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# Associations between bovine viral diarrhoea virus (BVDV) seropositivity and performance indicators in beef suckler and dairy herds

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ABSTRACT

Data from 255 Scottish beef suckler herds and 189 Scottish dairy herds surveyed as part of national bovine viral diarrhoea virus (BVDV) prevalence studies from October 2006 to May 2008 were examined retrospectively to determine the relationship between serological status and key performance indicators derived from national cattle movement records. On average, calf mortality rates were 1.35 percentage points higher in seropositive beef herds and 3.05 percentage points higher in seropositive dairy herds than in negative control herds. Seropositive beef herds were also more likely to show increases in calf mortality rates and culling rates between successive years. There were no discernible effects of BVDV on the average age at first calving or calving interval for either herd type.

Accompanying questionnaire data revealed that only 27% of beef farmers and 25% of dairy farmers with seropositive herds thought their cattle were affected by BVDV, which suggests that the clinical effects of exposure may be inapparent under field conditions or masked by other causes of reproductive failure and culling. Beef farmers were significantly more likely to perceive a problem when their herd experienced acute changes in calf mortality rates, culling rates, and calving intervals between successive years. However, only 35% of these perceived positive herds were actually seropositive for BVDV. These findings emphasize both the importance of routinely screening herds to determine their true infection status and the potential for using national cattle movement records to identify herds that may be experiencing outbreaks from BVDV or other infectious diseases that impact herd performance.



## Introduction

Bovine viral diarrhoea virus (BVDV) is an endemic cattle pathogen that causes significant economic losses for the beef and dairy industries through its effects on animal health and performance (Fray et al., 2000; Gunn et al., 2003). Cattle that become transiently infected close to breeding may have reduced conception rates (McGowan et al., 1993), while those infected during early gestation are at increased risk of pregnancy loss from early embryonic death and abortion (McClurkin et al., 1984; Houe, 1995). Fetal infections arising from the vertical transmission of BVDV in early gestation may result in the birth of persistently infected (PI) calves that shed large quantities of virus for life (McClurkin et al., 1984; Houe, 1995). Although some PI calves appear clinically normal and survive to enter the breeding herd (McClurkin et al., 1979; Muñoz-Zanzi et al., 2003; Bachofen et al., 2010), the majority are culled early due to poor growth performance, health complications secondary to immunosuppression, and the development of fatal mucosal disease (Houe, 1992, 1993). Higher mortality rates have also been reported amongst calves that are born weak or with congenital malformations following exposure to BVDV during late gestation (Kahrs et al., 1970).

Both empirical and theoretical studies have shown that prenatal infections account for a high proportion of financial losses incurred during a typical BVDV outbreak (Meyling et al., 1990; Valle et al., 2005; Varo Barbudo et al., 2008; Weldegebriel et al., 2009). However, the actual extent to which BVDV impacts herd performance under field conditions is highly variable and depends on complex factors such as the herd demographic structure at the time of disease introduction, the demographic characteristics of the index case, and the biosecurity practices in place to prevent on-farm transmission (Moerman et al., 1994; Rüfenacht et al., 2001; Valle et al., 2001). This has two important implications from a disease control perspective. First, if the clinical signs of BVDV in transiently infected cattle are mild and non-specific, famers may not be aware that their herd is experiencing a problem with BVDV or they may attribute the changes in performance to other non-infectious causes of reproductive failure and calf mortality (Lindberg et al., 2006). Second, even if farmers are aware that BVDV is present in the herd, they may not perceive any benefits to controlling disease

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if there are no demonstrable effects on herd performance or if losses are expected to diminish over the course of outbreak due the development of herd immunity (Smith and Grotelueschen, 2004). In both cases, these herds remain at risk of spreading disease to other cattle herds through movements or local transmission mechanisms (Alban et al., 2001; Ersbøll et al., 2010).

The detailed records stored in national cattle movement databases provide a unique opportunity to study the effects of BVDV on herd performance. Based on the epidemiological features of the disease, we would expect that herds with unusually high average ages at first calving or prolonged intervals between successive calvings may be experiencing pregnancy losses due to prenatal infections, while those with unusually high calf mortality rates may be experiencing the direct loss of persistently infected cattle. In this analysis, we used records from the Cattle Tracing System (CTS) database of Great Britain to investigate the relationship between BVDV seropositivity and several key measures of herd performance (calf mortality rates, average age at first calving, calving interval, and culling rates) in 255 Scottish beef suckler herds and 189 Scottish dairy herds that were surveyed from October 2006 to May 2008 as part of national seroprevalence studies. Information from the accompanying farm management surveys was also available to help assess how changes in herd performance over time may influence farmer perceptions of herd BVDV status. The results were used to highlight the potential opportunities and limitations in using national cattle movement databases to identifying herds that may be experiencing BVDV outbreaks.

## Materials and methods

### *Study herds*

A cross-sectional survey of 301 beef suckler herds was performed between October 2006 and September 2007 to estimate the prevalence of BVDV in the Scottish beef industry (Brulisauer et al., 2010). During the farm visit, blood samples were taken from approximately 10 randomly selected cattle between 6 and 16 months of age and processed using an indirect BVDV antibody ELISA to obtain antibody titres. For the purpose of this analysis, the 225 herds with little serological evidence of active infection in young stock were considered negative control herds and the remaining 76 herds with a within-group prevalence of more than 26.3%, (based on the two higher mixture distributions described previously for these data (Brulisauer et al., 2010)) were considered case herds. Herd owners or managers were also required to complete a management survey, which included questions on whether they thought their cattle were affected by BVDV.

A stratified survey of 374 dairy herds was performed between October 2007 to May 2008 to estimate the prevalence of BVDV in the Scottish dairy industry (Humphry et al., 2012). Bulk milk tank samples were obtained directly through the farm's milk purchaser at the time of collection and processed using an indirect BVDV antibody ELISA to obtain the percentage positivity (PP) scores. Farmers were also required to complete a management survey similar to the one used in the beef study. Herds that were routinely vaccinated for BVDV were identified and removed from subsequent analyses due to the potential for interference with the bulk milk tank serology results (Houe et al., 2006). Within the questionnaire, farmers were also surveyed as to whether or not they thought their cattle were affected by BVDV. Based on the Swedish BVDV eradication class system, the remaining 220 unvaccinated herds were assigned into one of four groups based on their PP score. Class 0 herds were considered unlikely to have any seropositive animals indicating a low probability of BVDV infection, while Class 3 herds were considered highly likely to have many seropositive animals indicating a recent or active infection. For the purpose of this analysis, the 77 herds designated as Class 0 or Class 1 were considered negative control herds and the remaining 143 herds designated as Class 2 or Class 3 were considered BVDV seropositive case herds.

### *Cattle movement data*

The CTS database contains virtually complete records of all births, deaths, and movements of individual cattle in Great Britain since January 2001 (Green and Kao, 2007), which can be used to generate several key indicators of herd performance (Caldow et al., 2005). Records for an individual herd can be accessed through its unique county-parish-holding (CPH) number. The original beef and dairy management data contained only information on the farm business name and main farm address and so, to link the serological results from the study herds with the corresponding cattle movement data, we attempted to match this information against a database of CPH codes provided by the Scottish government. Farms for which there was no available CPH code or for which there was an obvious discrepancy between the survey estimates of herd size and CTS database estimates of herd size were excluded. These were most likely herds where the cattle were housed on a different location than the main farm business. The final study sample contained 255 beef suckler herds (67 case herds and 188 control herds) and 189 dairy herds (122 case herds and 67 control herds).

All birth records from each study herd during the 2 year period prior to sampling were extracted from the Livestock Movements table and linked to demographic records from other CTS data tables to generate the following calving event information: calf birth date, calf death date, calf death location (abattoir or agricultural holding), dam birth date, dam death date, and when applicable, the date and location of any previous or subsequent calvings. Records from 240 of the 86,358 calving events (0.28%) with missing or inaccurate information were discarded. These included dams that were identified as being male, dams that were not located on the farm associated with the calf birth record at the time of calving, dams that were less than 19 months of age at the time of calving, and dams where the recorded birth date, calving date, and death date were not in chronological order.

### *Performance indicators*

The basic calving event records were used to generate the following performance variables: calf mortality rate, average age at first calving, culling rate, and calving interval. The calf mortality rate was calculated as the percentage of all calves born during the specified time period that died on an agricultural holding within 365 days of birth. It was assumed that calves slaughtered at an abattoir were intended for the veal production market and therefore excluded from the mortality calculations. The average age at first calving was calculated as the difference between the date of birth and the date at calving, in months, for all heifers that calved on the farm during the specified time period. A heifer was defined as an animal between 19 and 48 months of age with no previously recorded calving dates in the CTS database. The purpose for placing restrictions on age was to eliminate potential outliers that may have been caused by data entry errors or animals that may have delivered an unrecorded stillborn calf at an appropriate age. The culling rate was calculated as the percentage of dams that calved during the specified time period that were subsequently slaughtered or sold within 365 days of calving. The calving interval was calculated as the number of months between successive calving dates for the subset of dams that delivered another calf within 24 months. It was assumed that in most production herds, any animals that failed to deliver a calf within 24 months would be culled from the herd and outlying values were most likely attributable to data entry errors and unrecorded births, stillbirths, or abortions.

The performance variables were calculated both as an average over the entire 2 year period and then individually for each year within the 2 year time period. The purpose was to assess whether BVDV serological status and farmer perceptions of BVDV serological status were associated with acute changes in herd performance between years as well as general differences in the level of herd performance. The change in performance between years was expressed as the absolute difference between the value reported for the first year and the value reported for the second year.

### *Statistical analyses*

Data for the beef suckler herds and dairy herds were analysed separately due to inherent difference in management practices as well as differences in the sampling methodology used to assess seropositivity. For each herd type, two separate analyses were performed. The first analysis explored differences in performance between seropositive and negative control herds to evaluate the potential for using cattle movement records to identify affected herds. Given the importance of calf mortality, the percentage of calf deaths attributable to the herd BVDV status (population attributable risk) was calculated using the univariate odds ratio in Levin's formula (Bruzzi et al., 1985). The second analysis explored differences in performance between herds that were perceived to be affected by BVDV and herds that were perceived to have no problems with BVDV to determine whether poor performance or changes in performance were associated with farmer perceptions.

The mean and percentile distributions (10th, 25th, 50th, 75th, and 90th) for each performance variable were reported. Based on visual assessment of the variable distributions, univariate comparisons between case and control herds were made using Mann–Whitney *U*-tests for the 2 year averaged performance variables and Student's *t*-tests for the variables describing the change in performance between years. The cut-off value for statistical significance was set at $P < 0.05$. Multivariate logistic regression models were also constructed for the beef suckler herds to test the potential interactions between performance variables. However, as none of the variables reached significance in combination, the results are not presented here. For dairy herds, there were not enough significant associations in the univariate comparisons to warrant further multivariate analysis.

## Results

Descriptive univariate statistics on the performance of beef suckler herds and dairy herds by serological status are presented