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Herd-level risk factors for infection with bovine leukemia virus in Canadian dairy herds

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ABSTRACT

Enzootic bovine leukosis (EBL) is an economically important infection of dairy cattle worldwide, which is caused by bovine leukemia virus (BLV). The prevalence of infection in Canadian dairy herds is high and continues to increase; however, there has not been a national program to control BLV. This cross-sectional study was conducted to identify potentially important risk factors for BLV infection on Canadian dairy herds, which is a prerequisite to developing an effective control program.

During 1998–2003, based on a stratified two-stage random sampling process, 315 dairy farms from seven provinces of Canada were selected. Within each farm, 9–45 cows were bled and tested with a commercial serum ELISA kit for BLV antibodies. A comprehensive questionnaire, targeting potentially important herd-level management indicators, was successfully administered in 272 herds. A zero-inflated negative binomial (ZINB) regression model was fit to the resulting data to assess the potential associations between BLV seropositivity and a variety of herd-level factors.

Seventy-eight percent of the herds were identified as BLV-positive (had one or more test positive animals). In the negative-binomial part of the final ZINB model, herds with clinical cases of leukosis during the 12 months prior to sampling, as well as herds which purchased animals with unknown BLV infection status in the last five years, had a significantly larger proportion of BLV positive animals. Based on a significant interaction between two of the risk factors, changing gloves between cows during pregnancy examination was not statistically associated with lower proportion of infected cows compared with not changing gloves, in the western Canadian provinces. In the logistic part of the model, herds from eastern Canadian provinces and those not purchasing cows in the last five years had increased odds of being free from BLV. The high prevalence of infection across Canada should be addressed through the development and implementation of a nationwide control program which will address the regional and herd-level risk factors for BLV infection identified in this study.

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1. Introduction

Enzootic bovine leukosis (EBL) is an economically important infection of dairy cattle worldwide, which is caused by bovine leukemia virus (BLV). Clinical signs of the disease are not displayed by most infected cattle; fewer than 5% of them will eventually develop malignant lymphosarcoma. Premature culling, death, and condemnation of carcasses at slaughter due to lymphosarcoma, as well as trade restrictions imposed on infected cattle and their products, or even on BLV-infected countries, are among the most significant losses attributed to the disease (Sandev et al., 2000; Radostits et al., 2006; Erskine et al., 2012).

The usual method for spread of BLV infection in cattle populations is horizontal transmission through direct and indirect (e.g. iatrogenic) exposure of susceptible animals to the infected lymphocytes from blood or less likely milk. Although transplacental transmission of BLV has been documented, it seems to be infrequent (Radostits et al., 2006; Gillet et al., 2013). The contribution of different haematogenous modes of transmission depends on the frequency and nature of BLV exposure, along with the prevalence of infection within the herds (Gutiérrez et al., 2011). In order to control the infection, it is necessary to properly determine and inhibit the important modes of transmission. Once cattle become infected with BLV, they usually remain infected for life and have a continuous antibody response (Monti et al., 2007; Kobayashi et al., 2010); this characteristic of the infection adds to the validity of antibody-based diagnostic techniques.

The 2012 annual report of the European Union on bovine and swine diseases declared that many European countries including the UK, France, Germany, Spain, the Scandinavian countries, and the Netherlands were officially free from EBL (Annual EU report, 2012). Other countries, such as Japan, the United States, and Argentina, have been actively working on addressing their BLV problems in recent years in order to develop effective programs for their dairy industries. Control of EBL at the national level usually consists of one or more of the following three approaches: management interventions; test and segregation; and test and slaughter (Ott et al., 2003; Rodríguez et al., 2011; Murakami et al., 2011; Bartlett et al., 2014). Management interventions can only be effective if the most important management determinants are identified, well understood, account for a sizable attributable risk and allow easy and economical remediation (Erskine et al., 2012).

In different provinces of Canada, there have been a number of serological studies which have estimated the prevalence and impact of BLV infection. In 1980, national prevalence of BLV infection in Canadian dairy herds was estimated at 40.5%, while only 9.3% of tested cattle were positive (Samagh and Kellar, 1982). However, 15–20 years later, infection levels appeared to have increased substantially. Sargeant et al. (1997) indicated 69.6% of the 102 tested dairy herds, and 23% of the 1330 tested cows in Ontario were positive to BLV. VanLeeuwen et al. (2001) reported that 70% (60.3–79.7%) of herds in the Maritime region of Canada (including provinces of Prince Edward Island, New Brunswick, and Nova Scotia – forming part of the database for the current study) had at least one infected cow, while the prevalence of infection at the cow-level was estimated at 20.8% (15.8–27.0%). Similar studies (also forming part of the database for the current study) revealed a high herd-level prevalence of BLV infection across Canada (VanLeeuwen et al., 2005a, 2006; Scott et al., 2006). Measured at the herd level, the direct production losses from EBL in the Maritime Canadian provinces have been conservatively estimated at $806 per year in an average 50-cow herd (Chi et al., 2002). This does not include costs associated with lost sales of genetically superior purebred cattle, which are likely more substantial than the direct production impacts.

As there is no nationwide program for controlling EBL in Canada, this cross-sectional study was conducted to identify some of the most important risk factors associated with seroprevalence of BLV in Canadian dairy herds. This is the first time that herd-level risk factors for BLV have been investigated in Canada on such a broad scale.

2. Materials and methods

The data set was extracted from the Canada-wide surveys of production limiting diseases that took place between 1998 and 2003 on dairy farms of Prince Edward Island (PE), New Brunswick (NB), Nova Scotia (NS), Ontario (ON), Saskatchewan (SK), Quebec (QC), Manitoba (MB), and Alberta (AB). The primary objective of the project was to obtain reasonably valid estimates for herd-level prevalence of infection with four pathogens of interest (BLV, Bovine Viral Diarrhea Virus, *Mycobacterium avium* subspecies *paratuberculosis*, and *Neospora caninum*) in all of the participant provinces. British Columbia (BC) did not participate in the survey, and Ontario did not administer the questionnaire due to logistical reasons (e.g. funding, coordination, timing). Therefore, those provinces were not included in the present risk-factor study. A political map of Canada displaying its provinces and territories is presented in Appendix A. The following subsections provide a summary of the sampling and testing protocols.

2.1. Herd and animal selection

A stratified two-stage random sampling procedure was applied. Sample size was first based on the calculations carried out for the Atlantic provinces, and then adjusted for the other provinces considering the number of available herds, herd size, budget, and other logistics (VanLeeuwen et al., 2001). The minimum number of cows required from each herd to result in a reasonable estimate of within-herd prevalence was obtained based on the following assumptions: an average herd size of 45 lactating cows, within-herd prevalence of 0.05, and confidence level of 0.95. Therefore, approximately 30 cows per herd were needed. In herds with less than 30 cows, all cows were bled and tested. The minimum number of herds required from each province to get reasonably valid estimates for herd-level prevalence of the infection in all of the participant provinces was then calculated based on the following assumptions: an expected herd-level prevalence of 0.70, acceptable relative error of 0.10, and confidence level of 0.95.