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Review

Epidemiology and control of bovine herpesvirus 1 infection in Europe

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A B S T R A C T

Bovine herpesvirus 1 (BHV-1) causes infectious bovine rhinotracheitis (IBR), infectious pustular vulvovaginitis, abortion and balanoposthitis, as well as neurological and systemic disease in cattle. The virus is endemic in cattle populations worldwide although in Europe six countries and several regions in other countries have achieved 'IBR-free' status by implementing control measures.

According to European Union (EU) directives, all member states must comply with specific requirements related to BHV-1 infection status in semen and embryos. The requirement that 'IBR-free' states restrict the importation of cattle from endemically infected regions has motivated several European countries to instigate disease eradication programmes. Despite such control measures within the EU, outbreaks of IBR persist in 'IBR-free' states contiguous with infected countries. This review presents a summary of recent research on the epidemiology of BHV-1, highlights the control measures and surveillance systems in place, and discusses the challenges facing eradication schemes.

Introduction

Bovine herpesvirus 1 (BHV-1) has attracted global attention since it was first reported as a cause of infectious bovine rhinotracheitis (IBR) in dairy cattle in California, USA, in 1953 (Yates, 1982). Following its apparent emergence in the USA, IBR has been diagnosed worldwide (Straub, 1975). In the early 1950s, BHV-1 infection manifested as infectious pustular vulvovaginitis (IPV) in cows and infectious pustular balanoposthitis (IPB) in bulls. The virus is now recognised to cause a range of other clinical conditions in cattle, including abortion, infertility, conjunctivitis, encephalitis, mastitis, enteritis and dermatitis (Straub, 2001).

Isolates of BHV-1 have been classified into three subtypes (1, 2a and 2b) by restriction endonuclease analysis (Miller et al., 1991). Subtypes 1 and 2a mainly cause IBR, with attendant pyrexia, reduced milk production and abortion (Wentink et al., 1993). BHV-1 isolates from aborted fetuses are typically subtypes 1 or 2a (Miller et al., 1991). Infection with subtype 2b mainly results in IPV/IBP, but has also been associated with respiratory disease (Edwards et al., 1990; Wentink et al., 1993).

BHV-1 establishes latency in the trigeminal ganglion or pharyngeal tonsils following primary infection of the conjunctiva, oral and/or nasal cavities, or in the sacral ganglia following genital infection (Ackermann and Wyler, 1984; Winkler et al., 2000). Periodically, latent BHV-1 will reactivate, virus is shed and can be transmitted (Turin et al., 1999). Reactivation may be triggered by stress associated with parturition (Thiry et al., 1985), transport (Thiry et al., 1987), animal movement and mixing (Jones and Chowdhury, 2010), inclement weather (van Drunen Littel-van den Hurk, 2006), concomitant infection, poor husbandry or diet (Turin et al., 1999), overcrowding (van Drunen Littel-van den Hurk, 2006) or following treatment with corticosteroids (Winkler et al., 2000). Latently infected animals should always be considered a potential source of infection (Bitsch, 1973), although vaccination can considerably reduce the amount of virus excreted following reactivation (Bosch et al., 1997; Mars et al., 2001).

Since BHV-1 control schemes were first introduced in the 1980s, six European countries have achieved total eradication. European Union (EU) Directive 92/65/EEC specified that artificial insemination and embryo transfer centres had to be free of BHV-1 from 1 January 1999.[1] However, despite such measures, seropositive animals are still detected in regions of disease-free states bordering endemically infected countries (Ackermann and Engels, 2006; Blickenstorfer et al., 2010). Furthermore, not all EU states have implemented compulsory eradication programmes combining 'test and removal' with vaccination using marker vaccines. Some countries have initiated voluntary eradication schemes but these may not be sufficiently robust to eradicate BHV-1 from the EU (Franken, 1997; Vonk Noordegraaf et al., 1998).

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[1] See: http://ec.europa.eu/food/fs/sc/scah/out49_en.pdf. Sanco/C3/AH/R20/2000. Report on bovine herpesvirus (BHV) 1 marker vaccines and the accompanying diagnostic tests (accessed 13 May 2013).

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In this review, we outline the distribution of BHV-1 infection globally, assess risk factors that facilitate the spread of the virus, and discuss the advances and setbacks in its control.

Epidemiology of bovine herpesvirus 1 infection

Although BHV-1 infection occurs worldwide, there are differences in prevalence and incidence (Ackermann and Engels, 2006; Table 1). The virus has been eradicated from Austria, Denmark, Finland, Sweden, Switzerland and Norway (Ackermann and Engels, 2006), as well as from the Federal State of Bavaria in Germany (2011/674/EU) and the Province of Bolzano in Italy (2011/674/EU).

Increasing age is a risk factor for BHV-1 seropositivity (Msolla et al., 1981; Solis-Calderon et al., 2003; Kampa et al., 2004; Boelaert et al., 2005; Guarino et al., 2008; Jacevičius et al., 2008; Woodbine et al., 2009; Raaperi et al., 2010). Calves have a lower prevalence of infection (McDermott et al., 1997; Boelaert et al., 2005), although the incidence of seroconversion is higher among animals <24 months of age (Mars et al., 2001; Woodbine et al., 2009; Segura-Correa et al., 2010). The waning of maternal immunity is associated with an increased risk of infection and seroconversion; this leads to a higher prevalence of antibodies against BHV-1 in adult cattle, where the rate of seroconversion is lower due to 'herd immunity'.

Male animals are seropositive more frequently than females, indicating that sex is also a risk factor (Boelaert et al., 2005; Guarino et al., 2008). Bulls have a higher risk of infection than cows as they mix more frequently with other cattle (Boelaert et al., 2005). BHV-1 may be transmitted in imported semen (Kupferschmied et al., 1986), either due to virus contamination of semen or indirect transmission by personnel (Kampa et al., 2009; Raaperi et al., 2010). However, use of natural service rather than artificial insemination was found to be a risk factor for herd seropositivity in Brazil (Dias et al., 2013). Provision of protective clothing to visitors has been shown to be protective against BHV-1 infection (van Schaik et al., 1998, 2001, 2002).

Farms with mixed dairy and beef cattle have a higher risk of being seropositive than dairy-only holdings (Van Wuijckhuise et al., 1998; Boelaert et al., 2005). In Brazil, beef herds had a higher probability of being BHV-1 seropositive than dairy and mixed herds (Dias et al., 2013). There was no significant difference in seroprevalence for BHV-1 between dairy and beef herds in Ireland (Cowley et al., 2011), whereas herd and animal prevalences, as well as seroconversion rates, were greater in dairy herds than in beef suckler herds in England (Woodbine et al., 2009).

Table 1
Seroprevalence of bovine herpesvirus 1 infection in different countries/regions within and outside Europe.

Country	Herds (*n*)	Animals (*n*)	Prevalence (%)		Within-herd	Herd type	References
			Herd	Animal			
Within Europe							
Belgium	556	28,478	67	35.9	34	Dairy, beef	Boelaert et al., 2000
Southern Italian Apennines	81	948	98.8	77.5	–[a]	Dairy, beef, mixed	Rinaldi et al., 2007
England and Wales	341	–	69.2	–	–	Dairy	Paton et al., 1998
South-west England	114	15,736	43.1	42.5	–	Dairy, beef	Woodbine et al., 2009
Scotland	114	1152	48 (Dairy) 82 (Beef)	12	–	Dairy, beef	Msolla et al., 1981
Andalusia (Spain)	164	2393	70.4	45.7	–	Dairy, beef	Gonzalez-Garcia et al., 2009
Galicia (Spain)	All	–	50.4	38.4	–	Dairy, beef	Eiras et al., 2009
Ireland	1175	–	77.4	–	–	Dairy, beef	Cowley et al., 2011
Lithuania	–	346	–	14.0	–	Pedigree cattle	Jacevičius et al., 2008
Hungary	736 (Large herds)	–	79.3 (Large herds)	64.1 (Large herds)	–	Dairy	Tekes et al., 1999
	63,373 (Small herds)	–	13.5 (Small herds)	–	–		
The Netherlands	33,636	–	84	–	–	Dairy, mixed	Van Wuijckhuise et al., 1998
Northern Italy	51	6415	84.3	35.0	–	Dairy	Castrucci et al., 1997
Central Italy	4	564	100	38.7	–		
Estonia	1205	–	22	–	–		Raaperi et al., 2010
	64	–	–	–	31.5		
Other countries							
Uruguay	230	6358	99	37	–	Beef	Guarino et al., 2008
Ecuador	346	2367	82.1	43.2	64.1	Dairy, mixed	Carbonero et al., 2011
Parana State (Brazil)	2018	14,803	71.3	59	–	Dairy, beef, mixed	Dias et al., 2013
State of Bahia (Brazil)	–	558	–	56	–	Dairy, beef	Cerqueira et al., 2000
Turkey	31	13,011	97	53.2	–	Dairy	Alkan et al., 2005
Thailand	220	–	67	–	–	Dairy	Kampa et al., 2004
	11	–	–	–	5		
Peru	60	–	51	–	–	Dairy	Ståhl et al., 2002
China	–	1344	–	35.8	–	Dairy	Yan et al., 2008
India	4	595	–	60.8	–	Dairy, buffalo	Trangadia et al., 2010
Southern India	–	–	–	50.9 (Cattle) 52.5 (Buffalo)	–	Cattle, buffalo	Renukaradhya et al., 1996
Mexico	35	564	97	54.4	–	Beef	Solis-Calderon et al., 2003
Pacific Region, Central Costa Rica	35	496	94	48	43	Dairy, beef	Raizman et al., 2011
Southern Province, Zambia	–	116	–	48.3	–	Cattle	Mweene et al., 2003
Venezuela (Apure State)	–	615	–	67	–	Beef	Obando et al., 1999
Algeria	–	2948	–	20.5	–	Diseased cattle	Achour and Moussa, 1996
Tunisia	44	10%[b]	–	25.9	–	Cattle	Ghram and Minocha, 1990
Morocco	–	524	–	62.8	–	Cattle	Mahin et al., 1985

Large herds ≥ 50 animals; Small herds < 50 animals.
[a] Data not available.
[b] Approximately 10% of animals within herd.