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Evaluation of the Johne's disease risk assessment and management plan on dairy farms in Ontario, Canada

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ABSTRACT

Johne's disease (JD) is a production-limiting gastrointestinal disease in cattle. To minimize the effects of JD, the Ontario dairy industry launched the Ontario Johne's Education and Management Assistance Program in 2010. As part of the program, trained veterinarians conducted a risk assessment and management plan (RAMP), an on-farm questionnaire where high RAMP scores are associated with high risk of JD transmission. Subsequently, veterinarians recommended farm-specific management practices for JD prevention. Milk or serum ELISA results from the milking herd were used to determine the herd ELISA status (HES) and within-herd prevalence. After 3.5 yr of implementation of the program, the aim of this study was to evaluate the associations among RAMP scores, HES, and recommendations. Data from 2,103 herds were available for the analyses. A zero-inflated negative binomial model for the prediction of the number of ELISA-positive animals per farm was built. The model included individual RAMP questions about purchasing animals in the logistic portion, indicating risks for between-herd transmission, and purchasing bulls, birth of calves outside the designated calving area, colostrum and milk feeding management, and adult cow environmental hygiene in the negative binomial portion, indicating risk factors for within-herd transmission. However, farms which fed low-risk milk compared with milk replacer had fewer seropositive animals. The model additionally included the JD herd history in the negative binomial and the logistic portion, indicating that herds with a JD herd history were more likely to have at least 1 positive animal and to have a higher number of positive animals. Generally, a positive association was noted between RAMP scores and the odds of receiving a recommendation for the respective risk area; however, the relationship was not always linear. For general JD risk and calving area risk, seropositive herds had higher odds of receiving recommendations compared with seronegative herds if the section scores were low. This study suggests that the RAMP is a valuable tool to assess the risk for JD transmission within and between herds and to determine farm-specific recommendations for JD prevention.

Key words: paratuberculosis, risk assessment, control program, evaluation

INTRODUCTION

In many countries worldwide, Johne's disease (**JD**) has been acknowledged as a production-limiting, infectious, gastrointestinal disease in dairy cattle. The disease is caused by *Mycobacterium avium* spp. *paratuberculosis* (**MAP**), a very slow-growing and intracellular bacterium with a wide host spectrum. In Canada, economic losses due to JD have been estimated at Can$1,196 per 100 cows for the entire dairy industry, and Can$2,992 in an average-sized, seropositive dairy herd (Tiwari et al., 2008). Losses are attributable to a drop in milk yield, reduced slaughter weight, and early culling. Furthermore, MAP has been associated with Crohn's disease, a chronic gastrointestinal disease in humans. However, evidence supporting a zoonotic potential for MAP is not very strong and a definitive link between MAP and Crohn's disease has yet to be established (Waddell et al., 2008).

To limit the effects of JD on the cattle industry, many countries, including Canada, have implemented voluntary control and surveillance programs. Contrary to many other diseases in which control programs focus on testing and culling of infected animals, JD control is most commonly based on identification and reduction of transmission risk. A MAP infection is not easily detected clinically or with available diagnostic tests, and infected animals can remain undetected for years.

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Whereas calves have the highest probability of getting infected (Windsor and Whittington, 2010), the highest probability of being detected is in older animals. Detection by fecal culture is greatest at an age between 2.5 and 5.5 yr, and by antibody titers at an age between 2.5 and 4.5 yr (Nielsen and Ersbøll, 2006). When compared with fecal culture, the sensitivity of JD ELISA in serum or milk has been estimated to be 73.6 and 61.1%, respectively (Hendrick et al., 2005). Therefore, although a traditional test-and-cull program is unlikely to be successful, the tests can help to identify some infected and infectious animals in the herd. A major focus of JD-control programs is on preventing the spread of the disease in the early life of calves through best management practices, many of which are aimed at minimizing the exposure of newborn calves to infectious cows as well as their colostrum, milk, and manure.

A modeling study by Kudahl et al. (2008) demonstrated that although the prevalence of JD would increase when using a test-and-cull program only, it would decrease when combining the test-and-cull program with improved management over the first 6 mo of a calf's life. Furthermore, an empirical study from Canada showed that farms could reduce their JD prevalence through participation in a formal risk assessment-based JD-control program (Sorge et al., 2011).

In Ontario, Canada, the Ontario Johne's Education and Management Assistant Program (**OJEMAP**) was piloted in 2006 and launched in January 2010. The program is explained in greater detail on the program website (www.johnes.ca) and in Pieper et al. (2015). Briefly, all Ontario dairy farms were encouraged to do a risk assessment and management plan (**RAMP**) with their herd veterinarian. To administer the RAMP, trained and registered local veterinarians visited the farm and conducted a risk assessment using a standardized 1-page questionnaire. A detailed guide for the RAMP was provided to ensure objectivity of the assessment. The RAMP was adapted from the risk assessment used by Sorge et al. (2011), but the considerably shortened version used in the program had not yet been formally evaluated since the program was launched.

The RAMP consisted of 5 sections focusing on (1) general JD risk, (2) calving area risk, (3) preweaned heifer risk, (4) postweaned heifer risk, and (5) adult cow risk. Each section was assigned a score, with high-risk scores indicating a high risk of disease transmission. Based on information acquired while administering this questionnaire, veterinarians provided up to 3 farm-specific recommendations for improved JD prevention and control.

Each dairy farm in Ontario was eligible to test all milking cows in the herd for JD via milk or blood ELISA. The costs of the herd test were covered by the program if certain requirements were met. The 2 requirements to be met were: (1) a RAMP had to be conducted within 90 d of testing and (2) cows that had a high-positive test result [milk optical density (**OD**) $\geq$1.0 or serum sample-to-positive ratio (**S:P**) $\geq$1.0] were disposed of within 90 d after the test or before the next calving, whichever came first, while ensuring that the animal did not enter the human food chain and was not sold to another dairy farm. Using all available data from the first 3.5 yr of the OJEMAP, the objectives of our study were to (1) analyze whether RAMP questions identify risk factors for the number of seropositive cows in a herd, and (2) determine whether RAMP scores of the different sections influence recommendations and whether this relationship depends on herd ELISA status (**HES**).

MATERIALS AND METHODS

The OJEMAP database, containing observations from 2,103 herds evaluated between January 2010 and August 2013 was used for the analysis. Serum or milk ELISA results from the milking herd, individual questions, sections, and the overall RAMP scores, as well as JD-control recommendations for each herd, were available. The HES was considered positive if at least 1 cow tested positive on the ELISA and was considered negative if all tested animals were ELISA negative. For further data-handling procedures and descriptive statistics of the data, see Pieper et al. (2015). Spearman's rank correlation was used to evaluate associations among RAMP section scores.

All statistical analyses were conducted using the computer program Stata/IC 13.0 for Windows (StataCorp LP, College Station, TX). A probability of $P < 0.05$ was considered significant.

As shown by Pieper et al. (2015), significant clustering of the RAMP scores were observed at the level of the veterinarian, suggesting that veterinarians had specific management areas that they preferred to focus on. Therefore, clustering by veterinarian was accounted for in the statistical analysis by using mixed logistic regression models and by clustered sandwich estimates for the zero-inflated negative binomial model (**ZINB**). For graphical display of models addressing the presence of recommendations for a management section, the same fixed effects models that were built using mixed logistic regression were built again using simple logistic regression with clustered sandwich estimates.

For the number of ELISA-positive animals per farm as the outcome, a ZINB model was chosen based on the assumption that a zero count in a herd could arise from 2 different processes: (1) a herd has management practices that prevent it from introducing the infection into