OPEN ACCESS

SHORT COMMUNICATION

Mapping the global prevalence of bovine viral diarrhoea virus infection and its associated mitigation programmes

Veronika Richter,[1] Elisabeth Kattwinkel,[1] Clair L Firth,[1] Tatiana Marschik,[1] Marc Dangelmaier,[1] Martine Trauffler,[1] Walter Obritzhauser,[1] Walter Baumgartner,[2] Annemarie Käsbohrer,[1] Beate Pinior[1]

Abstract

The aim of this study was to collect information on the global distribution of the prevalence of bovine viral diarrhoea virus (BVDV) and respective mitigation programmes, using a questionnaire and literature review to provide as complete a picture of the worldwide BVDV situation as possible. This study collated information on 107 countries with respect to mitigation activities and 88 countries regarding BVDV infections during the observation period (1960–2017). A heterogeneous epidemiological situation for both BVDV prevalence and the presence of mitigation programmes was observed. The results of this analysis could be used to increase the visibility of the distribution of BVDV, to provide supporting data for global animal disease databases and to assist veterinary public health authorities in the decision-making processes to establish mitigation activities.

The pestivirus, bovine viral diarrhoea virus (BVDV), is found worldwide and has a significant economic impact, both directly via production losses,[1 2] and indirectly via the cost of control and eradication programmes.[3–5] Mitigation programmes are complicated by the presence of persistently infected (PI) animals, which continually excrete virus and are a permanent source of virus transmission. The immune system of PI animals recognises the BVD virus as 'self' and does not produce antibodies against this pathogen.[6] This means that routine antibody testing is generally not suitable for BVD mitigation programmes and repeated antigen testing must be carried out to determine which animals are persistently and which only transiently infected (TI). Animals which test positive for BVDV antibodies (AB) have either been naturally infected with the virus, have been exposed to AB via the consumption of colostrum or have been vaccinated.

The current analysis builds on that started by Scharnböck and others[7] with the addition of data provided by Chief Veterinary Officers (CVOs), OIE representatives and research institutions, as well as an extended literature review. The aim of this study was to collect information on the global distribution of BVDV infections (ie, PI, viraemic infected (VI) (VI including both PI and TI) and AB) and implemented mitigation programmes (ie, (i) surveillance activities intending to demonstrate the absence/presence of BVDV, or (ii) control (aiming to reduce BVDV prevalence) and/or eradication (aiming to provide a continued absence of BVDV) programmes).[8 9] This was done by means of a questionnaire (see online supplementary material) and literature review. The questionnaire was designed to collect information on BVDV mitigation programmes and any available BVDV prevalences in the global cattle population. In addition to CVOs, OIE delegates and research institutions dealing with BVDV were invited to answer the questionnaire. The questionnaire was sent by email to 167 countries to one of the three participant groups (the current responsible persons of BVDV control such as delegates of the countries were identified by the OIE member list http://www.oie.int/about-us/our-members/delegates-new/ (assessed 2

Veterinary Record (2019) doi: 10.1136/vr.105354

[1]Institute of Veterinary Public Health, University of Veterinary Medicine, Vienna, Austria
[2]University Clinic for Ruminants, University of Veterinary Medicine, Vienna, Austria

E-mail for correspondence: Beate.Pinior@vetmeduni.ac.at

Provenance and peer review Not commissioned; externally peer reviewed.

Received January 7, 2019
Revised April 1, 2019
Accepted April 7, 2019

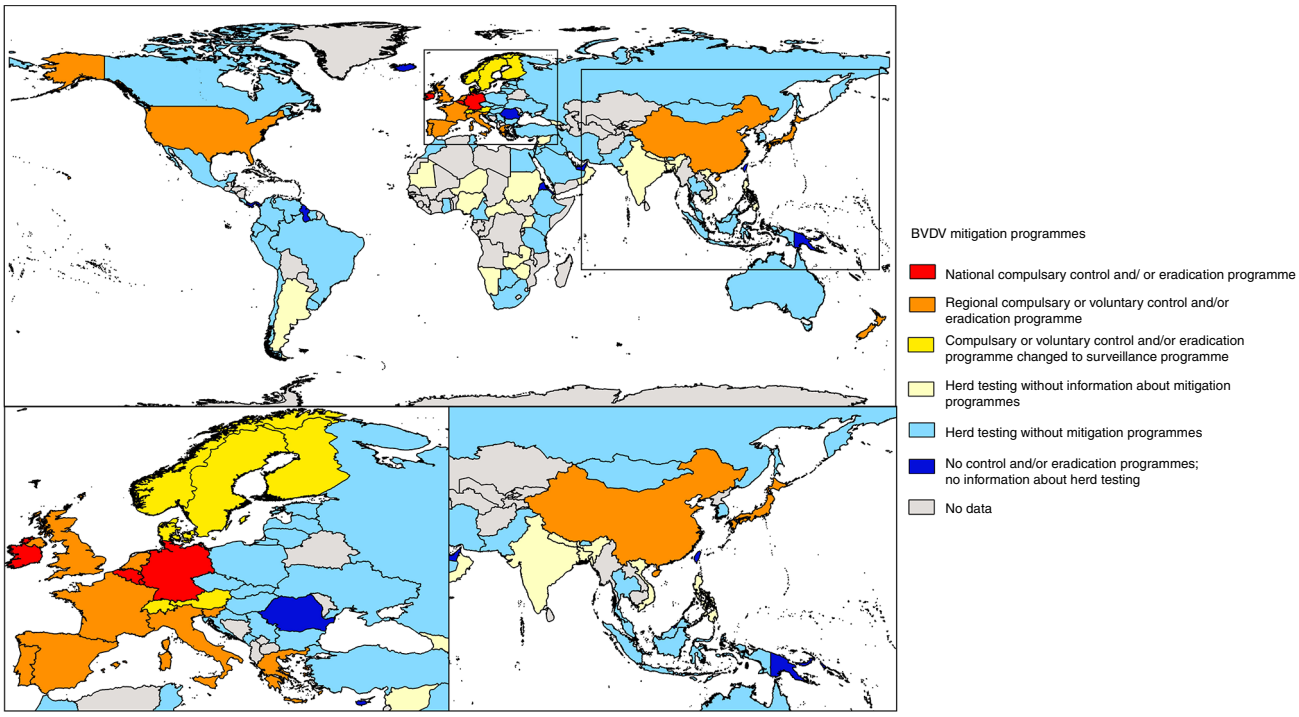

Figure 1 Worldwide map of bovine viral diarrhoea virus (BVDV) mitigation activities.

Nov 2018). Research institutions actually dealing with BVDV were identified through publication by using the described scientific databases: Scopus, ISI Web of Knowledge and PubMed) at the end of 2015. Addressees were given until February 2016 to reply to the questionnaire. In 2017, the authors contacted the countries who had initially responded positively but had not yet completed the questionnaire. Additionally, a literature review of implemented BVDV mitigation programmes worldwide and the level of BVDV infection (see online supplementary figure S1) was carried out using four online databases, namely ISI Web of Knowledge, PubMed, Scopus (until August 2017) and Google Scholar (until November 2018). All the identified studies were screened according to the different types of mitigation activities applied, the use of BVDV vaccine, BVDV prevalences (ie, PI, VI, AB), age of sampled animals, production system, clinical symptoms, diagnostic methods and sampling material. The most recently published information about the mitigation activities in the different countries was used in the presented study (figure 1; see online supplementary table S1) and all identified PI and VI prevalences (see online supplementary table S2) and AB prevalences (see online supplementary table S3) were collected in order to provide as complete a picture of the BVDV situation worldwide as possible between 1960 and 2017. As recent data on the prevalence of BVDV were not available for some countries and their regions, such as in South Africa, Uganda, Kenya, historical reports as far back as the 1960s have been included in the observation period presented here (see online supplementary tables S2 and S3).

Overall, 50 (30 per cent) of the 167 countries returned usable responses to the questionnaire. A total of 21 (42 per cent) of these 50 countries provided information about mitigation activities that were not covered by the published literature, 29 countries (58 per cent) reported activities in response to the questionnaire that were also published, and the activities of 57 of the countries included were only represented in the literature (see online supplementary figure S1). This study provided information on 107 countries with respect to mitigation activities and represented 59% of the OIE delegate countries (n=182) and 42 per cent of the worldwide countries and islands (n=253; including dependencies). An overview of the implemented mitigation activities per country is provided in figure 1 and online supplementary table S1. Information on the use of BVDV vaccine was provided or identified for 60 countries (see online supplementary table S1). In over half of these countries (n=37; 61 per cent), vaccination was permitted. BVDV infections were identified in 88 (35 per cent) countries and islands, of which 27 countries provided information via the questionnaire. More than 85 per cent of the relevant studies provided non-national BVD prevalences. The majority of BVDV infections were determined by the detection of AB (55 per cent), followed by PI (44 per cent) at animal and herd level. The presence of BVDV infection worldwide is shown in figure 2 and a detailed overview of the BVDV prevalences and the covariate information, such as applied diagnostic methods, are provided in online supplementary tables S2 and S3. By location, the mean AB prevalence at herd level and PI/VI prevalence at animal level varies between previously (before 2008) and recently (after 2008) published data (table 1). It is important to note that BVDV infection data by country can be influenced by many factors[10] such as animal imports, cattle markets, closed herds, reporting

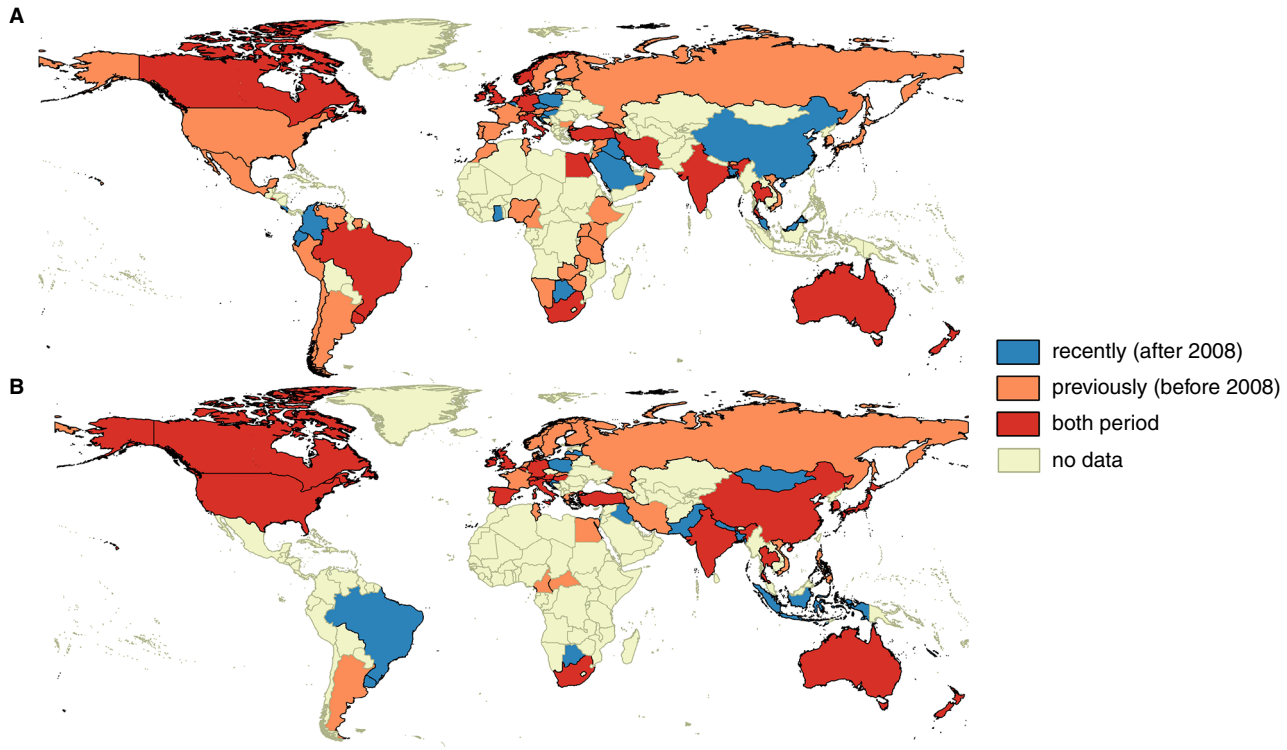

Figure 2 Worldwide bovine viral diarrhoea virus (BVDV) infections map stratified by recent (after 2008; coloured in blue) and historical reports (before 2008; coloured in orange). If one country reported data for both periods it was coloured in red. (a) Antibodies (AB) positive and (b) persistently infected (PI) and viraemic infected (VI) infections. Sampling years were not available for some countries such as Colombia, Czech Republic, Ghana and Hungary (AB prevalences), as well as Indonesia, Iraq, Pakistan and The Philippines (PI/VI prevalences). For these countries, the year of publication was used to illustrate the period of the BVDV infection.

of apparent and true prevalences and distinguishing between incidence and prevalences in the analysed studies.[7]

In contrast to work global BVDV prevalences recently published by Scharnböck and others,[7] the presented study provided detailed information on BVDV mitigation activities worldwide. Additionally, the authors attempted to gather as much information as possible on the worldwide BVDV infection situation by extending the literature review with a questionnaire sent to CVOs and OIE delegates. This led to the inclusion of data on BVD prevalences from 15 more countries and 34 more studies than in the previous work by Scharnböck and others.[7] According to Evans and others,[11] there are currently no formal reporting requirements for BVDV at a global level. Thus, this study provides data on global mitigation activities and a detailed temporal and spatial overview of PI, VI and AB prevalences, with covariate information such as age of sample animals/herds, in contrast to the data available in the OIE database (http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/Diseasedistributionmap (assessed 3 Dec 2018), http://www.oie.int/wahis_2/public/wahid.php/Diseasecontrol/controlmeasuresmap (assessed 3 Dec 2018)), which only records the presence or absence of BVDV per country. Comparing the presented BVDV results with available economic overviews of BVDV production losses[2] and expenditures of mitigation measures[3 4] revealed that more epidemiological data are available to countries regarding BVDV infections and implemented mitigation measures than economic data.[2–4 11] This indicates that the economics of losses caused by BVDV infection and the costs of programmes to control the disease are comparatively understudied and further research in this area is vital to support decision making in BVDV control policy. However, a heterogeneous epidemiological situation for both BVDV prevalence and the presence of mitigation programmes was observed. The results of this analysis could be used to increase the visibility of the distribution of BVDV, to provide supporting data for

Table 1 The mean prevalences of countries stratified by years and antibody positive (AB) herds and persistently and/or viraemic infected animals (PI/VI)

	Before 2008	After 2008
Antibody positive herds		
Asia	83%	73%
Europe	57%	46%
Oceania	87%	78%
Africa	83%	74%
Central America	54%	–
North America	61%	–
South America	93%	67%
Persistently and/or viraemic infected animals (PI/VI or PI or VI)		
Asia	6.9% (PI/VI); 4.0% (PI); 9.1% (VI)	4.5% (PI/VI); 0.2% (PI); 5.8% (VI)
Europe	5.0% (PI/VI); 3.6% (PI); 6.5% (VI)	0.5% (PI/VI); 0.2% (PI); 1.5% (VI)
Oceania	12.7% (PI)	0.3% (PI)
Africa	11.7% (VI)	19.1% (VI)
Central America	–	–
North America	8.6% (PI/VI); 0.9% (PI); 13.7% (VI)	3.6% (PI/VI); 0.5% (PI); 6.2% (VI)
South America	1.2% (VI)	2.3% (VI)

global animal disease databases and to assist veterinary public health authorities in the decision-making processes to establish mitigation activities.

Correction notice This article has been corrected since it was published Online First. The title has been updated.

Acknowledgements The authors would like to thank all those who responded to the questionnaire.

Funding This work was supported by the Project VET-Austria, a cooperation between the Austrian Federal Ministry of Labour, Social Affairs, Health and Consumer Protection, the Austrian Agency for Health and Food Safety and the University of Veterinary Medicine Vienna.

Competing interests None declared.

► Additional material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/vetrec-2019-105354).

References

1 Burgstaller J, Obritzhauser W, Kuchling S, *et al*. The effect of bovine viral diarrhoea virus on fertility in dairy cows: two case-control studies in the province of Styria, Austria. *Berl Munch Tierarztl Wochenschr* 2016;129:103–10.
2 Richter V, Lebl K, Baumgartner W, *et al*. A systematic worldwide review of the direct monetary losses in cattle due to bovine viral diarrhoea virus infection. *Vet J* 2017;220:80–7.
3 Pinior B, Firth CL, Richter V, *et al*. A systematic review of financial and economic assessments of bovine viral diarrhea virus (BVDV) prevention and mitigation activities worldwide. *Prev Vet Med* 2017;137:77–92.
4 Pinior B, Firth CL. The economics of bovine viral diarrhoea eradication. *Vet Rec* 2017;181:300.
5 Marschik T, Obritzhauser W, Wagner P, *et al*. A cost-benefit analysis and the potential trade effects of the bovine viral diarrhoea eradication programme in Styria, Austria. *Vet J* 2018;231:19–29.
6 Brownlie J, Clarke MC, Howard CJ, *et al*. Pathogenesis and epidemiology of bovine virus diarrhoea virus infection of cattle. *Ann Rech Vet* 1987;18:157–66.
7 Scharnböck B, Roch FF, Richter V, *et al*. A meta-analysis of bovine viral diarrhoea virus (BVDV) prevalences in the global cattle population. *Sci Rep* 2018;8:14420.
8 Andrews JM, Langmuir AD. The philosophy of disease eradication. *Am J Public Health Nations Health* 1963;53:1–6.
9 Houe H, Lindberg A, Moennig V. Test strategies in bovine viral diarrhea virus control and eradication campaigns in Europe. *J Vet Diagn Invest* 2006;18:427–36.
10 Duncan AJ, Gunn GJ, Humphry RW. Difficulties arising from the variety of testing schemes used for bovine viral diarrhoea virus (BVDV). *Vet Rec* 2016;178:292.
11 Evans CA, Pinior B, Larska M, *et al*. Global knowledge gaps in the prevention and control of bovine viral diarrhoea (BVD) virus. *Transbound Emerg Dis* 2019;66:640–52.