Mycoplasma Bovis

Control Tools

Diagnostics availability

Commercial diagnostic kits available worldwide

Some commercial ELISAs are available.

GAP:
Serological detection ELISA kits are produced by Biovet (Canada) and BioX (Belgium). BioX also produce an ELISA kit for antigen detection.

Previously the sensitivity and specificity of some of these kits has been questioned resulting in the change to the BioX serology ELISA kit recommended cut-off points to reduce false-positive results.

Improved knowledge of the sensitivity and specificity of tests is required when used on different age animals under different farming conditions.

Commercial diagnostic kits available in Europe

Yes, ELISA.

Diagnostic kits validated by International, European or National Standards

None.

Diagnostic method(s) described by International, European or National standards

Not included in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial animals.

Commercial potential for diagnostic kits in Europe

Potential exists with the need to identify whether *Mycoplasma bovis* is a primary or secondary causal agent associated with production problems.

GAPS: Considerable potential for the development of more specific and sensitive tests, ideally rapid with the possibility of pen-side application. Multiplexed testing for different organisms and activity associated with disease could be developed.

DIVA tests required and/or available

Would be helpful if effective vaccines are developed. Should be linked to the vaccine development. Note: an attenuated live vaccine has been described in China and an ELISA has been described with a cut-off point that differentiates vaccinated animals from infected animals (Han *et al*., 2015).

Opportunities for new developments

Availability of the five genome sequences of *Mycoplasma bovis* as well as accumulated data regarding the presence of variable
antigens and multiple repeat sequences may allow designing of molecular typing schemes for *Mycoplasma bovis* disease surveillance. In addition, decoding of molecular mechanisms responsible for antibiotic resistance may allow development of molecular assays to monitor antimicrobial resistance in clinical samples.

Sequence information has helped investigate the potential use of purified proteins for ELISA tests (Wawegama et al., 2014); and vaccines with different adjuvants (Prysliak and Perez-Casal, 2016).

**GAPS:**

**Improved diagnostic tests** required either to be developed or evaluated and implemented:

**Molecular** eg.: Improved R-T PCR, isothermal PCR tests; micro-array.

**Serological** eg.: Improved ELISA; Latex agglutination tests, lateral flow devices, resonance devices, etc.

**Culture:** Rapid systems, with species isolation and identification methods.

Methods for diagnosis should include **antibiotic sensitivity** testing and determining antibiotic resistance in real time.

**Penside tests** (serological and antigen detection)

Molecular epidemiological tests have been developed to differentiate isolates (VNTR and MLST), but a universal "typing scheme" has not been developed or "types" related to pathogenicity/clinical signs.

Multiplex testing for BRD organisms and mastitis organism to include *Mycoplasma bovis*.

### Vaccines availability

**Commercial vaccines availability (globally)**

Commercially available vaccines are licensed in the USA. These are Bacterin type vaccines with a number licensed for prevention of respiratory disease and others for the prevention of mastitis.

**GAPS:**

Autogenous vaccine used successfully on a few farms in the UK.

The contribution of the immune response to the development of chronic lesions indicates caution in the use of vaccines. The mechanism of disease development needs to be understood to develop safe and effective vaccines for worldwide use.

**Commercial vaccines authorised in Europe**

No commercial vaccines exist for *Mycoplasma bovis*.

**Marker vaccines available worldwide**

No.

**Marker vaccines authorised in Europe**

No.

**Effectiveness of vaccines / Main shortcomings of current vaccines**

Not applicable.

**Commercial potential for vaccines in Europe**

High provided demand and price are satisfactory.
Regulatory and/or policy challenges to approval

Use of genetically modified vaccines might be problematic in some countries. The field trials may need specific regulation regarding the release of GMOs into the environment.

Commercial feasibility (e.g. manufacturing)

Feasible.

Opportunity for barrier protection

Could be used to protect farms in regions or zones provided the vaccinated animals do not excrete the organism.

Opportunity for new developments

Genomic analysis and anticipated expansion to various species differing in clinical properties will aid the identification of species consensus target genes.

While there are several research groups worldwide that have both interest and expertise to work on vaccine development, it has been impossible to get proper funding for this topic in the past decade. The apparent disregard by funding organisations of mycoplasma-associated diseases is not due to insufficient evidence showing the economic importance, but rather a consequence of the generally low profile of these pathogens in the decision-making bodies.

GAPS:

Vaccine needs developing and marketing.

Should be safe, effective against all clinical signs, at all stages of animal production, against all Mycoplasma bovis variations, stable, ideally single shot, provide long-term effective protective immunity and be usable in all countries. DIVA would be beneficial.

Pharmaceutical availability

Current therapy (curative and preventive)

There is a poor response to treatments especially in cases of chronic respiratory disease or mastitis. The US Food and Drug administration have approved the only antibiotic for the treatment of bovine respiratory disease linked to Mycoplasma bovis. This is DRAXXIN (tulathromycin) an injectable solution produced by Zoetis. A range of other antibiotics are used against Mycoplasma bovis infection but high levels of resistance are seen with a number of the antibiotics.

GAP:

Lack of an understanding of the epidemiology of the disease at the herd level hampers the development of therapeutic preventive measures. Currently the most widely used preventive measure is chemotherapy but test and slaughter is a crude and less economical strategy to control this disease.

Future therapy

Effective anti-mycoplasma drugs.

Commercial potential for pharmaceuticals in Europe

High potential for an effective anti-mycoplasma drug but there could be constraints in relation to potential resistance if the antibiotic is applied widely.
Regulatory and/or policy challenges to approval

None foreseen.

Commercial feasibility (e.g. manufacturing)

Commercially feasible but would depend on the market, price and demand.

Opportunities for new developments

See Section "Vaccines availability – opportunities for new development".

Identification of the drug exporter ABC transporters in the Mycoplasma bovis genomes. Such proteins may be involved in the export of antibiotics and they are potential targets for development of new antimicrobial agents.

**GAPS:** Effective antibiotic treatment regimes need investigating, especially with the widespread occurrence of resistance. Development of new or alternative antibiotics is required. Consideration could be given to assessing the effectiveness of medicinal plants.

New developments for diagnostic tests

**Requirements for diagnostics development**

Diagnostics should be standardized, fast and cheap.

Comparison and evaluation of existing diagnostic tests on a pan-European scale is required but has not been conducted so far.

Commercial availability of more serological tests and their validation.

Development of rapid "field" test to identify infected cattle.

Development of rapid molecular assays for detection of resistant strains in the clinical samples.

**GAPS:**

As mentioned in Section "Vaccine availability – Opportunities for new developments", a number of possibilities already exist for test development and validation.

Herd positive and negative samples are usually readily obtainable. One potential problem is the different disease manifestations and interpretation of ‘healthy’ carrier animals and if the presence of the organism is an effective indicator of disease in the herd/group of animals.

Intermittent shedding of organisms can give rise to ‘false’ antigen negative animals.

Testing at individual animal level rather than herd level may be beneficial.

**Time to develop new or improved diagnostics**

In general, the development of tests is much faster and less expensive than developing vaccines. From development through validation to commercial availability will be time consuming and can take years.

**Cost of developing new or improved diagnostics and their validation**

The development and validation of new tests is time consuming and labour intensive which is costly. Costs cannot be specified as they will depend on the nature of the test and the cost of producing reagents and supplying reading or processing machines if necessary. Once validated there will need to be a commercial company willing to market the test.
**Research requirements for new or improved diagnostics**

Increased knowledge on pathogenesis and involved virulence factors.

Increased knowledge on host immune response.

Increased knowledge on ability of *Mycoplasma bovis* to invade host cells.

Extended sequencing of field strains from different clinical conditions.

**GAPS:**

Most technologies are available to develop the required new diagnostics, however the main issue is investment in the small number of workgroups working on these fastidious and specialist organisms. Limited investment in non-zoonotic and endemic diseases has restricted development of new improved diagnostics.

As mentioned in Section "Diagnostic availability – Opportunities for new developments", the following test would be beneficial.

**Improved diagnostic tests** required either to be developed or evaluated and implemented:

- **Molecular:** R-T PCR, isothermal PCR’s, micro-array
- **Serological:** ELISA, Latex agglutination tests, lateral flow devices, resonance devices, etc.
- **Culture:** Rapid systems, with species isolation and identification methods.
- **Methods for diagnosis should include antibiotic sensitivity testing.**
- **Penside tests** (serological and antigen detection)

Molecular epidemiological tests have been developed to differentiate isolates, but a universal “typing scheme” has not been developed or “types” related to pathogenicity/clinical signs.

Multiplex testing for BRD organisms and mastitis organism to include *Mycoplasma bovis*.

**Technology to determine virus freedom in animals**

Would need effective mechanisms to determine freedom from infection with *Mycoplasma bovis* using a mixture of culture, PCR and serology.

**New developments for vaccines**

**Requirements for vaccines development / main characteristics for improved vaccines**

Increase knowledge on host immune response.

Requirements for safer, immunogenic vaccine that in ideal case will be able to protect from infection with field isolate.

Some success has been reported using a saponised autogenous vaccine in the UK, but more funding for research projects is required to address this issue adequately.

**GAPS:**

Work in Canada is currently evaluating using purified proteins as potential vaccine candidates; and workers in China have described the development of a live attenuated vaccine.

Vaccine development is required. Some success has been reported using a saponised autogenous vaccine in the UK.

Some other vaccine development has resulted in exacerbation of disease. Other concerns relate to the variability of the surface proteins expressed by *Mycoplasma bovis* and the possible requirement to use multiple strains in a vaccine. Adjuvant selection could be critical is stimulating a protective immune response.

**Time to develop new or improved vaccines**

Depending on when a candidate vaccine could be identified the timescale will be 5-10 years. This will involve development, clinical trials and licensing. Potential vaccines need to be identified and subjected to initial trials and depending on the outcome will depend the time to commercial availability.
Cost of developing new or improved vaccines and their validation

Expensive with the need to develop and undertake all the relevant tests to provide data to enable the product to be authorised. Field trial will be difficult as will evaluating the results.

Research requirements for new or improved vaccines

Increase knowledge on host immune response.

Identification of protective antigens, which may be used as a vaccine candidates, through genomic, bioinformatics, proteomic, immunological and biological approaches.

GAPS:

Improved understanding of the disease pathogenicity and infectious routes along with a good understanding of the host’s immunological response would provide a sound basis for antigen and adjuvant selection.

In addition, a good reproducible model for disease is also essential, especially as the infection can result in varied clinical signs such as calf pneumonia, arthritis, mastitis, etc. Evaluation of potential vaccines against these clinical signs will be required.

New developments for pharmaceuticals

Requirements for pharmaceuticals development

GAPS:

Screening of novel chemicals and plant extracts is required to develop new pharmaceuticals. Proper regard will need to be given to meat and milk withdrawal times for newly developed pharmaceuticals.

Decoding molecular mechanisms responsible for antibiotic resistance.

Time to develop new or improved pharmaceuticals

Time to develop would depend on the product and the trials necessary to validate the efficacy and safety. Commercial production would then take further time. Five to 10 years seems a realistic timeframe.

Cost of developing new or improved pharmaceuticals and their validation

Expensive but difficult to assess as it will depend on the product and the trials necessary to validate and license.

Research requirements for new or improved pharmaceuticals

Standardization of MIC tests.

Determination of MIC breakpoints for Mycoplasma bovis.

Decoding mechanisms responsible for antibiotic resistance.

Identification of relevant protective antigens, through genomic, bioinformatic, proteomic, immunological and biological approaches.

GAPS:

Rapid and improved minimum inhibition concentration and mycoplasmacidal tests need developing and standardising. Breakpoint values need to be determined to relate in vitro tests to in vivo situations. These tests should take into account the possible impact of biofilm formation. The development of resistance and mechanisms of resistance will also need investigating.
**Disease details**

**Description and characteristics.**

**Pathogen**

*Mycoplasma bovis* is a member of the genus *Mycoplasma* and Family *Mycoplasmataceae* within the Class *Mollicutes*. *Mycoplasma bovis* was first detected as a cause of bovine mastitis in the USA in the 1960s and has since been detected in most countries worldwide with only a few exceptions.

**Variability of the disease**

*Mycoplasma bovis* is considered to be one of the more pathogenic species of *Mycoplasma* and is an important pathogen of cattle.

**GAPS:**

*Mycoplasma bovis* disease makes a significant economic impact on cattle rearing, but its importance has not yet been recognised sufficiently to be listed by The World Organisation for Animal Health (OIE).

The role of variable surface proteins is not currently understood. Availability of the *Mycoplasma bovis* genomes showed the enormous potential variation the organism has (Wise *et al*., 2011; Li *et al*., 2011; Qi *et al*., 2012). More genome sequences of isolates from hosts with different clinical signs could increase our knowledge of the organism’s mechanisms for survival and its evasion of the host defence mechanisms.

**Stability of the agent/pathogen in the environment**

*Mycoplasma bovis* can survive outside the host in the environment especially if protected from sunlight. At lower temperatures it can survive for days or weeks in water, manure etc.

**GAPS:** Mycoplasmas lack a cell wall that should make them susceptible to environmental pressures, however they do survive for long periods, with one report (Justice-Allen *et al*., 2010) indicating survival in bedding sand for 8 months. Recent research has partly explained extended survival through the presence of biofilms, however further work is required.

**Species involved**

**Animal infected/carrier/disease**

Infected cattle can become asymptomatic carriers and may shed the organism through nasal discharges or in milk for months to years without showing clinical signs. It is the most frequent *Mycoplasma* pathogen linked to pneumonia, mastitis, and arthritis in cattle.

**GAPS:** Other species may become infected, or be carriers – cases have been reported in sheep, goats, buffaloes, deer, chickens and swine. Diagnosis in sheep and goats is complicated by genetic homology of *Mycoplasma bovis* with *Mycoplasma agalactiae*.

**Human infected/disease**

No evidence for human disease with *Mycoplasma bovis*.

**GAP:** A few cases have been reported in immunocompromised patients (Pitcher and Nicholas, 2005).

**Vector cyclical/non-cyclical**

None.
Cattle and bison.

**Description of infection & disease in natural hosts**

**Transmissibility**

Highly contagious. Easily transmitted often by the aerosols.

**Pathogenic life cycle stages**

Not applicable.

**Signs/Morbidity**

The diseases caused by *Mycoplasma bovis* can be very variable. These include mastitis, pneumonia, arthritis and genital disorders which can occur in cattle of all ages. The organism has been associated with polyarthritis in feedlot cattle and otitis media in young calves. Subclinical, clinical or chronic mastitis may be caused by *Mycoplasma bovis*. Mastitis can be severe with one or all quarters being affected with a serous or purulent exudate. Cows may not show any systemic signs in spite of the udder infection *Mycoplasma bovis* is a primary cause of calf pneumonia typically in a non-specific respiratory disease that does not respond to antibiotics. In pneumonia it is nearly always associated with a range of other pathogens where it may have a synergistic role. As a consequence, *Mycoplasma bovis* may be overlooked as the causal agent due to the presence of the more familiar pathogens.

**GAP:** A few isolates have been made from the brain; one of these cases was associated with a large spheroidal fibrinous lesion in the heart.

**Incubation period**

Variable depending on the age of animals, the clinical and pathological effects of infection. Difficult to define due to difficulty in diagnosis and in assessing the time of infection. Experimentally incubation may be a few days for mastitis and from 7 days for pneumonia. Field cases of pneumonia are probably much longer and influenced by the co-infectants present.

**GAP:** In one herd with an outbreak of mycoplasma mastitis the incubation period was estimated to be 13.6 days (Punyapornwirthaya et al., 2011). The strain and herd management differences may impact on the length of the incubation period making this a relatively unknown factor in the control of the disease.

**Mortality**

Variable depending on the clinical disease, age of animals and other infections. Can be high in the case of pneumonia and arthritis.

**Shedding kinetic patterns**

Infected cattle can shed the organism for months to years.

**GAP:** Role of the asymptomatic carrier in a herd outbreak is largely unknown.

**Mechanism of pathogenicity**
*Mycoplasma bovis* can probably invade tissues and enter the bloodstream to spread to other tissues.

**GAPS:**

Mechanisms of pathogenicity are currently poorly understood for *Mycoplasma bovis*. Its transmission within the host, predilection for specific sites, intermittent shedding and differences in resulting clinical signs are not known. The role of some defined virulence factors such as the variable surface proteins in disease is still to be ascertained. Possible differences in route of infection, infectious dose, host susceptibility, age, breed etc also requires investigation. The ability of *Mycoplasma bovis* to invade bovine peripheral blood mononuclear cells and erythrocytes has been recently demonstrated by van der Merwe et al. (2010). The invasion of circulating immune cells and erythrocytes could play an important role in pathogenicity of *Mycoplasma bovis* disease (protection of the pathogen from host immune response, administered antibiotics and may lead to persistence of infection and dissemination of the pathogen between organ systems).

Methods of making *Mycoplasma bovis* genetic mutants have been developed (Chopra-Dewasthaly et al., 2005; Sharma et al., 2014; Sharma et al, 2015), coupling these with studies in animal models is critical to understanding pathogenesis.

**Zoonotic potential**

**Reported incidence in humans**

No evidence of transmission to humans.

**GAP:** A few cases have been reported in immunocompromised patients (Pitcher and Nicholas, 2005).

**Estimated level of under-reporting in humans**

Not applicable.

**GAP:** Possibility of under reporting as its specific diagnosis would not generally be considered.

**Risk of occurrence in humans, populations at risk, specific risk factors**

Not applicable.

**GAP:** Immunocompromised people with close contact with infected cattle or their products (infected milk or faeces).

**Symptoms described in humans**

Not applicable.

**GAP:** Respiratory disease, bronchopneumonia.

**Likelihood of spread in humans**

None.

**Impact on animal welfare and biodiversity**

**Both disease and prevention/control measures related**

Serious impact on the welfare of cattle through the disease it causes.

**Endangered wild species affected or not (estimation for Europe / worldwide)**
No information although cases of infections in buffalo and bison in the USA/North America caused high mortality.

**GAPS:** Some farmed species of bison, buffalo and deer have been affected, but spread into wildlife or their potential as hosts has not been investigated. Farmed bison have experienced acute outbreaks with high mortality in adults, and it is not known if this represents high susceptibility of this species or the naïve status of the herds. Probably low risk for cervids and antelope family of species. Spangser et al. (2013) reported *Mycoplasma bovis* in pigs sharing a pasture with infected cattle, therefore the potential is there to spread to wild boar.

*Slaughter necessity according to EU rules or other regions*

Culling infected carrier animals especially those with mastitis may be the only method of reducing the infection levels on a farm. Slaughter may be required for animal welfare reasons.

**Geographical distribution and spread**

**Current occurrence/distribution**

*Mycoplasma bovis* was first definitively identified in the USA in 1961, although clinical signs associated with *Mycoplasma bovis* were described previously. It is now considered to be present worldwide. It is the most important *Mycoplasma* pathogen in cattle in the USA and Europe.

**Epizootic/endemic - if epidemic frequency of outbreaks**

Can spread very rapidly once introduced into a herd. Spread to new herds is usually due to the movement of asymptomatic carriers being purchased and introduced into a clear herd.

**GAP:** Suspect that stress of cattle (climatic changes, overcrowding, introduction of new animals, and translocation) might trigger an outbreak.

**Seasonal cycle (seasonality)**

None.

**GAPS:** Calf pneumonia is undoubtedly higher during colder seasons with *Mycoplasma bovis* pneumonia appearing to account for approximately 20-30% of infections. Temperature fluctuations are more likely to be a key factor in disease and not just exposure to the cold. Poor housing conditions are probably an important contribution to pneumonia in winter conditions. In seasons of reduced pneumonia *Mycoplasma bovis* may account for a higher percentage of pneumatic cases.

**Speed of spatial spread during an outbreak**

Rapid.

**GAP:** Instances where just a few sero-positive animals within large sero-negative herds requires additional studies on the epidemiology of transmission.

**Transboundary potential of the disease**

High, association with movement of clinically normal infected animals.

**Seasonal cycle linked to climate**
No.

Distribution of disease or vector linked to climate

No.

Outbreaks linked to extreme weather

No, apart from the impact of adverse weather on associated stress on the animals.

**GAP:** Any links to sudden changes of weather.

Sensitivity of disease or vectors to the effects of climate change (environmental changes/land use)

No.

**Route of Transmission**

**Usual mode of transmission (introduction, means of spread)**

The primary routes of infection can vary depending on the problem in the infected herd but are usually close contact through direct nose to nose transmission via aerosols and/or by the ingestion of infected milk. Milking parlour hygiene for mastitis.

**GAP:** Intracellular role, bacteraemia and spread of *Mycoplasma bovis* which may be associated with the different clinical signs observed in animals, including arthritis, pneumonia, mastitis, and keratoconjunctivitis.

**Occasional mode of transmission**

Ingestion of contaminated milk is a major source for calves.

**Conditions that favour spread**

Movement of infected animals into clean herds or vice-versa.

Increased risk of mastitis linked to larger herds.

**Detection and Immune response to infection**

**Mechanism of host response**

Humoral response.

**GAP:** Immune response contributes to the lesion development, at least at chronic stage.

**Immunological basis of diagnosis**

Serological tests for the presence of antibodies.
Main means of prevention, detection and control

Sanitary measures

*Mycoplasmas* can be introduced in a herd by subclinical infected carriers. Once established in the herd, the infection is difficult to control.

Mechanical and biological control

Limited methods available for control. Control of other pathogens by vaccination to reduce the impact of *Mycoplasma bovis* is a secondary infection. When *Mycoplasma bovis* is the primary pathogen it can be difficult to control. Preventing the introduction into the herd by sourcing replacement stock from known free herds, management factors by avoiding mixing cattle of different ages especially calves and culling positive animals. Reducing co-mingling stress can reduce clinical presentations, both for mastitis or respiratory disease.

Diagnostic tools

Isolation and identification of *Mycoplasma bovis* from bulk milk tank or from cows with clinical mastitis. Use of *Mycoplasma bovis* specific PCR's, R-T PCR's and microarrays is increasing. Use of the 16S rDNA PCR and DGGE (denaturing gradient gel electrophoresis) detects and differentiates the many *Mycoplasma* species detected in cattle.

Serology using paired sera collected at 10-14 day intervals to detect rising antibody titres. Many different tests have been used including indirect ELISA, indirect haemagglutination etc.

**GAPS:** Intermittent shedding of organisms and the inhibitors present in milk may reduce the effectiveness of current tests. Isothermal amplification tests such as LAMP are being reported, but are not in routine use. Some workers describe the use of MALDI-TOF, but this generally requires culture of the organism before identification with MALDI-TOF. No pen-side tests are currently available.

Vaccines

A number of commercial vaccines exist prepared from a limited number of strains.

**GAP:** Autogenous vaccines are produced by several companies for use solely in the USA. Data about their effectiveness is sparse. Autogenous vaccine is prepared in the UK. Research needs to be addressed at the development of live vaccines.

Therapeutics

*Mycoplasma bovis* as with other organisms in the group lacks a cell wall, which means the organism is resistant to some commonly used antibiotics. In general *Mycoplasma bovis* is resistant to antibiotic therapy which can also be expensive and ineffective.

France has reported that an antibiotic resistant molecular type is now the dominant strain present in France.

Tulathromycin (Draxxin) has recently been approved in the USA for treatment.

**GAPS:** Several countries have reported antibiotic resistance by *Mycoplasma bovis* to many antibiotics, including macrolides, tetracyclines, lincosamides, aminocyclitols and fluoroquinolones. Some mechanisms of resistance have been determined as similar to other bacterial species, however some mechanisms have not yet been discovered and require further investigation. Efflux mechanisms are one possible area for investigation.

Biosecurity measures effective as a preventive measure

Limited effect, but a closed herd policy preventing the introduction of *Mycoplasma bovis* into a herd is important along with general measures to reduce the levels of infection in the environment. Avoid mixing calves of different age groups. Some recommend distancing dairy farms from calf fattening units.
Border/trade/movement control sufficient for control

No specific controls in place to control movements.  

**GAP:** NZ/Israel impose additional testing on exporting countries.

Prevention tools

Limited availability.

Surveillance

Sero-surveillance and disease surveys can be undertaken.  

**GAPS:** The prevalence seems to vary considerably by country. New Zealand indicated it was absent, and in the US and Canada the prevalence may vary from 2% to >30%, depending on the region. Mexico’s herd prevalence appears to be higher. The true incidence of *Mycoplasma bovis* is not really known, available information appears to be based on passive surveillance information. A serological survey and abattoir survey could give more information about its true prevalence. The real economic cost of the disease has not been determined – a survey to include all cost factors that includes mortality, veterinary costs, treatment, milk loss, added housing/feed costs through lack of weight gain etc would provide useful evidence.

Past experiences on success (and failures) of prevention, control, eradication in regions outside Europe

This is an organism which has spread widely since it was first identified. Successful measures to control the infection have been very limited. Culling and antibiotic treatments are used to reduce the impact of disease.  

The prevalence of mycoplasma disease has been reported to be increasing with a significant positive correlation with increasing herd size.  

**GAPS:** While it is clear the disease has spread by international trade and opening of EU single market, detection is also the result of increased awareness. Researchers in Ireland suspect the introduction of *Mycoplasma bovis* occurred with entrance into the EU.

Costs of above measures

Expensive. Culling can be devastating and the use of antibiotics is expensive.  

**GAPS:** Reports indicate that early recognition of disease and prolonged therapy is required and consideration should be given to metaphylaxic treatment of whole groups.

Disease information from the OIE

**Disease notifiable to the OIE**

Not notifiable to the OIE.

**OIE disease card available**

No.
Not applicable.

OIE Terrestrial Manual (reference)

Not applicable.

Socio-economic impact

Zoonosis: Impact on affected individuals and/or aggregated DALY figures

None.

Zoonosis: cost of treatment and control of the disease in humans

Not applicable.

Direct impact (a) on production

High with an impact on weight gain, carcase value and mortality as part of the bovine respiratory disease complex. Reduced milk production as a result of clinical and sub clinical mastitis. Overall increased mortality due to a range of clinical conditions. Sterility and abortions may also result from infection.

Direct impact (b) cost of private and public control measures

The cost associated with *Mycoplasma bovis* infection is borne by the private sector. These are related to the treatment, premature culling, mortality and the need to purchase of replacement animals.

Indirect impact

Causes disruption to production.

Trade implications

Impact on international trade/exports from the EU due to existing regulations

No restrictions on movements.

**GAP:** No official restrictions on movement within EU, however some countries importing cattle are increasingly aware of the risks of importing infected cattle and are requesting cattle are tested and shown to be free of *Mycoplasma bovis*.

Impact on EU intra-community trade due to existing EU regulations

No restrictions on movements.

Impact on national trade due to existing regulations

No restrictions on movements.
Main perceived facilitators for effective prevention and control

Effective vaccines.

**GAPS:**

- Effective vaccines.
- Reproducible vaccine challenge methods.

**Risk**

Impact on production.

**Main critical gaps**

Increased knowledge on ability of *M. bovis* to invade host is needed as is an understanding of the transmission within the host, predilection for specific sites, intermittent shedding and differences in resulting clinical signs all of which are still not known. The role of some defined virulence factors such as the variable surface proteins in disease is still to be ascertained. Possible differences in route of infection, infectious dose, host susceptibility, age, breed etc also requires investigation. The mechanism of disease development needs to be understood to develop safe and effective vaccines for worldwide use.

The role of variable surface proteins is not currently understood. The publication of genome sequences of several *M. bovis* strains have shown the enormous potential variation that the organism has. More genome sequences of isolates from hosts with different clinical signs could increase knowledge of the organism’s mechanisms for survival and its evasion of the host defence mechanisms. The identification of protective antigens through genomic, bioinformatics, proteomic, immunological and biological approaches is also important to enable the development of vaccine candidates.

**Conclusion**

There is a worldwide problem of disease caused by *M. bovis*; it has a significant economic impact on cattle rearing. It is a major constraint on intensive production affecting intensive beef production particularly in feed lots and milk production in high yielding herds. The following factors summarises the problems: i) No effective vaccines available, ii) Insidious infection not always easily diagnosed, iii) Difficult to eliminate from a herd, iv) Difficult to assess the cause of the bovine respiratory disease complex when a number of other pathogens are also involved and finally v) Development of antibiotic resistance to many of the antibiotics currently in use.

Lack of an understanding of the epidemiology of the disease at the herd level hampers the development of therapeutic preventive measures. Currently the most widely used preventive measure is chemotherapy but test and slaughter is a crude and less economical strategy to help control this disease.

**Sources of information**

**Name of expert group leader**

Expert group members are included where permission has been given

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**Name of reviewers**
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