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A multinational survey of companion animal veterinary clinicians: How can antimicrobial stewardship guidelines be optimised for the target stakeholder?

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ABSTRACT

Antimicrobial stewardship initiatives are widely regarded as a cornerstone for ameliorating the global health impact of antimicrobial resistance. Within companion animal health, such efforts have largely focused on development and dissemination of antimicrobial stewardship guidelines (ASGs). However, there have been few attempts to understand veterinarian attitudes towards and knowledge of ASGs or to determine how awareness regarding ASGs might best be increased. An online survey regarding ASGs was formulated for veterinarians who treat companion animals. The survey was distributed across 46 European and associated countries between 12 January and 30 June, 2022. In total, 2271 surveys were completed, with 64.9% of respondents (n = 1474) reporting awareness and usage of at least one ASG. Respondents from countries with greater awareness of ASGs tended to report more appropriate use of antimicrobials (Spearman's rank coefficient = 0.6084, $P \leq 0.001$), with respondents from countries with country-specific ASGs tending to score highest across both awareness and appropriate use domains. Respondents prioritised guidance around antimicrobial choice (82.0%, n = 1863), duration of treatment (66.0%, n = 1499), and dosage (51.9%, n = 1179) for inclusion in future ASGs, with 78.0% (n = 1776) of respondents preferring ASGs to be integrated into their patient management system. Awareness of ASGs and their use in companion animal veterinary practice appears to be greater than previously reported, with respondents tending to report antimicrobial prescription decision making broadly in line with current clinical recommendations. However, further initiatives aimed at maximising accessibility to ASGs both within countries and individual veterinary practices are recommended.

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Introduction

With increased awareness of the threats to human and animal health from antimicrobial resistance (AMR), national bodies, special interest groups and government agencies have generated antimicrobial stewardship guidelines (ASGs) to promote prudent antimicrobial use among companion animal veterinarians (Hillier et al., 2014; Lappin et al., 2017; Weese et al., 2019; Allerton et al., 2021a). The primary objective of these resources is to uphold clinical efficacy and preserve the effectiveness of currently accessible antimicrobials. They accomplish this by equipping prescribers with the information that supports appropriate use for animal therapy. Guidelines are an integral part of an enablement strategy of stewardship (Davey et al., 2017). Conversely, a restrictive stewardship approach, where the use of some antimicrobials is prohibited in animals due to their importance for treatment of severe, life-threatening infections in humans, e.g., the Veterinary Medicinal Products Regulation (Regulation (EU) 2019/6), imposes formulary restriction on veterinarians (European Parliament and of the Council, 2019). Member States and associated countries may further restrict the use of antimicrobials in animals in their territory in accordance with local legislation. For example, several European countries (including France and Germany; Moerer et al., 2022) require antimicrobial susceptibility testing in animals prior to prescribing fluoroquinolones or third generation cephalosporins (Hopman et al., 2019a).

The optimal means to influence prescriber behaviour has not yet been established. Studies evaluating the impact of national guidelines have demonstrated an underwhelming compliance with recommendations (Hardefeldt et al., 2017; Sarrazin et al., 2017; Van Cleven et al., 2018; Hubbuch et al., 2020). A more substantive effect on the prescribing habits of companion animal veterinarians may be achieved through active stewardship interventions that include elements of benchmarking and/or in-person prescriber education (Hopman et al., 2019b; Singleton et al., 2021; Walker et al., 2022). Influences on prescribing habits are inevitably multifactorial and quantifying the impact of a specific set of measures can be challenging. In Denmark, 65% of surveyed companion animal practitioners reported that national antimicrobial use guidelines had affected their prescribing habits (Jessen et al., 2017), whereas attitudes towards national guidelines in the Netherlands was more variable (Hopman et al., 2019a).

A previous survey (De Briyne et al., 2013, 2014) organised by the Federation of Veterinarians of Europe into factors influencing antibiotic prescribing habits obtained responses from 3004 practitioners from 25 European countries, including both companion and farm animal veterinarians. Practitioner surveys have also been performed to evaluate knowledge of AMR in the USA (Taylor et al., 2022), Italy (Barbarossa et al., 2017), Pakistan (Saman et al., 2023), Germany (Peter et al., 2022), South Africa (Maruve and Essack, 2022), Nigeria (Adekanye et al., 2020; Smith et al., 2022), Greece (Valiakos et al., 2020), and the UK (Hughes et al., 2012).

In the present study, an online survey was designed to evaluate the awareness and engagement of veterinarians working in Europe and near neighbour countries towards available ASGs for the treatment of companion animals (specifically dogs and cats). A secondary objective was to determine whether country-level awareness of multi-system ASGs affected self-reported adherence to common recommendations regarding antimicrobial use decisions.

Materials and methods

The survey received ethical approval from the University of Liverpool Research Ethics and Integrity Office (Approval number, VREC958; Approval date, 30 June 2020). The survey, comprising 21 questions (Tables S1-S23), was designed iteratively by a panel of veterinary clinicians, microbiologists, and epidemiologists representing seven countries. The questions were designed to engage across three thematic areas: demographic and personal antimicrobial usage; awareness of multi-system ASGs; and opinions regarding the preferred contents and design of future ASGs. The survey was translated into 27 languages (Table S24) from countries participating in the European Network for the Optimisation of Veterinary Antimicrobial Therapy (ENOVAT). An online survey platform designed specifically for education and research organisations was used (Jisc, 2023), with all translated versions accessible through a single website. Companion animal veterinary practitioners that routinely treat cats and dogs and who were practicing within 46 European countries or other countries participating in ENOVAT were eligible to participate. Participants were required to provide informed consent; all responses were anonymised, and no identifying information was collected. The survey was conducted over 170 days, from 12 January to 30 June, 2022.

The survey was distributed via social media, shared through online veterinary forums, and emailed to veterinarians through their national veterinary associations and regulatory bodies. Veterinary diagnostic laboratories across Europe were contacted and invited to include a link to the survey on laboratory reports. The survey was distributed and promoted via posters and oral presentations at key European veterinary conferences, including the 27th FECAVA (Federation of European Companion Animal Veterinary Associations) Euro Congress 8–11 June, 2022. A QR code for the survey was included in a summary article aimed at UK-based small animal veterinarians (Allerton et al., 2022). Upon closure of the survey, responses were retrieved from the Jisc Online Survey tool and, where necessary, translated into English by the original survey translator for the respective language.

Responses were descriptively analysed via percentages. Awareness of ASGs for companion animals, as identified in Allerton et al., (2021b), was determined based on responses to survey question 5 (Please indicate your awareness and use of the following guidelines). The number of respondents from each country that were aware of and had used at least one listed ASG was calculated and divided by the total number of responses from that country. Additionally, an antimicrobial stewardship agreement score (ASAS) was created based on a subset of responses to survey question 16 (To what extent do you agree that antibiotics should NOT be used for the following conditions?). According to multiple ASGs (Allerton et al., 2021b), antimicrobials are not recommended for clean surgical procedures or treatment of subclinical bacteriuria, acute diarrhoea, acute vomiting, or feline lower urinary tract disease. Respondents were asked if they strongly agreed (score 5), agreed (score 4), neither agreed nor disagreed (score 3), disagreed (score 2), or strongly disagreed (score 1), with each recommendation to not prescribe antimicrobials for such clinical scenarios or didn't know (not scored). The scores for the five conditions were combined to calculate the ASAS, with a maximum possible score of 25 indicating complete agreement with ASGs recommendations. Country-level median scores were determined using a bootstrapping resampling technique, repeated up to 1000 times per country to determine the distribution of median scores.

Estimated values for country-level awareness of ASGs were plotted against ASAS; a Spearman's rank correlation coefficient was used to assess the correlation between country-level awareness of ASGs and ASAS. All analyses were carried out in R version 4.3.0 (R: The R Project for Statistical Computing, 2023).

Results

In total, 2452 survey responses were collated, of which 2271 (92.6%) were completed, with respondents currently practising in 43 of 46 countries eligible for inclusion in this survey (Table S1). The distribution of respondents by country of current practice is shown in Fig. 1. Countries with the greatest number of responses were the UK (n = 287), Türkiye (n = 193), Sweden (n = 192), Romania (n = 171), and Norway (n = 152).

Of the 2271 completed surveys, 74.8% of respondents (n = 1699) worked in primary care, 21.2% in a referral hospital or university (n = 481), 3.0% (n = 69) in a variety of industry, research and

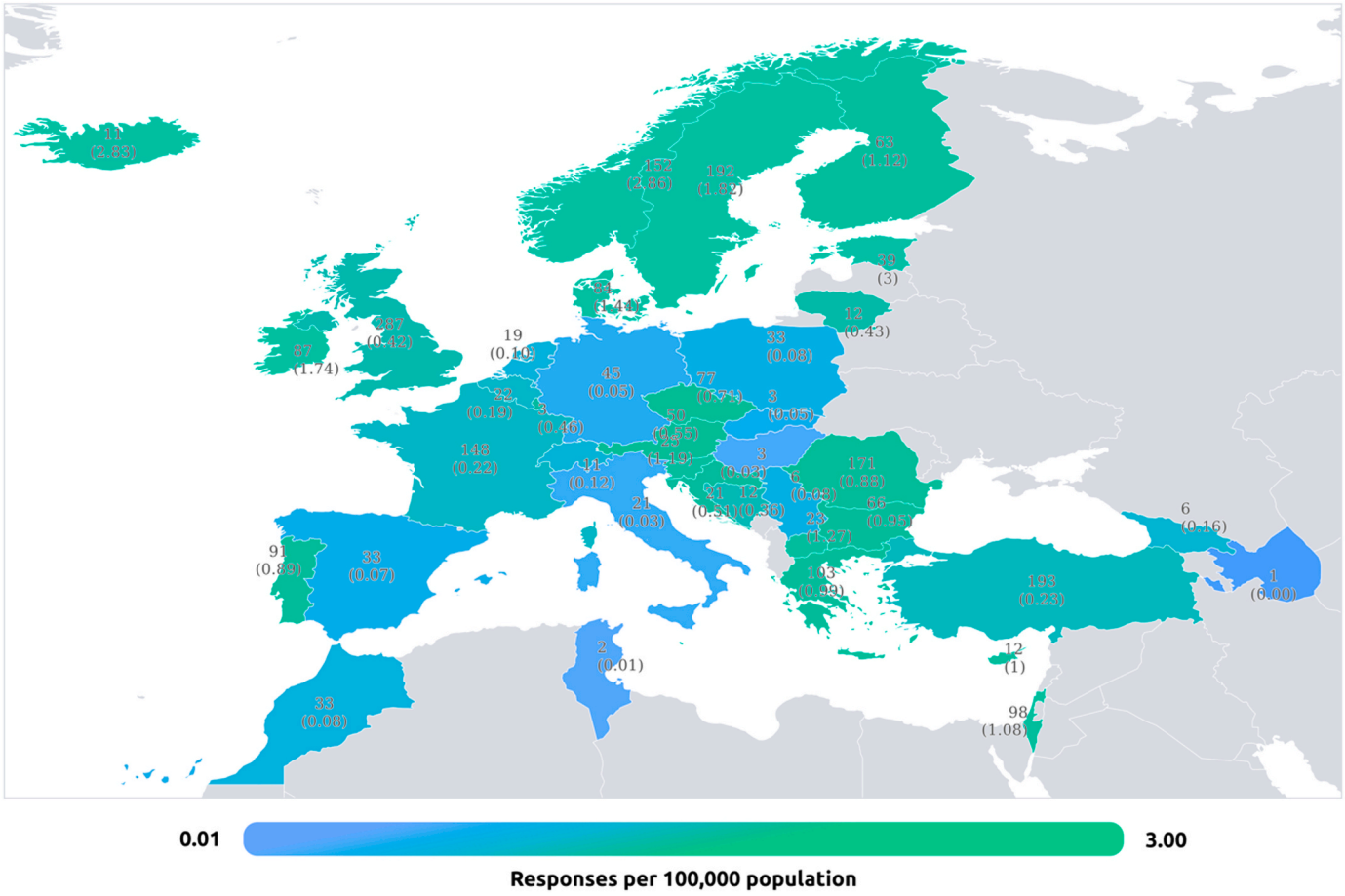

Fig. 1. The demographical distribution of responses to the question 1 ('In which country are you currently working?'). Top number displays number of responses, with the bottom number and colour representing number of responses per 100,000 head of population (Department of Economic and Social Affairs, 2022).

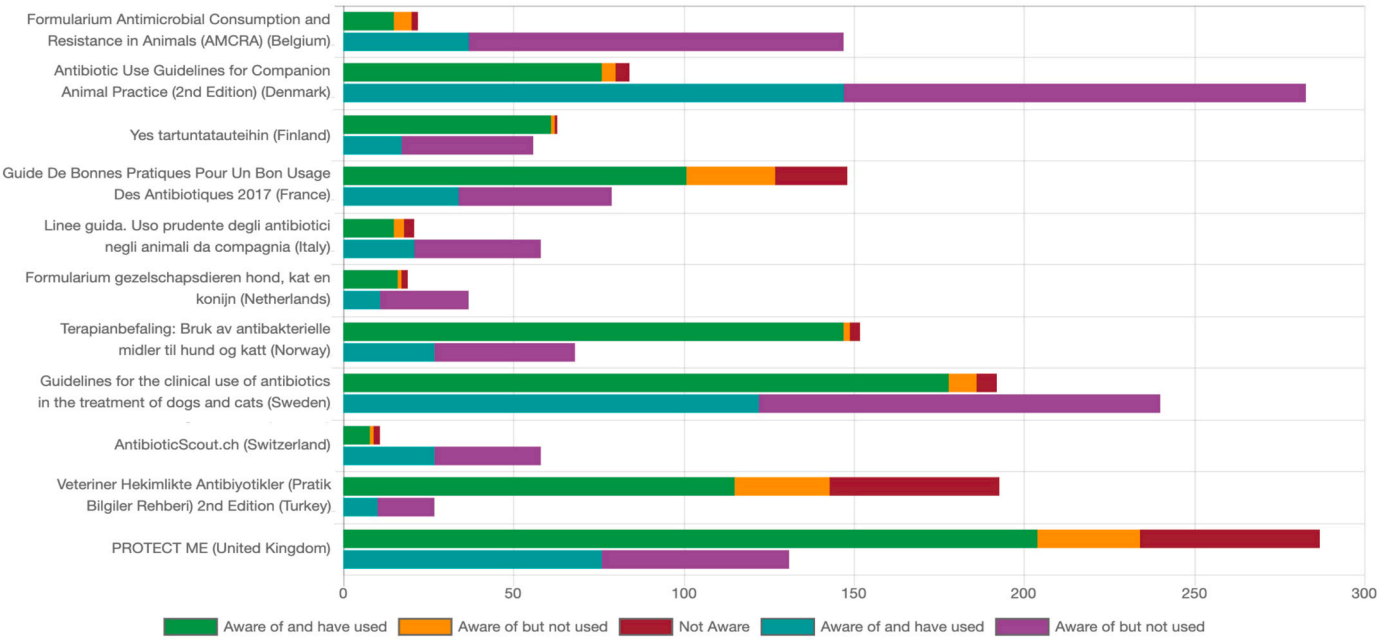

Fig. 2. Responses to question 5 ('Please indicate your awareness and use of the following guidelines'), with 13 antimicrobial stewardship guidelines (ASGs) across Europe given as options and with the respondent's awareness and utilisation recorded as 'Aware of and have used' / 'Aware of but not used' / 'None of the above'. For each ASG, values were split based on responses from within the country the guideline was produced (top) and all remaining responses (bottom).

consultancy positions, and 1.1% in animal shelters or charity practices ($n = 24$). The median year of graduation with a veterinary degree was 2010 (range, 1963–2022).

Awareness of various European multi-system ASGs is shown in Fig. 2. Of the guidelines listed, 64.9% ($n = 1474$) of participants reported that they were aware of and had used at least one of the listed ASGs, 28.9% ($n = 656$) reported that they were aware of but had not used at least one of the listed ASGs, while 6.2% ($n = 141$) reported that they were unaware of any of the listed ASGs. Overall, the most well-recognised and utilised multi-system ASG was the 'Recommendations for Appropriate Antimicrobial Therapy' (FECAVA, 2018). In all countries with national ASGs, the majority of respondents were aware of their countries' national guidelines (Fig. 2). The highest reported awareness of a national ASG was observed in Finland, where 98.4% ($n = 62/63$) of practising veterinarians were aware of and had used the Finnish ASG.

Fig. 3 displays respondents' level of agreement as to the appropriateness of using antimicrobials to treat predefined conditions. Most respondents strongly agreed or agreed that antimicrobials should not be used for acute vomiting ($n = 1797$, 79.1%), clean surgical procedures ($n = 1646$, 72.5%), acute diarrhoea ($n = 1538$, 67.7%), whilst just over half of respondents strongly agreed that antimicrobials should not be used for feline lower urinary tract disease ($n = 1256$, 55.3%) and subclinical bacteriuria ($n = 1183$, 52.1%); 13.7% of respondents indicated that antimicrobials should not be used for deep pyoderma. A moderately strong positive correlation between country-level awareness of ASGs and ASAS was found (Fig. 4, Spearman's rank coefficient = 0.6084, $P \leq 0.001$).

Participants were asked to select their top three priority components of an ASG (Table 1). Other features that respondents indicated should be included within future ASG are presented in Table 2. Although less than a third of respondents (30.2%, $n = 744$) ranked the inclusion of non-use recommendations (i.e. instructions not to use antimicrobials for certain conditions) as priority features, 92.5% ($n = 2101$) of total respondents were in favour of their inclusion, of which 1331 strongly agreed and 772 agreed.

Participants were able to select their preferred method(s) of presentation for ASGs. The majority of respondents (78.2%, $n = 1776$) expressed their preference for integration within their patient management system (PMS). A significant portion of participants (33.2%) called for a smartphone-based application, followed by a web-based solution for 29.9% (n = 678). The least popular options were a combination of web and paper-based offerings (26%) or a paper-based format, only preferred by 6.4% ($n = 146$) of respondents.

Presence of restrictive legislation in the country in which they were currently practising was reported by 22.0% ($n = 501$) respondents, without the opportunity to indicate whether or not they were in agreement with the restriction. Of the remainder, only 31.0% ($n = 548/1770$) supported the introduction of legislation restricting veterinary access to designated antimicrobials, while 47.7% ($n = 845/1770$) disagreed with any formulary restriction and 21.3% ($n = 377/1770$) were neutral.

Discussion

This survey, with responses from more than 2200 companion animal veterinarians, provides an overview of the opinions of a key stakeholder group on ASGs for the treatment of companion animals. Importantly, it offers further evidence as to the potential positive impact of ASGs, at least on self-declared prescribing habits. The ASAS correlated moderately with multi-system ASGs awareness and use, i.e., increased awareness of ASGs was associated with self-reported prescribing practices more in line with current ASG recommendations. Furthermore, countries with national guidelines tended to have higher ASAS than those countries without. Similar findings were found in a survey of American practitioners, where increased awareness of condition-specific guidelines produced by the International Society for Companion Animal Infectious Diseases (ISCAID) was associated with a lower likelihood of recommending antimicrobials for given scenarios (Taylor et al., 2022). Similarly, a survey on the use and impact of the Danish ASG for companion animal practice showed significantly different prescribing habits between users and non-users of the ASG (Jessen et al., 2017). This included more prudent antimicrobial selection among ASG users when treating urinary tract and skin infections. Factors other than ASGs that could contribute to differences in country scores include national legislation, to what degree antimicrobial stewardship is included in veterinary undergraduate education and the development of antimicrobial stewardship in human healthcare.

Of all available sources for guiding antimicrobial prescriptions,

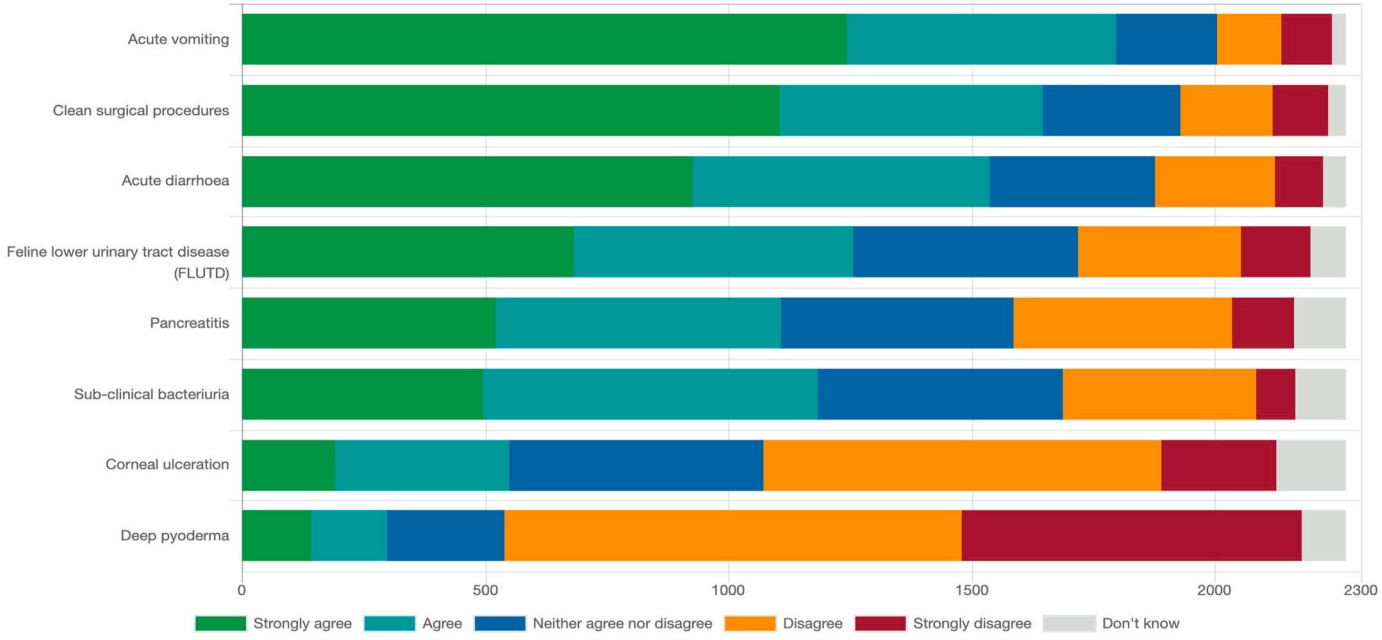

Fig. 3. Responses to question 16 ('To what extent do you agree that antibiotics should NOT be used for the following conditions?'), with a 5-point Likert scale (Strongly agree / Agree / Neither agree nor disagree / Disagree / Strongly disagree) or Don't know as options for eight given conditions.

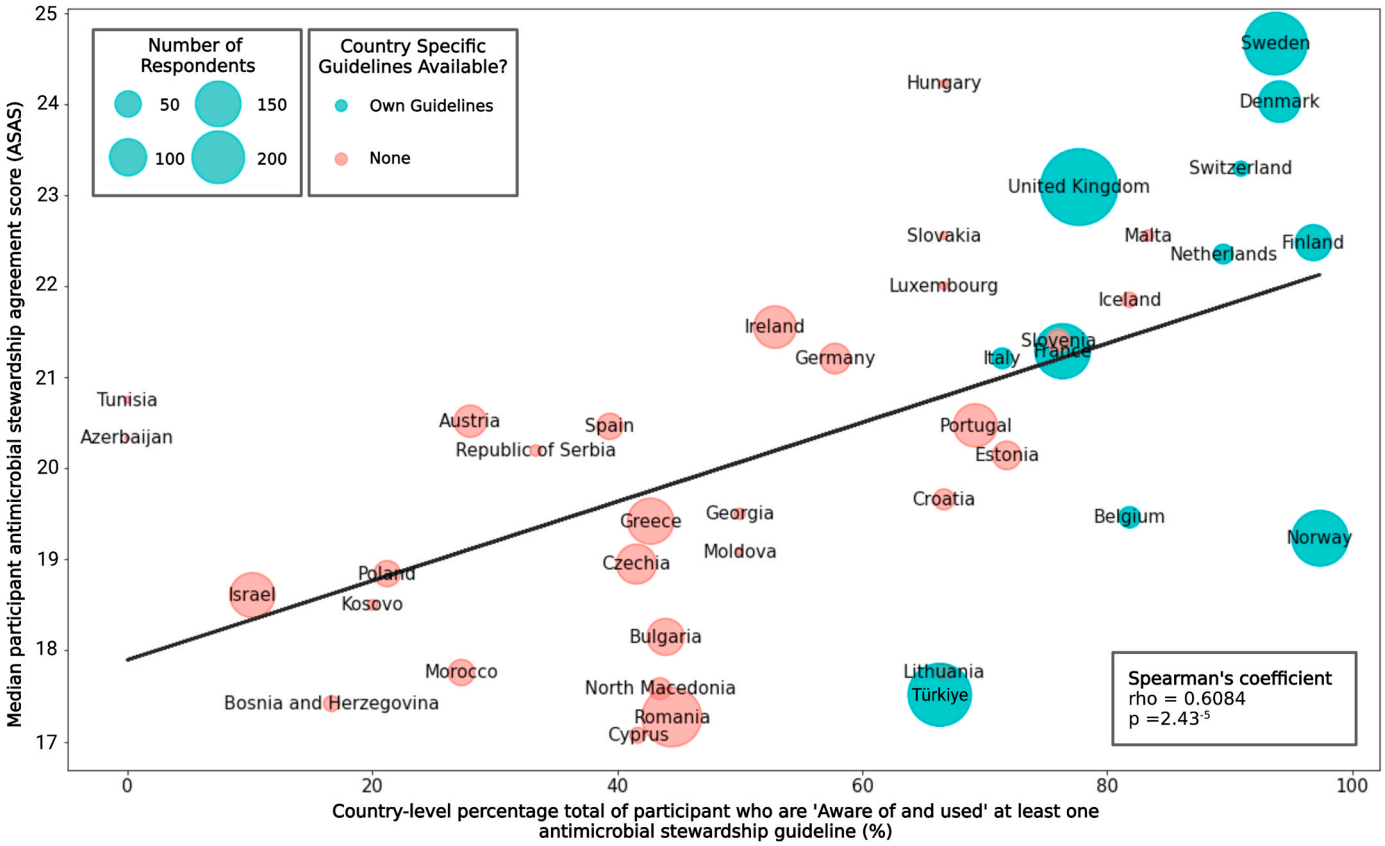

Fig. 4. Country-level median awareness and understanding scores for antimicrobial stewardship guidelines (ASGs). Scores were calculated from responses to question 5 ('Please indicate your awareness and use of the following guidelines') and question 16 ('To what extent do you agree that antibiotics should NOT be used for the following conditions?'). Bubble colour indicates whether a country has national ASGs (blue) or not (red). Bubble size corresponds to number of respondents currently practising in the respective countries.

Table 1
Responses from question 13, 'Which of the following elements should be prioritised for inclusion in antibiotic guidelines (please select the top three)?'.

Feature of antimicrobial stewardship guidelines	Number of respondents (n = 2271) including this as priority component (% of total)
Choice of antibiotic to use for each condition	1863 (82.0%)
Duration of antibiotic course	1499 (66.0%)
Optimal antibiotic dose	1179 (51.9%)
Non-use recommendations	744 (32.7%)
When to submit cultures	636 (28.0%)
Known drug interactions	423 (18.6%)
Side-effects of antibiotics	370 (16.3%)

Table 2
Responses from question 14, 'The following features should be included in antibiotic use guidelines to tackle antibiotic resistance. (Please select all that apply)'.

Other feature of antimicrobial stewardship guidelines	Number of respondents including this as priority component (% of total)
Surgical antibiotic prophylaxis guidance	1189 (52.3%)
Encourage greater use of culture and sensitivity testing	601 (26.5%)
Encourage greater use of in practice diagnostics (e.g., cytology Gram staining)	547 (24.1%)
Introduction of tiering systems to assign antibiotics into classes based on importance to human health.	488 (21.5%)
Minimising spectrum of antibiotics (narrow preferred over broad spectrum)	453 (19.9%)
Infection control approaches in practice	389 (17.1%)
Veterinary staff education resources	373 (16.4%)
Client education tools	252 (11.1%)
Encourage engagement in antibiotic use benchmarking	241 (10.6%)

multi-system ASGs were the most cited resource. Respondent awareness of national ASGs was greatest in the countries of their respective development. Language barriers, differences in the availability of antimicrobials, differences in the proportion of resistant pathogens, and local legislative requirements may limit the utility of international ASGs outside their target country. Notably, the FECAVA poster and the GRAM book, i.e., the two multi-system ASG resources produced and shared by international organisations, were familiar to the greatest number of respondents (Brissot et al., 2016; FECAVA, 2018). As such, there appears to be a value placed by practitioners on international ASGs, though national ASGs play an important role in translating international guidance into more local settings and increasing awareness of veterinarians towards stewardship of antimicrobials. Indeed, this finding mirrors recommendations from the WHO's Global Action Plan for AMR, which includes optimising antimicrobial use in human and animal health as one of its five objectives (World Health Organization, 2023).

Frameworks used to optimise guideline development (Brouwers et al., 2010) and implementation (Shiffman et al., 2005) in human medicine have been adapted to appraise existing veterinary ASGs (Hardefeldt et al., 2019; Allerton et al., 2021a). The degree of stakeholder engagement was found to vary widely across European veterinary ASGs and in many cases was not explicitly recorded (Allerton et al., 2021a), reflecting limited consideration of the views and preferences of the target guideline-user. Stakeholder engagement should be

encouraged during guideline development to help ensure that recommendations are relevant, accessible, and achievable. It is anticipated that purposeful adaptation of any guidelines towards the intended prescriber would translate into increased compliance and greater impact (Wathne et al., 2018; Petkovic et al., 2020).

A concerning 6.2% of respondents were unaware of any listed multi-system ASGs. Due to selection biases, this figure likely underestimates the true proportion of veterinarians working without knowledge of multi-system ASGs. Given the positive correlation between multi-system ASG awareness and stewardship agreement, as well as previous work demonstrating improved prescribing behaviour attributable to ASGs (Schmitt et al., 2019; Hubbuch et al., 2020; Walker et al., 2022), there exists a pressing need to promote and raise awareness of practitioners towards existing ASGs, to encourage access by sharing resources and facilitating translation and dissemination, and to ensure that practitioners can reference appropriate guidance to support their antimicrobial use in everyday practice. The advantages of national ASGs have also been highlighted in previous reports (Barbarossa et al., 2017; Valiakos et al., 2020; Saman et al., 2023), suggesting that widespread production and dissemination of country-specific ASGs, supported by robustly produced international guidelines, should be a key priority for companion animal health. A European survey in 2013 found that companion animal veterinarians considered their own previous experience, the antimicrobial product package inserts, and the Summary of Product Characteristics (SPC) as more useful sources of information to guide their antimicrobial prescription than ASGs (De Briyne et al., 2013). However, many of the current ASGs were developed and published after 2013, potentially accounting for the perceived greater role for ASGs in today's practice found in the present study. A recent survey in the United States found low overall awareness (60%) of ASGs (Taylor et al., 2022), albeit markedly higher than the awareness reported (12%) in previous informal surveys of companion animal practitioners in the US (Grayzel et al., 2015).

The views of key stakeholders, e.g., clinicians and patients, are an important component of guideline development in human medicine (Petkovic et al., 2020). However, practitioners working in veterinary primary care have inconsistently been consulted on the development of veterinary ASGs, even though they likely represent the bulk of antimicrobial prescribing and use in companion animals (Allerton et al., 2021a). Adoption of technological advances may increase the regularity with which users check guidelines and could improve adherence, as has been reported in human hospitals (Charani et al., 2013; Primhak et al., 2019). This study found a clear preference for the incorporation of guidance into web-based/smartphone-based applications and integration into electronic practice management systems. Such measures would require the involvement of a variety of software developers but may represent a worthwhile investment if key stewardship messages could be communicated at critical prescribing decision points. A free smartphone-based application has recently been made available by the Ontario Veterinary College on the First Line platform, providing evidence-based prescription recommendations to users (First Line Clinical Decisions, 2023).

When asked about preferred ASG content, respondents prioritised advice relating to the selection of the appropriate antimicrobial agent, duration of antimicrobial use, and dosage information. Optimal antimicrobial duration is a well-recognised knowledge gap in this field but is the subject of active research in both human (Spellberg, 2018; Wald-Dickler and Spellberg, 2019) and veterinary medicine (Allerton et al., 2021a). Respondents considered non-use recommendations to be less important, despite the potential for these to have a large impact on overall antimicrobial use. Large-scale studies of antimicrobial use behaviours have found that acute diarrhoea, acute respiratory tract disease, and pruritus are amongst the most common reasons for antimicrobial use in dogs and cats in primary care practice (Singleton et al., 2017). Advice to withhold antimicrobials for common clinical scenarios (acute vomiting, acute diarrhoea, feline lower urinary tract disease, and subclinical bacteriuria) also features in many international multi-system ASGs (Allerton et al., 2021a; Allerton et al., 2021b). The lower prioritisation of non-use recommendations may reflect a lack of familiarity among respondents with the non-use terminology and difficulties to translate this concept into different languages. We would thus recommend a focus on education surrounding non-use recommendations if this comparatively simple stewardship tool is going to have a meaningful impact on companion animal practice.

Respondents also recognised the importance of surgical antimicrobial prophylaxis guidance, the promotion of laboratory testing (i.e., culture and antimicrobial susceptibility testing, or performing cytology), and antimicrobial categorisation as valuable components of ASGs. A significant proportion (up to 40%) of antimicrobial use in human hospitals is for surgical prophylaxis and a concerning 40–80% of that use is contrary to guideline recommendations (Zarb et al., 2012; Magill et al., 2014; Ierano et al., 2019; Morioka et al., 2022). A recent survey of US veterinarians found that 35% of respondents would use antimicrobials for a routine dental extraction (Taylor et al., 2022), while similar proportions of practitioners from the UK and Australia recommended antimicrobial use for castrations and dermal mass removal (Knights et al., 2012; Hardefeldt et al., 2017). Surgical antimicrobial prophylaxis guidance represents a clear 'low hanging fruit' for meaningful impact on antimicrobial use in both medical and veterinary practice.

Caution is warranted when interpreting survey data, as these questions sought to evaluate respondents' self-reported idealised behaviours. A minority of respondents responded that antibiotics should not be used for deep pyoderma contradicting recommendations in ASGs and ISCAID guidelines (Allerton et al. 2021a; Hillier et al. 2014). This finding could reflect unfamiliarity with the different classifications of pyoderma, but could also be attributed to poor wording of the question or inattention from respondents challenging the reliability of other answers. Furthermore, there existed a potential selection bias among respondents, as the sample may have consisted of individuals who were specifically interested in antimicrobial stewardship or who possessed higher levels of technological proficiency and willingness to participate in an online platform. Interestingly, the proportion of respondents working in universities and referral hospitals seemed disproportionately high; this likely reflected the nature of established networks of those most actively disseminating the survey. A significant proportion of responses were from a small group of countries (e.g., UK, Türkiye) while fewer responses were received from others. The translation of surveys was performed by those with first language experience but was not independently verified due to financial constraints. There was a chance that the intended meaning of some questions had been altered, leading to differences in interpretation. Although the study found a moderate correlation between ASG awareness and improved antimicrobial use, causality could not be established given the cross-sectional design of the survey.

Conclusions

The correlation between agreement with recommended antimicrobial stewardship practice and awareness of ASGs found in this study offers further evidence of the value of these guidelines. Awareness of companion animal ASGs was greatest among countries that have national guidelines. This provides advocacy for national bodies to create new, or adapt existing, resources to improve local dissemination. The wide range of countries included in this survey brings previously unheard voices to the table. Antimicrobial resistance is a One Health issue that will require engagement from all veterinarians. Policymakers are encouraged to consider the views of this key stakeholder group regarding preferred content and format of future ASGs to direct the development of accessible and effective antimicrobial stewardship tools.

Declaration of Competing Interest

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.tvjl.2023.106045.

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