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Review

Mycoplasma mastitis in cattle: To cull or not to cull

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ABSTRACT

Bovine mastitis caused by mycoplasmas, in particular *Mycoplasma bovis*, is a major problem for milk production and animal welfare in large dairy herds in the USA and a serious, although sporadic, disease in Europe and the Middle East. It causes severe damage to the udder of cattle and is largely untreatable by chemotherapy. Mycoplasma mastitis has a distinct epidemiology and a unique set of risk factors, the most important of which is large herd size. The disease is often self-limiting, disappearing within months of outbreaks, sometimes without deliberate intervention. Improved molecular diagnostic tests are leading to more rapid detection of mycoplasmas. Typing tests, such as multi-locus sequence typing, can help trace the source of outbreaks. An approach to successful control is proposed, which involves regular monitoring and rapid segregation or culling of infected cows. Serious consideration should be given by owners of healthy dairy herds to the purchase of *M. bovis*-free replacements. Increased cases of disease could occur in Europe and Israel if the trend for larger dairy herds continues.

Introduction

Mastitis caused by mycoplasmas is less common than mastitis caused by other bacteria, but results in severe udder disease and has a distinct epidemiology, with a unique set of risk factors (Fox et al., 2003). It usually can be differentiated from mastitis caused by *Staphylococcus* and *Streptococcus* spp. because it: (1) is highly contagious; (2) affects more than one quarter; (3) causes a significant loss in milk production; (4) often is refractory to antibiotic treatment; (5) may result in an increase in purulent, although odourless, mastitis, often with the presence of abnormal and discoloured secretions; and (6) affected cows can remain externally normal, with few overt clinical signs, even in severe cases.

For these reasons, and despite its relative infrequency and sporadic nature in European herds, mycoplasma mastitis is feared by the dairy industry. In the USA and other countries with large dairy herds, this fear is justified, since it can cause significant losses in milk production. Such was the impact on the large dairy herds of the former German Democratic Republic that mycoplasma mastitis was declared a notifiable disease (Pfutzner et al., 1986), a declaration lost on German re-unification. The paucity of cases in Europe and Israel may change if the trend for larger dairy herds continues, bringing an increased risk of mycoplasma mastitis.

Mycoplasma mastitis is considered to be untreatable and, consequently, culling remains to be the most common recommendation for its control. This review discusses the risk factors associated with disease, examines new diagnostic and typing tests, which may help in the detection and tracing of the disease, and provides updated advice on control methods.

Causal species

Of the 25 or so mycoplasmas that have been detected in cattle, only a few have been linked to bovine mastitis. *Mycoplasma bovis* is most prevalent and was first isolated from mastitic cows in the USA in 1961. It was originally named *Mycoplasma agalactiae* var. *bovis* because of the similarity the small ruminant pathogen, *M. agalactiae*, with which it shares biochemical, immunological and genetic features. *M. bovis* is also a cause of other diseases, including pneumonia, arthritis and genital, ear and eye disorders. *Mycoplasma bovigenitalium*, the first mycoplasma ever to be linked to mastitis, or indeed any infectious disease in cattle, in 1960 in England (Davidson and Stuart, 1960), is occasionally found in milk and the reproductive tract, often in infertile cattle and/or those showing endometritis or vulvitis; it can also be found in clinically normal animals (Nicholas et al., 2008). More than half of mycoplasma mastitis cases in the USA are caused by *M. bovis*, while *Mycoplasma californicum*, *M. bovigenitalium*, *Mycoplasma alkalescens* and *Mycoplasma canadense* account for most of the other cases (Fox, 2012). In Europe, *M. bovis* is the dominant species, whereas other mycoplasmas are rarely involved, although this may reflect a lack of thorough investigation. Occasional isolations of *M. bovigenitalium* and *M. alkalescens* have been made from milk, but it is not easy to correlate their presence with disease (Lysnyansky et al., 2015).

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Prevalence

Until recently, outbreaks of mycoplasma mastitis in Europe and Israel were rare, although this was possibly due to under-reporting. Routine mycoplasma investigations were rarely conducted on undiagnosed cases of mastitis, estimated at over a quarter of clinical and nearly 40% of subclinical cases (Bradley et al., 2007). However, a survey of mastitic milk samples from over 100 dairy herds in the UK, from which no bacteria could be isolated, found only a single case positive for *M. bovis* (R. Nicholas, unpublished data). It is probably accurate that the number of cases of bovine mycoplasma mastitis in Britain is <1% per year, which is very similar to surveys performed in bulk milk tanks in France (Arcangioli et al., 2011).

The prevalence of mycoplasma mastitis may be somewhat higher in other European countries based on sampling bulk milk tanks, with reports of 1.5% in Belgium (Passchyn et al., 2012) and 5.4% in Greece (Filioussis et al., 2007). Outbreaks of mycoplasma mastitis have been reported in Denmark (Nielsen et al., 2015), Austria (Spergser et al., 2013), The Netherlands (van Engelen et al., 2015), Switzerland (Aebi et al., 2015) and, more recently, Norway, which, until 2014, had been *M. bovis*-free (.R. Nicholas, unpublished observations). In Israel, from 2004 to 2007, the percentage of *M. bovis* infected herds was <1%, but increased to nearly 4% during 2008 and ranged from <1% to 3% from 2009 to 2014. Since 2008, about 10 *M. bovis* positive dairy herds have been identified in Israel annually, over half of which were usually newly infected cases (Lysnyansky et al., 2015).

The herd level prevalence of mycoplasma mastitis is 55% in Mexico (Miranda-Morales et al., 2008) and 100% in Iran (Ghazaei, 2006). Recent surveys in Australia indicate that the prevalence of *M. bovis* is low in dairy herds (Morton et al., 2014), while New Zealand is probably free of *M. bovis* (McDonald et al., 2009). In the USA, the prevalence of mycoplasma ranges from <3% of bulk milk tanks in the Northeast and Midwest to 9.4% in the large dairy herds in the West (Fox, 2012).

Risk factors

Herd size

A few years after the first cases of *M. bovis* mastitis were seen in the USA, it became clear that the larger herds (>500 cows) were more vulnerable to mycoplasma mastitis than smaller herds. In a case control study, Thomas et al. (1981) found that herd size and culling percentage were significantly and positively correlated. However, it was not possible to resolve whether culling was a cause or an effect associated with the presence of mycoplasma mastitis, or whether herds that cull more cattle were likely to import more cattle into their herds, thus incurring a greater risk of introducing mycoplasma.

In a 2 year study of risk factors for mycoplasma mastitis involving >650 herds, Fox et al. (2003) showed that the somatic cell counts of the other major contagious mastitis pathogens, *Staphylococcus aureus* and *Streptococcus agalactiae*, did not correlate with the presence of mycoplasma in the bulk tank milk. However, larger herd size, as measured by the total amount of milk produced, was significantly correlated with the detection of *M. bovis* in bulk milk.

Conclusive evidence of herd size risk was provided by McCluskey et al. (2003), who demonstrated prevalences of mycoplasma in bulk milk tanks of 2.1%, 3.9% and 21.7% in herds with <100, 100–499 and more than 500 cows, respectively. In contrast, the prevalence of other bacterial mastitis pathogens was unrelated to herd size. The increase in incidence of cases of mycoplasma mastitis in Israel in recent years may be due to an expansion in herd size; the number of farms with >600 cows has doubled since 2008 (Lysnyansky et al., 2015).

While importing cattle clearly increases the chances of introducing mycoplasma to a farm, larger herd sizes also provide greater opportunity for the organism to spread and thus more easily to maintain itself within the population. Conversely, smaller herds allow more frequent breaks in mycoplasma transmission, probably as a result of lower stocking densities and fewer susceptible animals.

Introduced cattle

The contagious nature of mycoplasma infections means that infected animals are the main source of infections for other livestock. Bovine mycoplasmosis is no exception and new infections invariably can be traced to introduction or contact with clinically or subclinically affected cattle (Punyapornwithaya et al., 2010). Cows that have had contact with infected animals may harbour mycoplasma until stress such as calving results in the development of contagious disease. Once introduced into a herd, mycoplasma can be transmitted rapidly to up to 40% of healthy cattle unless they are segregated (Punyapornwithaya et al., 2012).

It is the resident cattle that are most likely to be affected following introduction of animals raised elsewhere. However, in some cases, it is the introduced animals that are most at risk on arrival to a farm with subclinical mastitis. Houlihan et al. (2007) reported severe outbreaks of mastitis and arthritis in newly purchased cows and heifers; more than half the 120 cows were culled due to unresponsive mastitis and arthritis, although none of the cows that had arthritis developed mastitis.

Dry cow period

In the UK, Bicknell et al. (1983) reported an outbreak of *M. bovis* mastitis among dry cows, which was unusual in that it continued for several months and only later appeared to spread to lactating cows and new heifers. The outbreak continued for over a year and was ostensibly controlled by targeted culling of diseased animals and stricter hygiene. It was strongly suspected, based on serological evidence, that animals purchased in the previous year were the source of the outbreak. Not all animals that were positive for *M. bovis* were clinically affected; furthermore, contrary to expectations, some diseased cattle cured spontaneously.

In the UK, four separate outbreaks of mycoplasma mastitis occurred in dry cows in the west Midlands and north east Wales in 2015 (Otter et al., 2015). Thorough evaluation of management and treatment techniques employed by the herdsmen failed to identify obvious faults. None of the herds had a history of *M. bovis* infection and only one had recently introduced cattle. Although culling was employed and the outbreaks in each case resolved, it was uncertain whether this practice was beneficial.

Other risk factors

Feeding waste milk or colostrum to livestock increases the risk of transmission to the rest of the herd and may cause otitis in calves (Foster et al., 2008); pasteurisation is recommended if this is practised. The lack of a well separated sick or hospital pen has also been identified as a risk factor in the spread of the infection (Fox, 2012; Jensen et al., 2015). Return of hospitalised cattle to the healthy pen should be considered very carefully, since they may excrete mycoplasma sporadically for >1 year.

Evidence is increasing that the presence of calves in close contact with dairy cattle is a risk factor, since respiratory secretions via aerosols and nose-to-nose contact are important in the spread of respiratory disease (Maunsell et al., 2011; Lysnyansky et al., 2015). Prolonged colonisation of the nasal cavity by *M. bovis* of young stock has been reported (Aebi et al., 2015); this could provide a source of infection for the lungs of cows, followed by spread to the mammary glands via the blood stream. The discovery of mycoplasma biofilms, in which there is differential gene expression,