Danish cattle veterinarians' perspectives on antimicrobial use: Contextual and individual influencing factors

Nanna K. Skjølstrup,^{1*} Mette Vaarst,² Carsten S. Jensen,³ and Dorte B. Lastein¹

¹Section for Production, Nutrition and Health, Department of Veterinary and Animal Sciences, Faculty of Health and Medical Sciences, University of Copenhagen, 1870 Frederiksberg, Denmark

²Department of Animal Sciences, Aarhus University, 8830 Tjele, Denmark

³Department of Sociology, Faculty of Social Sciences, University of Copenhagen, 1353 Copenhagen, Denmark

ABSTRACT

The global risk for antimicrobial resistance (AMR) can be reduced by reducing antimicrobial use (AMU). Veterinarians are one of the key actors in relation to AMU in livestock, and understanding the dynamics of veterinary treatment and prescription is central to achieving AMU reduction. Veterinary AMU decisions are influenced by a complex pattern of both individual and contextual factors. In this study, we conducted semi-structured interviews with 16 Danish cattle veterinarians to investigate their perspectives on AMU and current practices in a national context with low use and extensive legal control. We found that personal experiences and emotions, rather than scientific evidence, guided some veterinarians when making AMU choices. Furthermore, less-experienced veterinarians felt pressure to prescribe according to colleagues' and farmers' preferences for certain antimicrobials. We found that changes in Danish legislation seemed to have introduced hesitancy and a lack of motivation within the veterinary profession, and that AMR was perceived as an abstract threat not applicable to the veterinarians' daily professional decision making. We concluded that the lack of field-generated research of local relevance nourished a culture in which AMU choices are built on personal experience rather than scientific evidence, which also diminished newly educated veterinarians' self-confidence in relation to their AMU choices. Future research should focus on developing locally relevant research on optimal AMU choices and AMR, and the implications of extensive legal control of AMU in livestock farming should be further investigated to find a balance on the path to reducing AMU.

Key words: antimicrobial resistance, veterinarian perception and choices, societal context

INTRODUCTION

Reducing antimicrobial use (AMU) is one of the key ways to reduce the occurrence of antimicrobial resistance (AMR), as any use of antimicrobials can increase the risk of AMR (Tang et al., 2017; Schwarz et al., 2018). Veterinarians are one of the primary distributors of antimicrobials, which is why understanding the dynamics of veterinary treatment and prescription and how to change these patterns is a prerequisite for revising and reducing AMU in livestock.

The aim of this paper is to investigate how different factors influence Danish cattle veterinarians' antimicrobial treatment and prescription at a time characterized by an increasing focus on AMR. Particular focus is placed on (a) factors that characterize each individual veterinarian (e.g., personal experiences, feelings, attitudes, perceived risk of AMR) and (b) the context and the contextual factors that influence individual veterinarians' decisions on how and when to use antimicrobials. The contextual factors (e.g., legislation, working experience, farmers' and colleagues' preferences, and the structure of veterinary practices) influence and frame how the individual veterinarian will act in specific situations. We argue that close interconnection exists between the individual factors characterizing a veterinarian and the contextual factors within which he or she must act. These relationships are in focus in this study, and the interactions between factors are further explored in this paper.

Different factors influencing prescribing practices among veterinarians have been identified in the existing literature. Some studies have primarily focused on identifying whether an influencing factor is individual or contextual. For example, with regard to individual factors, personal experience of specific clinical situations and previous treatment responses have been found to influence veterinarians' choice of antimicrobials (De Briyne et al., 2013; McDougall et al., 2017). In addition, personal feelings have been found to influence veterinary AMU—for example, the fear of being blamed

Received July 8, 2021.

Accepted December 1, 2021.

*Corresponding author: nannaks@sund.ku.dk

by farmers if the proposed treatment fails (Gibbons et al., 2013).

Other studies have identified different contextual factors that influence a veterinarian's treatment and prescribing behavior. For example, the structure of veterinary practices and types of veterinary services have been found to influence veterinary AMU (Magalhães-Sant'Ana et al., 2017), and another study identified the need for further legal restrictions in the Netherlands to limit the influence from farmers on veterinary treatment and prescribing (Speksnijder et al., 2015a). In addition, Wilm et al. (2021) identified an apparent national context-dependent preference for the route of administration when treating acute mastitis (simultaneous systemic and local treatment) among Danish veterinarians, which varied from the approaches preferred by Swedish and US veterinarians, for example (Persson Waller et al., 2016; Winder et al., 2019). Treatment approaches therefore appear to be influenced by the national context. Furthermore, a lack of fast and effective diagnostic tools was also identified as a contextual factor influencing veterinary AMU (Speksnijder et al., 2015a).

Finally, some studies have emphasized the importance of combining both individual and contextual factors to understand how their interactions influence AMU. These studies have shown how individual preferences among veterinarians for using fewer antimicrobials have been "overruled" by the context in which the veterinarians work. For example, the perception of AMR as a risk and the incentive for veterinarians to adjust their prescribing behavior accordingly could be seen as an individual influencing factor. However, Golding et al. (2019) found that animal welfare considerations often overruled farmers' and veterinarians' concerns about AMR. Furthermore, Helliwell et al. (2019) found that veterinarians and farmers were not sufficiently equipped to recognize resistance at farm level, partly due to a lack of effective diagnostic tools. Therefore, the individual factor of risk perception was influenced by other factors, including contextual factors such as animal welfare status and the availability of diagnostic tools. Whether AMR is perceived as a risk and the influence that this perception may have on veterinary AMU might therefore be better understood by focusing on the complete pattern of interactive factors. In addition, social influence in terms of experienced pressure to prescribe from either colleagues or farmers has been perceived as an individual or interpersonal (Golding et al., 2019) as well as a contextual factor (Speksnijder et al., 2015a; Lorencatto et al., 2018; Borek et al., 2020; Redding et al., 2020). Golding et al. (2019) outlined how veterinarians experienced pressure to prescribe from farmers and described how this could be

influenced by individual factors such as feelings about maintaining a good working relationship. In addition, it was influenced by contextual factors such as poor farm management, as when the farmer did not identify a diseased animal until a late stage at which treatment was unavoidable, potentially lessening the veterinarians' determination to oppose the farmer's preference for prescribing antimicrobials (Golding et al., 2019). Higgins et al. (2017) also illustrated the complexity in defining social influence as either an individual or a contextual factor. They described how the contextual factors of lack of mentorship and time for clinical discussions with colleagues made it difficult for newly educated veterinarians to gain knowledge, which the veterinarians believed would help them gain trust from farmers and, in time, increase their influence over farmers' AMU.

These examples highlight the need to move beyond the mere description of influencing factors as either individual or contextual, and instead focus on the dynamics of their interaction, and we will attempt to address this in this paper. This perspective is also in line with observations within social science, where studies are increasingly exploring AMU and AMR, thus acknowledging that AMR is a complex One Health issue involving multiple actors and implying that solving the dilemma of AMR cannot be reduced to a matter of individual behavioral change (Moran, 2017; Chandler, 2019; Broom et al., 2020). As described by Golding et al. (2019), individual behavior is entangled with contextual factors in a reciprocal dynamic, which is why it is important to focus on both individual and contextual factors and the interaction between them to understand their influence on veterinary treatment and prescribing behavior (Chandler, 2019; Fischer et al., 2019; Redding et al., 2020).

Denmark is an example of a country where AMU regulations have been implemented for decades and current AMU is relatively low compared with other European countries. However, we have seen no further reduction in overall AMU in cattle over the past 5 years (European Medicines Agency, 2020; Korsgaard et al., 2020). Therefore, examining the perspectives of Danish veterinarians in relation to their individual AMU choices, alongside the influences they experience from their surroundings (i.e., through legislation and the structures determining their veterinary work) might contribute valuable insights to future work on reducing AMU in other national settings and further reducing AMU under Danish conditions.

Semi-structured interviews, as used in this study, can help to clarify the influence of and interaction between contextual and individual factors as experienced by the interviewed actors in more depth. The topic was

approached inductively through semi-structured interviews with Danish veterinarians, to explore their perspectives on AMU and current practices.

MATERIALS AND METHODS

This project complied with relevant Danish and international standards and guidelines for research ethics, and approval was granted by the Research Ethics Committee for Science and Health of the University of Copenhagen (ReF: 504-0066/19-5000). Furthermore, the project complied with the rules of the General Data Protection Regulation, and approval was granted (ref. no.: 514-0312/19-3000). The study has been reported in accordance with the COREQ checklist (Booth et al., 2014).

Setting

Danish cattle farmers with more than 100 adult cattle are obliged to choose from 4 different types of veterinary agreements that each dictate the content and frequency of the veterinarian's advisory visits to the farm (Ministry of Environment and Food of Denmark, 2018). All treatments at organic farms must be initiated by veterinarians (Organic Denmark et al., 2020). Therefore, veterinarians might visit regularly to treat sick animals, yet not within the framework of advisory services, as organic farmers often choose veterinary agreements that involve only 1 or 2 obligatory veterinary visits per year. In contrast, conventional farmers are allowed to have medicines available at the farm to treat certain defined diagnoses (prescribed by the veterinarian for certain animal groups) if they choose 1 of 2 specific veterinary agreements; the more liberal the access to medicines, the more frequent the visits. Depending on the size of the farm and the animal groups present, 4 to 26 yearly veterinary visits are required (Ministry of Environment and Food of Denmark, 2018). For example, veterinary visits typically include evaluation of treated and dead animals since the last visit, evaluation of herd health and production, antimicrobial use, animal welfare (2 visits per year with a special focus on this), and biosecurity (special focus once yearly). In addition, veterinarians are required to write farm-specific reports at regular intervals. The Danish Veterinary and Food Administration supervises practicing veterinarians, to evaluate their compliance with these regulations.

Participants and Recruitment

The inclusion criterion for this study was veterinarians working primarily with dairy cattle. Using a par-

ticipation matrix of gender, age, and employment status to ensure variation among participants, veterinarians were recruited via the researchers' professional network and official lists of practicing cattle veterinarians (i.e., through purposeful sampling). A small number of the recruited veterinarians were known professionally by the interviewer (first author), but no veterinarians with a close relationship were interviewed. Veterinarians were contacted via telephone by the interviewer, who briefly presented herself and asked whether they wanted to share their opinion on AMU in dairy farming in an interview. One of the 17 veterinarians declined due to time constraints. Data saturation was evaluated during the interview process. We concluded that data saturation had been achieved when the 16 interviews were finalized, as no new information came up in the final interviews (Fusch and Ness, 2015).

Before conducting the interviews, the interviewer reflected on her background as a former practicing veterinarian and PhD student at the time of the interviews, her own perception of rational AMU and expectations regarding replies from interviewees based on previous experience of the topic. The interviewer had no previous experience of conducting interviews but conducted 3 pilot interviews to practice and adjust the interview guide, and attended several practical courses in interview techniques before the interviews.

At the beginning of the interview, every participant signed an informed consent form, which included a brief summary of the project, an assurance of complete confidentiality, permission for the interviewer to use transcribed interviews for analysis, and information on the right to withdraw from the interview at any time before initiation of the interview analysis. No participants withdrew their consent.

Interviews

Between June and September 2019, the first author conducted all of the interviews using a qualitative, semi-structured approach. None of the interviews were repeated. Interviews were conducted in Danish, at the interviewee's workplace or home, or in a quiet public place without any disturbance from other people. An interview guide consisting of 7 themes (Table 1) directed the interviews, but the chosen order of the themes was flexible, and interviewees were encouraged to direct the course of the interviews themselves. Member checking (i.e., a brief summary of the main points of the interview given by the interviewer) was performed during the interview and at the end of the interview to give interviewees the opportunity to correct or add any information (Kvale and Brinkmann, 2014). Interviews

Table 1. Themes of the interview guide used in the interviews

Interview guide
<ul style="list-style-type: none"> - Motivation (what motivates you in your daily work, examples) - Collaboration with farmers (motivation, changes) - Antimicrobial usage (responsibility, information sources, thoughts on treatment: criteria, duration, choice of drug, use of guidelines, diagnostics) - Attitudes about antimicrobial usage (own, society's, colleagues', farmers') - Thoughts on antimicrobial resistance ("correct antimicrobial usage," information sources) - Change in antimicrobial usage (in relation to clients, examples) - Future antimicrobial usage in dairy farming (wishes, perspectives)

lasted on average 80 min (range: 50 to 115 min) and were audio recorded. No transcripts were returned to interviewees.

Interview Analysis

After every interview, relevant minor adjustments were made to the interview guide. Furthermore, the interviewer reflected on impressions from the interview as part of the analysis process. The first author transcribed all interviews to ensure continuity in terms of approach and impressions from the interviews, as well as in-depth knowledge of the data.

Transcription and coding were performed in Danish using NVivo version 12 Plus software (QSR International) through a non-verbatim approach. An asterisk (*) was used if names could be easily recognized, square brackets were used to provide explanatory information, and [. . .] was used to indicate where a quote had been shortened. The first author analyzed all interviews, inspired by the inductive methodological approach used within grounded theory (Corbin and Strauss, 2015). First, meaning condensates (sequences of statements

given a heading in line with the content) were created through open coding of all transcribed interviews, after which axial coding was performed to identify themes across interviews. Coding procedures and the meaning of central citations were discussed within the author group, and citations used in the paper were translated to English by the first author only. An overview of themes, codes, and selected meaning condensates can be seen in the coding tree in Appendix Table A1.

RESULTS

Sixteen veterinarians (V1–V16) were interviewed. They were distributed across gender, age, experience, and employment status (assistant or partner), and came from a geographically representative sample from areas with the largest density of cattle in Denmark. The individual characteristics of the interviewees can be found in Table 2.

Four distinct themes resulted from the inductive analysis of the interviews. They describe the individual and contextual factors influencing the use of antimicrobials among interviewed Danish cattle veterinarians,

Table 2. Individual characteristics of interviewees

Identification code	Gender	Employment status	Age (yr)	Years qualified	Time spent working with cattle (%)
V1	Female	Partner	<40	5	99
V2	Female	Partner	<40	5	90
V3	Female	Partner	>40	17	40
V4	Female	Partner	>40	18	99
V5	Female	Assistant	<40	4.5	100
V6	Female	Assistant	<40	1	99
V7	Female	Assistant	>40	9	100
V8	Female	Assistant	>40	14	100
V9	Male	Partner	<40	4.5	98
V10	Male	Partner	<40	7	100
V11	Male	Partner	>40	28	98
V12	Male	Partner	>40	22	90
V13	Male	Assistant	<40	8	96
V14	Male	Assistant	<40	0.5	100
V15	Male	Assistant	>40	19	100
V16	Male	Assistant	>40	17	100

as follows: (1) personal feelings, experiences, and the availability of medicines and scientific evidence guide everyday treatment decisions; (2) social relations and diverging interests influence antimicrobial use practices; (3) the current legislative and agricultural framework defines the room to maneuver in relation to antimicrobial use; and (4) resistance is rarely encountered on a daily basis but remains an abstract threat overshadowed by animal welfare concerns. Each of these themes and how they relate to the aim of this paper will be elaborated in the following sections.

Personal Feelings, Experiences, and the Availability of Medicines and Scientific Evidence Guide Everyday Treatment Decisions

All of the interviewed veterinarians were influenced by a variety of factors when making treatment decisions. These factors could be individual (such as personal attitudes, experiences, or emotions related to previous therapy choices) or contextual (such as the medicines and diagnostic tools available, current treatment traditions, local farm conditions, or available scientific evidence to support a choice of therapy). The extent to which veterinarians appeared to be influenced by these factors varied widely, and the interviewed veterinarians could therefore treat the same type of disease (e.g., mastitis caused by *Escherichia coli*, retained placenta, metritis) very differently.

Factors influencing and guiding treatment choices included personal and local farm experiences, as mentioned by many of the interviewed veterinarians. This was exemplified by V10: “If you are aware of a farm history, for example that Penovet [benzylpenicillin procaine] hasn’t worked for metritis cases, then that will not be your drug of choice! And if you have a good feeling about the response to Norodine [sulfadiazine trimethoprim] after evaluating its effect, then you should use that. I also find that is a better choice as it becomes concentrated in the urinary tract.” In addition, personal experiences at specific farms and with certain conditions guided many of the interviewed veterinarians’ antimicrobial choices, as exemplified by V12: “I typically know if some of my herds are having a bad period, meaning that cows get very sick when they are infected [. . .] It is often to do with the management level on the farm. If they have a high level of management [. . .], I will often be more likely to skip the antimicrobials and settle for painkillers and fluid therapy.” Certain periods or conditions at specific farms could therefore justify using antimicrobials in cases where veterinarians would normally have chosen not to.

Emotions also influenced treatment choices for many of the interviewed veterinarians, and V1 exemplified

this by telling a personal story: “I had been told by different people [colleagues and the Danish Veterinary and Food Administration] to start using only painkillers and fluid therapy. I told the farmer that antimicrobials had no effect in these cases [*E. coli* mastitis]. Then the mastitis cases started coming, and we used nothing but painkillers and fluid therapy. . . And so many cows died. . . I think five cows in total [. . .] That experience affected me—it was definitely not pleasant [. . .] So now we treat *E. coli* mastitis with broad-spectrum antimicrobials on top of the supportive therapy [. . .] That experience made me feel awful for the farmer.” For this veterinarian, the unpleasant emotional feeling related to this specific situation resulted in a change to the treatment regimen. Many of the interviewed veterinarians also mentioned how traditions influenced their treatment choices; that is, the approach to treatment was characterized by habits that were not questioned—ultimately to facilitate everyday treatment decisions.

For many of the interviewed veterinarians, treatment choices were also intertwined with the availability of scientific evidence. For example, V16 believed that there was no clear scientific evidence available, and therefore he continued treating acute mastitis cases caused by gram-negative bacteria with antimicrobials: “I am not aware of any solid scientific evidence about how to treat mastitis caused by *E. coli*. Therefore, I treat them with broad-spectrum antimicrobials, painkillers, and something in the teat as well [local treatment with antimicrobials].” In relation to this, some of the interviewed veterinarians highlighted a general lack of valid scientific evidence, which is why personal experiences often guided veterinary AMU. According to V9 and V15, this was because scientific evidence should be based on local, practical experiences as opposed to universal evidence, which they perceived as research conducted under conditions not comparable to the local farm environment. This type of scientific evidence is difficult to create, as described by V15: “We are often stuck with the fact that creating evidence is time consuming, and I mean scientific evidence created based on practical experiences. The practical experiences are often not tested under the right circumstances, as it is too expensive.”

A few interviewed veterinarians mentioned that taking a scientifically correct approach to treatment was further complicated by pharmaceutical companies perceiving the Danish cattle market as too small and uninteresting in terms of investment, leading to certain products going out of production or never being registered under Danish conditions. This includes narrow-spectrum antimicrobials for treatment at dry-off, as explained by V15: “It is not long ago that I wrote to one of the medicinal companies commenting on this [the

availability of medicines]. *I wrote that I thought it was a matter of time before someone questioned the veterinarians' use of broad-spectrum antimicrobials for dry-off treatments. I criticized them for having no alternatives available [. . .]. Using broad-spectrum antimicrobials for narrow-spectrum issues—that is not okay! We are just lucky that no one has realized this yet, probably because our level of resistance within the cattle industry is low.*"

The acknowledgment that their treatment choices were influenced by personal experiences made many of the interviewed veterinarians request diagnostic tools that could make diagnosis more objective, as explained by V2: *"I sometimes wish for diagnostic tools that are more objective. It is always a subjective assessment when you're standing there having to make a decision, and that depends a lot on your experience as a veterinarian."* Other suggestions for diagnostic tools that could assist in making the right diagnoses included cow-side blood tests to determine the cause of unspecific fever, identify the causal pathogens, and provide better estimates of prognosis in various cases, such as cows in lateral recumbency. The interviewed veterinarians emphasized that these tests should preferably be fast and precise to be useful.

Social Relations and Diverging Interests Influence Antimicrobial Use Practices

Colleagues' opinions and choice of antimicrobials appeared to be important influencing factors of AMU among interviewed veterinarians, especially for less-experienced veterinarians. Participant V9 explained how, in his first years as a newly educated veterinarian, he was very attentive and adaptive in relation to colleagues' knowledge and ways of working: *"I was taught to do things a certain way [in my first job], which was my sort of cornerstone, as we do not get that kind of knowledge from veterinary education [. . .]. You never see a case of mastitis in school—that is just how it is, so you are influenced by your first job in veterinary practice—they tell you how to approach a mastitis case."* Many of the interviewed veterinarians found that their colleagues' choices of antimicrobials could be different from what they themselves would have chosen. This was especially troublesome for the less-experienced veterinarians, because they often had a different view about the optimal choice of antimicrobials compared with their colleagues. This was explained by V14: *"Some of my colleagues do not want to stop using intrauterine antimicrobials [. . .] If you then choose not to use it in some cases, it will be your fault as a newly hired employee if the cow presents with metritis later on."* In cases where colleagues disagreed over the choice of antimicrobials and there was a lack of cure after

treatment, the veterinarian's own working experience became a determining factor in how his or her choice of antimicrobials was perceived and supported by both his or her colleagues and the farmer.

Some interviewed veterinarians, however, described that they were not affected by their colleagues' opinions on AMU choices; for instance, V3 stated, *"I am not always in agreement with my colleagues, and I don't think you need to be [. . .]."* In some of the interviewed veterinarians' practices that had no implemented practice policy regarding AMU choices, differences in use could also foster discussions that may or may not lead to changes in AMU choices. The need for such discussions was highlighted by many of the interviewed veterinarians; however, V9 mentioned veterinarians' need to have an independent attitude about AMU choices: *"We discuss things, but basically every veterinarian decides on their own. I think that is the thing with veterinarians—we are part of an independent profession, we are grownups, well-educated people who have been taught to think for ourselves. No one likes to be controlled from the top down."*

Agreement about antimicrobial choices among colleagues within a practice, however, was seen as beneficial by most of the interviewed veterinarians, as it could minimize the influence and pressure from farmers in terms of AMU choices. This was exemplified by V13: *"By always suggesting the same [antimicrobials], we avoid discussions about AMU choices at the farm. That is good for us, but it also makes it easier for the farmer [. . .] He knows what to expect."* Furthermore, standardized AMU within a practice was important for gaining respect and understanding from the farmer, but it was also acknowledged that it was difficult to change behaviors and attitudes among very experienced colleagues who had developed their routines based on years of personal experience. As explained by V1, if these very experienced veterinarians were to change their routines, it would indirectly imply that what they had previously done was wrong.

In addition to colleagues, farmers also influenced some of the interviewed veterinarians' AMU practices. This could include situations involving an acute case where the farmer wished to slaughter the cow in the near future, leading to a preference for antimicrobials with a short withdrawal time. Other situations could include the farmer preferring to inject a cow only once, leading the veterinarian to prescribe long-acting broad-spectrum antimicrobials. As was the case with influence from colleagues, the interviewed newly educated veterinarians in particular had trouble challenging farmer preferences; as V6 remarked, *"It can be quite difficult to argue with farmers who have had a good experience with some specific antimicrobials, which they then want to*

be prescribed.” Further, V14 described, “Some farmers are used to having certain antimicrobials prescribed, and you just need to follow that. If you don’t, it will be your fault as a newly educated veterinarian if the cow presents with disease later on. . . .” When facing this pressure to prescribe, the fear of being dismissed from their job was mentioned as the ultimate consequence of not following the farmer’s preferences. In relation to that, the structure and culture of veterinary practices can act as a barrier, as veterinarians must consider the threat of farmers going to another veterinary practice if they are dissatisfied with the services provided. This was mentioned by many of the interviewed veterinarians, irrespective of their level of working experience; V1 described how the structure of veterinary practices had an influence: “If I don’t do it this way, another veterinarian will come along and do it the way the farmer wants it.”

Interviewed veterinarians sometimes assumed that farmers wanted antimicrobials with short withdrawal times, as described by V4: “We mostly use broad-spectrum antimicrobials in the teat instead of penicillin [when treating gram-positive mastitis cases], as the withdrawal times are shorter [. . .] We think that is what the farmer wants [. . .]. We probably use more broad-spectrum antimicrobials than we should.” This same dilemma was handled differently at another practice, as described by V10: “Years ago, some farmers disliked Carepen [benzylpenicillin procaine] due to the six-day withdrawal time for milk. We just told them that they had to settle for systemic treatment only if they didn’t want Carepen. It makes no sense to use broad-spectrum antimicrobials in these cases [mastitis cases with gram-positive bacteria], [and] we will not do so.” As in this example from V10, most of the interviewed veterinarians generally did not believe the farmer influenced their AMU choices. Participant V3 had only once experienced pressure to prescribe from a farmer, which she tackled by telling the farmer a lie: “There was a product on the market that was attractive as there was no withdrawal time for milk [. . .] and could be used for many things. The farmer wanted to use that, so I just told him that this product had been banned. I use tricks like that. He is probably the only farmer pressuring me about my AMU choices.”

More often, farmers influenced veterinary AMU indirectly through their level of management. This was explained by V2: “I think that if some farmers actually called their veterinarian and followed up on their sick animals, we could avoid changing to broad-spectrum antimicrobials [due to undiscovered progression of disease] and instead just extend the treatment with narrow-spectrum antimicrobials.” The fact that farmers were bad at following up on treated animals often forced

the veterinarian to prescribe other antimicrobials than first intended. This management factor was related the previously mentioned contextual factor of farm-specific conditions.

Interviewed veterinarians approached these farmer preferences differently. As in the previous examples, the veterinarian could be confrontational (V10) and not accept these preferences if they were perceived as scientifically incorrect, regardless of the consequences. Another approach was to be “manipulative” by telling a lie (V3). Some veterinarians also described “nudging” as a way to slowly change the farmer’s attitude and preferences. This was perceived as a trade-off between not wanting to dissatisfy the farmer but still wanting to comply with scientific standards. This was described by V9: “I know that farmers sometimes use antimicrobials in a careless manner. If they have a cow that limps, or a cow that looks unwell, they have attempted to treat her for pneumonia.” (Pneumonia is one of the conditions Danish farmers are allowed to treat independently.) Veterinarian V9 continued, “I don’t confront them because I doubt it will have a positive effect to start arguing with them. It will just create a division in our relationship. Instead, I would rather nudge them [nudging understood by the veterinarian as slowly introducing his own perspectives over time by continuously returning to the discussions on AMU].”

Many of the interviewed veterinarians emphasized the importance of establishing trust in their relationship with the farmer, as described by V2: “It is very much about chemistry when you arrive as a veterinarian. [. . .] I can change their attitude if I gain their trust, for example by helping them in some acute situation—a difficult birth, for instance [. . .] or if they get the feeling that I am making an extra effort to help them. That way, you slowly build a relationship. . . . But it really takes a long time to do.” This established and ongoing bond was perceived as a prerequisite for changing farmer behavior or attitudes, and, according to V5, farmers generally have a great level of trust in the veterinary profession: “We have a large responsibility as veterinarians—we are the ones who can bring about change at these herds. The farmers are so faithful to us; what we say is the truth, and they trust us to a high degree—at least if you manage to have a good relationship with your farmers.” Furthermore, to be able to change anything within the collaboration, all of the interviewed veterinarians emphasized the importance of taking a farmer-specific approach, where the farmer’s own perception of his issues became the starting point. This was exemplified by V12: “I take a farmer-specific approach, I happily adapt according to the farmer. To be honest, that also helps to keep the farmers as our clients. [. . .] Then, on

days where the farmer actually has time to think about changes, [. . .] I ask him questions like what he himself perceives as the biggest problem at the farm, what makes him happy in his daily life, and so on. [. . .] You would be surprised by what farmers are motivated by.”

In this second theme, the interaction between individual and contextual factors in relation to AMU choices was illustrated. The contextual factor of experienced pressure from colleagues and farmers was intertwined with other contextual factors (i.e., the interviewed veterinarians’ level of working experience and the structure of veterinary practices) and individual factors (i.e., feelings related to causing dissatisfaction among farmers or colleagues).

Current Legislative and Agricultural Framework Define the Room for Maneuver in Relation to Antimicrobial Use

As part of the Danish legislative structure, the Danish Veterinary and Food Administration was mentioned by many of the interviewed veterinarians as influencing and directing veterinary AMU due to their controlling and supervising actions. Supervision of practicing veterinarians had changed some of the interviewed veterinarians’ AMU choices, as explained by V4: “*Being supervised by the Danish Veterinary and Food Administration greatly increased my motivation for changing my use practices. When they come and ask, ‘Why do you use this type of antimicrobial,’ that makes me change.*” Some interviewed veterinarians used the limit given by the Yellow Card initiative to describe and justify the AMU level at herds with a veterinary agreement; that is, if the AMU level was below the defined limit, it was perceived as an acceptable level. (Introduced in 2010, the Yellow Card Initiative is a legislatively defined limit for AMU among cattle. Presently this limit is 2 times the national average consumption. If the limit is exceeded, the farm will be subject to additional control visits by both the herd veterinarian and the Danish Veterinary and Food Administration, paid for by the farm.) Participant V3 suggested that veterinarians could be motivated to change their AMU if they were benchmarked against other veterinarians’ AMU levels, as they take pride in having a low AMU level at the herds they service.

New Danish legislation was introduced in 2006, allowing conventional farmers to have medicines available at the farm for treatment of certain diagnoses. Previously, the veterinarian had to initiate all medical treatments. Many of the interviewed veterinarians expressed concerns about the shared responsibility of AMU between farmers and veterinarians as introduced by the

current legislation. For instance, V3 remarked, “*I see it as a shared responsibility. I feel very responsible for the AMU level in the herds with which I have a veterinary agreement. It is not only because I could receive a fine of 5,000 DDK [~US\$800] if they [the Danish Veterinary and Food Administration] find something [. . .]. That doesn’t keep me awake at night, but I do think about it a lot. Especially because some of my herds use antimicrobials differently from what I would prefer. I wouldn’t terminate our agreement. . . but it does make me feel uncomfortable.*” In relation to that, the difficulty in balancing the dual role of being an enforcer of legislation and, at the same time, the farmer’s collaborator in terms of veterinary consultancy was described by many of the interviewed veterinarians, as exemplified by V1: “*I know that many of my farmers don’t comply with the rules for what they are allowed to treat. They don’t tell me, but I can sense it. [. . .] But what can I do? I am not there when it happens. [. . .] I can check if the cows have actually recovered, but I can’t really act more as a police officer than that. You cannot demand more from practicing veterinarians—we also need to be able to go there once a week. We can’t do that if we start berating the farmer.*”

The interviewed veterinarians had different views on how the liberalization of medicines had changed farmers’ AMU since its introduction in 2006. Some veterinarians were of the opinion that farmers had insufficient theoretical knowledge to handle antimicrobials independently, as V3 described: “[. . .] *We are not handing out sweets! It is crazy that we can expect farmers—not that they are unintelligent or anything, but they haven’t received any training in diseases, anatomy, or pharmacy. . . They only know how the animal looks from the outside. . . To say, ‘Here you go! Now you are the veterinarian for your own herd; you can easily do that! I’ll write you instructions of what to give them!’ That is crazy!*” According to V3, this lack of knowledge had resulted in a suboptimal use of antimicrobials among farmers. Participant V9 described this issue as a certain AMU culture: “*Some farmers lack knowledge—that is for sure. Another part is due to economics [. . .] They don’t want to spend money on a veterinarian, and they don’t know what is wrong or how to fix it—then it’s easy to just try something [medication]. That culture is getting worse by the year. [. . .] It is just the attitude within farming—that this is how you do it.*” Other veterinarians believed that the liberalization of medicines had resulted in a better alignment in the need for and use of treatment among farmers. This was explained by V7: “*At the beginning, farmers were very excited about having medicines at their farm, but after a while, their relationship with medicines changed. They realized that*

medicines were not always the solution. [. . .] Although they had the medicines, they didn't necessarily use them. [. . .] Nowadays, when a farmer has a case of mastitis, he can take a milk sample and wait for the results before initiating treatment. That wasn't the case back in the day, when the veterinarian was called and expected to initiate the treatment while they were there."

The interviewed veterinarians who had experienced the liberalization of medicines and the accompanying regular veterinary visits described how it had changed their role at the farms. This was exemplified by V8: *"Back then, we only went to a farm to treat and then left again; we had stagnated [as a profession]. Nowadays, we take a different approach—we look at what the problems are and what we can do to solve them."* Frequent visits were thought to enhance knowledge about the farms and the familiarity with the farmer, thereby increasing the chance that the veterinarian would be able to assist in solving farm-related issues. However, for many interviewed veterinarians, the current legislation created a feeling of apathy in their work at herds when the situation deviated from their own standards, as V4 remarked: *"In some herds, you just give up. You end up focusing on fulfilling your duties according to legislation and nothing more. Then I remind myself that it is actually not my responsibility if he doesn't succeed."* This feeling of apathy—expressed by V1 as being a "factory worker"—could also result from the many routine tasks that legislation dictates must be completed in relation to herd visits. As explained by V5, these routine tasks are time-consuming, taking energy and focus away from important farm health and AMU problems. Furthermore, these routine tasks are not something the farmer (or the veterinarian) had any influence over, thus decreasing the feeling of ownership of the advisory agreement and their motivation in general, as V5 expressed: *"The fact that many things are decided by law implies that many things are done the way legislation dictates. That means that the farmer does not make an active choice about what he wants us to do, and we are lacking an alignment of expectations in that sense."* Participant V3 described legislation as a "duvet" covering both farmers and veterinarians from above and determining their range of actions. At the same time, the current legislative framework was also perceived as an important factor in preserving AMU levels and animal welfare in cattle farming by many of the interviewed veterinarians. For instance, V13 described this: *"No doubt that some farmers could manage without legislation—veterinarians would remain an important collaborator for these herds. However, we would also have a percentage of farmers who do not perceive veterinarians as collaborators—those we would lose [the*

veterinarian would not visit regularly], and we wouldn't know the animal welfare standards at those herds."

In relation to this, many interviewed veterinarians suggested that farmers should only have narrow-spectrum antimicrobials available at the herd. This was perceived as a way to better synchronize the farmers' rights to handle antimicrobials independently and the veterinarians' law-enforcing obligations to ensure prudent AMU at farms. This was explained by V9: *"Penicillin is the only antimicrobial farmers should be allowed to handle. Penicillin is sufficient in many cases—and in cases where it is not, the farmer should call for assistance. One could hope that such an approach would result in more cases being given a better scientific assessment before treatment."*

This third theme mostly concerned the influence on AMU from contextual factors such as supervision by authorities and legislative structures that framed and influenced the veterinarian-farmer collaboration.

Resistance Is Rarely Encountered on a Daily Basis but Remains an Abstract Threat Overshadowed by Animal Welfare Concerns

Antimicrobial resistance was considered indirectly through the interviewed veterinarians' choice of antimicrobials (type and amount) and the focus on preventing disease, and was not considered to be a factor in their daily lives, as explained by V9: *"I do not think a lot about resistance itself. I have a fundamental position that a cow without an infectious disease shouldn't receive antimicrobials. However, if she has an infectious disease, she should receive all the antimicrobials needed. Without thinking directly about resistance, it is of course indirectly a part of that basic attitude; not because I encounter resistance, but because I believe it's scientifically correct."* For some veterinarians, justifying a certain choice of antimicrobials to the farmer was one of the few situations in their daily lives where they considered AMR, as expressed by V2: *"I think about it [AMR] when I need to discuss my choice of antimicrobials with the farmers. Then it hits me: I need to justify my choice, explain why I do what I do, tell them that there is no need to use broad-spectrum antimicrobials when we know this [penicillin] will work, and that we can potentially develop resistance if we do so."*

The interviewed veterinarians had different perceptions about the extent of AMR in the herds they serviced. According to V11, single cases of AMR could be encountered in one animal but never at farm level: *"We do not have local issues with resistance toward certain groups of antimicrobials. There can be single cases where a certain antimicrobial is ineffective, but then it works*

the next time and causes no further concerns. So I do not have the feeling that we have any resistance issues in Denmark, also based on the way we have used antimicrobials over time." Participant V10, by contrast, described a single case of farm-level resistance among calves with diarrhea, which after testing for susceptibility, could only be treated with Cobactan [cefquinome]. This veterinarian made a connection between the farmer's AMU practices and the development of resistance: *"He is one of those farmers with an excessive use of antimicrobials. It is getting better, and they have started to change their approach [to AMU]. The problem is that he would rather treat one time too many, instead of one time too few. Or even two times too many."* In that sense, having an excessive use of antimicrobials was linked to a higher risk of developing resistance.

Some veterinarians mentioned that, to their knowledge, other countries had bigger problems with AMR compared with Denmark, as V13 explained: *"I don't think about AMR as such. In Denmark, we have come a long way by only using penicillin for a long time. If you asked an Italian if he had concerns about the AMR problem—or a Dutch person for that matter—I think their answer would be different. Even though they have also come a long way."* Participant V5 had a similar opinion and expressed concerns that the restrictions on AMU could escalate and hamper competition in relation to the export of meat and dairy products: *"I think we need to continue as a pioneering country in relation to AMU, but we should also be careful not to put ourselves out of business. [. . .] If there comes a point when we are only allowed to prescribe narrow-spectrum antimicrobials, should we then put animals down if they don't recover? [. . .] I think that if additional restrictions continue to be added, we will end up having so many that we hinder ourselves in terms of the export market."* In addition to concerns about competitiveness, many of the interviewed veterinarians also mentioned compromised animal welfare as a result of restrictions on AMU. This was explained by V11: *"The balance between reducing AMU and animal welfare is very delicate. Or not delicate, but actually very fluid. The question is, when is it responsible to stop treating with antimicrobials when it comes to animal welfare? What is most important?"* Furthermore, animal welfare was seen as being difficult to measure, as people often have individual opinions on what constitutes good animal welfare, which further complicates the evaluation of whether welfare standards are met. However, we found that all the interviewed veterinarians consistently expressed the opinion that sick animals have the right to receive medical treatment due to welfare concerns.

Organic farming was mentioned by some of the interviewed veterinarians as an example of pioneering farm-

ers within the area of AMU reduction, as V11 observed: *"Organic farming has a goal to reduce antimicrobial usage, which has influenced the way organic farmers think and work. That focus and consciousness about AMU has made organic farming stronger and more visible."* However, organic farming was also mentioned as an example of a type of farming that had encountered issues in relation to the animal welfare dilemma described above. This was explained by V8: *"I like the thinking within organic farming—that they want to reduce their AMU, that they want to get away from this standard treatment approach to disease. But then you need to take preventive measures so that they don't get sick in the first place. [. . .] And when you have a sick cow, you need to treat it. It makes no difference to only treat the cow once."* Some interviewed veterinarians connected this resistance to treat for more than one day to the rules in force in organic farming, such as the requirement for veterinarians to perform all treatments. That would result in high economic expenses in relation to treatment and could discourage farmers from finishing the recommended course of treatment.

Within this fourth theme, individual and contextual factors collectively influenced the perception of AMR and hence the need to reduce AMU. Individual factors such as experiences with resistance and attitudes toward AMR were intertwined with contextual factors such as market forces, AMR levels in other countries, and different types of farming that have different starting points and agendas in terms of AMU reduction.

DISCUSSION

This qualitative study found that Danish veterinarians are influenced by a variety of interacting individual and contextual factors when prescribing antimicrobials. To our knowledge, this is the first study to investigate perceptions of AMU and current practices among veterinarians from a context of a low average level of AMU, where legislation on AMU has been implemented for decades. In this section, central findings will be discussed in an attempt to explain some of the factors affecting the dynamics of veterinary treatment and prescription as described by the interviewed veterinarians.

One of the central findings of this study was that the AMU choices of newly educated veterinarians were influenced by their colleagues and farmers. As mentioned in the Introduction, this contextual factor was also identified in the study by Higgins et al. (2017). However, the UK veterinarians explained their inability to oppose farmers' preferences through a combination of individual and contextual factors: a general lack of time to gain experience and knowledge from colleagues lowered their chance to increase their confidence in

their own abilities and thus gain trust from farmers. Trust was, in their opinion, a prerequisite for going against farmers' preferences. Influence from farmers and colleagues was experienced slightly differently in our study. First, some of the interviewed veterinarians identified fear as one of the primary drivers for complying with farmers' and colleagues' wishes and preferences. For example, in terms of antimicrobial therapy choices: for some of the interviewed veterinarians expressed fear of losing the animal if the therapy should fail, others had the fear of being blamed (by the farmer or colleagues) for the therapeutic failure, and others voiced fear of being dismissed from their job. This fear-driven compliance with preferences of social referents has previously been described among veterinarians (Gibbons et al., 2013; Speksnijder et al., 2015a). Second, the young veterinarians we interviewed experienced a discrepancy between the theoretical, evidence-based knowledge of prudent AMU choices they were taught at university and the reality they faced in their first practice job. Therefore, for newly educated Danish veterinarians, social influence from farmers and colleagues was interconnected with individual factors such as personal feelings of fear and confusion about the prudent use of antimicrobials to treat animals. This confusion might have diminished their confidence in their own knowledge. Edmondson and Lei (2014) suggested that confidence in one's own knowledge was an important prerequisite for psychological safety (i.e., not feeling fear) and for taking interpersonal risks (i.e., arguing against or opposing farmer preferences). The importance of knowledge in relation to self-confidence was similar for UK and Danish veterinarians, but the skepticism toward the knowledge embedded in practice (i.e., the way their colleagues administered antimicrobials based on personal experiences) was unique to the Danish veterinarians in this study.

Some of the interviewed veterinarians with more experience expressed a similar skepticism toward the way personal experiences guide veterinary AMU choices. They were of the opinion that it was due to a lack of scientific evidence applicable to a local farm context. It therefore seems important to address the contextual factor of a lack of scientific evidence to diminish the social influence from farmers and colleagues that newly educated veterinarians experience. If they find that their colleagues base their AMU choices on herd-level evidence, they might experience a better alignment between their own choices (based on the evidence-based approach they were taught at university) and the choices made by their colleagues. That way, newly educated veterinarians will have greater self-confidence in their own knowledge and AMU choices, thus feeling safer to oppose farmers' preferences if these differ from "best

practice." Studies have previously identified the need to use an evidence-based approach at herd level and the need for field-generated research on AMU and AMR that is applicable to veterinarians in a local farm context (Proctor et al., 2011; Lastein, 2012; Guardabassi et al., 2018). Furthermore, as requested by the interviewed veterinarians from this and previous studies (De Briyne et al., 2013; Speksnijder et al., 2015a; McDougall et al., 2017), objective and effective diagnostic tools should be developed to aid this evidence-based change in veterinary treatment and prescribing culture. To summarize, the contextual factor of social influence on veterinary AMU choices appears to be interconnected with a knowledge gap between theory and practice due to a lack of locally applicable evidence-based research. This knowledge gap affects newly educated veterinarians' confidence and trust in their own knowledge and AMU choices and thus their courage to resist or argue against farmers' and colleagues' experience-based and potentially biased preferences.

Another central finding of this study was the multiple reactions within the veterinary profession to increased legal control, such as regular supervision, lists of antimicrobials that cannot be used, the Yellow Card limit, liberalization concerning farmers' use of medicines and, as a consequence, the predefined content of veterinary herd health visits. These different legal actions all comprise contextual factors influencing veterinary treatment and prescription under Danish conditions. As expressed by the interviewed Danish veterinarians, the feeling of self-determination in veterinary work has decreased, and thereby also the responsibility and motivation for addressing suboptimal AMU within herds, creating a feeling of hesitancy or apathy on a personal level. However, regular supervision and control by the Danish Veterinary and Food Administration increased some of the interviewed veterinarians' motivation to change their AMU choices. As such, the contextual factor of legislation interacted with individual factors such as personal feelings of motivation and self-determination in both a positive (increasing motivation) and a negative direction (decreasing motivation). It seems as though the influence from legislation could at times be so determining that it left no space for individual motivation for action among the interviewed veterinarians. In contrast, legislation could also force the veterinarians to change their behavior when confronted by the authorities about their AMU choices. Few other countries have experienced the same level of legal control of AMU, with the possible exception of the Netherlands, where similar legal approaches have been taken, although private industry parties mainly drove these initiatives. The self-motivated and voluntary approach, with the government acting as a facilitator, was

highlighted as a way to ensure a sustainable reduction in AMU, as opposed to enforcement through legislation (Speksnijder et al., 2015b). The fact that legislation has been forced upon Danish veterinarians for decades might provide an explanation for the hesitancy and reduced motivation expressed among some of those interviewed. The interaction of legislation and motivation within veterinary herd health consultancy work should be considered carefully when planning future regulations in Denmark as well as in other countries.

One aspect of the contextual factor of legislation in particular; that is, the liberalization of medicines in 2006, influenced the interviewed veterinarians' AMU through a complex pattern. The interviewed veterinarians felt responsible for ensuring prudent AMU, but the ability to live up to this responsibility was complicated by the fact that they were no longer involved in the daily decisions about AMU at the farms. Instead, they acted from a distance, only through prescribing medicines. Previous research shows that being allowed to handle certain medicines has made some farmers much more self-reliant (Skjølstrup et al., 2021), and the interviewed veterinarians of our study supported this finding by insinuating a certain culture of suboptimal use of antimicrobials among some farmers. The interviewed veterinarians therefore felt decoupled in terms of knowledge of and influence over the treatments at the farm. The obligation to ensure prudent AMU forced them into a dual role of a "police officer" with the responsibility to control the farmer's AMU, while at the same time being a close advisor and collaborator. The complexity of having both a controlling and an advising role on farms has also been identified among Dutch veterinarians working under similar restrictions (Speksnijder et al., 2015a,b). When adopting the role of "police officer," an imbalance in power appears between the veterinarian and the farmer, and, according to Noe et al. (2015), this might lead farmers to try to resist being pushed in the "right direction," and veterinarians might experience little success in changing farmers' AMU practices. The interviewed veterinarians of this study appeared to handle this "police officer" role through "nudging" and farmer-specific approaches in combination with a focus on a good and trusting relationship with the farmers. In some cases, this approach seemed to have replaced the confrontational approach, where violation of the veterinarians' professional standards or regulation resulted in boundary-setting.

It seems that veterinarians could clarify and communicate when they are adopting the role of "police officer" with an obligation to set boundaries and when they are the advisory herd veterinarian with the farmer's interests in mind. Some of the interviewed vet-

erinarians indicated their success in making the farmer aware of these dual functions; they welcomed legislation as a way to control farmer AMU without them being perceived as directly responsible for remarks on the required reduction in AMU. Another solution to this problematic dual role, as suggested by some of the interviewed veterinarians, was to tighten the legislation by allowing only penicillin to be administered by farmers. (New Danish legislation was introduced in June 2021, allowing only narrow-spectrum antimicrobials to be used in the treatment of mastitis, with exceptions when diagnostic requirements are met.) In that way, the interviewed veterinarians believed their sense of responsibility in relation to the farmer's AMU would be more relaxed, as there would be a limit to how antimicrobials could be irresponsibly administered at the farm. This solution would thus be adding an "additional level" to the complexity within the contextual factor of legislation. To find the right balance of national legal control, future research should further investigate the implications of extensive AMU legislation on, for instance, veterinarians' motivation in their advisory work in relation to reducing AMU at their affiliated farms.

Another central finding of this study was that the interviewed veterinarians perceived AMR as a distant threat that they automatically managed through their legally determined restricted use of antimicrobials. Furthermore, animal welfare concerns and acutely diseased animals sometimes overshadowed the threat of AMR. A similar perception of AMR as something distant and often overshadowed by daily concerns has previously been identified among cattle veterinarians and farmers (Golding et al., 2019; Skjølstrup et al., 2021). The reason that veterinarians perceive AMR as a distant threat could potentially be explained by the complex nature of the AMR crisis. Chandler (2019) described how the risk of AMR is difficult to define and measure, and it has often been framed as a future "hypothetical" threat that, despite lacking accuracy, requires urgent action. Therefore, the risk of AMR can be difficult to comprehend. For veterinarians, action is not straightforward, because AMR is complex and entangled with emotions and everyday decisions about treatment and welfare issues, which is why distancing oneself from the "hypothetical" future risk can be seen as a natural reaction.

Blaming others was also identified among the interviewed veterinarians, but in a slightly different way to that identified and described in previous studies, where the need for inland reduction of AMU was broadly in focus and acknowledged (Speksnijder et al., 2015a; Golding et al., 2019). Being part of a low-AMU country influenced the self-image of some of the inter-

viewed veterinarians in this study, implying that they believed they were in a “safe space” and were therefore less obliged to change their prescribing practices and further reduce their AMU. Instead, it was perceived as more urgent that other countries adopted similar approaches to Denmark and demonstrate AMU reduction. Thus, the individual perception of AMR as a risk was intertwined with AMR being an abstract threat that is difficult to comprehend and contextual factors such as being part of a low-AMU country and rarely encountering AMR in everyday practice.

Chandler (2019) described how the framing of the AMR crisis has changed into a perception of a global issue that requires a multisectoral approach, as opposed to the previous perception of a few responsible actors who must individually change their behavior to “solve” the issue of AMR. According to Chandler, acting on the AMR crisis can be considered a political “investment,” and the extensive legal control on AMU in Denmark can be seen as an example of this. However, the contextual factor of legislation had an equivocal influence on the interviewed veterinarians’ prescribing behavior. The veterinarians perceived their AMU behavior as rational because they complied with legislation and official guidelines. At the same time, other countries’ relatively higher levels of AMU seemed to induce an abdication of responsibility among the interviewed veterinarians in terms of further reducing their own AMU. As such, individual factors of engagement and motivation for further reduction seemed to diminish with a high level of legislative control. This illustrates how the AMR crisis and the required reduction in AMU can be framed and decided at a societal level but perceived differently at an individual level, thus resulting in unexpected reactions, such as hesitancy among the veterinary profession. Therefore, as emphasized by Chandler (2019), future discourse on AMR should include perspectives from all levels, to offer a multisectoral approach that resonates with all actors concerned. If the global and complex issues of AMR (i.e., consequences for the global economy and human and animal health, conflicts that veterinarians face in their daily lives when trying to change AMU, and the collaborative effort that is required) are acknowledged and articulated, veterinarians might perceive the AMR crisis as being of closer personal relevance and may maintain their motivation to act upon it (Magalhães-Sant’Ana et al., 2017).

Limitations

The first author was primarily engaged in the coding and analysis process, thereby ensuring alignment and consistency across nonverbal impressions during interviews and analysis of the transcribed interviews,

although this could also be seen as a limitation of this study. Social desirability bias could be suspected in an interview study concerning AMU, as it can be a sensitive topic intertwined with multiple personal feelings and interests. However, interviewees shared AMU practices of which they were not proud, indicating that such a bias was largely not encountered in this study. Qualitative research is not intended to be generalizable, and the findings of this study arguably depend on their context. The UK, for example, has not seen the same level of state dominance through legislative control and influence over the veterinary profession (Hobson-West and Timmons, 2016). However, we argue that by describing the relatively low-level AMU context in which this study was conducted, the findings can form a basis for discussions and inform a hypothesis of influence from, for instance, changing legislation in other similar national contexts.

CONCLUSIONS

We found that the AMU practices of interviewed Danish veterinarians were influenced by individual and contextual factors in a complex and interactive pattern. The veterinarians were guided by personal experiences and emotions, intertwined with local or general scientific evidence in relation to their AMU practices. We found that less-experienced veterinarians felt pressured in their treatment and prescription choices from both their veterinary colleagues and farmers. Therefore, developing herd-specific evidence-based research on prudent AMU choices and objective diagnostic tools might align veterinarians’ approaches to AMU and empower newly educated veterinarians in their prescribing behavior. Furthermore, we found indications that the extensive legal control related to AMU introduced some challenges to the Danish veterinary profession, in the form of decreased motivation in their advisory work and the dual role of being a legal controller and an advisor at farms. Veterinarians could explicitly communicate this dual role as “police officer” and close collaborator at farms to overcome obstacles in the farmer-veterinarian relationship that might otherwise hinder collaboration to reduce AMU. Last, we found that some of the interviewed veterinarians did not perceive AMR as an everyday threat that required their sustained attention, and the discourse on AMR might therefore need to be reframed, considering all concerned actors and the full complexity of the issue.

ACKNOWLEDGMENTS

This work was funded by the University of Copenhagen, Denmark. A special thank-you to all of the veteri-

narians who openly and willingly participated in the interviews and generously shared their personal thoughts and experiences of antimicrobial use. The contribution to this article from the second author (M. Vaarst) was funded by ROADMAP (<https://www.roadmap-h2020.eu/>; grant agreement no. 817626), which received funding from the European Union's Horizon 2020 research and innovation program (Brussels, Belgium). This publication reflects the views only of the author, and the European Union cannot be held responsible for any use which may be made of the information contained therein. The authors have not stated any conflicts of interest.

REFERENCES

- Booth, A., K. Hannes, A. Harden, J. Noyes, J. Harris, and A. Tong. 2014. COREQ (Consolidated Criteria for Reporting Qualitative Studies). Pages 214–226 in *Guidelines for Reporting Health Research: A User's Manual*. D. Moher, D. G. Altman, K. F. Schulz, I. Simera, and E. Wager, ed. John Wiley & Sons, Ltd.
- Borek, A. J., S. Anthierens, R. Allison, C. A. M. McNulty, P. E. Anyanwu, C. Costelloe, A. S. Walker, C. C. Butler, and S. Tonkin-Crine. 2020. Social and contextual influences on antibiotic prescribing and antimicrobial stewardship: A qualitative study with clinical commissioning group and general practice professionals. *Antibiotics* (Basel) 9:859. <https://doi.org/10.3390/antibiotics9120859>.
- Broom, A., K. Kenny, B. Prainsack, and J. Broom. 2020. Antimicrobial resistance as a problem of values? Views from three continents. *Crit. Public Health* 31:451–463. <https://doi.org/10.1080/09581596.2020.1725444>.
- Chandler, C. I. R. 2019. Current accounts of antimicrobial resistance: Stabilisation, individualisation and antibiotics as infrastructure. *Palgrave Commun.* 5:53–13. <https://doi.org/10.1057/s41599-019-0263-4>.
- Corbin, J., and A. Strauss. 2015. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. 4th ed. Sage Publications Inc.
- De Briyne, N., J. Atkinson, L. Pokludová, S.P. Borriello, and S. Price. 2013. Factors influencing antibiotic prescribing habits and use of sensitivity testing amongst veterinarians in Europe. *Vet. Rec.* 173:475. <https://doi.org/10.1136/vr.101454>.
- Edmondson, A. C., and Z. Lei. 2014. Psychological safety: The history, renaissance, and future of an interpersonal construct. *Annu. Rev. Organ. Psychol. Organ. Behav.* 1:23–43. <https://doi.org/10.1146/annurev-orgpsych-031413-091305>.
- European Medicines Agency. 2020. Sales of veterinary antimicrobial agents in 31 European countries in 2018. Trends from 2010 to 2018. Tenth ESVAC report. EMA.
- Fischer, K., K. Sjöström, A. Stiernström, and U. Emanuelson. 2019. Dairy farmers' perspectives on antibiotic use: A qualitative study. *J. Dairy Sci.* 102:2724–2737. <https://doi.org/10.3168/jds.2018-15015>.
- Fusch, P. I., and L. R. Ness. 2015. Are we there yet? Data saturation in qualitative research. *Qual. Rep.* 20:1408–1416. <https://doi.org/10.46743/2160-3715/2015.2281>.
- Gibbons, J.F., F. Boland, J.F. Buckley, F. Butler, J. Egan, S. Fanning, B.K. Markey, and F.C. Leonard. 2013. Influences on antimicrobial prescribing behaviour of veterinary practitioners in cattle practice in Ireland. *Vet. Rec.* 172:14. <https://doi.org/10.1136/vr.100782>.
- Golding, S. E., J. Ogden, and H. M. Higgins. 2019. Shared goals, different barriers: A qualitative study of UK veterinarians' and farmers' beliefs about antimicrobial resistance and stewardship. *Front. Vet. Sci.* 6:132. <https://doi.org/10.3389/fvets.2019.00132>.
- Guardabassi, L., M. Apley, J. E. Olsen, P.-L. Toutain, and S. Weese. 2018. Optimization of antimicrobial treatment to minimize resistance selection. Pages 637–673 in *Antimicrobial Resistance in Bacteria from Livestock and Companion Animals*. S. Schwarz, L. M. Cavaco, J. Shen, and F. M. Aarestrup, ed. ASM Press.
- Helliwell, R., C. Morris, and S. Raman. 2019. Can resistant infections be perceptible in UK dairy farming? *Palgrave Commun.* 5:12. <https://doi.org/10.1057/s41599-019-0220-2>.
- Higgins, H. M., S. E. Golding, J. Mouncey, I. Nanjiani, and A. J. C. Cook. 2017. Understanding veterinarians' prescribing decisions on antibiotic dry cow therapy. *J. Dairy Sci.* 100:2909–2916. <https://doi.org/10.3168/jds.2016-11923>.
- Hobson-West, P., and S. Timmons. 2016. Animals and anomalies: An analysis of the UK veterinary profession and the relative lack of state reform. *Sociol. Rev.* 64:47–63. <https://doi.org/10.1111/1467-954X.12254>.
- Korsgaard, H., J. Ellis-Iversen, U. W. Sönksen, and S. Skovgaard. 2020. DANMAP 2019—Use of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals, food and humans in Denmark. Statens Serum Institut, National Food Institute, Technical University of Denmark.
- Kvale, S., and S. Brinkmann. 2014. Interview. *Det Kvalitative Forskningsinterview Som Håndværk* [in Danish]. 3rd ed. Hans Rietzels Forlag.
- Lastein, D. B. 2012. Herd-specific randomized trials: An approach for effect evaluation in a dairy herd health management program. PhD thesis. Department of Large Animal Sciences, University of Copenhagen.
- Lorencatto, F., E. Charani, N. Sevdalis, C. Tarrant, and P. Davey. 2018. Driving sustainable change in antimicrobial prescribing practice: How can social and behavioural sciences help? *J. Antimicrob. Chemother.* 73:2613–2624. <https://doi.org/10.1093/jac/dky222>.
- Magalhães-Sant'Ana, M., S. J. More, D. B. Morton, and A. J. Hanlon. 2017. Challenges facing the veterinary profession in Ireland: 2. On-farm use of veterinary antimicrobials. *Ir. Vet. J.* 70:28. <https://doi.org/10.1186/s13620-017-0106-9>.
- McDougall, S., C. W. R. Compton, and N. Botha. 2017. Factors influencing antimicrobial prescribing by veterinarians and usage by dairy farmers in New Zealand. *N. Z. Vet. J.* 65:84–92. <https://doi.org/10.1080/00480169.2016.1246214>.
- Ministry of Environment and Food of Denmark. 2018. Bekendtgørelse om sundhedsrådgivningsaftaler for kvægbesætninger [in Danish]. BEK nr. 1649 af 18/12/2018. Copenhagen, Denmark.
- Moran, D. 2017. Antimicrobial resistance in animal agriculture: Understanding user attitudes and behaviours. *Vet. Rec.* 181:508. <https://doi.org/10.1136/vr.j5142>.
- Noe, E., H. F. Alrøe, M. H. Thorsøe, J. E. Olesen, P. Sørensen, B. Melander, and E. Fog. 2015. Knowledge asymmetries between research and practice: A social systems approach to implementation barriers in organic arable farming. *Sociol. Ruralis* 55:460–482. <https://doi.org/10.1111/soru.12078>.
- Organic Denmark, Danish Agriculture and Food Council, and Danish Dairy Board. 2020. Anbefalinger for at højne dyrevelfærd, miljø og etik ved produktion af økologisk mælk og kød fra bedrifter med kreaturer [in Danish]. Organic Denmark, Organic Sector of Danish Agriculture and Food Council, The Danish Dairy Board.
- Persson Waller, K., V. Hårdemark, A.-K. Nyman, and A. Duse. 2016. Veterinary treatment strategies for clinical mastitis in dairy cows in Sweden. *Vet. Rec.* 178:240. <https://doi.org/10.1136/vr.103506>.
- Proctor, A., P. Lowe, J. Phillipson, and A. Donaldson. 2011. Veterinary field expertise: Using knowledge gained on the job. *Vet. Rec.* 169:408–410. <https://doi.org/10.1136/vr.d5387>.
- Redding, L. E., C. Brooks, C. B. Georgakakos, G. Habing, L. Rosenkrantz, M. Dahlstrom, and P. J. Plummer. 2020. Addressing individual values to impact prudent antimicrobial prescribing in animal agriculture. *Front. Vet. Sci.* 7:297. <https://doi.org/10.3389/fvets.2020.00297>.
- Schwarz, S., L. M. Cavaco, J. Shen, and F. M. Aarestrup, eds. 2018. *Antimicrobial Resistance in Bacteria from Livestock and Companion Animals*. ASM Press.

- Skjølstrup, N. K., D. B. Lastein, C. S. Jensen, and M. Vaarst. 2021. The antimicrobial landscape as outlined by Danish dairy farmers. *J. Dairy Sci.* 104:11147–11164. <https://doi.org/10.3168/jds.2021-20552>.
- Speksnijder, D. C., A. D. C. Jaarsma, A. C. van der Gugten, T. J. M. Verheij, and J. A. Wagenaar. 2015a. Determinants associated with veterinary antimicrobial prescribing in farm animals in the Netherlands: A qualitative study. *Zoonoses Public Health* 62:39–51. <https://doi.org/10.1111/zph.12168>.
- Speksnijder, D. C., D. J. Mevius, C. J. M. Bruschke, and J. A. Wagenaar. 2015b. Reduction of veterinary antimicrobial use in the Netherlands. The Dutch success model. *Zoonoses Public Health* 62:79–87. <https://doi.org/10.1111/zph.12167>.
- Tang, K. L., N. P. Caffrey, D. B. Nóbrega, S. C. Cork, P. E. Ronksley, H. W. Barkema, A. J. Polachek, H. Ganshorn, N. Sharma, J. D. Kellner, and W. A. Ghali. 2017. Restricting the use of antibiotics in food-producing animals and its associations with antibiotic resistance in food-producing animals and human beings: A systematic review and meta-analysis. *Lancet Planet. Health* 1:e316–e327. [https://doi.org/10.1016/S2542-5196\(17\)30141-9](https://doi.org/10.1016/S2542-5196(17)30141-9).
- Wilm, J., L. Svennesen, E. Østergaard Eriksen, T. Halasa, and V. Krömker. 2021. Veterinary treatment approach and antibiotic usage for clinical mastitis in Danish dairy herds. *Antibiotics* (Basel) 10:189. <https://doi.org/10.3390/antibiotics10020189>.
- Winder, C. B., J. M. Sargeant, D. Hu, C. Wang, D. F. Kelton, M. A. Godkin, K. J. Churchill, and A. M. O'connor. 2019. Comparative efficacy of antimicrobials for treatment of clinical mastitis in lactating dairy cattle: A systematic review and network meta-analysis. *Anim. Health Res. Rev.* 20:229–246. <https://doi.org/10.1017/S1466252319000318>.

ORCIDS

Nanna K. Skjølstrup <https://orcid.org/0000-0001-9863-3348>

Mette Vaarst <https://orcid.org/0000-0003-2830-2847>

Carsten S. Jensen <https://orcid.org/0000-0002-5760-9648>

Dorte B. Lastein <https://orcid.org/0000-0003-3628-5418>

APPENDIX

Table A1. Coding tree, Danish cattle veterinarians' perspectives on antimicrobial use: contextual and individual influencing structures

Selected meaning condensates and examples of statements	Code	Theme
No broad-spectrum antimicrobials for <i>Escherichia coli</i> mastitis (<i>"I was raised to treat these cows with broad-spectrum antimicrobials, but we have recently discussed trying to start the treatment with narrow-spectrum antimicrobials and supportive therapy."</i>) No treatment of mastitis before diagnostic result is ready Should be based on science but is often based on personal experiences instead	"Correct" approach to treatment	Personal experiences and availability of medicines guide everyday treatment decisions
Proper use of diagnostics Setting standards for antimicrobial use (AMU)	What is perceived as important	
Difficult to change treatment pattern when accustomed to something Difficult for experienced and older veterinarians	Changing habits	
Courses and experts Colleagues Clinical experiences (own and others') Local evidence as opposed to general evidence	Influencing factors	
More objective diagnostic tools More local evidence produced	Wishes	
Some veterinarians are busy and do not prioritize diagnostics Older veterinarians have been used to having all antimicrobials available	Attitudes toward other veterinarians	
Some farmers know what antimicrobials they want; others let the veterinarian decide Some farmers want quick answers and action	Attitudes toward farmers	Social relations and diverging interests influence AMU practices
Not letting the farmer determine the veterinarian's AMU Delivering results, changing farms Retaining clients	What is perceived as important	
Condition of the cow Farmers' wishes and preferences (<i>"For some farmers, the antimicrobials just need to work and have as short a withdrawal time as possible."</i>) Colleagues' choices Traditions	Influencing factors	
Some veterinarians break the law to retain their clients Some veterinary practices teach their employees bad AMU habits	Attitudes toward other veterinarians	
Some farmers only want the veterinarian to perform the tasks determined by legislation (<i>"Some farmers just want you to come and do your job. They perceive me as a legislatively determined measure. I only need to do the things required by law."</i>) Some farmers break the law	Attitudes toward farmers	Current legislative and agricultural framework and room to maneuver in relation to AMU
Balancing dual roles Liberalization of medicines is bad for AMU and animal welfare	Attitudes toward advisory services	
Must regulate our AMU Outlines what veterinarians can force farmers to do Necessity	Attitudes toward legislation	
Complying with legislation Being below official limits for AMU	What is perceived as important	
More control over farmers' treatments Adjusting official limits for AMU	Wishes	
Affected by benchmarking in relation to AMU Some veterinarians run on routine due to legislation	Attitudes toward other veterinarians	

Continued

Table A1 (Continued). Coding tree, Danish cattle veterinarians' perspectives on antimicrobial use: contextual and individual influencing structures

Selected meaning condensates and examples of statements	Code	Theme
Worse in other countries (<i>"You can get quite frustrated; we do a lot of good things in Denmark, but you just need to cross the border. . . we know that the AMU levels are completely different there."</i>) Primarily in relation to cows, not humans	Attitudes toward antimicrobial resistance (AMR)	AMR rarely encountered on a daily basis—remains an abstract threat overshadowed by animal welfare concerns
Farmers Both farmers and veterinarians	Responsibility for AMU	
Always use narrow-spectrum antimicrobials if there is a documented effect When first initiated, continue treatment for a long enough duration Sick animals need treatment	"Correct" approach to treatment	