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# Calf and replacement heifer mortality from birth until weaning in pasture-based dairy herds in New Zealand

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## ABSTRACT

The aims of this study were to (1) estimate the perinatal (birth to 24 h) and postnatal (~24 h to the mean weaning age of 13 wk) mortality risk in pasture-based dairy calves until weaning, and (2) identify associated risk factors in the 2015 calving season. A prospective survey of 32 seasonal calving dairy farms was undertaken. Farmers recorded (daily) the number and sex of the calves alive or dead in the paddocks where cows calved. All daily animal movements in and out of the calf rearing facilities, including death and euthanasia, and the identification of the animals (if applicable) were recorded, and a survey of the farm management practices was undertaken. Individual and farm-level risk factors for perinatal mortality were modeled separately using generalized logistic mixed models with a random effect fitted for herd. Postnatal mortality incidence risk was calculated using time at risk for each calf from 24 h of age, collapsed into weeks, and multiplying the incidence risk by the mean weaning age of the study population. Farm-level risk factors contributing to postnatal mortality in the first week of life were assessed using a multivariable logistic mixed regression model. The mean perinatal mortality risk was 5.7% (95% confidence interval 5.4 to 6.1%) with a range from 2.2 to 8.6% (18,437 calves, 30 farms). Perinatal calf mortality was greater for male relative to female calves (odds ratio 1.39; 95% confidence interval 1.22 to 1.59), calves born in the first week of the calving period in comparison to wk 2 to 11 (odds ratio 0.32 to 0.66), and those born on days with greater rainfall (odds ratio 1.01 per 1 mm increase; 95% confidence interval 1.00 to 1.02). At the farm level, perinatal mortality increased for every extra week of calving period length (odds ratio 1.12; 95% confidence interval 1.06 to 1.17). The mean postnatal mortality risk was 4.1% (95% confidence interval 3.6 to 4.6%) with a range of 0 to 11% between farms. Farm-level risk factors contributing to mortality in the first week of life included farmer-reported disease problems in calves (odds ratio 2.2; 95% confidence interval 1.62 to 2.96), or calves hand-fed colostrum in the first 12 h of life (odds ratio 1.66; 95% confidence interval 1.26 to 2.19), which was assumed to be associated with poor colostrum quality and bacterial contamination. Regional differences were also observed in both perinatal and postnatal mortality risks, indicating that weather conditions, herd size, and management variations contribute to mortality incidence. In summary, the mortality risk of perinatal calves and postnatal calves until weaning on pasture-based farms is comparable with data published from other dairying systems despite the notable management differences. Several risk factors were identified that could be managed to reduce mortality incidence of dairy calves.
**Key words:** mortality, perinatal, postnatal, calf, dairy

## INTRODUCTION

Calf mortality is a significant economic and welfare concern on dairy farms worldwide (Mee, 2008a). Unsurprisingly, interest is growing in characterizing the incidence and risk factors associated with calf mortality to develop reduction strategies.

The timing of calf mortality can be categorized into 2 phases: (1) perinatal mortality, which typically refers to mortality of full-term calves during parturition and up to 24 (or 48 h) after birth, and (2) postnatal mortality, which refers to mortality after the perinatal period, up to a designated time point, such as weaning. Although case definitions and data accuracy can vary, estimates of perinatal mortality incidence risk range from 3 to 9% across dairy industries internationally, and the postnatal mortality incidence risk until weaning is reported at between 5 and 11% (Compton et al., 2017). However, most published studies on calf mortality have been conducted in housed systems where cows calve indoors

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and animal management, disease risk, per cow milk production, genetics, and nutrition are quite different from pasture-based dairy systems, such as those operated in New Zealand and Australia, or in Ireland and other parts of Europe. Few retrospective studies have estimated the incidence of perinatal mortality in these herds where cows often calve outdoors (4 to 7%; Pryce et al., 2006; Berry et al., 2007; Mee et al., 2008) and in those studies the quality of the data is variable. For example, Mee et al. (2008) reported that, in the database they used to examine calf mortality in pasture-based herds in Ireland, 46% of herds had no recorded perinatal mortality data. A similar situation may occur in the New Zealand system, as calves that are stillborn, that are born alive but die within 48 h, and the majority of male dairy calves are not permanently identified with an ear tag number and are, therefore, commonly not entered into the software recording systems. Furthermore, to our knowledge, no reports have been published of postnatal mortality incidence rates in pasture-based systems, even though mortalities of these animals may be of greater welfare concern and incur a greater financial cost, relative to calves that are stillborn or aborted. A more accurate estimation of perinatal and postnatal mortality incidence risk is, therefore, required to benchmark these systems.

A wide variety of risk factors have been associated with perinatal and postnatal mortality including dystocia (Wells et al., 1996; Gundelach et al., 2009; Bleul, 2011), age of dam, twin calving, year, sex of calf (Mee et al., 2008; Bleul, 2011), and first colostrum feeding method, timing, and volume (Wells et al., 1996; Tyler et al., 1998). These risk factors were almost exclusively identified in systems where cows calved indoors, and limited data are available in pasture-based systems where cows calve outdoors during late winter/early spring with minimum supervision. In seasonally concentrated pasture-based calving systems, newborn calves are born outside and are left there with their dams for 1 to 24 h before being collected and brought into the indoor calf rearing facility. The variation in collection time is dependent on whether farmers collect newborn calves once or twice a day in New Zealand. The calf rearing facilities typically have a shed design that is open on one side as has multiple sections or pens within them. Calves are managed in groups of 10 to 20 per pen until approximately 1 mo of age, following which calves are commonly given access to pasture during the day until approximately 3 mo of age. They are weaned based on either quantity of grain or concentrate consumption, weight, or age and then grazed outside for the remainder of their lives. At approximately 6 mo of age, the majority of calves are transported to a separate farm (grazier) where they are grown, mated, and then returned home at approximately 22 mo before calving (Cuttance et al., 2017). To develop strategies to reduce calf mortality on pasture-based dairy farms, it is imperative that calf- and farm-level risk factors that are important under these conditions are identified.

The aims of this prospective study were, therefore, to determine the perinatal (~0–24 h old) and postnatal (i.e., from entry to the calf rearing shed until the time of weaning) mortality risk of dairy calves in a pasture-based system, and to identify potential risk factors for mortality.

## MATERIALS AND METHODS

### *Experimental Design*

This study was a prospective, observational study of 32 seasonal, pasture-based dairy farms from the Waikato, North Island (n = 19; region 1) and Canterbury, South Island (n = 13; region 2) regions of New Zealand. This study and the associated survey were approved by the New Zealand Ethics Committee (Dunedin), application number 2015#32.

The farms were primarily chosen from a cohort of 35 farms already randomly selected to be part of another study investigating the incidence, risk factors, and long-term effects of failure of passive transfer (**FPT**) in dairy calves. Herd selection for the original study was performed by listing all the dairy clients of the veterinary practice VetEnt in the Waikato, and then, separately, the dairy clients of VetEnt in Canterbury, in alphabetical order. The clients were divided by the total number of farms to be included in the FPT study (18 per region) then every nth farm was selected (i.e., systematic random sampling). Due to difficulty in securing enrollment in region 2, an extra farm was enrolled in region 1 and was selected randomly from the remaining clients in the same manner as the original selection. The farmers that agreed to participate and were enrolled in the FPT study were then invited to participate in this calf and heifer replacement mortality study. If farmers declined to participate in this study or failed to meet the inclusion criteria, another farmer was chosen by systematic random sampling of the remaining VetEnt clients that were not already involved in the FPT study in that region.

The herd inclusion criteria were that all cows in the herd were due to calve between July and October (spring calving) and the farmer was willing to record, on a daily basis, the number and sex of calves found alive or dead in the paddocks where the cows calved. They also had to agree to the recording of all animal