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Associations between exposure to bovine herpesvirus 1 (BoHV-1) and milk production, reproductive performance, and mortality in Irish dairy herds

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ABSTRACT

As cost-benefit analyses are required to prioritize and promote disease control and eradication programs within a jurisdiction, national data relating to disease-related production losses are particularly useful. The objectives of the current study were to use Irish bovine herpesvirus 1 (BoHV-1) prevalence data in dairy herds, obtained by bulk milk sampling on 4 occasions over the 2009 lactation, to document associations between milk production, fertility performance, mortality, and BoHV-1 herd status. Bulk milk (n = 305) antibody ELISA was used to classify farms as positive or negative in terms of endemic BoHV-1. Cow-level (milk parameters only) and herd-level performance data were sourced from the Irish Cattle Breeding Federation. Ordinary linear and negative binomial regressions were used to investigate associations between milk, fertility, and mortality performance and herd-level BoHV-1 results (both categorical and continuous variables). Only slight effects on the rates of carryover cows, nonpregnant cows, and total deaths were highlighted with increasing ELISA sample/positive (%) values (incidence rate ratio = 1.001). Multiparous cows in herds BoHV-1 bulk milk antibody positive recorded a reduction in milk yield per cow per year of 250.9 L in the multivariable linear model. Milk fat and protein yields were also affected by herd BoHV-1 status, again highlighting sub-optimal milk production in BoHV-1 bulk milk-positive herds. The current study has highlighted an economical method of investigating losses due to endemic infection using repeated bulk milk sampling over a single lactation. These data can contribute to analyzing the cost-benefit of applying BoHV-1 control strategies both on farm and at a national level.

Key words: bovine herpesvirus 1, dairy herd, milk, fertility, mortality

INTRODUCTION

Approximately 80% of the world's population live in developing countries, and the demand for meat and milk products in these countries is growing (Delgado, 2003; Narrod et al., 2012). In developed countries, consumption of these products is reducing, but the quality of product demanded is increasing (Narrod et al., 2011). To meet the demands of expanding markets and increased quality of product while remaining competitive, livestock producers will require improvements to the efficiency of animal production. Based on World Organisation for Animal Health (OIE) estimates that 20% of livestock production losses are directly related to animal disease (Vallat, 2008), epidemiological investigations outlining the specifics of disease-related production losses are necessary.

Planning and monitoring of disease eradication or control programs is most effective when based on knowledge of the prevalence of disease in a given population, the factors associated with occurrence of the disease, the methods available to control those factors, and finally the costs and benefits involved for a particular region (Thrushfield, 2005). As cost-benefit analyses are also required to both prioritize and promote disease control and eradication programs within a jurisdiction (Narrod et al., 2012), national data relating to disease-related production losses are particularly useful (Häsler et al., 2012).

Infectious bovine rhinotracheitis (**IBR**), caused by bovine herpesvirus 1 (**BoHV-1**), is a highly contagious viral disease of cattle (Engels and Ackermann, 1996; Muylkens et al., 2007; Raaperi et al., 2012a). It has a worldwide distribution and significant efforts have been made, particularly in European Union countries, to control and eradicate BoHV-1 (Ackermann and Engels, 2006). One of the many ways a disease can be characterized is by its economic consequences, and the primary motivation for eradication of BoHV-1 from livestock populations is its reported impact on the economic success of farming enterprises. Clinical signs of infection include abortion (Givens and Marley, 2008; Graham,

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2013), suboptimal fertility, respiratory disease, reduced milk production, and increased mortality under experimental conditions (Bowen et al., 1985; Chiang et al., 1990; Miller et al., 1991) and natural field infection.

More specifically, Hage et al. (1998) described a significant decrease in milk production of 9.52 kg over a 14-d infectious period in BoHV-1 seronegative animals that became infected with the virus. Statham et al. (2015) recently reported a milk yield loss of 2.6 kg/d in BoHV-1 seropositive compared with seronegative dairy cows. A Dutch modeling exercise quantified losses of 0.92 kg of milk per cow per day during a BoHV-1 herd outbreak (van Schaik et al., 1999). Raaperi et al. (2012a) highlighted that herds with a BoHV-1 within-herd seroprevalence of between 1 and 49%, have a higher risk of abortion (odds ratio = 7.3). Moeller et al. (2013) reported that 2% of calves submitted for necropsy to the California Animal Health and Food Safety Laboratory (Tulare, CA) over a 6-yr period had lesions consistent with systemic BoHV-1 infection.

Although suboptimal performance due to infection with BoHV-1 has been reported widely, it should be noted that many studies have yielded contradictory results. Reproductive losses, for example, have not been found to be associated with exposure to BoHV-1 in beef herds (Waldner, 2005; Waldner and Kennedy, 2008) or in a dairy herd during a subclinical BoHV-1 infection (Hage et al., 1998). These contradictory findings are most likely due to the timing of infection, differences in the type of cattle herds being investigated (beef versus dairy), the jurisdiction where the study was completed, and livestock management systems operating in those jurisdictions. This stresses the importance of completing investigations specific to a particular region and livestock system.

Ireland is a net exporter of agricultural produce, with over 90% of dairy produce exported (Geary et al., 2010). Most Irish dairy farmers operate a pasture-based system, and Irish dairy cows graze pasture for approximately 10 mo of the year (Drennan et al., 2005). Limited data are available on the impact of BoHV-1 in such a system, and it is important to examine whether the effect of BoHV-1 in Ireland is similar to that reported previously in more intensive livestock systems. Prevalence estimates of BoHV-1 exposure can be established using bulk milk analysis. A recent Irish study (Sayers et al., 2015) has outlined a bulk milk BoHV-1 seroprevalence in Irish dairy herds of 80%. The objectives of the current study were to use these Irish prevalence data to document associations between milk production, fertility performance, mortality and viral status.

MATERIALS AND METHODS

Herd Selection and Classification

Selection of herds for this 2009 study was previously described, as was their BoHV-1 status (Sayers et al., 2015). Briefly, milk recording herds and members of HerdPlus (a breeding information tool; Irish Cattle Breeding Federation, Bandon, Co. Cork, Ireland) recorded in the Irish Cattle Breeding Federation (**ICBF**) database were used as the sample population and contained 3,500 members in 2009. Stratified proportional random sampling based on herd size and geographical location was used to select farmers for participation in the study. Of the 500 farmers invited to participate, 312 were eventually recruited on a voluntary and nonincentivized basis.

Over the 2009 lactation, 4 bulk milk samples (March 23, June 8, August 31, and November 2) were submitted by each study farm. Commercially available ELISA kits were used to test bulk milk samples for the presence of anti-BoHV-1 antibodies. Relevant kit performance data are outlined in Table 1, including manufacturer-recommended positive cut-off values used to classify herds as bulk milk antibody positive or negative.

Table 1. The ELISA kits used to test bulk milk samples for anti-bovine herpesvirus 1 (BoHV-1) antibodies in vaccinated and unvaccinated study herds

BoHV-1 herd vaccination status	BoHV-1 antigen target	Positive cut-off value[1]	Sensitivity (%)	Specificity (%)	Within-herd prevalence detectable (%)
Unvaccinated	Ultrapurified IBR lysate[2]	≥25 % S/P	100	99.6	10.0–15.0[3]
Vaccinated	IBRgE[4]	≤0.8 S/N ratio	72.0–88.4	100	Not available

[1]S/P (sample/positive) = [optical density at 450 nm of sample (OD_{450}) – OD_{450} of negative control]/(mean OD_{450} of positive control – OD_{450} of negative control) × 100; S/N (sample/negative) ratio = (sample mean – absorbance at 650 nm)/negative control mean.

[2]Institut Pourquier (Montpellier, France). IBR = infectious bovine rhinotracheitis.

[3]Wellenberg et al. (1998); Kramps et al. (2004).

[4]Idexx Laboratories (Westbrook, ME).