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CAMPUS VETERINAIRE DE LYON

Année 2025 - Thèse n° 059

UTILISATION DES ANTIBIOTIQUES CONTRE LES INFECTIONS A MYCOPLASMES EN PRATIQUE VETERINAIRE BOVINE : RECUEIL DE DONNEES DE TERRAIN ET COMPARAISON AUX RECOMMANDATIONS

THESE

Présentée à l'Université Claude Bernard Lyon 1
(Médecine – Pharmacie)

Et soutenue publiquement le 25 septembre 2025
Pour obtenir le titre de Docteur Vétérinaire

Par

SAUDOYEZ Susan

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AST : Antimicrobial susceptibility tests

BRD : Bovine Respiratory Disease

CBPs : Clinical Breakpoints

CBPP : Contagious Bovine PleuroPneumonia

CMI : Concentration minimale inhibitrice

DGGE : Denaturing Gradient Gel Electrophoresis

DNA : Deoxyribonucleic Acid

ELISA : Enzyme-Linked Immunosorbent Assay

EMA : European Medicines Agency

FVE : Fédération des Vétérinaires d'Europe

JPIAMR : Joint Programming Initiative on Antimicrobial Resistance

M. arginini : *Mycoplasma arginini*

M. bovis : *Mycoplasma bovis*

M. bovirhinis : *Mycoplasma bovirhinis*

M. californicum : *Mycoplasma californicum*

M. dispar : *Mycoplasma dispar*

PCR : Polymerase Chain Reaction

SmPC : Summary of Product Characteristics

WOAH :World Organisation for Animal Health

INTRODUCTION

Les mycoplasmes sont des bactéries ubiquitaires appartenant à la classe des Mollicutes, dépourvues de paroi cellulaire de type bactérienne (Gautier-Bouchardon, 2018). Ces bactéries sont des agents pathogènes des humains, mammifères, reptiles, poissons, arthropodes et plantes (Maunsell et al., 2011). Parmi la trentaine d'espèce de mycoplasmes commensales, opportunistes ou pathogènes isolées chez les ruminants, *Mycoplasma bovis* est l'agent étiologique le plus fréquent responsable de mycoplasmoses chez les bovins en Amérique du Nord, en Europe et plus récemment en Asie où des prévalences élevées ont été reportées (Aebi et al., 2012; Caswell & Archambault, 2007; KONG et al., 2016; Maunsell et al., 2011; Maunsell & Donovan, 2009; Nicholas, 2011). Des bovins de tout âge (nouveau-nés, sevrés, en post-sevrage et adultes) et de toute catégories de production (vaches laitières, vaches allaitantes, veaux et bovins de boucherie) peuvent être atteints et les affections provoquées par *M. bovis* sont variées : broncho-pneumonies souvent associées à d'autres agents pathogènes, mammites, arthrites et otites moyennes sont les plus rencontrées. D'autres espèces de mycoplasmes tels que *Mycoplasma dispar* ou *Mycoplasma californicum* peuvent également être à l'origine d'infections respiratoires et de mammites chez les bovins (Nicholas, 2011). La voie aérienne constitue le principal mode de transmission des mycoplasmes mais d'autres voies sont également impliquées dans la dissémination de ces agents, telles que l'ingestion de lait contaminé par les veaux, la pénétration directe via le canal du trayon, la voie génitale et la transmission transplacentaire (Dudek et al., 2020). Les animaux infectés peuvent excréter les mycoplasmes de manière intermittente sur plusieurs mois, représentant ainsi une source persistante de contamination. Le diagnostic repose principalement sur des techniques de diagnostic direct comme la culture bactérienne, qui reste la méthode de référence permettant une détection large des espèces, ou la PCR (Polymerase Chain Reaction) qui permet une

détection sensible et ciblée des mycoplasmes. Des méthodes de détection indirectes par sérologie notamment les tests ELISA (Enzyme-Linked Immunosorbent Assay) sont également utilisées pour la détection d'anticorps dirigés contre les mycoplasmes et confirmer ou infirmer la présence de l'agent pathogène au sein du troupeau (Calcutt et al., 2018; Dudek et al., 2020). Toutefois, la culture des mycoplasmes nécessite un temps d'incubation long (de 3 à 10 jours) et des conditions de croissance très spécifiques : températures comprises entre 33 et 38°C, atmosphère à teneur contrôlée en CO_2 (entre 5 et 10%) et pH à 7,5 (MCVEY, 2022).

Si la lutte contre les mycoplasmes repose en grande partie sur les traitements antimicrobiens, la nature multifactorielle et chronique des infections à *M. bovis* rendent sa prise en charge difficile. De plus, les particularités microbiologiques de cet agent pathogène, notamment l'absence de paroi cellulaire, le rendent naturellement résistant à plusieurs classes d'antibiotiques couramment utilisés, comme les bêta-lactamines ou les sulfamides (Gautier-Bouchardon et al., 2014). Si certains antibiotiques restent théoriquement efficaces, les taux croissants de résistance observés dans le monde compliquent davantage sa prise en charge thérapeutique. Les fluoroquinolones, antibiotiques critiques, sont désormais les seuls antibiotiques totalement efficaces contre cet agent pathogène dans certains pays (Lysnyansky & Ayling, 2016).

De plus, en raison de leur croissance lente et de leurs exigences en milieux de culture, aucune méthode classique habituellement utilisable pour la réalisation de tests de sensibilité aux antibiotiques n'est aujourd'hui applicable aux mycoplasmes. En effet, l'efficacité des antibiotiques est évaluée par des tests *in vitro* déterminant la concentration minimale inhibitrice (CMI) pour chaque molécule par dilution en milieu liquide ou en milieu gélosé, et certaines recommandations pour la réalisation de ces tests sur les mycoplasmes vétérinaires ont été publiées il y a longtemps (Hannan, 2000). Toutefois, l'efficacité *in vivo* des antimicrobiens à partir des valeurs de CMI *in vitro* est difficile à extrapoler, car il n'existe ni normes

standardisées pour les tests *in vitro***,** ni seuils de concentration critiques définis (Gautier-Bouchardon et al., 2014; Lysnyansky & Ayling, 2016).

Face à ces défis, le réseau MyMIC , un consortium international regroupant 22 instituts de recherche issus de 18 pays, a été créé en 2023 avec le soutien de l'initiative JPIAMR (Joint Programming Initiative on Antimicrobial Resistance) (JPIAMR, 2025). L'un des objectifs majeurs de ce réseau est d'évaluer l'utilisation des antibiotiques contre les mycoplasmes par les vétérinaires de terrain, dans le but d'harmoniser les pratiques de diagnostic, les tests de sensibilité aux antimicrobiens (AST) et leur interprétation clinique pour les mycoplasmoses des animaux de production. Dans ce contexte, une enquête mondiale a été menée auprès de vétérinaires pour recueillir des données sur les pratiques de terrain en matière de diagnostic et de traitement des infections à mycoplasmes dans les élevages bovins, porcins et avicoles. L'enquête internationale et l'étude qui en découlent ont été menées en collaboration avec Romain Hollard et Héloïse Marquet, deux autres étudiants vétérinaires. Afin de garantir une analyse spécifique à chaque espèce animale ciblée par l'enquête, les données ont été traitées séparément pour chaque espèce animale. Cette répartition a donné lieu à trois analyses distinctes, chacune aboutissant à une publication scientifique dédiée à l'espèce animale étudiée.

Ce travail de thèse s'inscrit dans cette initiative et présente l'analyse des pratiques des vétérinaires intervenant en élevage bovin, notamment en ce qui concerne l'utilisation des antibiotiques, les méthodes diagnostiques employées et les stratégies de gestion des infections aux mycoplasmoses bovines. Cette étude doit notamment permettre d'identifier les écarts entre les recommandations scientifiques et les pratiques de terrain, afin de proposer des pistes d'amélioration pour le contrôle de ces infections, et aider, avec les résultats des deux autres études, à l'établissement de recommandations pour des méthodes de diagnostic et de tests de sensibilité aux antibiotiques standardisées à l'échelle internationale. L'article scientifique issu de ce travail étant rédigé en anglais, les parties reprenant l'article dans ce manuscrit sont

présentées en anglais. Des résumés sont présentés en français à la fin de chaque grande partie de l'article. Une courte étude des infections à mycoplasmes chez les bovins est présentée en première partie, qui correspond à l'introduction de l'article, suivie d'une partie détaillant la méthodologie et les résultats et d'une troisième partie de discussion pour finir sur une conclusion. Des compléments, qui n'étaient pas utiles ou assez pertinents pour l'article scientifique avec un format court, ont été ajoutés en français dans les parties de résultats et de discussion.

PARTIE 1 : ÉTUDE BIBLIOGRAPHIQUE DES INFECTIONS A MYCOPLASMES CHEZ LES BOVINS

1. Presentation of mycoplasmas infections in cattle :

Mycoplasmas are responsible of important diseases and economic losses in livestock productions. Several *Mycoplasma* species have been implicated in disease processes in cattle such as *Mycoplasma dispar*, *Mycoplasma californicum, Mycoplasma bovis* or *Mycoplasma mycoides* subsp. *mycoides*, the last one being associated to Contagious Bovine PleuroPneumonia (CBPP), which is a disease listed by the WOAH (World Organisation for Animal Health) mainly present in Africa and not considered here (Calcutt et al., 2018). Some other species such as *Mycoplasma bovirhinis* or *Mycoplasma arginini* are considered part of the resident microbiome, with limited or no direct pathogenic role. Hemoplasmas are also part of this genus but are not well known in cattle and not cultivable. *M. dispar* is primarily associated with respiratory disease in young calves, particularly bovine respiratory disease (BRD) (Maunsell & Donovan, 2009). It is frequently isolated in co-infections with other viral or bacterial respiratory pathogens and is known to contribute to lung lesions and chronic respiratory conditions. *M. californicum* is responsible of subclinical or clinical mastitis, and occasionally respiratory or joint infections in young calves (Dudek et al., 2020). M. bovis is one of the most predominant pathogenic mycoplasma species, associated with bovine respiratory disease, mastitis, arthritis, and otitis media, and can affect cattle of all ages (neonatal, preweaned, postweaned, and adult) across different production categories, including dairy, beef, and rearing (Dudek et al., 2020). Intermittent shedding and the multifactorial nature of disease expression could lead to under-evaluated *M. bovis* prevalence, further compounded

by factors such as limited diagnostic capacity in some laboratories or a lack of recognition of *M. bovis* as a major concern in certain countries. However, many studies have shown high prevalences of this pathogen and a widespread presence in the whole world (Aebi et al., 2012; Caswell & Archambault, 2007; Maunsell et al., 2011; Maunsell & Donovan, 2009; Nicholas, 2011). Given this global distribution, it could be assumed that treatment strategies targeting mycoplasmas infections may often need to consider *M. bovis* as a likely causative agent. However, due to the diversity of mycoplasma species, accurate species-level identification is essential for guiding diagnosis, treatment, and control strategies.

2. Diagnosis and control of mycoplasma infections in cattle :

Mycoplasmas infections could be demonstrated by detection of the microorganism in milk, joints, bronchoalveolar lavage fluid, swabs or serum samples (Dudek et al., 2020). Culture enables the isolation of mycoplasma species from clinical cases, allowing the establishment of banks of isolates that are essential for Minimum Inhibitory Concentrations (MICs) and Antimicrobial Susceptibility Tests (ASTs) performance and so antimicrobial resistance surveillance, and effective disease control (Calcutt et al., 2018). However, despite its diagnostic value, culture is slow and technically demanding, as it requires specialized equipment and not all laboratories have the expertise to perform it routinely. Moreover, some mycoplasma species, such as *M. dispar*, are very difficult to grow, and others, like hemoplasmas, are even considered impossible to culture. Culture is also influenced by several factors such as prior antimicrobial treatment, co-infections, or improper sample handling (Calcutt et al., 2018). To overcome these limitations, molecular methods, such as species-specific Polymerase Chain Reaction (PCR), or serological methods, such as specific antibodies detection, have been developed. These techniques offer faster results with higher sensitivity and specificity, and some, such as multiplex-PCR or PCR-Denaturing Gradient Gel Electrophoresis (DGGE), allow the

simultaneous detection of multiple *Mycoplasma* species or co-infecting agents thus leading to their widespread use by field veterinarians (Maunsell & Donovan, 2009).

As part of the *Mollicutes* class and due to the lack of cell-wall, *Mycoplasma* are intrinsically resistant to antimicrobial classes that target the cell-wall synthesis like beta-lactams, glycopeptides, fosfomycin and polymyxins. They also do not synthesize folic acid, making them intrinsically resistant to sulfonamides and trimethoprim. Conversely, mycoplasmas are originally susceptible to antimicrobials that act on proteins like macrolides, tetracyclines, florfenicol, lincosamides and aminoglycosides, or on DNA like fluoroquinolones (Heuvelink et al., 2016; Lysnyansky & Ayling, 2016). Most of these antimicrobial classes are reported in national guidelines leading veterinarians for treating mycoplasmas depending on the clinical presentation. Although effective treatments and control measures have been well documented, a broad variability in resistance to antimicrobial classes effective against mycoplasmas, particularly *M. bovis*, has been reported in many studies worldwide (Gautier-Bouchardon, 2018; Gautier-Bouchardon et al., 2014; Lysnyansky & Ayling, 2016). Treating mycoplasmoses in cattle is then a challenge, especially for the main clinical presentations, BRD and mastitis due to *M. bovis*.

In acute BRD cases associated to mycoplasma infection, an early antimicrobial treatment represents the best opportunity to control disease and florfenicol, tetracyclines, or macrolides are widely recommended in scientific literature (Calcutt et al., 2018). An early diagnosis and isolation of infected animals are also often recommended (Dudek et al., 2020). A study also demonstrated that prophylactic antimicrobial treatment at the time of calf entry in feedlot had a positive impact on health and growth performance, by reducing incidence of respiratory disorders (Rérat et al., 2012). Beneficial use of metaphylactic antimicrobial treatment to prevent BRD in feedlot beef cattle as also been demonstrated in several surveys (Godinho et al., 2005; Hendrick et al., 2013; Sultana et al., 2023). However, the frequent association of mycoplasmas

with other pathogens, their capacity to develop biofilms, and the chronic nature of respiratory disease could result in treatment failures (Andrés-Lasheras et al., 2024; Caswell & Archambault, 2007) leading to significant economic impacts. One study actually estimated losses in US beef industry at 32$ million per year primarily due to weight gain and carcass value reduction (Sultana et al., 2023).

Mycoplasma mastitis, particularly caused by *M. bovis*, remains highly contagious and causes significant loss in milk production as a study estimated losses at 108$ million per year in dairy production (Maunsell et al., 2011). Culling of infected animals is generally the primary measure to take, mainly due to the lack of effective treatment. The fact that infected cows often remain externally normal, with few clinical signs, even in severe cases also contributes to the persistence of intermittent shedders within the herd (Gelgie et al., 2024; Nicholas, 2011; Nicholas et al., 2016).

The challenge of treatment in the field is reinforced by the lack of methods to evaluate susceptibility of mycoplasmas. Due to the slow growth and irregular culture media requirements of mycoplasmas, standard methods to test antimicrobials susceptibility is not possible. The effectiveness of antimicrobials is assessed by *in vitro* testing to measure the minimum inhibitory concentration (MIC) and some guidelines for *in vitro* testing of veterinary *Mycoplasma* species have been published a long time ago (Hannan, 2000). However, the *in vivo* efficacy of antimicrobials from *in vitro* MIC values is difficult to extrapolate as no *in vitro* testing standards and no clinical breakpoint concentrations (CBPs) have been determined (Gautier-Bouchardon et al., 2014; Lysnyansky & Ayling, 2016).

3. Study context :

This study is part of the work carried out by the MyMIC network, an international consortium of 22 research institutes from 18 countries established in 2023, and supported by the Joint Programming Initiative on Antimicrobial Resistance (JPIAMR) organisation (JPIAMR, 2025). The aim of this network is to standardize diagnosis, antimicrobial susceptibility testing (AST), and clinical interpretation in veterinary mycoplasmas. To achieve these objectives, one part of the project was to evaluate field practices of veterinarians concerning diagnosis and treatment of mycoplasmas infections in livestock. A survey, by mean of a specific questionnaire, was performed to collect data from veterinarians worldwide on their use of antimicrobials, and their practices of diagnostic methods and AST in case of *Mycoplasma* infections in bovine, swine and poultry. The aim of this study is to describe the results of the survey for cattle veterinarians about diagnostic approaches and antimicrobial use and to compare them with the practices recommended by scientific researches and national guidelines.

PARTIE 2 : ÉTUDE

1. Materials and Methods :

1. Survey:

The survey was developed to collect data on veterinarians' treatment practices worldwide in case of *Mycoplasma* infections in cattle, swine and poultry. A structured questionnaire of 23 items was designed for data collection using Formdesk software (Formdesk, 2024). The questionnaire design was based on a previous survey published by Janssen et al. in 2022 (Jansen et al., 2022). It included single choice, multiple choice and open questions to collect data on veterinarians' profile and their diagnostic and treatment choices in case of *Mycoplasma* infections. Subsequently, analysis was performed on the frequencies of diagnostic tests and antimicrobials susceptibility tests (ASTs) in case of *Mycoplasma* infection, the preferred treatment and the choices in case of failures and metaphylactic use of antimicrobials. For questions related to frequency of certain practices, a five-point scale (never, rarely, occasionally, often, always) was employed. The intermediate scale levels were defined as follow: "Rarely" meant the frequency was less than 1 in 10 cases; "Occasionally" referred to a frequency between 1 in 10 and 1 in 2; "Often" meant the frequency was greater than 1 in 2. Some questions in the survey used percentage-based intervals, but the boundaries of these intervals were not explicitly defined. This may have led to variations in how respondents interpreted the categories, although the aim was not to obtain precise quantitative values.

The questionnaire, translated in Dutch, English, Finnish, French, German, Hungarian, Italian, Polish, Portuguese, Spanish and Swedish by the MyMIC members, was available online between 22nd April and 30th September 2024, using a QR code or a weblink. The survey

(Supplementary Figure 1) was distributed to veterinarians worldwide through international veterinary associations and the Federation of Veterinarians of Europe (FVE) who distributed the survey to their general and specialist practitioners' members. Members of the MyMIC network also contributed to the distribution of the survey. Distribution was ensured using e-mails, newsletters, professional journals, and communications at national and international congresses.

2. Data Handling and Statistical analysis:

Data were collected anonymously, but veterinarians were free to leave their email address at the end of the questionnaire if they wanted to be informed of the outcome of the survey. The collected data were exported in a Microsoft® Excel file and calculations of percentage and graphics were performed in RStudio (R Core Team., 2024) for each species separately. The comparison of implementation of metaphylactic treatment in European countries vs. others was done using a Pearson's Chi-squared test. Due to low expected counts in several cells of the original 5-category contingency table (never, rarely, occasionally, often and always), data were analysed in grouped categories (rarely or never, occasionally, frequently; $\chi^2 = 3.81$, df = 2, p = 0.149).

Table I summarizes the dosage practices (dose and duration) of veterinarians when they applied a treatment in case of cattle *Mycoplasma* infection compared to the Summary of Product Characteristics (SmPC) in their countries. Each response was provided as a free-text field, allowing veterinarians to describe dosage regimens in their own words. Each free-text response was then interpreted in relation to the SmPC of the antimicrobial class chosen by veterinarians as preferred option treatment for each cattle category. When the free-text field referred to a dosage component (e.g., a dose or a duration), and the respondent selected multiple antimicrobial classes for different production categories without specifying distinct dosages per

class, the same dosage was compared individually to the SmPCs corresponding to each molecule cited in those categories. The number of boxes in the table is therefore greater than the number of respondents to the dosage question. SmPCs were found in different drugs databases depending on the country (AMCRA, 2025; Australian Pesticides and Veterinary Medicine Authority, 2025; European Medicine Agency EMA, 2025; Government of Canada, 2010; Ministerio de Sanidad, 2025; South African Health Products Regulatory Authority SAHPRA, 2022; Veterinary Medicine Directorate, 2025).

Table II provides the antimicrobial classes recommended in case of *mycoplasma* infection in cattle depending on the type of affection according to national guidelines of different countries provided by veterinary associations supported or not by government, and Health or Food ministries. References are available in the legend of Table 2.

L'enquête a été élaborée afin de recueillir des données sur les pratiques de traitement des vétérinaires en cas d'infections à mycoplasmes chez les bovins. Un questionnaire de 23 questions a été diffusé en 11 langues entre avril et septembre 2024. Il combinait des questions à choix unique, multiple et ouvertes, portant sur le profil des vétérinaires, leurs pratiques diagnostiques, leurs choix thérapeutiques, le recours aux tests de sensibilité (AST) et l'usage de pratiques métaphylactiques. Les fréquences de pratiques étaient évaluées sur une échelle à cinq niveaux : jamais, rarement, occasionnellement, souvent et toujours. L'enquête a été distribuée en ligne à l'aide d'un lien ou d'un QR code, via des associations vétérinaires internationales, la Fédération des Vétérinaires d'Europe (FVE), ainsi que les membres du réseau MyMIC, notamment par e-mails, newsletters, journaux professionnels et lors de congrès.

Les données ont été collectées de manière anonyme et analysées via RStudio. Une comparaison de l'usage de la métaphylaxie entre l'Europe et les autres régions a été réalisée via un test du Chi carré de Pearson (après regroupement des catégories de réponse en trois classes : rarement/jamais, occasionnellement, fréquemment).

Deux tableaux sont présentés dans cette étude. Le Tableau I présente les réponses des vétérinaires en termes de posologie (dose et durée) en cas d'infection à mycoplasmes chez les bovins. Elles ont été interprétées grâce à la comparaison avec les Résumés des Caractéristiques du Produit (RCP) disponibles dans les bases de données nationales des différents pays. Lorsque plusieurs classes antimicrobiennes étaient citées sans précision de dose pour chacune, la posologie unique déclarée était attribuée à toutes. Cela explique que le nombre de données dans le tableau soit supérieur au nombre de répondants.

2. Résultats :

A total of 469 responses from 40 different countries were collected in this survey, for the three livestock species (cattle, swine and poultry).

1. Demographic features of cattle veterinarians who answer the study:

Among the 469 respondents to the survey, 270 were from veterinarians working with cattle. The responses, represented in Figure 1, came from France (n = 101), Canada (n = 30), United Kingdom (n = 22), Sweden (n = 13), Switzerland (n = 13), Austria (n = 11), Germany (n = 11), Pakistan (n = 11), Belgium (n = 8), Finland (n = 7), South Africa (n = 7), The Netherlands (n = 5), Australia (n = 4), Hungary (n = 4), and Italy (n = 3). Fewer responses came from Argentina, the Czech Republic, Israel, Kenya, Mauritania and Turkey (n = 2 for each country) and from Burkina Faso, New-Zealand, Nigeria, Norway, Poland, Romania, Saudi Arabia and Thailand (n = 1 for each country).

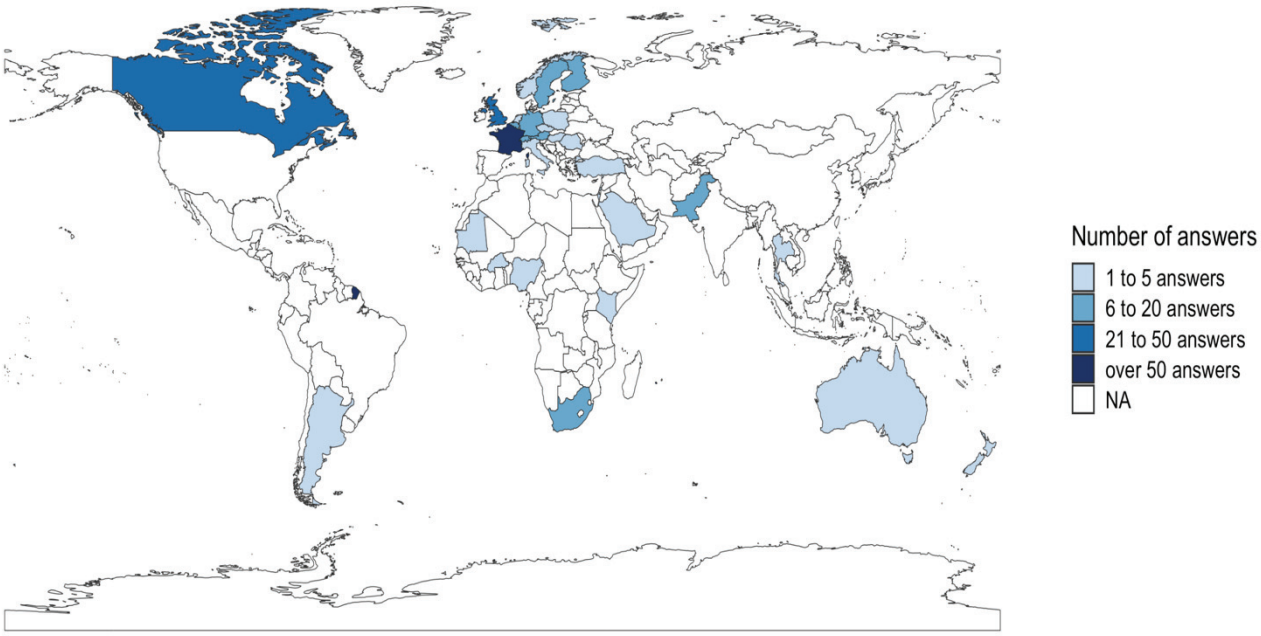

Figure 1: Countries of practice of cattle veterinarians who answered to the survey (n = 270).

Legend: Shades of blue represent the variations of number of answers per country to the question "In which country do you work as a veterinary practitioner?".

Veterinarians involved in cattle treatment that contributed to the survey mostly had between 6 to 15 years of experience as practitioner (n = 96), followed by those over 25 years (n = 72), between 16 to 25 years (n = 69), and less than 5 years (n = 33). Most veterinarians worked in mixed practice (n = 153) or were specialized in cattle (n = 118), while less were specialized in poultry (n = 9), pigs (n = 7) or worked in other veterinary fields like small ruminants or research or in academia (n = 12). Concerning the number of veterinarians employed in their veterinary practice, 90 veterinarians answered between 1 to 3, 89 worked with 4 to 6 other veterinarians, 48 with over 10 veterinarians and finally 43 with 7 to 9 veterinarians.

The cattle production categories in which the survey's veterinarians worked with were dairy cattle (n = 219), beef cattle (n = 188) and cattle rearing (n = 149). To a lesser extent, these veterinarians also worked with pig nursery, weaning piglets, fattening pigs and breeding sows (n = 23, 22, 29 and 25 respectively) and with layers, breeders and broilers chickens and meat

turkeys (n = 25, 17, 27 and 9 respectively). Only responses concerning cattle are presented in this study.

2. Mycoplasma species frequently found in cattle:

Almost all respondents working with cattle (n = 270) came across *Mycoplasma* infection at least once in their practice (n = 244) and very few didn't (n = 26). *Mycoplasma* infections were mostly encountered in cattle rearing (n = 152), in dairy cattle (n = 138) and then in beef cattle (n = 114). The *Mycoplasma* species most commonly associated with clinical signs in cattle cited by veterinarians was *M. bovis* regardless of the production category as it represented 78.8% of answers (n = 130) in cattle rearing, 80% (n = 124) in dairy cattle and up to 81.3% (n = 100) in beef cattle. In a few cases, veterinarians were unsure of the *Mycoplasma* species they were dealing with (n = 18, 23 and 18 for the 3 different categories, respectively). Other mycoplasma species were mentioned only in a few cases and were always cited with *M. bovis*. *M. dispar* was reported by 5 veterinarians in dairy cattle, 5 in cattle rearing and 1 in beef cattle. *M. bovirhinis* was cited once in each of the three cattle production categories. In dairy cattle, *M. californicum* and *M. putrefaciens* were each reported once. Finally, *M. wenyonii*, which is not a mycoplasma *sensu stricto* but a hemoplasma, was mentioned three times.

Figure 2 presents the proportion of animals affected in case of clinical disease due to mycoplasma infection. Most veterinarians indicated that less than 10% (n = 117, 52.7%) of the animals were affected followed by 10 to 25% (n = 67, 30.2%), 25 to 50% (n = 28, 12.6%), 50 to 75% (n = 6, 2.7%) and over 75% (n = 4, 1.8%).

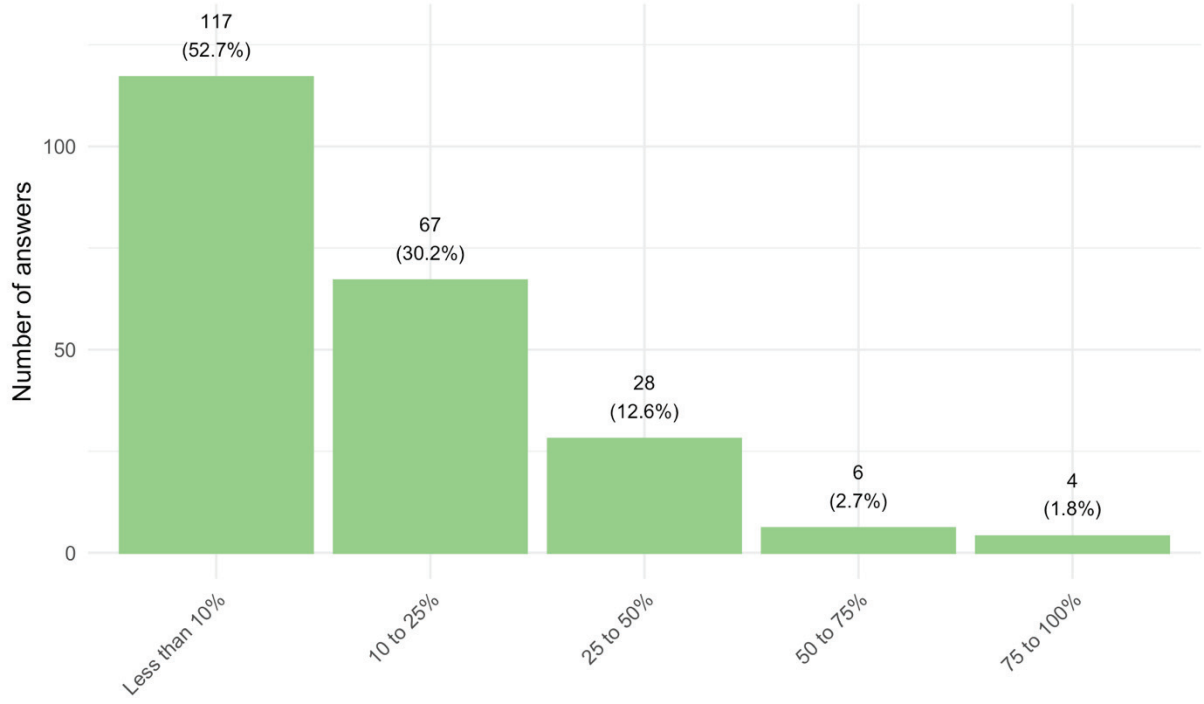

Figure 2: Proportion of animals affected in case of clinical disease due to Mycoplasma infection (n = 221).

Legend: This graph represents the number of answers given to the question "What is the proportion of animals affected when you encounter a clinical infection with *Mycoplasma*?".

3. Diagnosis method and AST performance frequency:

In cases of a suspected *Mycoplasma* infection based on clinical signs, diagnostics tests were used with different frequency: always 11.9% (n = 27), often 27.9% (n = 63), occasionally 27.0% (n = 61), rarely 23.0% (n = 52), never 10.2% (n = 23).

As shown in Figure 3, the diagnostic method performed most often was PCR (n = 172, 42.5%), followed by necropsy (n = 92, 22.7%), culture (n = 70, 17.3%), serology (n = 51, 12.6%), and histopathology (n = 16, 4%). Responses classified as 'Other' (n = 4, 1%) for this question are provided in the figure caption. These few results should be interpreted with caution, as they mostly refer to complementary examinations rather than primary diagnostic methods.

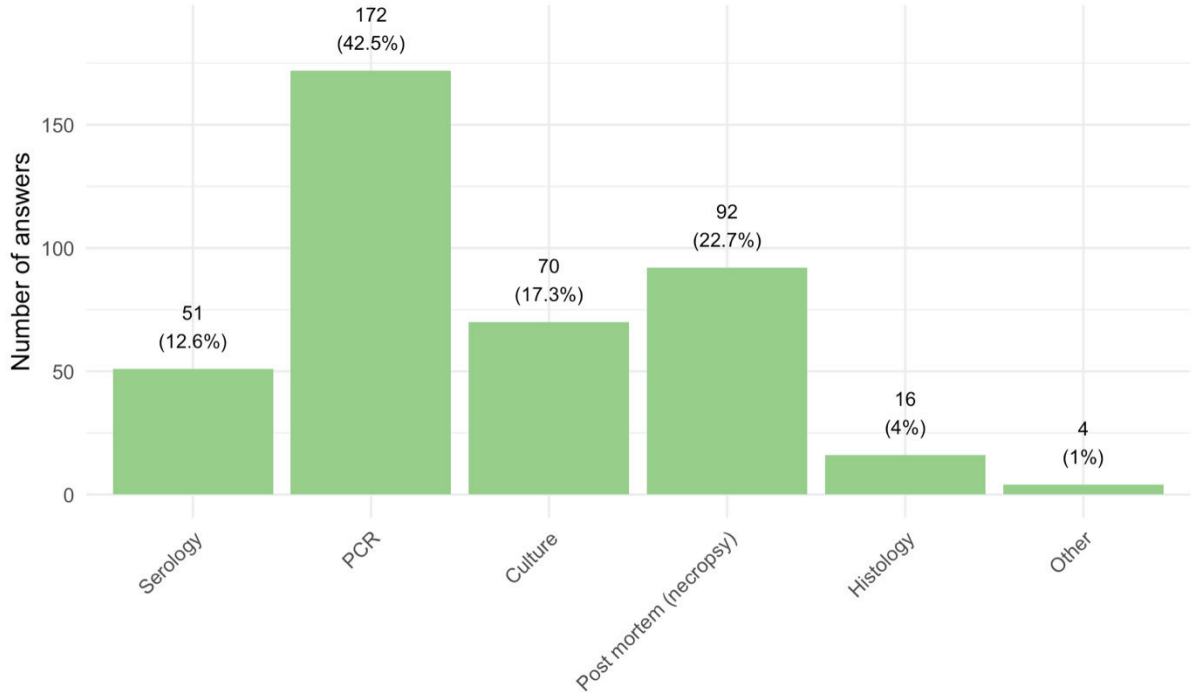

Figure 3: Additional diagnostics performed by veterinarians in case of mycoplasma infection suspicion (n = 405).

Legend: This graph represents the number of answers given to the multiple-choice question "If yes, what additional diagnosis?". PCR and culture are specific methods, whereas the others (necropsy, histology and the others answers reported) are conclusive about the disease but are not able to confirm the aetiological pathogen. The others answers reported were: "Immunohistochemistry on the pulmonary lesions; Blood smear and PCR if *M. wenyonii* is suspected; Nasal swab; Transtracheal lavage."

Figure 4 presents the number of veterinarians that performed AST. According to this figure, 28.6% never applied ASTs (n = 65), 20.7% applied it rarely (n = 47), 27.8% occasionally (n = 63), 15.4% often (n = 35), and only 7.5% in every case of confirmed *Mycoplasma* infection (n = 17). Among veterinarians who use culture 30% (n = 21/70) performed AST often or always, compared to 15.5% (n = 31/200) among those who did not.

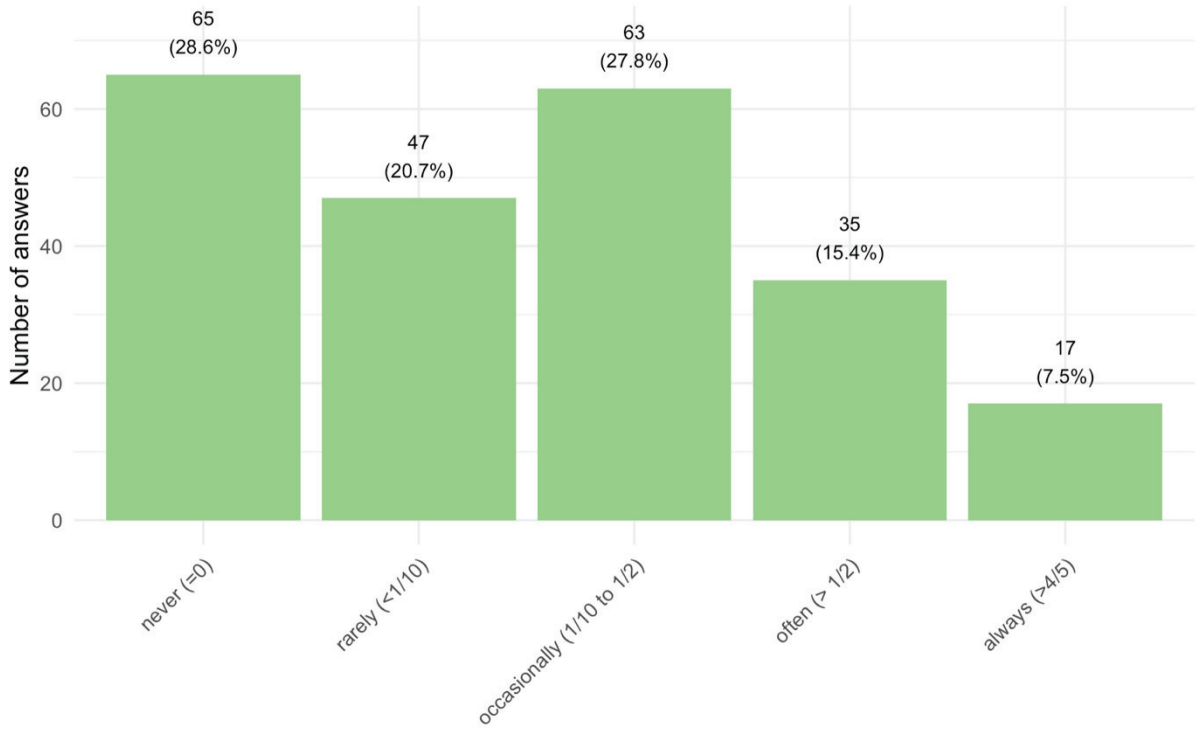

Figure 4: Number of veterinarians that perform or let a third party perform antimicrobial susceptibility test in case of suspected mycoplasma infection (n = 227).

Legend: This graph represents the number of answers given to the single-choice question "Do you perform (or let a third party perform) antimicrobial susceptibility tests?".

4. Conditions of treatment in case of *Mycoplasma* infection:

When managing mycoplasma infections, 40.1% (n = 91) and 40.5% (n = 92) of veterinarians reported that treatment was always or often necessary, 13.2% (n = 30) believed treatment was occasionally required, and 3.1% (n = 7) indicated that treatment was rarely or never needed.

The primary reason veterinarians cited for administering treatment in cases of infection was by order of importance: i) the severity of clinical signs (n = 193, 45.8%), ii) the results of the laboratory testing (n = 82, 19.5%), iii) the risk of rapid spread of the disease (n = 57, 13.5%), iv) the percentage of diseased animals (n = 55, 13.1%), v) the request from farmers or industries (n = 25, 5.9%). To complete their responses, some veterinarians mentioned never initiating treatment in case of *M. bovis* mastitis (n = 3) and one mentioned that clinically ill animals were

usually treated before *Mycoplasma* diagnosis. The implementation of vaccination instead of treatment was also a reason cited by one veterinarian to orient his medical management.

In contrast, the primary reason why veterinarians chose not to treat animals for mycoplasma infections was the expected lack of efficacy (n = 115, 41.2%). The other motivations reported were : treatment costs (n = 54, 19%), logistical challenges related to withdrawal times (n = 41, 14.4%), legal restrictions (n = 22, 7.7%), and concerns about the impact of treatment on trade or the industry agreements (n = 12, 4.2%). Among the 38 veterinarians who reported other reasons for not initiating treatment, 31.6% (n = 12) mentioned that the clinical signs impacted their decision (either absent or too severe) and 13.2% (n = 5) mentioned that culling of affected animals was carried out instead of implementing treatment. Vaccination and the farmer's refusal were also cited by 2.6% (n = 1 for each). Finally, 34.2% (n = 13) of the respondents stated that they always treat affected animals.

5. Preferred option treatment applied for cattle *Mycoplasma* infection:

To make their choice for treatment, the veterinarians primarily referred to national treatment guidelines (n = 108, 27.7%), farm history (n = 92, 23.6%), and overview of antimicrobial susceptibility of the etiological agent (n = 82, 21%). Other motivations were the economic feasibility of the treatment (n = 59, 15.1%) and the AST results (n = 47, 12.1%).

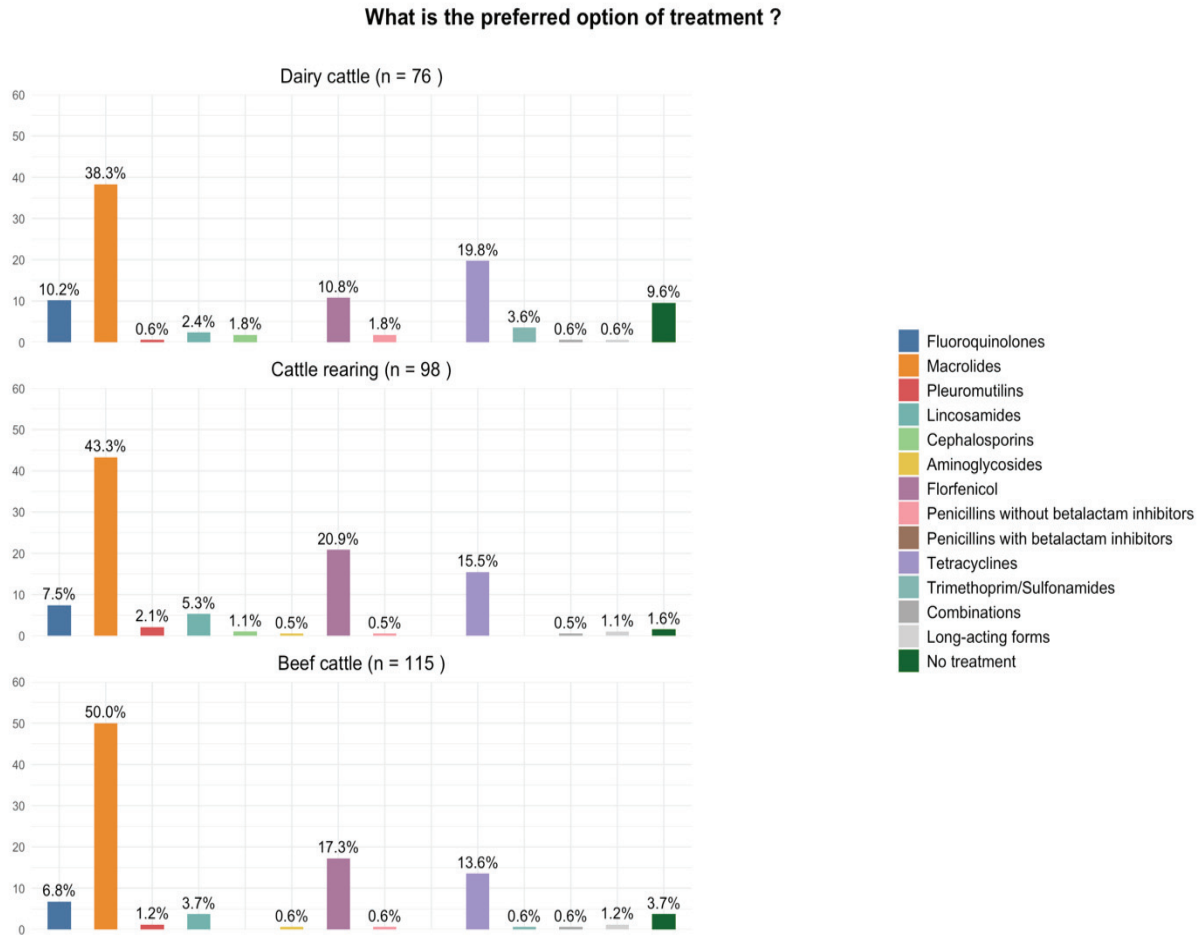

Figure 5: Preferred option treatment for each cattle production category.

Legend: Each graph shows the percentage of answers for one antimicrobial family to the question "What is the preferred option of treatment?". Numbers of answers vary per production category according to the number of veterinarians treating these categories. Veterinarians could only select one antimicrobial family per category.

The preferred option treatment for each production category is presented in Figure 5. Macrolides were the first choice for the three cattle production categories. Some veterinarians clarified that they used macrolides long-acting formulations (n = 1, n = 4 and n = 9 for dairy cattle, cattle rearing and beef cattle, respectively). Florfenicol and tetracyclines were respectively the second and third most selected antimicrobials except for dairy cattle, for which tetracyclines were the second most selected and florfenicol the third. Fluoroquinolones were the preferred option treatment in 10.2%, 7.5% and 6.8% of cases in dairy cattle, cattle rearing

and beef cattle, respectively. Finally, 9.6% (n = 16) of veterinarians preferred not to treat dairy cattle in case of *Mycoplasma* infections, due to the lack of effective or authorized treatment, especially for mastitis (n = 6/13).

Among the 269 cattle veterinarians, 221 responded to the open question regarding the dosage. They were asked to specify the criteria used for the prescribed dosage for each antimicrobial class and each cattle production category. Theren, 167 responses were provided for dairy cattle, 190 for cattle rearing and 164 for beef cattle. Among the 496 answers collected for this question, 440 (88.7%) were interpretable as they included a mention of either a dose or a duration that could be compared to the corresponding SmPC. The remaining responses (56, 11.3%) could not be analysed because no usable information on dose or duration was provided. The results – including the detailed numbers of responses per antimicrobial class and category- are presented in Table I. According to these results, the veterinarians declared to follow the SmPC indications in 236 responses (47.6%), but the information about the duration and the dose of treatment was not provided in 15 and 51 cases respectively. The main deviation from the SmPC indications was the extended duration of treatment (181 cases; 36.5%), while the increase or decrease of the dose was reported in 27 cases (5.4%).

Tableau I: Number of veterinarian's responses regarding dose and duration treatment practices per production category and antimicrobial classes (n = 496).

Production category	Dairy cattle (n = 167)								Cattle rearing (n = 190)								Beef cattle (n = 164)								
Antimicrobial class	Florfenicol	Tétracyclines	Macrolides	Lincosamides	Fluoroquinolones	Other molecules	Combinations	No Treatment	Florfénicol	Tétracyclines	Macrolides	Lincosamides	Fluoroquinolones	Other molecules	Combinations	No Treatment	Florfénicol	Tétracyclines	Macrolides	Lincosamides	Fluoroquinolones	Other molecules	Combinations	No Treatment	
n	16	34	68	4	16	13	0	16	40	31	83	10	13	9	1	3	28	23	82	6	12	6	1	6	n
SmPC Dose + Duration	**4**	**11**	**24**	**3**	**7**	**5**			**13**	**8**	**33**	**4**	**3**	**4**			**9**	**6**	**29**	**2**	**3**	**2**			**170**
SmPC dose Duration not provided	**2**	**2**			**1**	**1**			**1**	**1**		**1**	**1**				**1**	**1**	**1**	**1**	**1**				**15**
SmPC Duration Dose not provided	**1**	**7**	**3**	**1**		**2**			**3**	**1**	**13**			**1**			**1**	**2**	**12**	**3**		**1**			**51**
SmPC Dose + Longer duration	*4*	*6*	*14*		*1*	*2*			*15*	*12*	*13*	*2*	*4*	*1*	*1*		*9*	*9*	*15*		*2*				*110*
Longer Duration Dose not provided	*2*	*2*	*18*			*1*			*3*	*3*	*11*	*3*		*1*			*6*	*1*	*11*		*1*	*1*			*64*
SmPC Dose + Shorter duration					*1*								*1*								*1*				*3*
Higher dose + SmPC Duration	*1*		*1*		*1*					*1*	*1*		*1*						*1*		*1*				*8*
Lower Dose + SmPC Duration	*1*												*1*								*1*				*3*
Higher Dose + Longer Duration					*1*				*2*				*1*												*4*
Lower Dose + Longer Duration		*1*								*1*								*1*							*3*
Higher Dose Duration not provided		*1*	*1*		*1*				*1*	*1*	*1*						*1*	*1*	*1*						*9*
Uninterpretable responses	1	4	7		3	2			2	3	11		1	2			1	2	12		2	2	1		56

Legend: **Bold** characters indicate doses and durations compliant with the SmPC, *italic* characters indicate doses and durations not compliant with the SmPC. If veterinarians mentioned only one dosage, without specifying the antimicrobial class, and chose different antimicrobial classes for each cattle production category, then the dosage was applied for each antimicrobial class chosen for each cattle production category. The number of boxes in this table is therefore greater than the number of respondents to the dosage question.

6. Use of metaphylactic treatment:

In case of *Mycoplasma* infection, more than half of respondents answered that they never (n = 89, 39.4%) or rarely (n = 52, 23%) performed metaphylactic treatment, some performed it occasionally (n = 42, 18.6%) or often (n = 34, 15%) and a very few performed it always (n = 9, 4%). The comparison of implementation of metaphylactic treatment in Europe vs. other countries was done using a Pearson's Chi-squared test. No significant difference (p-value = 0.149) was found between European and non-European countries in the usage of metaphylactic treatment.

The reasons for the usage of metaphylactic treatment were: the percentage of diseased animals (n = 86, 33.2%), the severity of clinical signs (n = 65, 25%), the risk for a rapid spread of the disease (n = 62, 23.9%), the results of laboratory diagnostic (n = 21, 8.1%) and the request from farmer or industry (n = 20, 7.7%). The most common application routes of metaphylactic treatment for each antimicrobial class are shown in Supplementary Figure 2. Parenteral routes were the most commonly employed when a metaphylactic treatment was applied, compared to oral routes, with intravenous administration representing 30% of fluoroquinolone treatments.

7. Second-choice treatment in case of failure:

In case of failure, 213 veterinarians answered about their second-choice treatment. Fluoroquinolones were the most used antimicrobials (n = 59), followed by macrolides (n = 39) and florfenicol (n = 36) as shown in Figure 6. Some veterinarians also reported that no treatment was done in second intention (n = 20), primarily because of the expected lack of efficacy of a second treatment and then for economic reasons.

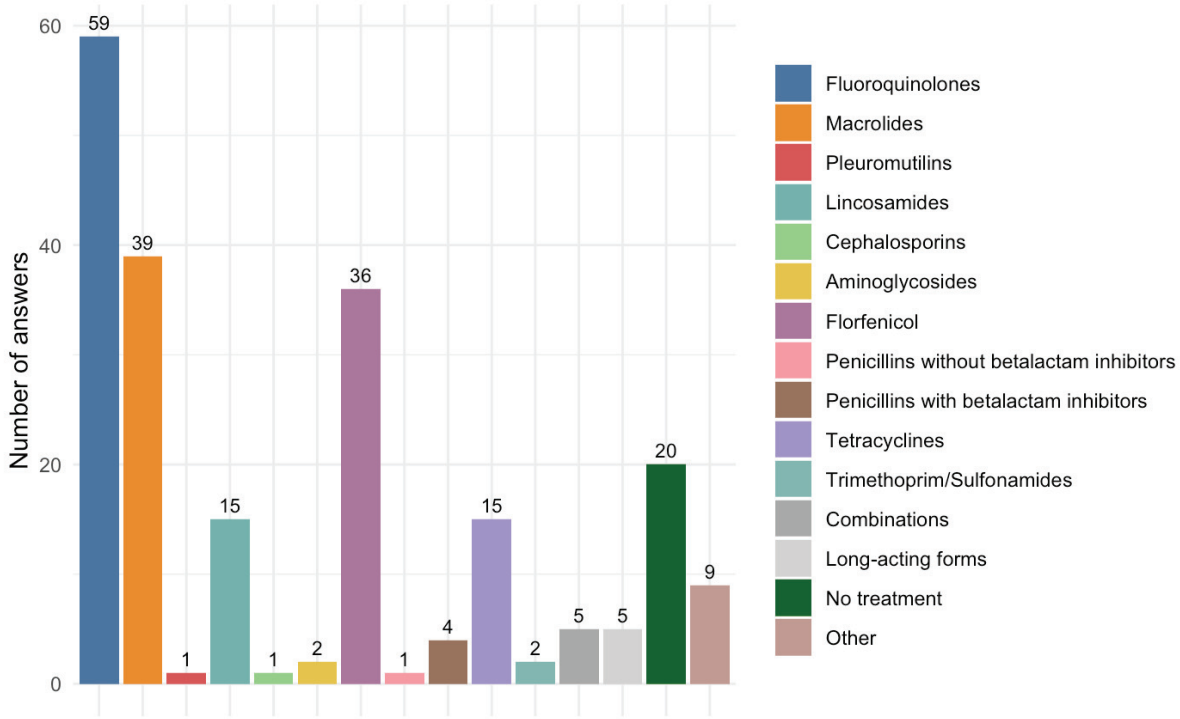

Figure 6: Second choice of treatment applied by veterinarians in case of failure of treatment (n = 213).

Legend: This graph represents the number of answers given to the single-choice question "In case of failure of treatment, what is the second choice of treatment available?".

8. National guidelines for cattle *Mycoplasma* infections:

In order to compare veterinarians' practices with recommendations, national guidelines have been compiled in Table II. While most countries provide such guidelines for treatment, only a few—such as the Republic of Ireland, New Zealand, and Finland—have implemented specific indications for eradication or control programs (Dudek et al., 2020).The majority of the guidelines listed in Table II focus exclusively on *M. bovis* with its diverse clinical aspects.

Tableau II: National Guidelines provided by National Veterinary Associations or Ministries for Mycoplasma infections in cattle.

Guidelines provided by	*National Veterinary Associations supported by the Government*							
Country	Canada		Australia			Switzerland		
	Dairy cattle	Beef cattle	Dairy cattle	Cattle rearing	Beef cattle	Dairy cattle	Cattle rearing	Beef cattle
Mastitis	No treatment recommended	ND	No treatment recommended Culling of infected animals	ND		No treatment recommended	ND	ND
BRD (associated with Mycoplasma bovis	**Florfenicol*** **Oxytetracycline dihydrate** Oxytetracycline hydrochloride Tilmicosin* Tulathromycin*	**Florfenicol** **Oxytetracycline dihydrate** Oxytetracycline hydrochloride Tilmicosin Tulathromycin *Danofloxacin* *Enrofloxacin*	**Oxytetracycline** **Tulathromycin**	**Tulathromycin** **Tilmicosin** **Florfenicol**		ND	**Florfenicol** Tetracyclines *Fluoroquinolones*	ND
Otitis media	**Florfenicol*** **Oxytetracycline** Tilmicosin* Tulathromycin* *Enrofloxacin*	**Florfenicol** **Oxytetracycline dihydrate** Oxytetracycline hydrochloride Tilmicosin Tulathromycin *Enrofloxacin*	ND	**Tulathromycin** **Tilmicosin** **Florfenicol**		ND	**Tetracyclines** Florfenicol *Fluoroquinolones* *Macrolides*	ND
Arthritis	ND		**Tulathromycin** **Oxytetracycline**	**Tulathromycin** **Tilmicosin** **Florfenicol**		**Tetracyclines** Enrofloxacin		

Guidelines provided by	*Health or Food Ministries*				
Country	Finland			Spain	Italy
	Dairy cattle	Cattle rearing	Beef cattle	Cattle	Dairy cattle
Mastitis	No treatment recommended Culling of infected animal even if milk is normal. Notifiable animal disease.	ND		ND	No treatment recommended
BRD (associated with Mycoplasma bovis	**Oxytetracycline**	**Oxytetracycline** Macrolides		**Tetracyclines** Lincosamides Tulathromycin Tilmicosin Tylosin Florfenicol *Enrofloxacin* *Marbofloxacin*	**Tetracyclines** Lincosamides Macrolides *Quinolones*
Otitis media	**Oxytetracycline**	**Oxytetracycline** Macrolides		ND	ND
Arthritis	**Oxytetracycline** Notifiable animal disease			ND	**Tetracyclines** Lincosamides Macrolides *Quinolones*

Guidelines provided by	*National Veterinary Associations*						
Country	Belgium			Germany**	Netherlands		Sweden	USA
	Dairy cattle	Cattle rearing	Beef cattle		Cattle rearing	Beef cattle	Cattle	Cattle
Mastitis	ND			**Fluoroquinolones** **Lincosamides** **Macrolides** **Pleuromutilins** **Tetracyclines**	ND		ND	No treatment recommended Culling of infected animals
BRD (associated with Mycoplasma Bovis	**Florfenicol** Doxycycline Lincomycin + Spectinomycin Oxytetracycline Tilmicosin Tulathromycin Tylosin *Danofloxacin* *Difloxacin* *Enrofloxacin* *Marbofloxacin*				Parenteral **Florfenicol** **Oxytetracycline** Tylosin Tulathromycin *Enrofloxacin* *Marbofloxacin* Oral **Doxycycline** **Tilmicosin** **Tylosin** *Enrofloxacin*		**Oxytetracycline** Florfenicol Tulathromycin Gamithromycin Not recommended: Fluoroquinolones	**Florfenicol** **Tulathromycin** **Gamithromycin** **Pradofloxacin** **Danofloxacin** *Enrofloxacin*
Otitis media	**Florfenicol** Doxycycline Oxytetracycline Tilmicosin Tulathromycin Tylosin *Danofloxacin* *Difloxacin* *Marbofloxacin*				Parenteral **Florfenicol** **Tilmicosin** **Tylosin** Tulathromycin *Enrofloxacin* Oral **Doxycycline** **Tilmicosin** **Tylosin**		ND	ND
Arthritis	No antimicrobial authorized for the arthritis indication, determination of the pathogen's entry point (pneumonia / infected wound / umbilical infection) and treatment according to the indication for these conditions. Lincomycin + Spectinomycin *Enrofloxacin*				Parenteral **Oxytetracycline** **Tilmicosin** **Tylosin** Tulathromycin *Enrofloxacin*		ND	ND

Antimicrobials which are shown in **bold** are those recommended as first-choice treatments, those in underline are recommended as second-choice treatments, and those shown in *italic* are recommended as third-choice treatments. These guidelines were found in : (Canadian Veterinary Medical Association CVMA & Agriculture and Agri-Food Canada, 2008) ; (Australian Veterinary Association (AVA), Animal Medicines Australia (AMA), & Meat and Livestock Australia (MLA), s. d.) ; (Australian Veterinary Association (AVA), Animal Medicines Australia (AMA), & Dairy Australia, s. d.) (Faculté Vetsuisse & (OFAV), 2022) ; (Ministerio de Sanidad, 2025) ; (Elintarviketurvallisuusvirasto Evira ja & Helsingin yliopiston eläinlääketieteellinen tiedekunta, 2016); (Ministero della Salute, 2023) ; (AMCRA, 2025) ; (Bundestieraerztekammer (BTK), 2015) ; ((KNMVD) et al., 2017) ; (The Swedish Veterinary Association, 2013) ; (Maunsell et al., 2011).

*The Canadian guidelines precise that Tilmicosin and Tulathromycin must not be used in lactating dairy cattle and only in dairy cattle under 20 months of age.

**The German guidelines provide a general list of antimicrobials for treatment of Mycoplasma infections.

9. Analyse de l'impact de la catégorie de production traitée sur certaines pratiques:

Afin d'évaluer si les catégories de production de bovins traités pouvaient avoir un impact sur les réponses données par les vétérinaires, les questions concernant la proportion d'animaux atteints en cas d'infection à mycoplasmes, la fréquence de réalisation de tests diagnostiques et la fréquence de réalisation d'AST ont été analysées en fonction de la catégorie de production traitée par les vétérinaires.

La figure 7 représente la proportion d'animaux présentant des signes cliniques lors d'affection à mycoplasmes, en fonction des catégories de bovins traités par les vétérinaires. Cette figure montre que, quelle que soit la catégorie de bovins, la distribution des proportions d'animaux affectés en cas d'infection apparaît relativement homogène.

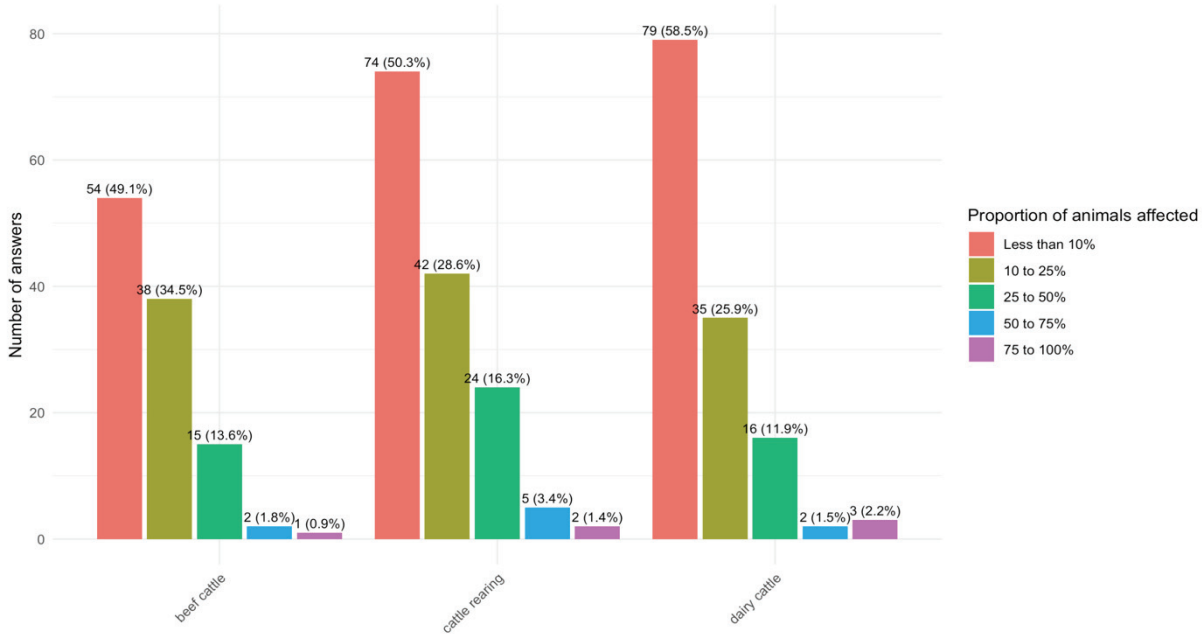

Figure 7: Proportion d'animaux présentant des signes cliniques en cas d'affection à mycoplasmes en fonction de la catégorie de bovins traitée par les vétérinaires.

La figure 8 présente la fréquence de réalisation de tests diagnostiques en fonction de la catégorie de bovins traitée par les vétérinaires. Cette figure met également en évidence une distribution homogène de la répartition des réponses entre les catégories de production.

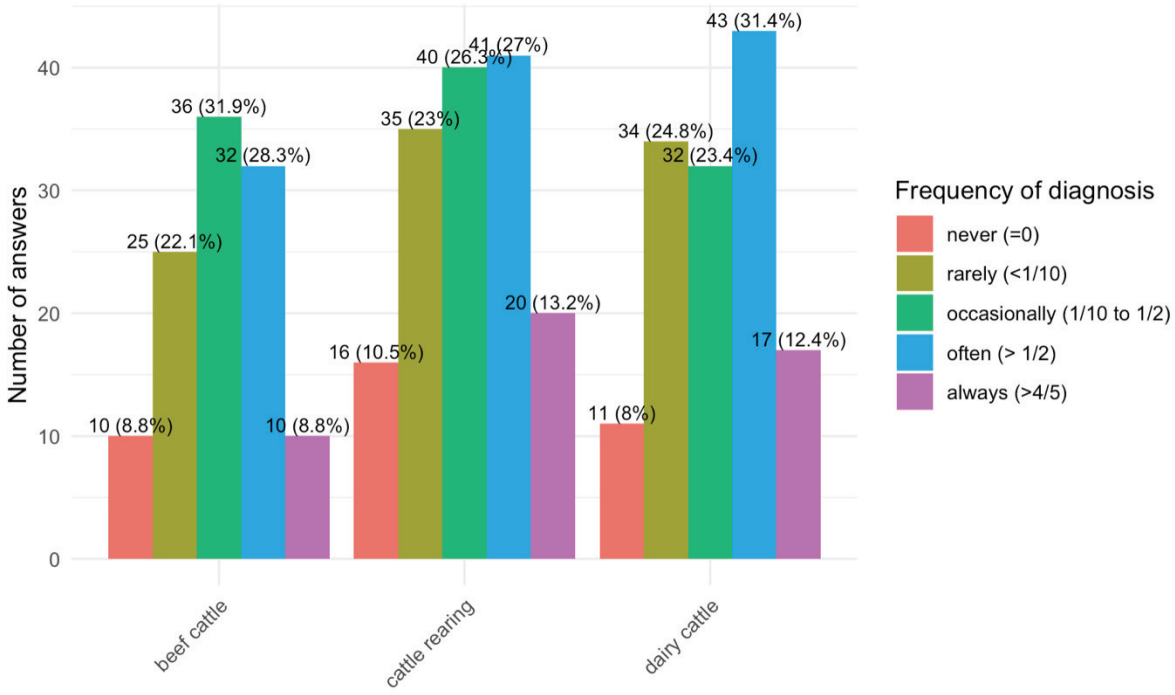

Figure 8 : Fréquence de réalisation de tests diagnostiques en fonction de la catégorie de bovins traitée par les vétérinaires.

Enfin, la figure 9 présente la fréquence de réalisation d'AST en fonction de la catégorie de production des bovins. La distribution des réponses à cette question montre une fréquence de réalisation d'AST plus importante dans le cas des bovins allaitants (n = 21 soit 18,5% réalisent des AST « souvent » et n = 12 soit 10,5% des vétérinaires en réalisent « toujours »). Un pourcentage plus élevé de réponses est d'ailleurs attribué aux vaches laitières et aux bovins d'engraissement pour les fréquences « jamais » et « rarement » de réalisation d'AST.

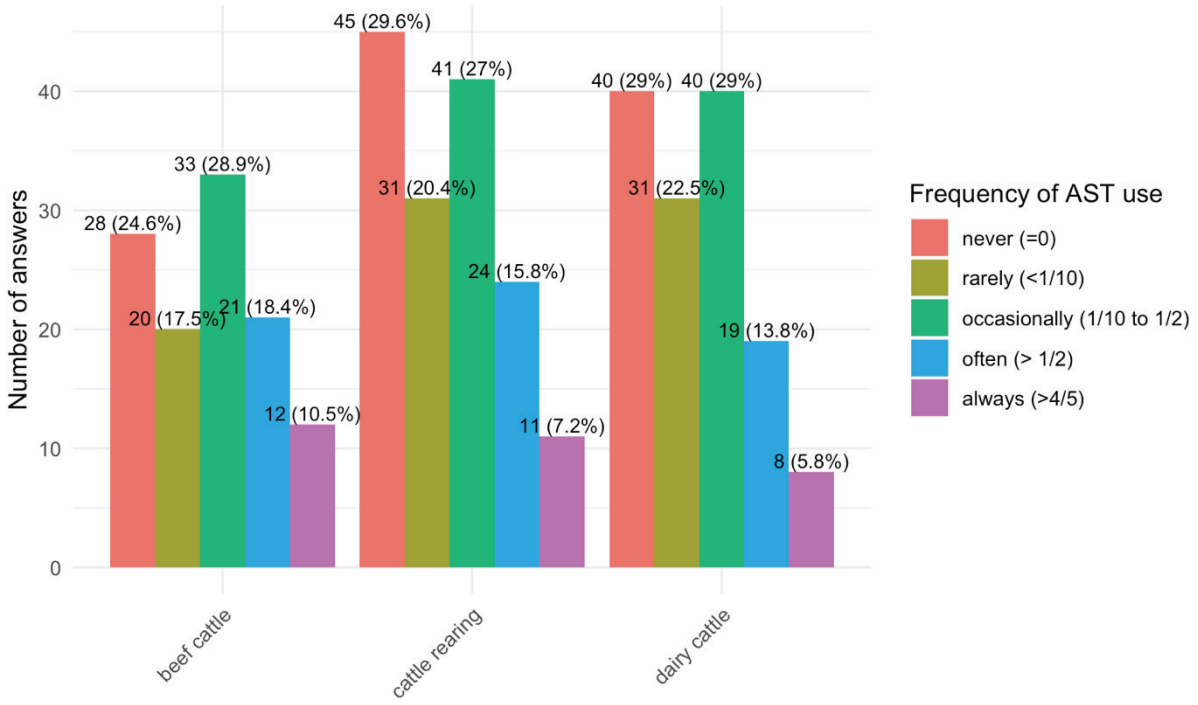

Figure 9: Fréquence de réalisation d'AST en fonction de la catégorie de bovins traitée par les vétérinaires.

L'étude a récolté 469 réponses dont 270 provenaient de vétérinaires traitant les bovins, dans 40 pays. Plus de 50% des réponses concernant les bovins provenaient de France (n = 101) du Canada (n= 30) et du Royaume-Uni (n = 22). La majorité des vétérinaires avaient une pratique mixte (n = 153) ou étaient spécialisés en médecine bovine (n = 118). Les vaches laitières représentaient la première catégorie de production traitée par les vétérinaires (n= 219), suivies des vaches allaitantes (n = 188) et bovins d'engraissement (n = 149). En cas d'infection clinique, *M. bovis* était l'espèce la plus rencontrée par les vétérinaires (environ 80% pour chacune des catégories de production) et plus de 50% des répondants ont indiqué que moins de 10% des animaux présentaient des signes cliniques en cas d'infection.

Environ 39% des vétérinaires ont indiqué que la réalisation de tests diagnostiques était nécessaire de manière fréquente (catégorie « souvent » et « toujours »). Le test le plus utilisé était la PCR dans 42,5% des cas alors que la culture n'était réalisée que dans 17,3% des cas.

Concernant la mise en œuvre de tests de sensibilité aux antibiotiques, 49,3% des vétérinaires ont indiqué ne pas y avoir recours. La plupart des vétérinaires ayant répondu à l'étude ont mentionné qu'en cas d'infection à mycoplasmes chez les bovins, un traitement était souvent (40,5% ; n = 92) voire toujours (40,1% ; n = 91) nécessaire et la première raison évoquée pour instaurer un traitement était la gravité des signes cliniques (n = 193, 45,8%) et les résultats d'analyses mis en place (n = 82, 19,5%). À l'inverse, le manque d'efficacité attendu du traitement (n = 117, 41,2%) était la première raison pour laquelle les vétérinaires ne mettaient pas en place de traitement.

Pour choisir le traitement à mettre en place, les vétérinaires se referraient principalement aux guides nationaux (n = 108, 27,7%), à l'historique de l'élevage (n = 92, 23,6%) et aux résultats des tests de sensibilité (n = 82, 21%). La classe antibiotique la plus utilisée en traitement de première intention était les macrolides, choisis à 38,3%, 43,3% et 50% respectivement chez les vaches laitières, les bovins d'engraissement et les vaches allaitantes. Le florfénicol et les tétracyclines comptaient également parmi les molécules les plus utilisées. Chez les vaches laitières, l'option de ne pas initier de traitement a été mentionnée dans 9,6% des cas, en indiquant comme principale raison l'absence de traitement autorisé ou efficace en cas de mammite.

Parmi les 270 répondants à l'étude, 221 ont complété la question portant sur le dosage prescrit pour chacune des classes antibiotiques qu'ils avaient choisies pour chaque catégorie de production. Le tableau I, met en évidence que la majorité des répondants respectent les doses et durées indiquées dans les RCP des médicaments prescrits. La principale divergence mentionnée concerne une augmentation de la durée du traitement par rapport aux recommandations du RCP, puisqu'elle concerne 181 cas, indépendamment de la dose utilisée et de la catégorie de bovins traités.

Plus de la moitié des répondants ont indiqué ne jamais (n = 89, 39.4%) ou rarement (n = 52, 23%) initier de traitement métaphylactique. Un test du Chi carré de Pearson a été réalisé pour comparer l'utilisation d'un traitement métaphylactique entre les pays européens et les autres pays, ne mettant pas en évidence de différence d'utilisation significative entre ces régions. La première raison mentionnée par les vétérinaires pour décider d'initier la métaphylaxie d'un troupeau était le pourcentage d'animaux malades (n = 86, 33.2%) et la sévérité des signes cliniques (n = 65, 25%).

En cas d'échec lors d'un premier traitement, les fluoroquinolones devenaient la classe d'antibiotiques la plus utilisée (n = 59/213), suivis des macrolides (n = 39/213) puis du florfénicol (n = 36/213).

Un des objectifs de l'étude était de comparer les pratiques de prescription des vétérinaires en cas d'infections à mycoplasmes chez les bovins aux recommandations nationales et internationales. Une revue de ces recommandations a été réalisée et le Tableau II reprend les classes d'antimicrobiens recommandées dans ces lignes directrices, pour différents pays, émises par des associations vétérinaires, soutenues ou non par les gouvernements et les ministères de la Santé ou de l'Agriculture/Alimentation. Les classes d'antibiotiques les plus citées en traitement de première intention dans ces recommandations sont notamment le florfénicol, les tétracyclines et les macrolides.

PARTIE 3: DISCUSSION

This is the first study evaluating veterinary practices with regard to bovine mycoplasmas worldwide. With 469 answers collected in 40 countries, and 270 from cattle veterinarians, this study represents a high participation rate of livestock veterinarians providing a robust insight in veterinary practices concerning *Mycoplasma* infections worldwide and particularly in Europe. The large number of responses from cattle veterinarians (n = 270) and the diversity of their practices profiles provides the first representation of both the most used diagnostic methods and the antimicrobials used for treating mycoplasma infections in cattle. However, the high number of responses from cattle veterinarians from France (37.4%) and Canada (11.1%) may reflect stronger local engagement or an initial distribution bias and constitutes a geographical coverage bias that may affect generalisability of the results. Even if some veterinarians dealt with other animal species (n = 28), most of the respondents treated only cattle (n = 118) or worked in mixed practices (n = 153), the answers can then be considered as representative of bovine practitioner specialists.

1. Diagnostic practices :

The results of the survey point out some inconsistencies concerning the diagnostic practices in case of mycoplasma infection in cattle. Firstly, the fact that most veterinarians report encountering *M. bovis* as the main mycoplasma species is likely related to good diagnostic practices, as 67.1% of them routinely use lab diagnosis. However, the first diagnostic method used by veterinarians is PCR in 42.5% of cases, while culture, mentioned in 17.3% of cases, remains the gold standard method when AST is required (Dudek et al., 2020). The fact that culture is a laborious diagnostic method, requiring several days to weeks to obtain results and that it can only be performed in specialized laboratories may orient veterinarians to faster and

more available diagnostic methods such as PCR. This method has increasingly replaced culture for *Mycoplasma* detection due to its higher sensitivity and specificity, as well as its ability to provide results within a single day. Additionally, PCR can still be performed even when antimicrobial treatment has already been initiated, which is not the case for culture. Another advantage of PCR is its versatility, particularly when using multiplex panels that can simultaneously detect *M. bovis* along with other pathogens, such as BVDV or bacteria that may be involved in diseases like BRD or arthritis (Caswell & Archambault, 2007; Maunsell & Donovan, 2009). This comprehensive approach proves diagnostic accuracy in the field. Although PCR does not allow for antimicrobial susceptibility testing (AST) to be performed, as culture does, more targeted treatment strategies should be considered regarding antimicrobial resistance.

Giving the low number of culture-based identifications reported in the survey, ASTs are rarely implemented, with 48.7% of veterinarians not performing AST routinely and up to 77% performing it infrequently or not at all. This can be explained by several factors. First, to perform ASTs culture is required and as discussed previously, this diagnostic method has several disadvantages making it rarely used by veterinarians. Among veterinarians who use culture, 30% (n = 21/70) frequently performed AST (i.e., often or always), compared to 15.5% (n = 31/200) among those who did not. Additionally, the lack of standardized culture conditions and interpretation criteria for bovine *Mycoplasma* in laboratories limits access to AST of certified quality, which may also influence veterinarians' diagnostic decisions. These results highlight the lack of systematic performing of AST in the practitioners' diagnostic routine. This could lead to the choice of ineffective treatment by veterinarians and consequently to the selection of resistance in mycoplasmas or in non-targeted pathogens.

2. Prescription practices compared to recommendations :

According to scientific literature and National Guidelines provided in Table II, the antimicrobials classes considered effective against mycoplasmas are represented by macrolides, tetracyclines, florfenicol, lincosamides, fluoroquinolones and some aminoglycosides (Heuvelink et al., 2016; Lysnyansky & Ayling, 2016). Tetracyclines and florfenicol are consistently cited as a first-line treatment in BRD, while macrolides and fluoroquinolones are recommended as second and third-line treatment respectively. In cases of mycoplasma mastitis, recommendations are consistent in advising against treatment and instead suggest culling the affected animals. The antimicrobials classes most prescribed by veterinarians as first-line treatment in case of *Mycoplasma* clinical disease in cattle were macrolides, florfenicol, and tetracyclines. Moreover, the usage of antimicrobials which are ineffective against mycoplasmas, such as betalactams, cephalosporins and trimethoprim/sulfonamides were almost never used. According to the 2023 Annual Surveillance report on European sales and use of antimicrobials for veterinary medicine published by the European Medicines Agency (EMA)(European Medicines Agency., 2025), penicillins and polymyxins were the most antimicrobial class sold for food-producing animals with respectively 31.4% and 21.6% of sales. These antibiotics are ineffective against mycoplasmas and their use by veterinarians is very limited or even non-existent for mycoplasmoses in our study. These results highlight veterinarians' ability to select antimicrobials based on the microbiological properties of mycoplasmas, and the supporting targeted prescription practices. Eventually, many veterinarians didn't use antimicrobial treatment for mastitis due to the expected lack of treatment efficacy in case of *mycoplasma* mastitis. These results highlight the consistency between veterinary practitioners' behaviour and scientific recommendations and national guidelines on the prudent use of antimicrobials, underscoring their skill in selecting appropriate antimicrobial therapies based on the microbiological characteristics of mycoplasmas and

supported by targeted prescribing practices. However, those results should be interpreted with caution and may not completely reflect the field reality as the data were collected based on voluntary recruitment and self-reporting, introducing some bias. First, a selection bias is to be considered as veterinarians who decided to participate in the study could be more interested in *Mycoplasma* infections in cattle and more aware of the recommended treatment practices. Then, a recall bias and social desirability bias could also impact the results of the survey, as the data collection method was based on veterinarian's self-reporting here (Coron, 2020).

Although veterinarians appear to use recommended antimicrobial classes against classes mycoplasmas in our survey, many resistances to these antimicrobials' classes have been observed in vitro worldwide. Acquired resistance has been frequently reported for macrolides in western Canada (Hendrick et al., 2013), USA (Ricardo F. Rosenbusch et al., 2005), Japan (Kawai et al., 2014), China (KONG et al., 2016) and Israel (Gerchman et al., 2009) and European countries like France (Gautier-Bouchardon, 2018), Belgium (Bokma et al., 2020), United-Kingdom (Ayling et al., 2014), Hungary (Sulyok et al., 2014) and the Netherlands (Heuvelink et al., 2016). High MICs values for both first and new-generation macrolides are frequently identified in *M. bovis* strains (Gautier-Bouchardon et al., 2014) and cross resistance between some macrolides like tylosin and tilmicosin is observed (Bokma et al., 2020). However, a study published by Godinho KS et al. reveals the clinical efficacy of tulathromycin against *M. bovis* strains with high MIC values (>64 µg/mL) (Godinho et al., 2005), highlighting field efficacy despite *in vitro* indicators of reduced susceptibility. This may explain its widespread use in cases of *M. bovis* infection, as observed in our survey. Acquired resistance to tetracyclines has been demonstrated in Canada (Francoz et al., 2005), Japan (Kawai et al., 2014), Israel (Gerchman et al., 2009), the Netherlands (Heuvelink et al., 2016) and France (Gautier-Bouchardon et al., 2014), while susceptible strains of *M. bovis* were found in Belgium (Bokma et al., 2020) and China (KONG et al., 2016). Minimal acquired resistance to florfenicol

was demonstrated in some European countries, North America and China (Lysnyansky & Ayling, 2016) while susceptible *M. bovis* strains to florfenicol were still found in Canadian cattle feedlots (Sultana et al., 2023). Finally, fluoroquinolones remain the antimicrobial class for which the least resistance has been demonstrated as susceptible strains of *M. bovis* to fluoroquinolones were isolated in Japan (Kawai et al., 2014) and China (KONG et al., 2016) and limited acquired resistance was found in Belgium (Bokma et al., 2020), France (Gautier-Bouchardon et al., 2014) and North America (Lysnyansky & Ayling, 2016). However, a high percentage of acquired resistance of *M. bovis* has been highlighted in Spain (García-Galán et al., 2020) and Italy (Klein et al., 2019). Although some studies show no difference in susceptibility among different production categories (Bokma et al., 2020), others indicate that variations in *M. bovis* resistance depend on geography, livestock species or animal health status (Lysnyansky & Ayling, 2016). A comparison between national usage of antimicrobials and these available studies on acquired resistance in each country would make it possible to assess veterinarians' ability to adapt their prescribing practices to recent scientific data and to update national guidelines accordingly. However, the interpretation of *in vitro* resistance data remains challenging due to the absence of harmonized culture methods and clinical interpretative criteria (such as ECOFFs and clinical breakpoints (CBPs)). This gap is particularly relevant for the MyMIC project, as it complicates the clinical interpretation of MIC values and highlights the need for treatment decisions to be guided by pathogen identification and AST. It reinforces the importance of the MyMIC network's work on harmonizing mycoplasma AST procedures.

3. Metaphylactic practices :

Regarding the management of metaphylaxis, 62.4% of respondents reported not implementing metaphylactic treatment, and up to 81% indicated that they did not use it routinely. This outcome could be related with the low proportion of affected animals in case of *Mycoplasma* infection reported in the survey, because the main motivation described by veterinarians for implementing a metaphylactic treatment was the percentage of diseased animals. These results are inconsistent with some studies describing the beneficial use of metaphylactic antimicrobial treatment to prevent BRD in feedlot beef cattle (Godinho et al., 2005; Hendrick et al., 2013; Sultana et al., 2023). On the contrary other studies underscore the role of metaphylactic antimicrobial use in the selection and dissemination of resistant bacterial strains, particularly in the context of BRD (Amat et al., 2019; Becker et al., 2020). A possible explanation for this disagreement could be the chronic nature of mycoplasmosis in the complex of BRD, while metaphylaxis is mainly used when an acute outbreak of BRD occurs, probably linked to other bacterial infection, as *Mannheimia haemolytica* or *Histophilus somni*. Therefore, the results of the survey concerning metaphylaxis management seems to reflect a more prudent approach to antimicrobial stewardship when chronic case of BRD occurs. This could be subject to debate, given the rapid spread of mycoplasmas infection within a herd and the delay between infection and the appearance of clinical signs. In such cases, avoiding metaphylactic treatment may be imprudent, as it could lead to wider infection and require treatment of a greater number of animals—particularly in case of asymptomatic carriers.

4. Identification of practices that may have an impact on the development of antimicrobial resistance in bovine mycoplasmas :

Some prescription practices that may have an impact on the development of antimicrobial resistance in mycoplasmas and other pathogens in cattle had been highlighted in this survey. Firstly, the frequent use of fluoroquinolones, classified as critically important antimicrobial by the WOAH (WOAH, 2025), may represent the primary risk practice identified in this survey. Fluoroquinolone's administration is conditioned upon the results of pathogen identification and AST in Europe (Commission Implementing Regulation (EU) 2024/1973, 2024). Their use is also strictly regulated in Canada and the USA as prescription before use is required in both countries and extra-label use is forbidden in the USA (Canada, 2017) (FDA & Medicine Center for Veterinary, 2024). In our survey, fluoroquinolones ranked as the fourth most preferred treatment in the three cattle production categories (Figure 5) and became the first therapeutic choice in case of treatment failure (Figure 6). These findings are particularly concerning when correlated with the unsatisfactory results of the study on veterinarians' antimicrobial susceptibility testing practices. Data collected in scientific literature regarding the acquired resistance of *M. bovis* show that fluoroquinolones remain the antimicrobial class for which the least resistance has been demonstrated (except in Italy and Spain). The frequent use of fluoroquinolones by veterinarians in our survey could be explained by their awareness of the preserved susceptibility of *mycoplasmas* to this class. The choice of treatment with fluoroquinolones could also be guided by its pharmacological properties, as it has a mycoplasmacidal effect, whereas most other antimicrobials only have a mycoplasmastatic effect (Lysnyansky & Ayling, 2016) and by disease expression as it has a good joint's distribution (Maunsell et al., 2011). The suspicion of bone involvement infection was therefore

cited by one veterinarian of the survey to justify the use of fluoroquinolones as preferred option treatment. In any case, these combined results highlight the inappropriate use of fluoroquinolones, which increases the potential risk of selecting resistant strains of *Mycoplasma* and other bacterial agents, including zoonotic ones, to this class of antimicrobials. These findings point out the need to raise awareness among veterinarians regarding the prudent use of critically important antimicrobials and the importance of implementing AST. Promoting harmonized AST procedures would improve access to these diagnostics, both for laboratories and veterinarians. Monitoring the antimicrobial resistance profiles in the field is also essential to guide treatment strategies and reduce the use of critically important antimicrobials. In France for example, such surveillance is conducted annually through the Vigimyc network (Jaÿ et al., 2021).

Inadequate dosage prescriptions had also been reported by some veterinarians in this survey. While overdosing was reported occasionally (Table 1, n = 12), the prolongation of treatment duration was the most frequently inappropriate practice as it was mentioned in 181 cases in this survey. Lower doses (Table 1, n = 6) and shorter treatment durations than those recommended by the SmPC were reported in several antimicrobial classes and in different cattle category production. Such deviations from the SmPC may impact treatment efficacy and contribute to the selection of antimicrobial resistance particularly in the cases of concentration-dependant antimicrobials like florfenicol or fluoroquinolones. However, this interpretation should be done with caution, as the way Table I was constructed may introduce potential sources of bias. The application of a single unspecified dosage to multiple antimicrobial classes across production categories may artificially inflating the number of observations, weakening the accuracy of dosage‑class associations, and potentially distorting conformity assessments with SmPC guidelines. Shorter treatment durations may lead to a relapse of the infection and an increase in chronically infected animals, finally resulting in greater antimicrobial use and a higher risk of

resistance selection. Conversely, longer treatment durations may cause unnecessary overuse of antibiotics, which also increases the risk of resistance development and leads to additional costs for farmers, including more frequent treatments and extended withdrawal periods (Riviere et al., 1998). Moreover, the ACVIM consensus statement on antimicrobial use in veterinary medicine (Weese et al., 2015) recalls that antimicrobials should be stopped once there is clinical and microbiological evidence that the infection has been eliminated. Such bacteriological healing is impossible to reach in cases of mycoplasma infection as the pathogen persistence in the herd is frequent, primarily due to rapid spread and the intermittent shedding of infected animals for weeks to months (Dudek et al., 2020). These difficulties, particularly in case of mycoplasma mastitis may induce longer treatment durations. This extended persistence is also associated with the ability of mycoplasmas to localize in anatomical niches, such as joints, within the host animal or to trigger chronical lesions in lungs where antimicrobials are not effective. Although further studies are needed to understand the direct impact of antimicrobial prescription conditions (such as dose and duration) on the selection of resistance, the development of mycoplasma CBPs and standardized AST procedures, which is the focus of the work conducted by the MyMIC network remains once again essential to reduce the risk of antimicrobial resistance.

Very few veterinarians cited the use of antimicrobials ineffective against mycoplasmas, such as beta-lactams, trimethoprim, and sulfonamides. When mentioned, their use was mainly justified by the need to target co-infecting pathogens rather than mycoplasmas. In BRD cases, *M. bovis* is commonly associated with other pathogens, with co-infections involving viruses and bacteria detected in 37.2% and 36.0% of samples respectively in a recent Quebec study (Buczinski et al., 2024). However, *M. bovis* was also the sole pathogen isolated in 34% of fatal pneumonia cases (Caswell & Archambault, 2007) and shows high prevalence in both Europe and North America (Nicholas, 2011; Sultana et al., 2023). It should therefore be considered as

a major BRD pathogen, requiring treatment strategies that target both *M. bovis* and potential co-infecting agents. Re-evaluating the treatment strategy is also particularly important in cases involving caseo-necrotic lung lesions or when there is no response to initial therapy, especially in BRD cases associated with arthritis or otitis media (Maunsell & Donovan, 2009; Nicholas, 2011). Moreover, while antimicrobial resistance in mycoplasmas has been well documented, antimicrobial resistance has also been reported in other BRD-associated pathogens, such as *Pasteurella multocida* and *Mannheimia haemolytica* (Alhamami et al., 2021; Sultana et al., 2023) further underscoring the need for an informed and comprehensive antimicrobial selection.

Those last results show once again that the prescription of antimicrobials in case of *Mycoplasma* infection in cattle should be supported by diagnostic tests and AST, made possible by the work carried out by the MyMIC network on the harmonization of AST methods. Surveillance networks such as VIGIMYC (VIGIMYC, 2022) are also of great importance, as they provide updated data on the various *Mycoplasma* strains circulating in the field and their level of antimicrobial resistance. It also points to the importance of coordinated actions at different levels: prevention among farmers and veterinarians for carrying out identification and antimicrobial susceptibility testing, development of guidelines and harmonized procedures concerning AST for mycoplasmas and accessibility for veterinarians to specialized laboratories able to perform it.

5. Limites et perspectives de l'étude :

Avec un total de 469 réponses provenant de 40 pays, l'enquête réalisée dans le cadre du projet de recherche menée par le réseau MyMIC fournit une revue complète de la prise en charge des mycoplasmoses chez les bovins par les vétérinaires à l'échelle mondiale. Le nombre important de réponses provenant de vétérinaires traitant les bovins (n = 270) donne une représentation robuste des pratiques diagnostiques et thérapeutiques des mycoplasmoses bovines et particulièrement liées à *M. bovis* à travers le monde. Toutefois, la disparité de répartition des réponses à travers le monde constitue l'une des principales limites de cette étude. Un nombre plus important et équivalent de réponses entre les pays et par catégorie de bovins permettrait une analyse plus poussée et comparative des données qui n'a pas pu être réalisée au cours de cette étude. En effet, l'analyse des réponses données par les vétérinaires aux questions concernant la proportion d'animaux atteints en cas d'infection à mycoplasmes, la fréquence de réalisation de tests diagnostiques et la fréquence de réalisation d'AST par catégorie de production doit être exploitée avec prudence car le nombre d'animaux traités par les vétérinaires ayant répondu à l'étude est différent pour chaque catégorie de production. En effet, pour rappel, les vaches laitières représentent la première catégorie étant citée (n = 219 fois), puis les vaches allaitantes (n = 188) et enfin les bovins d'engraissement (n = 149). Cette disparité d'échantillonnage entre les catégories de production à la base induit nécessairement une disparité de distribution des réponses de l'étude. Un recrutement plus important de vétérinaires permettrait également de réaliser des analyses statistiques multivariées, et ainsi vérifier si certains « profils types » de vétérinaires (âge, années d'expérience, type d'activité) ont une influence sur les pratiques diagnostiques et thérapeutiques lors d'infections à mycoplasmes chez les bovins.

Les résultats de l'étude mettent en évidence un recours fréquent à la PCR pour diagnostiquer les mycoplasmes bovins, alors que la culture et les tests de sensibilité aux antibiotiques restent peu utilisés. En matière d'antibiothérapie, les pratiques des vétérinaires sont concordantes avec les recommandations scientifiques internationales et directives nationales, puisque les macrolides, le florfénicol et les tétracyclines sont les molécules les plus utilisées en traitement de première intention pour les infections à mycoplasmes, alors que les pénicillines et polymyxines restent les plus majoritairement vendues en Europe (European Medicines Agency., 2025). Cet usage thérapeutique reflète une prescription raisonnée, fondée sur les propriétés microbiologiques des agents pathogènes ciblés. Cependant, même si les pratiques d'antibiothérapie sont concordantes avec les recommandations officielles de différents pays, la façon dont ces dernières ont été établies, n'a pas été étudiée et la prise en compte des résistances acquises aux antibiotiques par les mycoplasmes n'a pas été évaluée. De nombreuses études mettent en effet en avant une tendance croissante de résistances aux antibiotiques des mycoplasmes à l'international. Une confrontation entre les recommandations nationales et les études sur les résistances acquises disponibles pour chaque pays permettrait d'évaluer la capacité des vétérinaires à adapter leur prescription aux données scientifiques récentes et d'actualiser les guides nationaux.

A contrario, l'usage peu fréquent de la culture et des tests de sensibilité aux antibiotiques (AST) en tant qu'aide diagnostique, le recours à des antibiotiques d'importance critique (fluoroquinolones), notamment en deuxième intention et les écarts de posologie par rapport aux Résumés des Caractéristiques des Produits (RCP), constituent les principales pratiques à risque identifiées dans cette étude. Ces pratiques peuvent contribuer à la sélection de souches de mycoplasmes résistantes chez les bovins menant à une réduction des options thérapeutiques disponibles et déjà limitées par les caractéristiques spécifiques de ces bactéries. La sélection de

résistances d'autres bactéries, notamment en cas de maladie respiratoire bovine, peut également être favorisée par ces pratiques.

Le recours plus fréquent aux méthodes diagnostiques et le développement de tests de sensibilité (AST) harmonisés et accessibles, ainsi qu'une meilleure diffusion et application des recommandations scientifiques et nationales en matière de traitement, sont des enjeux majeurs mis en lumière par cette étude. Cela permettra d'améliorer la prise en charge et le traitement des mycoplasmoses bovines. C'est en ce sens que le réseau MyMIC travaille à la standardisation des méthodes de culture et de tests de sensibilité pour les mycoplasmes des animaux de production, afin de permettre une utilisation appropriée des antibiotiques contre les mycoplasmes bovins notamment, d'assurer une bonne santé des élevages à l'échelle mondiale, et de contribuer à la lutte contre la résistance aux antibiotiques.

CONCLUSION

Avec trois publications portant sur l'analyse des pratiques diagnostiques et d'antibiothérapie en cas d'affection à mycoplasmes pathogènes chez les bovins, porcs et volailles, le groupe de recherche MyMIC est à l'origine de la première étude d'une telle ampleur concernant les mycoplasmoses des animaux de production à l'échelle internationale. Cette étude, complétée par des travaux de recherche sur le recueil des données disponibles sur les CMI des mycoplasmes pathogènes des animaux de production doit conduire à l'élaboration de méthodes de référence pour la réalisation des tests de sensibilité aux antibiotiques et à la définition de valeurs seuils épidémiologiques (ECOFFs) qui n'existent pas à ce jour. L'enquête réalisée pour l'espèce bovine a profité d'une participation importante des vétérinaires à l'échelle mondiale, donnant des résultats interprétables et fiables. Un recrutement plus important de vétérinaires dans certains pays aurait néanmoins permis une analyse plus complète et comparative des données. Si les pratiques d'antibiothérapie relevées dans l'étude concordent bien avec les recommandations internationales, certaines pratiquent notamment l'usage d'antibiotiques critiques et le recours peu fréquent aux tests de sensibilité aux antibiotiques restent problématiques. Ces pratiques à risque mettent en lumière le besoin de rendre disponibles et accessibles les tests de sensibilité et d'appuyer les études déjà menées d'une communication efficace auprès de tous les acteurs liés au mycoplasmoses animales : éleveurs, vétérinaires et laboratoires. Les actions du réseau MyMIC sont indispensables pour le développement de méthodes d'AST standardisées toujours inexistantes à ce jour, et pour la diffusion future de ces méthodes en tant que référence à l'échelle mondiale. Ces travaux s'inscrivent ainsi dans un enjeu international d'amélioration de la prise en charge des affections à mycoplasmes chez les animaux de production et de limitation de la sélection de souches résistantes de ces agents pathogènes majeurs dans le secteur des productions animales.

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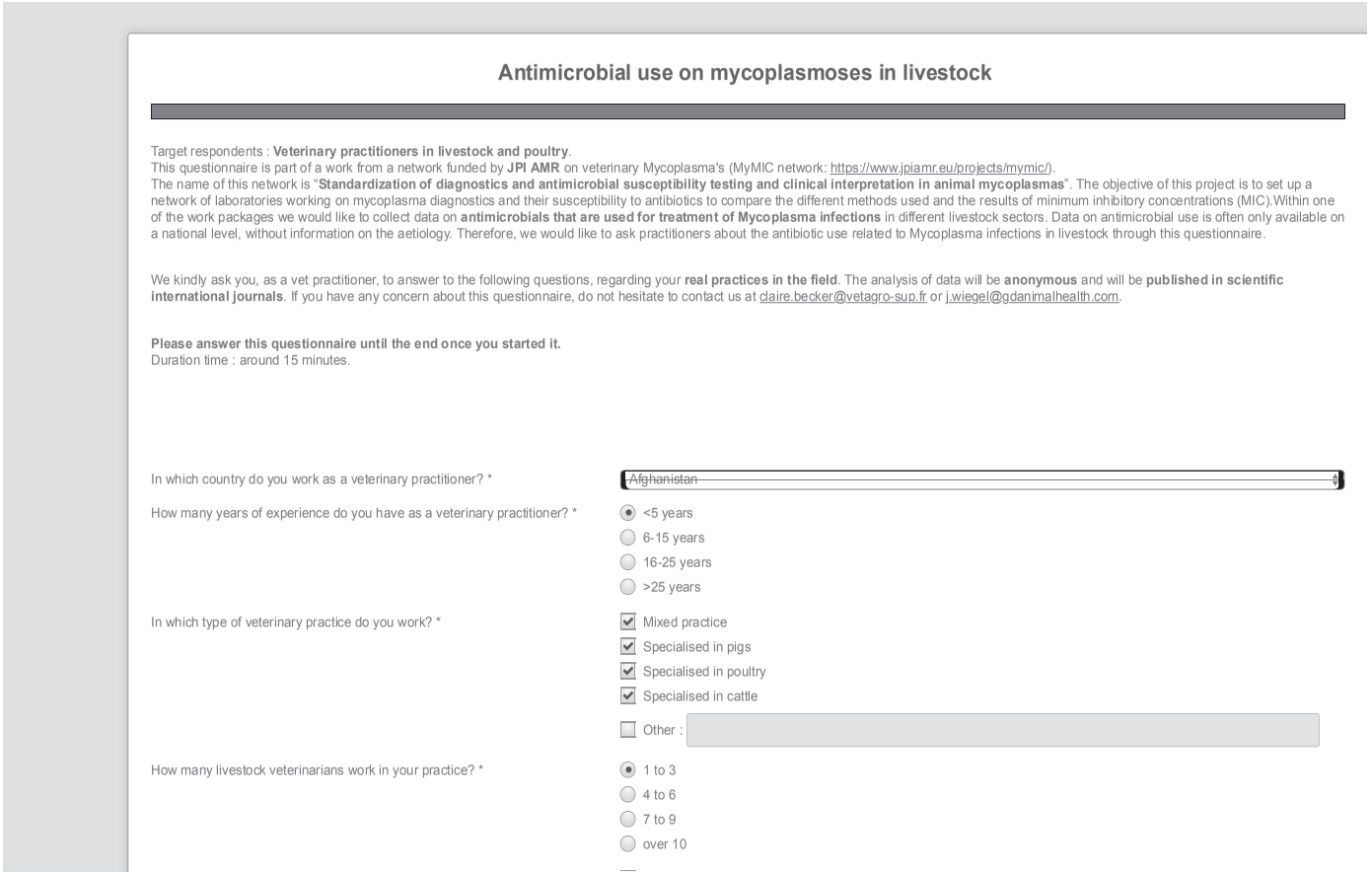
ANNEXES

Annexe 1 : Apparence du questionnaire sur la page web.



Antimicrobial use on mycoplasmoses in livestock

Target respondents : **Veterinary practitioners in livestock and poultry**.
This questionnaire is part of a work from a network funded by **JPI AMR** on veterinary Mycoplasma's (MyMIC network: https://www.jpiamr.eu/projects/mymic/).
The name of this network is "**Standardization of diagnostics and antimicrobial susceptibility testing and clinical interpretation in animal mycoplasmas**". The objective of this project is to set up a network of laboratories working on mycoplasma diagnostics and their susceptibility to antibiotics to compare the different methods used and the results of minimum inhibitory concentrations (MIC).Within one of the work packages we would like to collect data on **antimicrobials that are used for treatment of Mycoplasma infections** in different livestock sectors. Data on antimicrobial use is often only available on a national level, without information on the aetiology. Therefore, we would like to ask practitioners about the antibiotic use related to Mycoplasma infections in livestock through this questionnaire.

We kindly ask you, as a vet practitioner, to answer to the following questions, regarding your **real practices in the field**. The analysis of data will be **anonymous** and will be **published in scientific international journals**. If you have any concern about this questionnaire, do not hesitate to contact us at claire.becker@vetagro-sup.fr or j.wiegel@gdanimalhealth.com.

Please answer this questionnaire until the end once you started it.
Duration time : around 15 minutes.

In which country do you work as a veterinary practitioner? * Afghanistan

How many years of experience do you have as a veterinary practitioner? *
- (•) <5 years
- ( ) 6-15 years
- ( ) 16-25 years
- ( ) >25 years

In which type of veterinary practice do you work? *
- [x] Mixed practice
- [x] Specialised in pigs
- [x] Specialised in poultry
- [x] Specialised in cattle
- [ ] Other :

How many livestock veterinarians work in your practice? *
- (•) 1 to 3
- ( ) 4 to 6
- ( ) 7 to 9
- ( ) over 10

What are the main livestock species you work with?
Follow up questions will appear related to the species that are selected.
Multiple species are possible. *

- [x] dairy cattle
- [x] cattle rearing
- [x] beef cattle
- [x] pig nursery
- [x] weaning piglets
- [x] fattening pigs
- [x] breeding sows
- [x] chickens - layers
- [x] chickens - breeders
- [x] chickens - broilers
- [ ] meat turkeys
- [ ] other :

Do you encounter Mycoplasma infections in the animals you see? *

- (•) Yes
- ( ) No

If yes, select the animal species. *

- [x] dairy cattle
- [x] cattle rearing
- [x] beef cattle
- [x] pig nursery
- [x] weaning piglets
- [x] fattening pigs
- [x] breeding sows
- [x] chickens - layers
- [x] chickens - breeders
- [x] chickens - broilers
- [ ] meat turkeys
- [ ] other :

[BOVINE]

[Dairy cattle] What Mycoplasma species do you encounter related to clinical disease? *

- [x] M. bovis
- [ ] Don't know
- [ ] Other :

[Cattle rearing] What Mycoplasma species do you encounter related to clinical

- [x] M. bovis

disease? *

- [ ] Don't know
- [ ] Other :

[Beef cattle] What Mycoplasma species do you encounter related to clinical disease? *

- [x] M. bovis
- [ ] Don't know
- [ ] Other :

[Bovine] What is the proportion of animals affected when you encounter a clinical infection with Mycoplasma?

- ( ) Less than 10%
- (•) 10 to 25%
- ( ) 25 to 50%
- ( ) 50 to 75%
- ( ) 75 to 100%

[Bovine] Are additional diagnostics applied when a Mycoplasma infection is suspected (on the differential diagnosis)?

- ( ) never (=0)
- ( ) rarely (<1/10)
- (•) occasionally (1/10 to 1/2)
- ( ) often (> 1/2)
- ( ) always (>4/5)

[Bovine] If yes, what additional diagnostics? *

- [ ] Serology
- [ ] PCR
- [x] Culture
- [ ] Post mortem (necropsy)
- [ ] Histology
- [ ] Other :

[Bovine] Do you perform (or let a third party perform) antimicrobial susceptibility tests? *

- ( ) never (=0)
- ( ) rarely (<1/10)
- (•) occasionally (1/10 to 1/2)
- ( ) often (> 1/2)
- ( ) always (>4/5)

[Bovine] Is treatment required for Mycoplasma infections? *

- ( ) never (=0)
- ( ) rarely (<1/10)
- (•) occasionally (1/10 to 1/2)
- ( ) often (> 1/2)
- ( ) always (>4/5)

[Bovine] When do you decide to apply treatment for Mycoplasma on diseased animals ? *

- [ ] based on the severity of signs and the most likely diagnosis
- [ ] results of further laboratory testing
- [x] known disease which spreads quickly
- [ ] percentage of animals diseased
- [ ] request from farmer/industry
- [ ] other:

[Bovine] Do you perform metaphylactic treatment for Mycoplasma infections? *

- ( ) never (=0)
- ( ) rarely (<1/10)
- (•) occasionally (1/10 to 1/2)
- ( ) often (> 1/2)
- ( ) always (>4/5)

[Bovine] What is the reason that makes you decide to apply metaphylactic treatment on a lot ? *

- [ ] severity of signs
- [ ] results of laboratory tests
- [x] known disease which spreads quickly
- [ ] percentage of animals diseased
- [ ] request from farmer/industry
- [ ] other:

[Bovine] If you decide not to treat for Mycoplasma infections, why is that? *

- [ ] Expected lack of efficacy
- [ ] Impact of treatment on trade / Due to industry agreements
- [x] Legal boundaries
- [ ] Logistic problems due to withdrawal times
- [ ] Cost
- [ ] Other :

[Bovine] What is the preferred option of treatment on Mycoplasma infections? (only answer for the species that you treat)

	fluoroquinolones	macrolides	pleuromutilins	lincosamides	cephalosporins	aminoglycosides	florfenicol	penicillins without betalactam inhibitors	penicillins with betalactam inhibitors	tetracyclines	trimethoprim / sulfonamides	combinations	long-acting forms	no treatment
dairy cattle	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	(•)	( )	( )

cattle rearing	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	
beef cattle	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	

[Bovine] If you ticked combinations, please precise the molecules :

,

[Bovine] If you ticked long-acting forms, please precise the molecules :

,

[Bovine] If you ticked no treatment, please precise why :

,

[Bovine] Concerning the preferred treatment option selected, what dose and duration do you generally apply ? If you selected multiple options, please precise the molecules. *

,

[Bovine] What is your preferred treatment option based on? *

- ☐ National treatment guidelines
- ☑ Farm History
- ☐ Antimicrobial Susceptibility Testing results
- ☐ Overviews of Antimicrobial Susceptibility of the agent
- ☐ Economic feasability of treatment
- ☐ Other :

[Bovine] How often do you use the following antimicrobial classes for treatment of Mycoplasma infections? (only answer for the species that you treat)	never (=0)	rarely (<1/10)	occasionally (1/10 to 1/2)	often (> 1/2)	always (>4/5)
fluoroquinolones	○	◉	○	○	○

macrolides	○	○	◉	○	○
pleuromutilins	○	○	○	◉	○
lincosamides	○	○	◉	○	○
cephalosporins°	○	◉	○	○	○
aminoglycosides	○	◉	○	○	○
florfenicol	○	◉	○	○	○
penicillins without betalactam inhibitors°	○	◉	○	○	○
penicillins with betalactam inhibitors°	○	◉	○	○	○
tetracyclines	○	◉	○	○	○
trimethoprim/sulfonamides	○	◉	○	○	○
long-acting forms	○	◉	○	○	○
combinations	○	◉	○	○	○

°NOTE: cephalosporins and penicillins are not effective in treating Mycoplasma. Please explain in the textbox why you have selected this option :

;

[Bovine] If you ticked combinations, please precise the molecules :

;

[Bovine] If you ticked long-acting forms, please precise the molecules :

;

[Bovine] What is the most frequent pattern for metaphylactic treatment that you apply in your practice ? Tick the corresponding boxes - antibiotic and administration route	per os / premixed feed	per os / feed top dressing	per os / drinking water	parenteral / subcutaneous	parenteral / intramuscular	parenteral / intravenous	other
fluoroquinolones	◉	○	○	○	○	○	○
macrolides	◉	○	○	○	○	○	○
pleuromutilins	◉	○	○	○	○	○	○
lincosamides	◉	○	○	○	○	○	○
cephalosporins°	◉	○	○	○	○	○	○
aminoglycosides	◉	○	○	○	○	○	○
florfenicol	◉	○	○	○	○	○	○
penicillins without betalactam inhibitors°	◉	○	○	○	○	○	○
penicillins with betalactam inhibitors°	◉	○	○	○	○	○	○

tetracyclines	◉	○	○	○	○	○	○
trimethoprim/sulfonamides	◉	○	○	○	○	○	○
long-acting forms	◉	○	○	○	○	○	○
combinations	◉	○	○	○	○	○	○

°NOTE: cephalosporins and penicillins are not effective in treating Mycoplasma. Please explain in the textbox why you have selected this option :

'

[Bovine] If you ticked combinations, please precise the molecules :

'

[Bovine] If you ticked long-acting forms, please precise the molecules :

'

[Bovine] In case of failure of treatment, what is the second choice of treatment available?

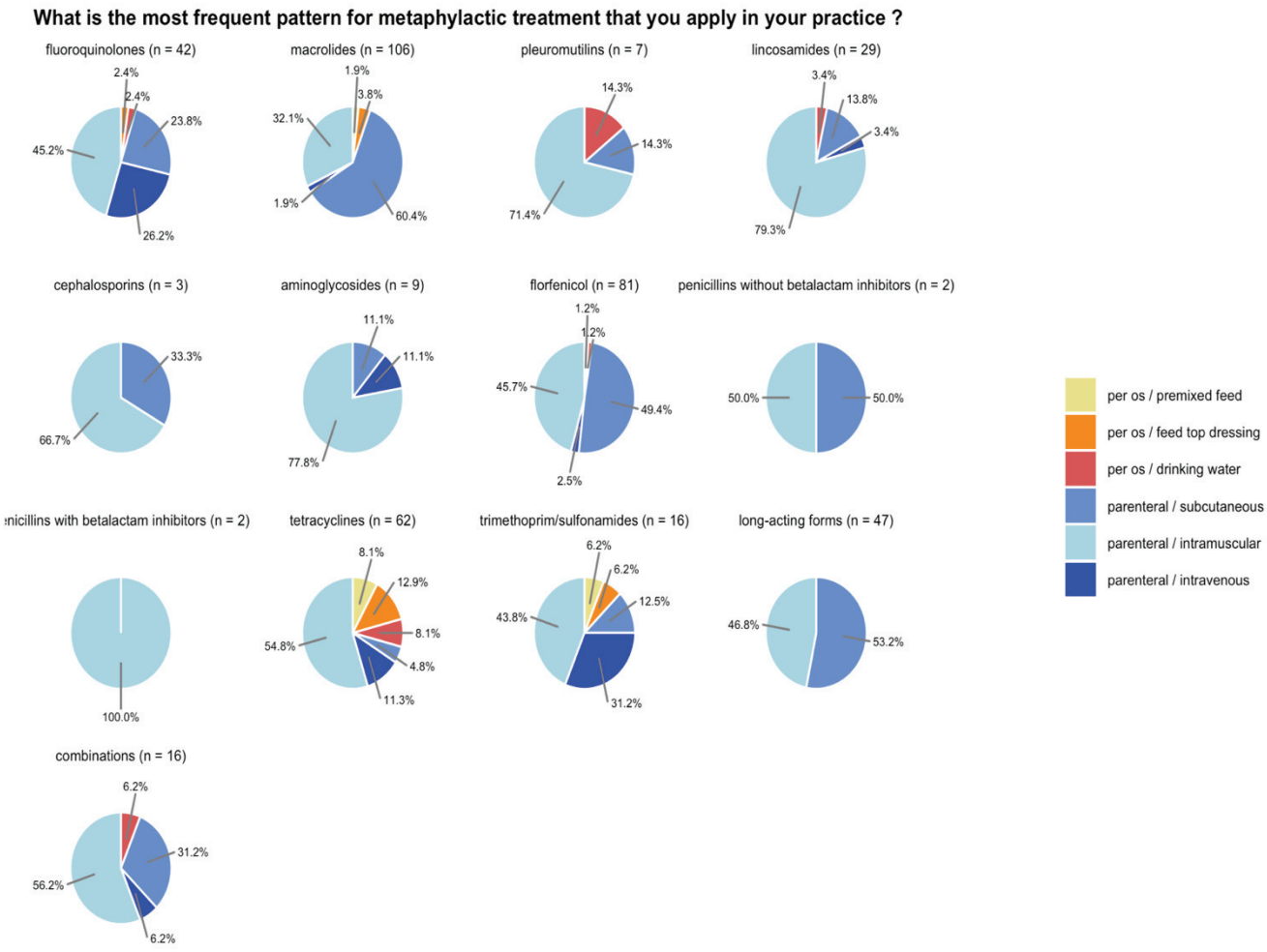
- ○ fluoroquinolones
- ○ macrolides
- ○ pleuromutilins
- ○ lincosamides
- ○ cephalosporins
- ○ aminoglycosides

- florfenicol
- penicillins without betalactam inhibitors
- penicillins with betalactam inhibitors
- tetracyclines
- trimethoprim/sulfonamides
- (•) combinations (write the molecules below)
- long-acting forms (precise below)
- no treatment, because:

[Bovine] If you ticked combinations, please precise the molecules :

;

Annexe 2 : Voie d'administration des traitements métaphylactiques les plus fréquemment utilisés par les vétérinaires bovins pour chaque classe d'antimicrobiens.



UTILISATION DES ANTIBIOTIQUES CONTRE LES INFECTIONS A MYCOPLASMES EN PRATIQUE VETERINAIRE BOVINE : RECUEIL DE DONNEES DE TERRAIN ET COMPARAISON AUX RECOMMANDATIONS

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Résumé

Les mycoplasmes sont des agents pathogènes importants chez les bovins, responsables de plusieurs maladies telles que des affections respiratoires, des mammites et de l'arthrite, entraînant d'importantes pertes économiques en production bovine. Les caractéristiques microbiologiques de ces agents rendent leur diagnostic, leur traitement et certains tests de laboratoire – comme les tests de sensibilité aux antibiotiques (AST) – particulièrement complexes. Cette étude, portée par le réseau MyMIC fait le bilan des pratiques de diagnostic et de traitement utilisées par les vétérinaires bovins à travers le monde grâce à une enquête, pour les infections à mycoplasmes, notamment à *M. bovis*. L'enquête a recueilli 270 réponses de vétérinaires traitant des bovins provenant de 40 pays. Les résultats montrent que *M. bovis* était l'agent pathogène le plus rencontré et que la PCR était la méthode de diagnostic la plus fréquemment utilisée, tandis que la culture et les tests AST étaient réalisés moins souvent. Les macrolides, le florfénicol et les tétracyclines étaient les antibiotiques les plus utilisés, en accord avec les recommandations actuelles. Certaines pratiques de prescription s'écartaient toutefois des directives, notamment l'utilisation de classes d'antibiotiques inefficaces ou de doses ou durées de traitement inappropriées. La pratique la plus préoccupante relevée était l'usage fréquent d'antibiotiques d'importance critique, comme les fluoroquinolones, sans réalisation préalable d'un AST, ce qui pourrait favoriser la sélection de souches de mycoplasmes résistantes, alors que cette classe est l'une des dernières pour laquelle très peu de résistances sont observées. Ces résultats soulignent la nécessité d'actions coordonnées à plusieurs niveaux : encourager chez les vétérinaires l'identification des mycoplasmes et la réalisation d'AST, diffuser des recommandations actualisées en matière de diagnostic et de traitement, et élaborer des lignes directrices et procédures standardisées pour les AST chez les espèces de mycoplasmes vétérinaires, accompagnées de seuils d'interprétation. Par son travail sur la standardisation des méthodes AST pour les mycoplasmes, le réseau MyMIC joue un rôle clé dans la lutte contre la résistance aux antimicrobiens et dans l'amélioration de la santé des systèmes de production animale.

Mots-clés

Mycoplasmes, antibiotiques, bovins, recommandations

Jury

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