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Capturing the complexity of veterinarians' antibiotic prescribing practices in the livestock sector: a meta-ethnography across contexts

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Strategies and policies to tackle the global public health threat of antimicrobial resistance are increasingly addressing antimicrobial use prescribing practices in both the human and animal health sectors. Veterinarians' antibiotic prescribing practices are influenced by different factors and conditioned by the context within which antibiotic prescribing decisions are made, complexifying the implementation of behaviour change interventions. A better understanding of these factors could therefore help in the design and application of such interventions. Meta-ethnography was used to explore the antibiotic prescribing behaviour of veterinarians in different contexts and to construct a new conceptual framework. A search was conducted in PubMed, Web of Science Core Collection and SciELO Citation Index between 2016 and 2024. The final sample consisted of 29 articles, 27 of which were selected from the 561 articles identified in the search and 2 of which were added by the authors. The results were synthesized and presented through four contextual situations influencing antibiotic prescribing by livestock veterinarians: priorities and pressures, uncertain field conditions, systemic challenges and an enabling environment. The results are presented as a conceptual framework that views veterinarians' antibiotic prescribing behaviour as dynamic, adapting in response to the different contextual situations they encounter. The findings provide an integrated and contextualized understanding of veterinarians' antibiotic prescribing behaviours, which could be implemented to facilitate the development and application of future antimicrobial stewardship interventions.

Introduction

Antimicrobial resistance (AMR) is increasingly recognized as a major global challenge with implications across the One Health spectrum for human, animal and environmental health.[1] Initiatives to address AMR are increasingly taking the form of strategies and policies aimed at reducing antimicrobial use (AMU) in both the human and animal health sectors,[2–4] leading to a growing interest in the antibiotic prescribing practices of doctors and veterinarians. The antibiotic prescribing practices of doctors have been the focus of research in human medicine since the 1940s,[5] with more recent research focusing on understanding the psychological, social and contextual factors that play a critical role in influencing antibiotic prescribing practices.[6,7] Factors identified as influencing antibiotic prescribing by doctors include fear (e.g. being accused of negligence if not prescribing antibiotics) and external responsibility (e.g. considering the responsibility for AMR to rest with other actors).[8,9] Factors influencing AMU decision-making in the animal health sector have also been examined, although much of the research in this sector has focused largely on farmers and pet owners, rather than veterinarians.[10–13] This is an important gap, as veterinarians are often the main source of antibiotics and advice for farmers and pet owners.[14,15] However, most studies in the human and animal health sector have considered the influence of different factors in a static manner independent of context. A deeper, contextualized understanding of the factors that influence veterinarians' AMU decision-making is still needed to better tailor antimicrobial stewardship (AMS) interventions.

We consider context to be not only the systems of social, technical and economic structures within which different actors (e.g. veterinarians) operate but to be also constituted of the ways in which actors interact with and within these systems. Context

has been shown to be an important influence on decisions related to AMU for both the human and animal health sectors,[16–19] but contextual influences are often considered as specific individual factors, rather than presented as situations to which actors may respond in dynamic ways. Context here refers to the situations in which actors have to interact and make decisions, but the term encompasses not only the roles and rules of social interactions but also how they are embedded and enacted in the surrounding sociotechnical and socio-economic structures. Qualitative research can be used to provide an in-depth understanding of such a complex issue and therefore has the potential to provide insight into how veterinarians' decision-making processes may vary across different contexts. However, while the body of qualitative research on antibiotic prescribing practices in the animal health sector has grown over the past decade, the evidence remains disparate, often localized to specific settings and therefore difficult to synthesize. Recent methodological advances have addressed the challenges of synthesizing qualitative findings, with meta-ethnography identified as a promising method for doing so.[20,21]

Meta-ethnography is an interpretive method for synthesizing qualitative findings, originally developed by sociologists in the field of education.[22] A meta-ethnography can be used to create a new inductive framework from the available qualitative findings, with the potential to generate wide-ranging insights.[22,23] It differs from quantitative synthesis approaches in that it does not aim to aggregate evidence from individual studies, but rather to develop novel explanations.[23] It is therefore of interest for developing an explanation of how different contextual situations could influence antibiotic prescribing behaviour. This method has been widely used in health and social care research,[24,25] where it has generated knowledge that has enabled the development of innovative healthcare interventions.[26–28] By the same principle, meta-ethnography could be used to explore the complexity of AMU decision-making processes in different contextual situations, complementing previous studies which have considered the impact of individual factors influencing veterinarians' prescribing in static situations.[29,30]

This meta-ethnography takes an integrated approach to analysing how contexts shape veterinarians' antibiotic prescribing practices. The aim of this meta-ethnography is to generate a new conceptual framework describing veterinarians' AMU practices within different contextual situations. The findings from this review could inform the design and application of AMU interventions.

Methods

A meta-ethnography was conducted following the seven steps defined by Noblit and Hare[22] and further refined by Sattar *et al.*[25]: (i) getting started, (ii) deciding what is relevant to the initial interest, (iii) reading the studies, (iv) determining how the studies are related, (v) translating the studies into one another, (vi) synthesizing the translations and (vii) expressing the synthesis. The eMERGe guideline was used as a reference for reporting the meta-ethnography.[31,32]

Search strategy and processes

The research question was 'what are the contextual situations influencing veterinarians' antibiotic prescribing practices?'. The PICO framework was used,[33] with veterinarians as the population (P), antibiotic prescribing practices in farm animals as the context (C) and psychosocial determinants as the outcome (O); however, no intervention (I) was associated.

Keywords and predefined inclusion criteria were used to ensure a robust review. Specific keywords were used with Boolean operators ('OR' to differentiate keywords within each PCO category, 'AND' to combine keywords between PCO categories) (Table S1, available as Supplementary data at *JAC-AMR* Online). The search was exhaustive (i.e. all available research articles were searched). Articles from all countries, written in English, were included. Only articles from 2016 onwards were included, as there were very few qualitative research articles available before this date.

The search was performed on 7 October 2021 and updated on 14 April 2024. Three databases were used: PubMed, SciELO Citation Index and Web of Science Core Collection.

Selection of articles

All the articles from the three databases were listed in Microsoft Excel. The identification process eliminated duplicate articles. The screening process was based on article titles and abstracts. Inclusion criteria were study type (i.e. original study), data type (i.e. qualitative or mixed), study participants [i.e. stakeholders—focusing on veterinarians but including articles with some other stakeholders (such as farmers and veterinary paraprofessionals) for data triangulation], study topic (antibiotic prescription) and study setting (livestock farms, including mixed practice) (Table S2). A conservative approach was taken; where there was uncertainty about the inclusion criteria, articles were retained for full review. Grey literature (i.e. unpublished research, dissertations, conference proceedings, presentations, government documents or any other document not published in journals and therefore not referenced in a database search) was excluded from this review. During the inclusion process, the final sample of articles was read in full. Articles that did not include original quotations from participants were also excluded. The identification, screening and inclusion processes were carried out jointly by S.M., R.H. and M.C.P., without recourse to an additional reviewer, by mutual agreement.

The Dixon-Woods *et al.*[34] categorization was used to assess the quality of the selected articles. According to this categorization, all articles were considered as key, satisfactory or unsure (Table S3).

Data extraction

The data presented in the abstract and full text of all selected articles were extracted by S.M. and M.C.P. using NVivo software (version release 1.5 (935), QSR International). The concept of first-, second- and third-order constructs was adopted from Britten *et al.*[35] First-order constructs are the original quotations from participants, second-order constructs are the original authors' interpretations of the first-order constructs and third-order constructs are the review authors' interpretations.

Initially, first- and second-order constructs were identified. These constructs were coded by the authors using previously established codes based on the themes (central ideas, concepts or patterns that emerge from data analysis) and sub-themes (specific ideas, concepts or patterns that are part of a theme) presented in the original articles (i.e. a deductive approach) (Table S3). Then, following a subsequent inductive approach, further codes were progressively included. These codes were generated by the authors (S.M. and R.H.) from third-order constructs and added further nuance to the findings.

Relation and translation of articles

The relationships between the concepts in the articles were established by S.M. and R.H. A list of sub-themes was developed based on the first- and second-order construct codes. This list was used to search for and compare common and recurring concepts across articles.[36] The sub-themes from the different articles were then grouped into themes in an iterative process.[25] This resulted in a synthesis of the third-order construct.

Data synthesis

Thematic analysis was used as described by Braun and Clarke,[37] but adapted to be combined with the concept of first-, second- and third-order constructs from Britten *et al.*[35] Both S.M. and R.H. generated themes based on first-, second- and third-order constructs and discussed the synthesis of the themes across the different articles. First, second- and third-order construct codes were associated with 'units of meaning' (a segment of content—word, phrase, sentence or paragraph—of the data analysed in relation to the research question) (Table S4). Deductive coding (i.e. codes based on the original articles; first from first-order constructs and second from second-order constructs) and then inductive coding (i.e. codes proposed by the review authors; third from third-order constructs) were performed. The 'units of meaning' were linked to sub-themes, and these sub-themes were in turn grouped into themes. The themes were presented in the Results section of this review.

Results

A total of 561 articles were identified in the identification process (Table S5). Thirty-eight articles were kept after initial screening (abstract and title), and 27 articles remained after full-text screening (Figure 1). Of the 11 articles excluded during the full-text screening, 2 articles were excluded because they did not have primary data collection,[38,39] 3 articles were excluded because they were quantitative,[40–42] 5 articles were excluded because they did not have first-order constructs (i.e. original quotations from participants)[43–47] and 1 article was discarded because its main focus was not AMU.[48] Two articles considered relevant to this meta-ethnography were subsequently added by the authors.[49,50] Thus, this meta-ethnography had a final sample of 29 articles.[49–77]

The characteristics and details of the 29 studies in the final sample are described in Tables S6 and S7. The countries, sectors and stakeholders of the studies are described in Table 1.

Analysis of results to develop themes and sub-themes from the 29 studies allowed us to elaborate 4 contextual situations influencing veterinarians' antibiotic prescribing practices (Table 2; third-order constructs). Veterinarians' antibiotic prescribing behaviour was conceptualized as being dynamic, in that veterinarians' behaviour could be influenced by different factors to differing degrees depending on the contextual situation.

Contextual situation 1: priorities and pressures

AMR is 'just something to be weighed up against all other factors'.[53]

The first contextual situation occurred where veterinarians faced competing priorities and pressures, such that AMR was only one consideration among many when prescribing antibiotics. In the absence of direct evidence of AMR, the need to manage animal disease and welfare in the short term took precedence over veterinarians' sense of responsibility for AMR and was also influenced by pressures to prescribe antibiotics from others including farmers.

Some of the studies found that while veterinarians were aware of AMR, it was not considered to be an immediate risk for their day-to-day functioning.[51–56] This was in part due to the lack of immediate visibility of AMR on farm, as one veterinarian explained: 'there are an awful lot of other factors that affect treatment outcome as well as resistance … there are vanishingly few situations in which I as a clinician would kind of recognise that I encountered a problem caused by antimicrobial resistance and would make different treatment decisions as a result'.[55] As a consequence, the threat of AMR was felt by veterinarians in some studies to be insufficiently urgent or relevant to influence their decision-making in the face of more immediate priorities and pressures, such as the need to appropriately manage animal health and welfare and time and financial pressures. In such cases, AMR was 'just something else to be weighed up against all other factors'.[53]

The influence of different priorities was evident in the description of and reasons given by some veterinarians for the prescription of antibiotics.[50,52,62,64] One clear priority for veterinarians and other actors was ensuring animal health and welfare, with antibiotics prescribed out of fear that animal health would not improve or would worsen (e.g. increased mortality) without antibiotic treatment.[50–53,65–67,69–71,74] For example, one veterinarian highlighted the importance of treatment even where prudent AMU was a consideration: 'to me, yes, we need to be prudent with our antibiotic usage. But to me, it's like we also have to treat the animal'.[71] Fear of failing to manage disease was mentioned by some veterinarians: 'there's always the fear … I don't think I'd be brave enough not to prescribe an antibiotic',[53] '… there is this fear of what if I neglect to treat something that I should have treated?'[54] and 'and I suppose fear of it causing a disaster on the farm is maybe one of the limitations … I think cows will die'.[56]

In other cases, prophylactic use of antibiotics was considered to be in line with responsible AMU, as some respondents believed that prophylactic use could prevent the increased use of antibiotics at a later stage of disease, which could ultimately result in higher costs and greater potential risk for AMR—reflected in statements such as 'with current knowledge I consider it really dangerous to strictly introduce this [selective dry cow therapy] then you just run into more problems, more antimicrobial use'[50] and 'sometimes you have to treat sub-clinical … it's not only cheaper for the client, but you're actually using a lot less antibiotics, so it's much more responsible'.[77] The prophylactic prescription of antibiotics was therefore justified by some veterinarians as a means of minimizing the risk to animal health and welfare and the overall use of antibiotics.

AMR was also a lower priority compared to time and financial constraints and external pressures from others to prescribe antibiotics. In particular, the pressure to act in a timely fashion was reported as modifying veterinarians' antibiotic prescribing behaviours. This was exemplified by one veterinarian: 'you immediately start with antimicrobial group treatment. Because treating 350 piglets individually, that is not feasible at that very moment … you need to act immediately'.[50] Similarly, although on-farm visits were recognized by veterinarians as important for monitoring animal health and advising farmers on animal management,[50,51,74] other veterinarians said that they did not have enough time to make these visits.[58] Veterinarians also reported facing external pressures from clients which influenced their antibiotic prescribing behaviours. In particular, veterinarians reported being reluctant to argue for preventive measures in place of antibiotics,[58,60] because farmers considered antibiotics to be faster-acting and more cost-effective.[50,52] In some studies, veterinarians felt that clients pressured them to prescribe antibiotics, which they were beholden to do when they were financially dependent on farmers as clients,[50,51,54,56,72] or feared complaints to higher authorities.[66] This was described by one veterinarian—'if we don't have clients, we don't get paid or have a job. So at some point you do have to

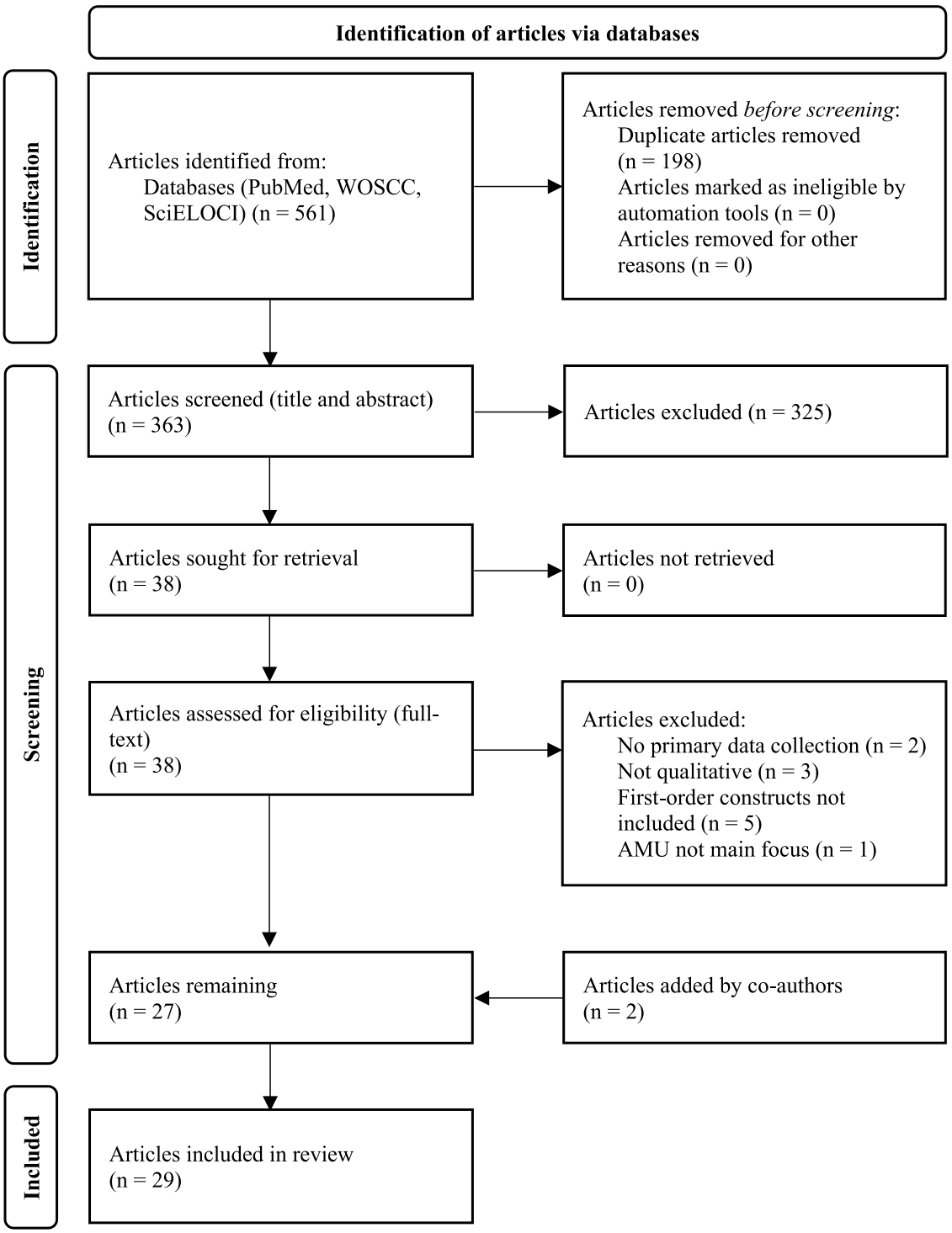

Figure 1. PRISMA flow diagram.

keep them happy'.[54] Others considered that if veterinarians did not prescribe antibiotics to farmers, it made no difference because farmers could access antibiotics through other veterinarians,[51,53,63,69,71,74,75] noting: 'if I don't do it this way, another veterinarian will come along and do it the way the farmer wants it'[51] and 'someone else is happy to visit once and prescribe three times'.[59] On some occasions, veterinarians and animal health professionals described prescribing antibiotics to avoid an argument with their clients, even when these antibiotics were not necessary,[50,52,53,58,65,74,75] noting: 'for

Table 1. Countries, sectors and stakeholders of the studies included in the meta-ethnography

Countries	No.	Studies
UK	10	Crawford *et al.*[69]; Elkholly *et al.*[73]; Farrell *et al.*[74]; Hinchliffe *et al.*[77]; Llanos-Soto *et al.*[58]; Rees *et al.*[64]; Golding *et al.*[53]; Helliwell *et al.*[55]; Higgins *et al.*[56]; Coyne *et al.*[52]
France	4	Moya *et al.*[70]; Llanos-Soto *et al.*[58]; Bourély *et al.*[49]; Poizat *et al.*[62]
Denmark	3	Kongsted and Loughlin[67]; Skjølstrup *et al.*[51]; Llanos-Soto *et al.*[58]
Ireland	3	Farrell *et al.*[74]; Llanos-Soto *et al.*[58]; Magalhães-Sant'Ana *et al.*[59]
Australia	2	Llanos-Soto *et al.*[58]; Hardefeldt *et al.*[54]
Canada	2	Cobo-Angel *et al.*[71]; Millar *et al.*[68]
The Netherlands	2	Llanos-Soto *et al.*[58]; Speksnijder *et al.*[50]
USA	2	Llanos-Soto *et al.*[58]; Moore *et al.*[60]
Bangladesh	1	Nahar *et al.*[61]
Fiji	1	Khan *et al.*[66]
India	1	Hennessey *et al.*[76]
Lebanon	1	Dankar *et al.*[72]
Sweden	1	Gröndal *et al.*[75]
Switzerland	1	Pucken *et al.*[63]
Tanzania	1	Caudell *et al.*[65]
Thailand	1	Lekagul *et al.*[57]
Others	1	Llanos-Soto *et al.*[58]
Sector	**No.**	**Studies**
Cattle	22	Cobo-Angel *et al.*[71]; Dankar *et al.*[72]; Elkholly *et al.*[73]; Farrell *et al.*[74]; Gröndal *et al.*[75]; Hennessey *et al.*[76]; Millar *et al.*[68]; Caudell *et al.*[65]; Khan *et al.*[66]; Skjølstrup *et al.*[51]; Llanos-Soto *et al.*[58]; Moore *et al.*[60]; Rees *et al.*[64]; Golding *et al.*[53]; Helliwell et a.[55]; Pucken *et al.*[63]; Bourély *et al.*[49]; Hardefeldt *et al.*[54]; Higgins *et al.*[56]; Magalhães-Sant'Ana *et al.*[59]; Poizat *et al.*[62]; Speksnijder *et al.*[50]
Sheep	8	Crawford *et al.*[69]; Elkholly *et al.*[73]; Gröndal *et al.*[75]; Hennessey *et al.*[76]; Caudell *et al.*[65]; Golding *et al.*[53]; Bourély *et al.*[49]; Speksnijder *et al.*[50]
Pig	7	Gröndal *et al.*[75]; Kongsted and Loughlin[67]; Lekagul *et al.*[57]; Golding *et al.*[53]; Bourély *et al.*[49]; Coyne *et al.*[52]; Speksnijder *et al.*[50]
Poultry	7	Moya *et al.*[70]; Hennessey *et al.*[76]; Hinchliffe *et al.*[77]; Khan *et al.*[66]; Golding *et al.*[53]; Bourély *et al.*[49]; Speksnijder *et al.*[50]
Horse	5	Gröndal *et al.*[75]; Golding *et al.*[53]; Bourély *et al.*[49]; Hardefeldt *et al.*[54]; Speksnijder *et al.*[50]
Others	4	Gröndal *et al.*[75]; Hennessey *et al.*[76]; Caudell *et al.*[65]; Nahar *et al.*[61]
Stakeholders	**No.**	**Studies**
Veterinarians	27	Moya *et al.*[70]; Cobo-Angel *et al.*[71]; Dankar *et al.*[72]; Elkholly *et al.*[73]; Farrell *et al.*[74]; Gröndal *et al.*[75]; Hennessey *et al.*[76]; Hinchliffe *et al.*[77]; Kongsted and Loughlin[67]; Millar *et al.*[68]; Caudell *et al.*[65]; Khan *et al.*[66]; Skjølstrup *et al.*[51]; Lekagul *et al.*[57]; Llanos-Soto *et al.*[58]; Moore *et al.*[60]; Rees *et al.*[64]; Golding *et al.*[53]; Helliwell *et al.*[55]; Pucken *et al.*[63]; Bourély *et al.*[49]; Hardefeldt *et al.*[54]; Higgins *et al.*[56]; Magalhães-Sant'Ana *et al.*[59]; Poizat *et al.*[62]; Coyne *et al.*[52]; Speksnijder *et al.*[50]
Farmers	9	Crawford *et al.*[69]; Hennessey *et al.*[76]; Hinchliffe *et al.*[77]; Kongsted and Loughlin[67]; Millar *et al.*[68]; Caudell *et al.*[65]; Rees *et al.*[64]; Golding *et al.*[53]; Helliwell *et al.*[55]
Para-veterinarians, farm advisors, agrovets, veterinary and livestock officers, drug shop owners, animal health association, human health association and pharmaceutical representatives and others	8	Hennessey *et al.*[76]; Caudell *et al.*[65]; Khan *et al.*[66]; Lekagul *et al.*[57]; Moore *et al.*[60]; Nahar *et al.*[61]; Magalhães-Sant'Ana *et al.*[59]; Poizat *et al.*[62]

the sake of an easy life, sometimes you're just like fine, fine, you're wrong, but fine'[53] and 'you know, you are tired, it is a late night, you: "Yes, fine" You sometimes don't have the energy to take the discussion'.[75]

Contextual situation 2: uncertain field conditions

'It's just something that we've tried over the years and it works, so that's what we do'.[64]

Table 2. Contextual situations influencing veterinarians' antibiotic prescribing practices

Contextual situation	Summary
1. Priorities and pressures	Although veterinarians were aware of AMR, it was not a priority as the immediate impact of AMR was not perceived on farm, and veterinarians had to manage more pressing/immediate concerns including • The potential immediate consequences for animal health and welfare of not using antibiotics • Time and financial constraints • Pressure from farmers to prescribe antibiotics
2. Uncertain field conditions	Veterinarians were operating in conditions of uncertainty because • Clinical guidance was absent or not considered relevant to the field conditions where veterinarians were working • Diagnostic tests (for bacterial identification and susceptibility testing of antibiotics and for diagnosing clinical disease) were not considered feasible for reasons of time or cost, or because the information they provided was not considered useful • Reasons for treatment failure were challenging to identify
3. Systemic challenges	Veterinarians felt a sense of fatalism or inevitability regarding prescription of antibiotics, due to systemic/intractable challenges including • Belief that changes in their own behaviour would make no difference unless other stakeholders and sectors took action on AMR • Belief that antibiotics were necessary to manage animal disease
4. An enabling environment	Veterinarians were able to act on their sense of responsibility for AMR in the presence of enabling factors: • Relationships of collaboration and trust between veterinarians and farmers and between different colleagues/peers • Access to diagnostic tools and other supporting resources

The second contextual situation described where veterinarians operated with some degree of uncertainty, lacking information on treatment guidance or diagnostic outcomes relevant to their specific field conditions. Under such circumstances, veterinarians relied on their own empirical knowledge and habits, as well as the collective experience of trusted colleagues/peers, to the preference of external guidelines or diagnostic procedures.

Veterinarians and other actors reported making antibiotic prescribing decisions based on empirical evidence and, more particularly, their own and their colleagues/peers' personal knowledge and experience.[49–51,54,55,63,65,70–74] For example, one veterinarian expressed that when making a decision to prescribe antibiotics: 'I would base it on my own clinical experience and kind of knowledge of the likely causes of those conditions'.[73] Veterinarians perceived that there were empirical practices and prescribing habits that were collectively accepted.[51,52,54] This took on a particular emphasis in situations where clinical guidance or diagnostic testing was considered insufficient. Some interviewed veterinarians reported that they felt that guidance on AMU prescribing was either lacking[57,68] or, where it existed, was not always relevant to the local field conditions[51,60]—in some cases expressing a sense of disjunct between the theory of responsible AMU and the reality of working in the field.[51] Some interviewed veterinarians also noted a more general lack of farm-level data on AMU and AMR which made it challenging to make informed decisions on AMU prescribing,[59] while others emphasized the importance of determining the most appropriate antibiotic treatment based on their knowledge of the specific farm's clinical history[52,5]—'treatments … might be generic [but] … they're farm specific really. You need to know what's going on, on the farm, to be able to advise them'.[53]

Another feature of field conditions that led veterinarians to rely principally on their experience and habits was uncertainty—both with regard to the clinical diagnosis of the disease they were treating and the identification of resistance that might exist in their local context. In some studies, veterinarians reported prescribing antibiotics without bacterial identification (e.g. bacterial culture) and susceptibility tests (e.g. antibiogram), preferring to rely on their own expertise.[50,54,55,72] This was in some cases due to a lack of accessibility of such testing, with veterinarians reporting high costs of testing, limited numbers of local laboratories and poor laboratory support services as barriers to performing these tests.[49,54,65,66,68,71,72] Some veterinarians expressed their frustrations at these limitations, explaining: 'I would love to take samples for confirmation before antimicrobial prescription, this is how it should be, but we are facing a big problem concerning the lack of laboratories'.[72]

However, even where such antibiotic susceptibility testing was accessible, veterinarians did not always avail themselves of this resource. One reason for this was the delays in obtaining results, which compromised rapid treatment.[50,52,55,74] Some veterinarians observed: 'there isn't time to send something to culture … I need to make a decision there and then, it's what the farmer has got me out for'[55] and 'the problem is that it takes a long time to get an answer [of the results of a diagnostic test] and you can't wait that long to treat'.[68] In addition, sometimes the information provided was not considered useful—for example, veterinarians noted that *in vitro* susceptibility could differ from that in the field,[60] or believed they always found the same result ('usually there is the same finding each time and then the motivation of the farmers to do this investment is lacking'),[50] or assumed their field knowledge was sufficient: 'we already had an answer. So quite honestly we based things on the field response and didn't use an antibiogram'.[49] In other cases, veterinarians noted that if the results of antibiotic treatment in the field clashed with the results of susceptibility testing, the susceptibility testing was ignored.[50] Diagnostic tests to obtain a clinical diagnosis (other than bacterial identification and susceptibility testing) were also not always performed before prescribing antibiotics for reasons of cost constraints,[49,50] with veterinarians noting that: 'it's going to cost less to confirm, to actually diagnose the problem, than to just treat blindly'.[49] Respondents also noted the need for

expertise even where diagnostic tests were available: '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'.[51] Furthermore, in situations of antibiotic treatment failure (where an antibiotic did not produce the expected or desired effect), there was often uncertainty about the cause—whether this was due to AMR, incorrect administration or a range of other clinical factors. When faced with antibiotic treatment failure, some veterinarians considered that these failures were not caused by AMR, but were more likely to be due to issues of administration,[52,55,60] and some responded to antibiotic treatment failure by trying different antibiotics in succession,[51,52,54,72] following what one veterinarian described as a 'good feeling'.[51]

Interviewees suggested that some antibiotic prescribing practices were difficult to change due to being ingrained habits,[58,62,64] especially for senior veterinarians.[51,71] Nonetheless, the veterinarians interviewed demonstrated responsiveness to certain influences, with some veterinarians, changing their prescribing practices in response to new AMU regulations[49,50,70,71] and government control and monitoring measures.[51] Other veterinarians indicated that they would change their prescribing practices if farmers believed these to be outdated.[56] Veterinarians could also change their views of alternatives to prescribing antibiotics based on experimentation with different approaches, suggesting flexibility with the context.[49,53,56,62] This suggests that veterinarians were open to changing their practices and habits under certain conditions.

Contextual situation 3: systemic challenges

'I accept there is a problem but in a sense it is not my problem'.[59]

The third contextual situation occurred where systemic or intractable challenges led to a sense of fatalism regarding prescription of antibiotics. In this context, veterinarians felt that the contribution of other stakeholders to AMR meant changes in their own antibiotic prescribing behaviour could make very little difference and viewed use of specific antibiotics as a necessity to manage animal health and welfare. In such situations, the prescription of antibiotics by veterinarians was viewed as a necessity resulting from factors beyond their control. Under such circumstances, the motivation of veterinarians to undertake diagnostic tests and preventive measures was diminished.

One situation that led to a sense of loss of influence on AMU among veterinarians was the view that their personal contribution to AMR was minimal relative to other stakeholders or sectors. Although veterinarians in most studies expressed a sense of responsibility for AMR to some degree, some also expressed frustration at the assumption that they were to blame for what they viewed as a collective responsibility and were sceptical about their contribution to AMR relative to others.[50–54,59,61,74] This was described as 'other-blaming' in some of the studies and occurred at several levels—from veterinarians' and animal health professionals believing that the problem came from other stakeholders working in the same sector (including farmers and other veterinarians/animal health professionals),[53,61,65,66,72,74] that the livestock sector they worked in had more appropriate AMU than other species (in the case of pig veterinarians,[52,73] dairy cattle veterinarians[71] and horse and cattle veterinarians),[54] that the country they worked in was more responsible in its veterinary AMU than other countries (in the case of Denmark,[51] the Netherlands[50] and the UK)[52,73] or that the animal health sector as a whole was being unfairly blamed for a problem that some veterinarians attributed to the human health sector.[50,52–54,71,73,74] This meant that even where veterinarians felt responsibility for AMU, they had difficulty in taking ownership of this responsibility as they did not feel that their contribution would make a meaningful difference. This was epitomized by one veterinarian who considered that to change their prescribing practices, other actors would first have to change theirs: 'my contribution is so minor and so small and so insignificant that actually I don't need to do anything or change. Because there are other people who have much more influence on the thing than I do and if they change then I will change'.[59]

A sense of the inevitability of AMU was also visible in that antibiotics, and particular types of antibiotics, were considered necessary for veterinarians to treat disease and prevent animal suffering.[50–53,67] Veterinarians in some studies reported sometimes prescribing antibiotics designated as critically important antibiotics (classified as such either by the WHO or their national authority).[49,52,58,62,72,73] Veterinarians were often aware of recommendations or regulations to not prescribe such antibiotics, but viewed their use as a necessity because they were the only effective antibiotics available,[52,71] or because their particular properties (being fast-acting or long-acting,[49,62] low cost[58] and having a short withdrawal time),[49,72] meant they were more adapted for use. In cases where veterinarians felt their advice was ignored, there could also be a sense of apathy: 'in some herds, you just give up … it is actually not my responsibility if he doesn't succeed'.[51] Consequently, it seemed that under such circumstances where veterinarians' felt their influence to be minimal or non-existent, it was challenging for them to take ownership of AMU decisions.

Contextual situation 4: an enabling environment

'I can change their attitude if I gain their trust'.[51]

The fourth contextual situation is an enabling environment. In the presence of a number of enabling factors, such as sufficient time and opportunity to establish relationships of trust between veterinarians and farmers and discuss cases with colleagues/peers, and access to supporting resources such as diagnostic tests, veterinarians felt more empowered to act on their sense of responsibility for AMR and to use approaches such as diagnostic testing to reduce uncertainty.

Respondents in many of the studies reported being aware of the potential implications of their antibiotic prescribing for AMR and that they felt responsible for AMU[50–55,69,71–74,76]: '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',[51] 'it's always in the back of your mind, every time you prescribe an antibiotic … am I selecting for resistance in any way?'[53] and 'I'm worried about my influence, if I'm causing it'.[54] However, the ability to act in a way consistent with this sense of responsibility was contingent on the presence of certain enabling factors. One factor that was highlighted was the presence of collaborative and functional relationships between veterinarians and their clients and other colleagues/peers. Many respondents emphasized the

importance of collaboration and trust in the relationship between veterinarians and farmers and in the decision-making process related to AMU.[49,51–53,60,67,68,74,75,77] The existence of a relationship of collaboration and trust was the counterpart to the descriptions of client pressure to prescribe antibiotics mentioned in the first contextual situation and led to different antibiotic prescribing behaviours. Trusting relationships were viewed by veterinarians as a key condition to changing farmer AMU practices: 'I can change their attitude if I gain their trust … But it really takes a long time to do'[51] and 'again it probably comes down to whether or not you are trusted in the first place, because you cannot come to whomever and say "This is how it is"'.[75] Veterinarians also highlighted the need for sufficient time to invest in engaging with farmers through on-farm visits and taking a herd health planning approach to AMU.[53,56] Respondents in some of the studies also remarked on the importance of collaboration between veterinary colleagues/peers and stressed the need for a unified and consistent message to farmers regarding AMU in order to counter pressure from farmers,[51,53,56,70,71] explaining that they aimed: 'despite occasional differences of opinion, to justify this as part of an overall approach to farmers, so that they don't encounter any inconsistencies, regardless of which vet',[70] using terms such as 'being all on the same page',[71] 'united approach'[56] and 'working as a team'.[52]

Another enabling factor was the availability and reliability of testing. Unlike in the second contextual situation where diagnostic testing was viewed as time consuming and even uninformative, when availability permitted it, some veterinarians waited for bacterial culture and antibiogram results before prescribing antibiotics.[49,50,52,61,63] The motivations of these veterinarians included the belief that treating diagnosed disease ultimately resulted in lower financial costs than treating undiagnosed disease,[49] the fear of not treating a pathogen with an appropriate antibiotic in the absence of testing and the ability to subsequently adjust antibiotic treatment based on the results of testing.[50,71] Bacterial cultures and antibiograms were also viewed by some veterinarians as a communication tool, used to demonstrate the presence of pathogens and thereby explain their antibiotic prescriptions to farmers.[49,50]

Discussion

Interventions to address AMU in both humans and animals are increasingly used as part of local and international efforts to tackle AMR. This meta-ethnography contributes to the body of research providing insights into the dynamic and contextual factors influencing antibiotic prescribing behaviours, which can inform intervention design and application. Meta-ethnographies have been conducted to examine antibiotic prescribing practices in the human health sector, but the approach has not yet been applied to antibiotic prescribing practices in the animal health sector. Other mixed qualitative and quantitative reviews have described the factors influencing veterinarians' prescribing practices[29,30,78]—however, in these studies, the determinants of antibiotic prescribing are considered in isolation and often presented as static influences, rather than varying with context. This meta-ethnography integrates the findings of different qualitative studies to present veterinarians' antibiotic prescribing behaviours as a dynamic process, varying within different contextual situations. We constructed a conceptual framework consisting of four contextual situations: priorities and pressures, uncertain field conditions, systemic challenges and an enabling environment. This conceptual framework allowed us to describe how different contexts in which veterinarians interact and operate tend to shape their antibiotic prescribing practices.

An important feature that we advance in the proposed conceptual framework is the recognition that veterinarians' antibiotic prescribing habits are both context-contingent and dynamic. The influence of context on antibiotic prescribing habits has been demonstrated elsewhere for doctors,[16,17] and we argue that veterinarians' antibiotic prescribing is context-contingent insofar as the way in which a veterinarian prescribes antibiotics changes depending on the conditions in which they are prescribing antibiotics. The importance of context has been highlighted in quantitative systematic reviews[79] and is also of relevance for meta-ethnographies. The extension of this argument is the dynamic nature of antibiotic prescribing behaviours, such that the same veterinarian may operate within different contextual situations throughout their work and change their prescribing behaviours accordingly. In other words, we argue that antibiotic prescribing practices are not tied to specific veterinarians, but to specific contexts, which may elicit different behaviours. In structuring the conceptual framework in this way, we attempted to capture some of the nuance and complexity that informs veterinarians' antibiotic prescribing decisions. This can help to explain why varied results were found, even within a given study—for example, the finding that diagnostic tests provided no added informational value for some veterinarians,[50,54,55] and yet were crucial for others,[49,50,52,61,63] or that the relationship veterinarians had with their clients could be a source of pressure leading to prescription of unnecessary antibiotics in one context[50,51,54,56] and an opportunity to collaborate on improving approaches to AMU in a different context.[49,51–53,60] Furthermore, it is important to consider that veterinarians are likely to be subject to elements of each of the different situations simultaneously—a veterinarian may face competing priorities and pressures, uncertain field conditions, systemic challenges and an enabling environment all at once in a given environment and may even face these alongside specific enabling factors such as strong farmer–veterinarian relationships. However, it is likely that one may carry more weight in influencing veterinary prescribing decisions at any one time. The conceptual framework we propose is necessarily a simplification of this complex and nuanced landscape—but by proposing the four contextual situations as distinct entities, we wished to highlight the key contextual elements that may predominate at any given time, to give a manageable tool for informing AMS interventions. More practically in the field, this approach has the potential to help understand why an intervention may work or not in a given context and to help identify broader influences that may need to be addressed before an intervention can be successful. Conducting a thorough contextual analysis based on our conceptual framework prior to or during intervention design would allow interventions to be tailored to specific priorities and pressures, field conditions, systemic challenges and enabling factors. Such an approach would necessitate the involvement of key stakeholders from the outset to ensure that interventions are aligned with the realities on the ground.

One of the other important elements of our conceptual framework is that it allowed us to describe AMU prescribing decisions within the context where they were made. There is increasing recognition of the importance of considering context and situation

when describing AMU practices of different actors[18,80,81]—to do so, this implies an acceptance that what may be appropriate AMU in one context may not be appropriate or feasible in another. We therefore attempted to describe the AMU behaviours of veterinarians without using language that implied a value judgement on these behaviours. To a certain extent, this is unavoidable, as the discourse around AMU is so well established that even the veterinarians themselves make reference to responsible/prudent/appropriate AMU—however, we have attempted to avoid passing such judgements ourselves and attempted to rather describe the prescribing behaviours of veterinarians alongside the rationale and the context which informed them.

The four contextual situations of veterinarians in relation to antibiotic prescribing practices identified in this study have the potential to help interpret the antibiotic prescribing habits of actors and to inform the implementation of AMU interventions across the veterinary and healthcare sectors more broadly. The generic nature of the contexts we described (e.g. accessibility/availability of diagnostic tests and relationships between veterinarians and their clients) suggests that they may hold relevance for counties and sectors other than those in the included studies as well. This is supported by evidence of similar situations and influences to those described in our conceptual framework in qualitative studies on the AMU prescribing practices of companion animal veterinarians.[82–86] Similarly, in the human health sector, meta-ethnographies have generated conceptual frameworks for doctors' antibiotic prescribing practices.[87–89] In particular, Germeni *et al.*[87] described 'contexts of consultation' which influenced both antibiotic prescribing behaviours and the acceptability of interventions. These contexts included situations similar to those considered important in our findings, including diagnostic uncertainty and non-clinical system factors. This has implications for the design and implementation of interventions to address AMU behaviours with a One Health focus, as it may be possible to take an integrated approach to target patterns of antibiotic prescribing behaviour in response to different contextual situations in veterinarians and doctors. Integrating a multidisciplinary approach would allow intervention design to be adaptive to contextual situations in human and veterinary medicine, and developing flexible frameworks would ensure that interventions can be adjusted to evolving contexts in real time.

The synthesis of qualitative findings is a necessarily subjective approach, and we recognize that the interpretations we made (third-order constructs) may be different to those that would be obtained by a different set of researchers. However, this is inherent to the nature of meta-ethnographies and qualitative research more broadly and should not preclude our findings from being considered theoretically relevant to other situations. To ensure transparency with regard to our interpretations, we followed the eMERGe reporting standards for meta-ethnographies[31] and provided in-text examples of first-order constructs (original quotations from participants in the original studies) and descriptions of the second-order constructs (original authors' interpretations of the first-order constructs) within the results to help illustrate the third-order constructs that we made. Although the inclusion of first-order constructs may perhaps lead to an overrepresentation of studies that provided such quotations, we believe this is compensated for by the benefit of providing direct textual evidence of the interpretations and arguments made. One of the challenges for this meta-ethnography was determining how to analyse the heterogeneous presentation of first-order constructs, with different studies referring to participants as individuals (e.g. veterinarian—V1),[49–51,53,57,59,62] participants as part of a collective group (e.g. veterinarians—V)[55,63] and others not indicating which participant provided a given quotation.[52,54,56,58,60,61,64] We decided to use a pragmatic approach and to refer to first-order constructs without identifying and linking quotations to each individual participant. We also did not explicitly link the contextual situations to specific settings such as different countries, types of production system, animal management practices, farm sizes and scales, regulations and markets. This was because our aim was to identify the contextual elements that could remain stable across different settings—for example, our results suggest that diagnostic uncertainty is relevant for a variety of production systems in Fiji,[66] Australia,[54] Canada,[68,71] Tanzania[65] and France (albeit for different reasons)[49] and therefore may be relevant for other countries and production systems. By highlighting contextual factors which have an influence across such different settings, we aimed to identify elements which could be of broader interest for future research. Nonetheless, it is important to recognize that the underlying drivers of the contextual situations we identified (such as diagnostic uncertainty) will likely vary with different types of production systems and countries, related to the organizational and economic structures in place. It would therefore be useful for future research to make more explicit the link between the contextual situations we identified and the settings which influence them.

Many of the challenges in drawing together the findings of different qualitative papers were due in part to the disparate and static nature of the current body of research available on veterinarians' antibiotic prescribing practices. There is a need for more qualitative research to help understand behaviours related to antibiotic prescribing and use by different stakeholders in different situations—as this evidence base grows, the explanations that can be drawn by meta-ethnographies and their implications for practice will likely improve. This meta-ethnography represents a first step in this process.

Conclusions

The success of efforts to understand and ultimately influence AMU prescribing practices of veterinarians is contingent on a contextualized understanding of the factors that influence these practices. This meta-ethnography illustrated some of the contextual factors found to influence veterinarians' antibiotic prescribing practices and argued that these operate in a dynamic manner. We believe that the proposed conceptual framework of dynamic contextual situations has the potential to be used in the development and implementation of flexible interventions to tailor the approaches used to the needs and requirements of the antibiotic prescribing practices of different veterinarians as these change over time and place.

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Transparency declarations

None to declare.

Supplementary data

Tables S1 to S7 are available as Supplementary data at *JAC-AMR* Online.

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