Preventive Veterinary Medicine 116 (2014) 75–88

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Quantitative assessment of the risk of introduction of bovine viral diarrhea virus in Danish dairy herds

Alessandro Foddai[a,*], Anette Boklund[a], Anders Stockmarr[b], Kaspar Krogh[c], Claes Enøe[a]

[a] Section for Epidemiology, National Veterinary Institute, Technical University of Denmark, Bülowsvej 27, DK-1870 Frederiksberg C, Denmark
[b] Statistics and Data Analysis Section, Department of Applied Mathematics and Computer Science, Technical University of Denmark, Matematiktorvet, DK-2800 Lyngby, Denmark
[c] Knowledge Centre for Agriculture, Cattle, Danish Cattle Federation, Agro Food Park 15, Skejby, 8200 Aarhus N, Denmark

ARTICLE INFO

Article history:
Received 27 September 2013
Received in revised form 2 April 2014
Accepted 17 May 2014

Keywords:
BVDV
Risk assessment
Scenario tree model
Stochastic simulations

ABSTRACT

A quantitative risk assessment was carried out to estimate the likelihood of introducing bovine viral diarrhea virus (BVDV) in Danish dairy herds per year and per trimester, respectively. The present study gives important information on the impact of risk mitigation measures and sources of uncertainty due to lack of data. As suggested in the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), the OIE Terrestrial Animal Health Code was followed for a transparent science-based risk assessment. Data from 2010 on imports of live cattle, semen, and embryos, exports of live cattle, as well as use of vaccines were analyzed. Information regarding the application of biosecurity measures, by veterinarians and hoof trimmers practicing in Denmark and in other countries, was obtained by contacting several stakeholders, public institutions and experts. Stochastic scenario trees were made to evaluate the importance of the various BVDV introduction routes. With the current surveillance system, the risk of BVDV introduction was estimated to one or more introductions within a median of nine years (3–59). However, if all imported animals were tested and hoof trimmers always disinfected the tools used abroad, the risk could be reduced to one or more introductions within 33 years (8–200). Results of this study can be used to improve measures of BVD surveillance and prophylaxis in Danish dairy herds.

1. Introduction

Bovine viral diarrhea (BVD) is a disease of domestic and wild ruminants (Olafson et al., 1946; OIE, 2004). It has been eradicated in Denmark, Sweden, Norway and Finland without the use of vaccination (Bitsch and Rønsholt, 1995). In Lower Austria and Switzerland, eradication programs have been launched leading to a significantly reduced prevalence of infected herds (Rossmanith et al., 2010; Presi et al., 2011). Nevertheless, BVD is considered to be distributed worldwide (OIE, 2004) and although its course is usually subclinical, outbreaks can have an important impact on animal health, welfare and economic income for farmers (Sørensen et al., 1995).

BVD is caused by a single-stranded RNA Pestivirus of the Flaviviridae family, which is closely related to Classical Swine Fever (CSFv) and Border Disease viruses (BDv)

* Corresponding author. Tel.: +45 27499397; fax: +45 35886001.
E-mail addresses: alefo@vet.dtu.dk, alessandrotula@hotmail.it (A. Foddai).

http://dx.doi.org/10.1016/j.prevetmed.2014.05.005
0167-5877/

(Collett et al., 1988; Peterhans et al., 2010). Two BVDV species are well described, BVDV-1 and BVDV-2. Recently, discussion arose over the emergence of a new BVDV species (BVDV-3, atypical or 'HoBi'-like bovine Pestiviruses) (Ståhl et al., 2007; Liu et al., 2009). Virus isolates within these groups show biological and antigenic diversity. Moreover, BVDV can be classified in two biotypes: cytopathic and non-cytopathic, according to the damage caused in cell cultures (Corapi et al., 1988; Peterhans et al., 2010).

The principal sources of infection are the persistently infected (PI) animals (Niskanen et al., 2000). PIs have been exposed to BVDV in the uterus before the 120th day of the dam' pregnancy (Brownlie et al., 1987), and will shed the virus in large amounts throughout their lives. Other acutely infected cattle seroconvert 2–3 weeks after infection and obtain lifelong immunity (Baker, 1990). These transiently infected (TI) animals are considered to be of minor importance for the spread of the disease (Niskanen et al., 2000). However, BVDV can circulate within a herd for long time due to TI animals and in the absence of PIs (Moerman et al., 1993).

In Denmark, BVD is considered an exotic disease (Uttenthal et al., 2005). During the study period, all dairy herds were screened quarterly by bulk tank milk (BTM) testing, while beef herds were screened by blood sampling at slaughter.[1] Moreover, milk-producing herds are screened every month (in the BTM) for a six month period, if they have imported animals from other countries. An enzyme-linked immunosorbent assay (ELISA) is used, to detect antibodies against BVDV (Rønsholt et al., 1997) in milk and blood samples. If antibodies are found, the herd is classified as "suspected of harboring PIs", all animals in the herd are tested for BVDV and PIs are eliminated as soon as possible. From 2007 to 2011, three Danish dairy herds out of approximately 4000 were tested positive with BVD. In one herd infected in 2010, BVD was imported with pregnant cows carrying PI calves. In the other two herds, the path of disease introduction is uncertain.

The main routes of BVDV introduction in free countries are considered to be the import of infected cattle or pregnant cows carrying PI calves, contaminated semen, and embryos (Lindberg et al., 2006). Semen and embryos are treated prophylactically during the preparation procedures. However, it cannot be excluded that virus shedding bulls are present in artificial insemination (AI) centers (Polak and Zmudzinski, 1999).

Applying washing and trypsin treatments, as recommended by the International Embryo Transfer Society (IETS), cannot assure complete removal of BVDV from contaminated embryos and ova (Bielanski and Jordan, 1996; Trachte et al., 1998; Gard et al., 2009).

BVDV-transmission via live vaccines (Barkema et al., 2001; Antonis et al., 2004), contaminated equipment and medicines has been reported in the literature (Niskanen and Lindberg, 2003; Katholm and Houe, 2006).

Biting flies have been shown capable of carrying BVDV under experimental conditions, but vector-born transmission has not been shown in the field (Lindberg et al., 2006), while airborne transmission could occur at short distances, e.g. 4–40 m (Mars et al., 1999; Bitsch et al., 2000).

The risk of introducing BVDV to previously uninfected herds via wildlife is usually considered to be very low (Lindberg et al., 2006) and none of the wild deer (roe, fallow, sika and red) tested in Danish studies were tested positive with BVDV (Nielsen et al., 2000; Uttenthal et al., 2007 in Danish).

The risk of disease transmission through contact of cattle with other domestic ruminants (e.g. sheep and goats) can be considered low, and the presence of sheep is not expected to compromise the efficacy of BVD eradication programs (Synge et al., 1999; Lindberg et al., 2006). Danish dairy herds are very specialized on milk production and the proportion of dairy farms with both cattle and sheep (or goats) is small. Moreover, very few sheep and goats are imported to Denmark. According to data obtained from the Danish Cattle Federation (2002–2013), the median number of imported sheep and goats per year is 48 (19–131) and 2 (0–287), respectively. Hence, the risk of introducing BVDV into Danish dairy herds due to import of sheep and goats is expected to be very low.

In this analysis, we focused on risk of BVDV introduction in Danish dairy herds. In Denmark, dairy and beef herds can be considered as two different specialized production types, without much contact between them. Most often, if there are contacts between the two productions types, animals are moved from dairy to beef herds (e.g. male calves). Furthermore, Danish beef herds are recognized as free from BVD. The last case of BVD in Danish beef herds was reported in 2010 and was not related to the case reported in the same year in dairy herds.

Danish farmers export animals to other countries. Keeping the herds free from BVD results in higher revenues from exported animals and better animal health and income for farmers, therefore keeping the Danish dairy population free from BVD is highly prioritized.

The first objective of this study was to estimate the risk of introduction of BVDV to Danish dairy herds (with exposure of at least one animal to the virus), including a description of the relative importance of the different introduction pathways. The second objective was to investigate the impact of intervention strategies, such as compulsory testing of imported animals and disinfecting tools used for cross-border hoof trimming and veterinary practices.

2. Materials and methods

2.1. Data collection and analysis

Datasets on imported (a) live cattle, (b) semen, (c) embryos and on (d) exports of live animals were obtained from the Danish Cattle Federation for the year 2010, while data on (e) vaccines used was obtained for the same year from the Danish register on use of veterinary medicines and

[1] From beef herds, 4 animals are tested every year at slaughter. From herds with imported beef cattle, 2 animals are tested every month at slaughter for a 1 year period.