Preventive Veterinary Medicine 116 (2014) 37–46

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

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

Estimation of the probability of freedom from Bovine virus diarrhoea virus in Norway using scenario tree modelling

Madelaine Norström[a,*], Malin E. Jonsson[a], Johan Åkerstedt[b], Anne Cathrine Whist[c], Anja Bråthen Kristoffersen[a], Ståle Sviland[a], Petter Hopp[a], Helene Wahlström[d]

[a] Norwegian Veterinary Institute, P.O. Box 750 Sentrum, NO-0106 Oslo, Norway
[b] Norwegian Veterinary Institute, P.O. Box 295, NO-4303 Sandnes, Norway
[c] Norwegian School of Veterinary Sciences, Department of Production Animal Clinical Sciences, P.O. Box 8146 Dep. , NO-0033 Oslo, Norway
[d] National Veterinary Institute, Department for Disease Control and Epidemiology, Zoonosis Center, SE-751 89 Uppsala, Sweden

ARTICLE INFO

Article history:
Received 6 December 2013
Received in revised form 14 April 2014
Accepted 23 June 2014

Keywords:
Bovine virus diarrhoea
Scenario tree model
Surveillance
Cattle
Norway
Freedom from disease

ABSTRACT

Disease caused by Bovine virus diarrhoea virus (BVDV) is notifiable in Norway. An eradication programme started in 1992. The number of herds with restrictions decreased from 2950 in 1994 to zero at the end of 2006. From 2007, the aim of the programme has been surveillance in order to document freedom from the infection. To estimate the probability of freedom from BVDV infection in the Norwegian cattle population by the end of 2011, a scenario tree model of the surveillance program during the years 2007–2011 was used. Three surveillance system components (*SSCs*) were included in the model: dairy, beef suckler sampled at farms (2007–2010) and beef suckler sampled at slaughterhouses (2011). The design prevalence was set to 0.2% at herd level and to 30% at within-herd level for the whole cattle population.

The median probability of freedom from BVDV in Norway at the end of 2011 was 0.996; (0.995–0.997, credibility interval). The results from the scenario tree model support that the Norwegian cattle population is free from BVDV. The highest estimate of the annual sensitivity for the beef suckling *SSCs* originated from the surveillance at the slaughterhouses in 2011. The change to sampling at the slaughterhouse level further increased the sensitivity of the surveillance.

1. Introduction

Bovine virus diarrhoea (BVD) is caused by bovine virus diarrhoea virus (BVDV) in the genus pestivirus. The virus is the cause of mucosal disease (MD) and haemorrhagic syndrome, but the economically most important manifestation of the disease is related to infection in pregnant animals, which may result in embryonic death, abortion and congenital defects (Radostitis et al., 2000). If the dam is infected during day 42 and 125 of the pregnancy, persistently infected calves may be born (Radostitis et al., 2000).

* Corresponding author. Tel.: +47 23 21 64 82; fax: +47 23 21 64 85.
E-mail addresses: madelaine.norstrom@hotmail.com (M. Norström), malin.jonsson@vetinst.no (M.E. Jonsson), johan.akerstedt@vetinst.no (J. Åkerstedt), anne.c.whist@nvh.no (A.C. Whist), anja.kristoffersen@vetinst.no (A.B. Kristoffersen), stale.sviland@vetinst.no (S. Sviland), petter.hopp@vetinst.no (P. Hopp), helene.wahlstrom@sva.se (H. Wahlström).

http://dx.doi.org/10.1016/j.prevetmed.2014.06.012

These are considered to serve as the main reservoir of infection to other animals (Baker, 1995). In Norway, BVD/MD is a notifiable disease (Anonymeous, 1989). From 1984 to 1986, preliminary investigations indicated that nearly 30% of the dairy herds had animals with antibodies to BVDV (Løken et al., 1991), whereas for other production types the prevalence was unknown. The annual losses in cattle in Norway due to BVDV infection was estimated to be between 40 and 50 million NOK (Krogsrud and Løken, 1992).

A surveillance and control programme started in December 1992 (Løken and Nyberg, 2013) as collaboration between Governmental institutions and the cattle industry. A cattle herd was considered to be BVDV infected if all sequential tests were positive including virus identification from at least one animal.

The latest BVDV infected cattle herd was identified in April 2005 and the restrictions due to BVDV were lifted in November 2006 (Kampen et al., 2007). As a result, the objective of the control and surveillance programme shifted from eradication of BVDV to surveillance to document freedom from disease. From the beginning of 2007, no BVDV infected herds have been identified in Norway and no herd have been subject to restrictions for BVD (Åkerstedt et al., 2012). The current surveillance program includes dairy as well as beef suckler herds. The only bull station in Norway is approved by the European Union (EU). This requires a testing regime including a several infectious diseases amongst BVD is included (European Commission, 1988). Imported live cattle, semen and embryos undergo additional testing for BVDV in accordance with the cattle industry's own requirements handled by the Norwegian Livestock Industry's Biosecurity Unit (KOORIMP).

The aim of the current study was to estimate the probability of freedom from BVDV infection in the Norwegian cattle population by the end of 2011.

2. Materials and methods

This study was based on the information from the Norwegian surveillance program of BVDV in cattle during 2007–2011, a period where no known BVDV infected herds were reported in Norway. The probability that the cattle population in Norway was free from BVDV by the end of 2011 was calculated using scenario tree modelling (Martin et al., 2007b).

2.1. Data sources and definition of cattle herd production types

The following data sources were used to calculate the population size and categorise the Norwegian cattle population into production types: the Registry of Production Subsidies (RPS, Norwegian Agricultural Authority, Oslo), Statistics Norway (SSB, Oslo), and the Agricultural Property Register (Norwegian Agricultural Authority, Oslo). As of 01.01.2011, the Norwegian cattle population consisted of 856,349 animals distributed in 16,401 herds.

The herds were categorised into

i) dairy herds defined as herds that delivered milk to dairies, including herds with combined production of dairy and beef (66.6%)
ii) beef herds divided into beef suckler herds defined as herds with more than one breeding cow (23.8%), with one breeding cow (1.0%), and beef finishing herds (8.5%) with no breeding cows
iii) farm stead dairy (0.1%), defined as herds with on-farm production of dairy products and no delivery of milk to dairies (Table 1).

Records on milk delivering cattle were obtained from the dairy industry. Test results and sample information were obtained from the Norwegian Veterinary Institute.

2.2. Surveillance system components

The three surveillance system components (*SSCs*) of the current official Norwegian surveillance program for BVDV during the study period were dairy, beef suckler sampled at farms and beef suckler sampled at slaughterhouses (Fig. 1). Each *SSC* is described below.

2.2.1. Dairy SSC

Annually, 12.5% of all dairy herds were randomly selected for sampling which ensured bulk tank milk (BTM) samples from at least 10% of the herds. The number of herds tested decreased from 1575 in 2007 to 1226 in 2011 (Table 2) due to a decrease in the number of dairy herds in Norway. In 2008, herds selected for BVDV testing the previous year were excluded from the sampling frame, and from

Table 1
Number of Norwegian cattle herds distributed on production types from 2007 to 2011.

Year	Category	No. of dairy delivering milk*[a]	No. of dairy farm stead dairy	No of beef suckler >1 cow*	No of beef suckler 1 cow	No of beef finishing	Total
2007	Herd	140,78	26	3926	213	1634	19,877
	Animal	732,920	1354	131,372	1731	33,273	900,650
2008	Herd	13,227	25	3716	211	1563	18,742
	Animal	725,027	1370	129,247	2257	33,546	891,447
2009	Herd	12,221	23	3834	180	1509	17,767
	Animal	701,310	1320	135,904	1740	35,505	875,779
2010	Herd	11,501	21	3883	176	1491	17,072
	Animal	686,946	1254	141,368	1780	35,082	866,430
2011	Herd	10,928	20	3903	158	1392	16,401
	Animal	672,891	1231	145,707	1491	35,029	856,349

*Included in the surveillance program.
[a] Includes combined herds.