (L)[b] | Interview | 78 | 2.7 ± 0.7 | 0.01 | 0.34 |
| Time in calving pen (days) | Interview | 82 | 0.6 ± 1.03 | 0.36 | 0.03 |
| Period of whole milk feeding (days) | Interview | 82 | 28 ± 24.9 | 0.75 | 0.00 |
| Water first offered (days) | Interview | 80 | 8.1 ± 16.6 | 0.28 | 0.08 |
| Time in single pen (days) | Interview | 82 | 10 ± 17 | 0.85 | 0.01 |
| Group pen size ($m^2$) | Interview | 82 | 20 ± 14 | 0.25 | 0.04 |
| Separation of sick calf | Interview | | | | |
| Yes | | 53 | | 0.04 | 0.04 |
| No | | 29 | | | |
| Veterinarian disbuds | Interview | | | | |
| Yes | | 64 | | 0.07 | 0.01 |
| No | | 18 | | | |
| Ventilation type | Interview | | | | |
| Natural | | 30 | | 0.69 | 0.05 |
| Forced | | 44 | | | |
| Both | | 8 | | | |

[a] Breeds other than Holstein or Ayrshire.
[b] Maximum amount indicated.
[c] Standard deviation.

Farms were visited once between January and April 2012 by one of three trained veterinarians. The farm visit included a structured interview that consisted of four questionnaire sections to capture information regarding management issues relevant to calf mortality suggested by the literature. The questionnaire included 34 closed questions on calf management practices potentially relevant for calf mortality, health and welfare. In addition, the typical group pen size of calves was measured.

Calf mortality data for each farm were acquired from the Finnish Agricultural Data Processing Centre for 2011, where farmers are required by law (1391/2006) to report deaths and changes in animal numbers within a week of the event. In addition, data about herd size, milk yield, parity and breed were retrieved from the records. The mortality risk of newborn calves was calculated by dividing the number of dead calves (born dead or died at 0–6 days) by the total number of calves born and multiplying the result by 100. The mortality risk of calves <180 days of age was calculated by dividing the number of calves that died during the year <180 days of age by the number of live calves at 7 days of age and multiplying the result by 100.

*Statistical analysis*

Herd was considered to be a statistical unit when data for mortality risks of calves aged 0–6 days and 7–180 days were analysed using separate linear mixed models (SPSS 21.0, IBM). Logarithmic transformation was used to normalise mortality data for calves aged 7–180 days prior to analysis. Variables were first submitted to univariable analysis and then included in a multivariable model if $P \leq 0.1$ (Table 1). No correlations between explanatory variables were >0.6 when evaluated by Spearman's rank correlation test. However, total breeding value was correlated with herd average milk yield ($r^2 = 0.3$) and only one was used in same multivariable model. Manual stepwise backward selection was performed. Model fit was monitored using Akaike information criteria. Potential confounders were inspected by considering changes in parameter estimates with and without the possible confounder. There were no changes >30%. All variables that reached the level of $P < 0.06$ remained in the final models. Interactions between variables in the final model were tested one by one, but they were non-significant. The normality of residuals was explored graphically.

In order to account for the effect of sold calves on the mortality risk in those same farms, we conducted survival analysis using a different data source that included information about birth and death dates of calves in 2011. A Cox proportional hazard regression model was used to explore the effects of factors that were significant in linear model analysis of mortality from 7 to 180 days of age. Data retrieved from 81 farms included 13,583 survival records that showed whether the individual calves died or survived during the follow-up. One farm was excluded from survival analysis because of incomplete records. The time from birth to death was the response of interest. Calves were censored at the respective date if they survived for 180 days, survived to the end of the follow-up period (31 December 2011) or were sold. The initial model included the whole milk feeding period, time in calving pen, herd average milk yield, and whether a veterinarian disbudded the calves. All variables that reached the significance level of $P < 0.05$ remained in the final model. The results are reported as hazard ratios with 95% confidence intervals (CIs).

## Results

Data were derived from 50 farms with parlour milking and 32 farms with automatic milking systems geographically dispersed throughout Finland. The mortality risk (mean ± standard deviation) of calves <7 days of age was 5.2 ± 2.3% and the mortality risk of calves 6–180 days was 5.7 ± 6.2%.

A higher mortality risk of calves <7 days of age was associated with larger herd size and a management practice of not separating sick calves (separating calves 4.7 ± 0.3 vs. not separating 6.0 ± 0.4%; Table 2). The mortality risk of calves aged 7–180 days was higher in farms with a shorter milk feeding period, a longer period in the calving pen, and lower herd average milk yield (Table 2). In addition, the mortality risk of calves was lower on farms where a veterinarian disbudded calves.

**Table 2**
Herd and management factors associated with mortality of newborn calves and with mortality of calves aged 7–180 days in Finland in 2011 (82 farms).

| Factors analysed by range of calf ages | Slope | 95% Confidence interval | *P* |
|---|---|---|---|
| 0–6 days | | | |
| Herd size (≥100 cows) | 1.606 | 0.51–2.70 | 0.005 |
| Proportion of breeds other than Holstein or Ayrshire | –0.308 | –0.62 to 0.00 | 0.051 |
| Management practice of separating sick calf | –1.275 | –2.23 to –0.32 | 0.009 |
| 7–180 days | | | |
| Period of whole milk feeding (days) | –0.013 | –0.02 to –0.01 | 0.001 |
| Time in calving pen (days) | 0.184 | 0.03–0.34 | 0.022 |
| Herd average milk yield (1000 kg) | –0.236 | –0.43 to –0.04 | 0.017 |
| Veterinarian disbuds | –0.435 | –0.82 to –0.05 | 0.026 |