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A cohort study of the effect of winter dysentery on herd-level milk production

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ABSTRACT

Winter dysentery (WD) is a contagious disease caused by bovine coronavirus. It is characterized by acute onset of diarrhea, fever, depression, and reduced milk yield in adult cattle. Although production loss is a well-known consequence of WD, large-scale studies estimating the effect on milk production are lacking. The objective of this study was to estimate the effect of farmer-reported WD on herd-level milk production and milk composition. A cohort study was performed based on reports of herd outbreaks of winter dysentery during a regional epidemic in Norway during the winter of 2011–2012. Reports were made by farmers, and diagnosis was based on a herd outbreak of acute diarrhea in adults. Milk shipment data were retrieved from the dairy company, and information on herd size and milking system were retrieved from the Norwegian Dairy Herd Recording System. We compared milk production in herds with reported outbreaks of WD (n = 224) with all herds in the same area without a reported outbreak (n = 2,093) during the same period. The outcome variable in the analysis was milk volume per cow per day, and the main predictor was whether the herd had a reported outbreak of WD or not. We assessed the effect of WD on milk production by fitting a linear mixed model, adjusting for milk production in the herd before the outbreak. Similarly, we assessed the effect of WD on milk composition using linear regression, adjusting for the levels of milk components before the outbreak. This study estimated a total loss of 51 L/cow during the study period, from 7 d before to 19 d after a reported outbreak. The lowest estimated production was 2 d after the outbreak was reported, when the average milk yield was 19.4 L/cow per day, compared with 23.0 L/cow per day 7 days before notification (i.e., a difference of 3.6 L/cow, or 15%). The effect gradually declined with time. The estimated effect on milk composition was modest, but an increase of 11% in free fatty acids and a small increase in fat/protein ratio indicated that WD might put cows into negative energy balance. Descriptive analysis indicated that herd milk yield was still reduced 4 mo after an outbreak. This cohort study showed that WD causes considerable decreases in milk production, and it alters milk composition. These findings highlight the important negative consequences of WD, and should motivate actions to prevent between-herd spread of bovine coronavirus.
Key words: dairy, bovine coronavirus, milk composition, milk yield

INTRODUCTION

Winter dysentery (**WD**) in dairy herds is characterized by the sudden onset of diarrhea in several adult cattle (Clark, 1993). It typically occurs as epidemics during the winter, and is caused by bovine coronavirus, which is endemic in cattle populations worldwide (Saif, 1990; Alenius et al., 1991; Paton et al., 1998; Boileau and Kapil, 2010). Previous studies have shown high prevalence in the Norwegian national dairy herd as well. Gulliksen et al. (2009) found that 39% of examined calves were antibody positive, and Toftaker et al. (2016) found antibodies in bulk tank milk in 72% of all study herds. Bovine coronavirus also causes calf diarrhea and respiratory disease in both calves and adult animals (Boileau and Kapil, 2010). The clinical signs of WD include watery diarrhea with or without blood in the feces, fever, depression, decreased milk production, anorexia, and sometimes cough or nasal discharge (Boileau and Kapil, 2010). Mortality is low, but morbidity in affected herds is high, and outbreaks can result in poor herd health and reduced animal performance (Clark, 1993; Tråvén et al., 2001; Boileau and Kapil, 2010). Reduced milk production is an important consequence for the farmer, because of associated economic losses. The acute drop in milk yield associated with WD is well known, but estimates of the magnitude of this drop are often based on a few animals or on outbreaks in only a few herds. Furthermore, the reported magnitude of this drop varies widely (Durham et al., 1989; Fleetwood et al., 1989; Tråvén et al., 2001).

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Diseases associated with reduced general condition often result in reduced milk production. A rapid decrease in milk yield has been described for several viral diseases in cattle, including foot and mouth disease, bovine herpesvirus 1 infection, and bovine leukemia virus infection (Lyons et al., 2015; Statham et al., 2015; Yang et al., 2016). Studies have also shown that viral infections can affect milk quality (Rola et al., 2015; Yang et al., 2016). However, this has not previously been shown for WD on a larger scale. Possible effects on milk composition are important because altered composition could adversely affect milk quality, which in turn has economic consequences for the farmer and the processing industry.

The Norwegian dairy herd is a suitable study population for quantifying the effects of WD, because the presence of other endemic diseases that could confound results is low. This also means that the list for differential diagnosis of WD is limited. Norwegian cattle are free of many infectious agents such as bovine viral diarrhea virus, bovine herpes virus 1, *Mycobacterium avium* ssp. *paratuberculosis,* and *Brucella abortus,* and they are virtually free of *Salmonella* spp. (prevalence <0.5% in farmed species; Sviland et al., 2015; Åkerstedt et al., 2016a; Åkerstedt et al., 2016b; Heier et al., 2016).

The endemic occurrence of bovine coronavirus regularly causes respiratory disease and diarrhea, and is a concern for animal health and economic sustainability (Gulliksen et al., 2009; Klem et al., 2014). Large-scale observational studies estimating the effect of WD on milk production under field conditions are lacking, and further knowledge in this area is in demand. Reliable estimates of both the magnitude and duration of effect of WD on milk production are important for motivating famers and others to prevent the spread of bovine coronavirus between herds. Furthermore, quantifying the effects of WD on milk composition would add valuable input to the overall picture of the economic consequences of this disease. The objectives of this study were to estimate the effect of an outbreak of farmer-reported WD on (1) herd-level milk production, as measured by volume of milk per cow per day at the time of outbreak, and (2) herd-level milk composition. A secondary objective was to explore the duration of the effect on milk production.

MATERIALS AND METHODS

Background

During the winter of 2011–2012, a seasonal epidemic of WD took place in Norway. It started in the eastern part of the country in the autumn, and spread in an epidemic pattern throughout most parts of the country. Initially, bovine coronavirus was confirmed as the causative agent in a limited number of herds by antigen (PCR) or antibody detection (seroconversion), or both. Salmonellosis, bovine viral diarrhea, and Schmallenberg virus infection were ruled out. Later in the outbreak, laboratory confirmation of the diagnosis was usually not performed. During this epidemic, the advisory service of the largest dairy company (TINE SA) developed a voluntary surveillance system in the eastern part of Norway, where farmers and veterinarians were encouraged to report outbreaks of contagious diarrhea, so that herd-level biosecurity measures could be implemented. The farmers were advised to report outbreaks of acute diarrhea affecting several adult cattle. These reports were the basis for the present study.

Study Population

In total, 241 cases of farmer-reported WD in dairy herds were made from November 4, 2011, to March 13, 2012. These reports were from 7 counties in eastern Norway: Østfold, Akershus, Oslo, Hedmark, Oppland, Buskerud, and Vestfold, which constituted the study area and defined the source population. We performed a cohort study, the study unit being the herd. Herds from which outbreaks were reported by the producer were considered exposed (**WD+**). All other dairy herds in the same area were considered non-exposed (**WD−**). Inclusion criteria were member of the Norwegian Dairy Herd Recording System; milk shipment data available for the time of the outbreak (at least 21 d before and 19 d after the day of notification); and location within the study area. In this study, the day the farmer notified the advisory service of a current outbreak was day 0, and all references to time were relative to this. Because all included herds had milk shipments throughout the study period, study groups were considered closed, and a risk-based design was applied (Dohoo et al., 2009). For a visual overview of all study herds with respect to exposure status, a point map was made.

Data

Access to milk shipment data on volume and composition was provided by the dairy company (TINE SA). The total volume of milk was recorded for each shipment (i.e., every time the milk truck collected milk from the farm bulk milk tank). Milk quality was evaluated at the dairy plant by analyses of milk composition approximately twice per month. The number of cows contributing monthly test day samples was retrieved from the Norwegian Dairy Herd Recording System, along with data on the average annual herd size, milking system, and production type (freestall/tiestall).