



Factors influencing antibiotic prescribing habits and use of sensitivity testing amongst veterinarians in Europe

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The Heads of Medicines Agencies and the Federation of Veterinarians of Europe undertook a survey to gain a better insight into the decision-making process of veterinarians in Europe when deciding which antibiotics to prescribe. The survey was completed by 3004 practitioners from 25 European countries. Analysis was to the level of different types of practitioner (food producing (FP) animals, companion animals, equines) and country for Belgium, Czech Republic, France, Germany, Spain, Sweden and the UK. Responses indicate no single information source is universally considered critical, though training, published literature and experience were the most important. Factors recorded which most strongly influenced prescribing behaviour were sensitivity tests, own experience, the risk for antibiotic resistance developing and ease of administration. Most practitioners usually take into account responsible use warnings. Antibiotic sensitivity testing is usually performed where a treatment failure has occurred. Significant differences were observed in the frequency of sensitivity testing at the level of types of practitioners and country. The responses indicate a need to improve sensitivity tests and services, with the availability of rapid and cheaper testing being key factors.

Introduction

Use of antibiotics in human and animal medicine, especially misuse, has been associated with the selection and spread of antibiotic-resistant strains in human beings and animals (Barbosa and Levy 2000, Berge and others 2006, Jensen and others 2006). In order to evaluate measures to reduce selective pressure and the selection of resistant strains in animal health, monitoring of the use of antibiotics and the level of antibiotic resistance has been initiated in the EU.

Numerous strategies, recommendations and treatment guidelines on responsible use of antibiotics have been developed by a variety of national, European and international bodies (EPRUMA 2008, FVE 2012, OIE 2012). The aim of these strategies is to encourage veterinarians to prescribe responsibly and prudently, as well as to reduce antibiotic use. For any such strategy to be effective it is necessary to understand the factors influencing veterinary antibiotic prescribing. A number of these strategies include recommendations to use antibiotic sensitivity testing (AST) to inform effective prescribing at an individual animal level. There were only limited data available on the extent, and circumstances under which AST is used across Europe.

In order to fill these evidence gaps, the Heads of Medicines Agencies – Veterinary Medicines (HMA-V) and the Federation of Veterinarians of Europe (FVE) undertook a survey.

Materials and methods

The survey questionnaire was designed to identify factors and information sources used to decide prescribing behaviour, influencers for seeking AST and the frequency of use of such services. The one-month survey was launched in the form of an electronic 'Zoomerang' survey in March 2012 in five languages (English, French, German, Spanish and Polish). All national veterinary organisations that are members of FVE, as well as EU Medicines Agencies, were requested to promote the completion of the survey by veterinarians. Participants were requested to answer: some personal questions (country of practice, years in practice), some regarding the type of practice (first opinion or referral, main species seen) and some regarding factors and information used to decide prescribing behaviour and frequency and reasons to do sensitivity testing. Private and personal information were anonymised before analysis. For ease of interpretation, the scoring system used in the questionnaire for a number of the questions has been reversed so that the higher the score the more important the factor. To avoid confusion between responsible use warnings and other warnings on medicines, the questionnaire specified that responsible use warnings do not simply mean using less antibiotics, but means justified use (based on a properly established diagnosis) of the most appropriate antibiotic in order to optimise its clinical efficacy in the specific clinical case, and taking reasonable steps to ensure the method of use (including dose regime) and precautions applied, help limit the potential for resistance to develop. Data were analysed for all responses (gross total), and at the level of (a) FP animals practitioners, companion animal (CA) and equine practitioners (E), (exotic animal practitioners were excluded as these accounted for <0.5 per cent of responses), (b) country, primarily selected on the basis of receiving

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TABLE 1: Responses received per country

Country	Responses/number of veterinarians*	(%)	Country	Responses/number of veterinarians*	(%)
≤10 respondents representing <1% of veterinarians in the country			≥10 respondents representing <1% of veterinarians in the country		
Austria	7/3358	(0.2)	Czech Republic	36/4500	(0.8)
Cyprus	1/150	(0.7)	Italy	55/27000	(0.2)
Finland	10/1922	(0.5)	Netherlands	18/5815	(0.3)
Latvia	4/988	(0.4)	Poland	31/13230	(0.2)
Lithuania	6/1132	(0.5)	Romania	57/7400	(0.8)
Portugal	9/3842	(0.2)			
Slovakia	1/2800	(<0.1)			
Switzerland	5/2700	(0.2)			
>10 respondents representing ≥1% of veterinarians in the country			≤10 respondents representing ≥1% of veterinarians in the country		
Belgium	227/5000	(4.5)	Iceland	4/124	(3.2)
Denmark	40/3104	(1.3)	Liechtenstein	2/11	(18.2)
France	1072/17186	(6.2)	Luxembourg	3/150	(2.0)
Germany	337/35098	(1.0)			
Ireland	70/2570	(2.8)			
Norway	66/2400	(2.8)			
Spain	303/28188	(1.1)			
Sweden	350/2700	(13.0)			
UK	290/19000	(1.5)			

No responses were received from Bulgaria, Estonia, Greece, Hungary, Malta or Slovenia, representing a registered veterinary practitioner base of 6985, 570, 2500, 3200, 33 and 1306, respectively

*Number of active veterinarians per country: Federation of Veterinarians of Europe Data 2010 (noting generally 2/3 of the active veterinarians are practitioners while the other 1/3 is active in other areas)

TABLE 2: Proportion (%) of the different types of practitioners responding to the survey according to country (balancing % are the exotic animal practitioners)

	All countries	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK
CA practitioners	58.8	50.7	77.1	61.3	65.2	63.0	70.0	44.9
FP animal practitioners	31.2	41.9	17.2	36.4	24.4	32.0	16.5	16.5
E practitioners	9.7	7.5	2.9	2.2	10.1	3.6	12.9	38.6

CA, Companion animal; E, Equine; FP, Food producing

more than 200 responses, and this representing more than 1 per cent of veterinarians in that country (Belgium, France, Germany, Spain, Sweden and the UK) with the addition of one Central European country with more than 20 responses, and this representing 0.8 per cent of veterinarians in that country (Czech Republic). Responses from practitioners working in mixed practices mainly with CAs were added to the responses from CA practitioners and those working with mainly FP animals with the FP animal practitioners. Statistical packages used were MS Excel and SPSS (descriptive statistics) and STATA (log-linear models for statistical analysis).

Results

There were 3004 responses from 25 European countries. Overall, 1.5 per cent of active veterinary practitioners in Europe participated in the survey (Table 1). There were differences between countries in the distribution of the different types of practitioners who responded (Table 2).

Information sources

Respondents were asked to score the importance given (scale 0–4) to 10 listed information sources including sources such as their own

TABLE 3: Mean score of importance given by the responses from different types of practitioners and from practitioners from seven different countries to the information sources on a scale of 0–4 (0 – not important; 4 – most important)

Factor	All responses mean (95% CI)	CA practitioners	FP animal practitioners	E practitioners	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK
Training/literature	2.97 (2.93 to 3.01)	3.05	2.78	3.08	2.93	2.83	2.97	3.30	2.96	2.65	2.93
Experience	2.75 (2.71 to 2.79)	2.67	2.85	3.00	2.63	2.89	2.56	3.00	2.78	2.63	2.99
Label/leaflet	2.66 (2.61 to 2.70)	2.65	2.81	2.32	2.67	2.83	2.80	3.06	2.76	1.68	2.75
Antibiogram	2.60 (2.55 to 2.64)	2.65	2.49	2.50	2.63	2.60	2.58	3.04	2.55	2.67	2.15
University	2.43 (2.38 to 2.47)	2.43	2.33	2.72	2.60	1.89	2.35	2.31	2.35	2.60	2.59
SPC*	2.37 (2.32 to 2.41)	2.42	2.45	1.81	2.35	2.74	2.44	2.37	2.44	2.18	2.10
Colleagues	2.22 (2.17 to 2.25)	2.10	2.28	2.76	1.96	2.37	1.82	2.48	2.31	2.58	2.63
Guidelines	2.06 (2.01 to 2.10)	2.07	2.08	1.94	1.63	1.77	1.83	2.03	1.76	3.24	1.91
Commercial Info	1.89 (1.84 to 1.92)	1.89	1.94	1.72	2.23	1.86	1.83	1.73	1.90	1.78	1.83
Official reports	1.69 (1.64 to 1.73)	1.72	1.65	1.65	1.93	2.20	1.42	1.58	1.63	2.31	1.33

*This is a document which is required within the European Union before any medicinal product is authorised for marketing and is approved by regulators, and which forms the basis of information for health professionals to know how to use the specific product safely and effectively

CA, Companion animal; E, Equine; FP, Food producing; SPC, Summary of product characteristics

previous experience, Summary of Product Characteristics (SPC), and official reports from regulators which would include documents such as Public Assessment Reports on authorised veterinary medicines (Table 3). When considering all respondents, information from published literature and training followed by their own experience were the most important sources influencing their prescribing behaviour. Other important sources were information written on the label and the package information leaflet (PIL), and results from anti-biograms. Least important, were commercial information and Public Assessment Reports from regulatory agencies (official information). Similar patterns are observed when the results between practitioners in the CA and FP animal sectors are compared. By contrast with the other comparator countries, Swedish respondents said that the most important sources for them are prescribing policies/guidance notes. The mean score for importance of the SPC was higher in the Czech Republic compared with the other six countries.

Referring to the SPC before treatment was explored in a further question indicating this was undertaken 'very regularly' (10 per cent), 'regularly' (34 per cent), 'occasionally' (43 per cent) and 'seldom' (13 per cent). Respondents consulted the SPC mainly via the formulary/compendium as well as specific websites. Some practitioners from Italy, The Netherlands, Sweden and the UK were unfamiliar with the term SPC, and some confused it with the PIL, a more user-friendly version of the SPC which is included within the packaging of the product.

Prescribing factors

Respondents were asked to score the importance given (scale 0–4) to 17 listed factors which could influence prescribing behaviour, including considering the risk of development of antimicrobial resistance (AMR), ease of administration, legal restrictions, practice policies (Table 4).

Considering respondents as a whole they indicated that the most important factors which govern their selection of an antibiotic are: sensitivity test results, their own experience, the risk for antibiotic

resistance developing, and ease of administration. The least important factors were considered to be owner demand, culture, profit margin and advertising. The group of factors linked to responsible use and professional judgment appear to be more influential in governing antibiotic prescribing habits. No marked differences are observed between the different types of practitioners with the obvious exception that withdrawal periods are an influential factor in the case of FP species practitioners. When comparing the answers for the seven countries studied, similar patterns were observed to the overall results, though economic factors, particularly profit margin and marketing offers, had a higher mean score in the Czech Republic compared with the other countries. The lack of correlation between profit motive and type of practitioner suggests that differences in country practitioner type profile doesn't explain the different emphasis between countries given to economic factors.

Overall, the majority of practitioners replied they take responsible use warnings in the SPC and/or PIL into account in most cases, with less than 5 per cent indicating they never take them into account (Table 5). Dichotomising the response variable into: Always/Most cases versus Seldom/Never (ie, usually compared with rarely) showed that veterinarians from Sweden take account of these warnings significantly more often ($P < 0.001$) compared with the six other countries. There was an increased odds of equine practice veterinarians taking into account responsible use warnings compared to other veterinary practice types ($P < 0.001$).

Most frequent reasons given for not taking into account responsible use warnings, were: to make the administration easier, for example, it is often difficult to give oral antibiotics to cats so veterinarians prefer a long-acting injectable antibiotic; owner requests a broad spectrum antibiotic with a short withdrawal period which is easy to administer; in the case of critically ill animals, veterinarians prefer to initiate treatment with a broad spectrum antibiotic; for minor species (eg, rabbits) there is a very limited number of authorised medicines, and hence, often no choice; due to previous experience; for welfare reasons (they do not want the animal to suffer longer than is necessary);

TABLE 4: Mean score of importance given by the responses from different types of practitioners and from practitioners from seven different countries for the factors influencing prescribing behaviour suggested on a scale of 0–4 (0 – not important; 4 – most important)

Factor	All responses mean (95% CIs)	CA Practitioners	FP animal Practitioners	E Practitioners	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK	
Responsible use factors	Sensitivity	3.19 (3.15 to 3.23)	3.21	3.10	3.4	3.14	2.92	3.18	3.26	2.98	3.56	3.11
	AMR risk	2.98 (2.94 to 3.02)	3.03	2.89	3.0	2.80	2.75	2.98	3.02	2.73	3.39	2.91
	Legal restrictions	2.67 (2.63 to 2.71)	2.63	2.79	2.5	2.60	2.81	2.56	2.21	2.74	3.15	2.72
	SPC responsible use warnings	2.57 (2.53 to 2.61)	2.64	2.55	2.2	2.52	2.67	2.52	2.60	2.64	2.67	2.38
	Formulary/prescription guidelines	2.43 (2.39 to 2.47)	2.48	2.34	2.4	2.25	2.39	2.12	2.62	2.37	2.69	2.91
Professional judgement factors	SPC	2.72 (2.68 to 2.76)	2.75	2.80	2.3	2.61	2.81	2.76	2.87	2.72	2.60	2.59
	Convenience factors	Ease of admin	2.82 (2.78 to 2.86)	2.80	2.87	2.8	2.93	2.56	2.97	3.03	2.97	2.11
Ease to obtain		2.17 (2.13 to 2.21)	2.23	2.05	2.2	2.19	2.56	2.01	2.07	2.52	2.06	2.38
Cultural/society factors	Practice policy	2.39 (2.35 to 2.43)	2.43	2.44	2.0	2.27	2.33	2.60	2.36	2.07	2.67	1.87
	Owner demand	1.02 (0.98 to 1.06)	1.02	1.31	1.0	1.04	1.53	1.15	0.67	1.01	0.78	1.16
	Advertisement	0.82 (0.79 to 0.86)	0.85	0.86	0.5	0.98	1.44	0.65	0.55	1.05	0.92	0.65
	Culture	0.84 (0.80 to 0.88)	0.75	1.03	0.8	0.73	1.19	0.77	0.79	0.81	1.13	0.69
Economic factors	Price	2.0 (1.96 to 2.04)	1.94	2.11	2.0	2.05	2.44	2.22	1.46	2.21	1.30	2.21
	Withdrawal period	1.75 (1.69 to 1.80)	1.22	2.90	1.5	1.92	2.36	1.96	1.52	1.77	1.13	1.53
	Profit margin	0.72 (0.68 to 0.76)	0.72	0.77	0.5	0.97	1.78	0.69	0.57	1.17	0.31	0.42
	Marketing offers	0.77 (0.74 to 0.81)	0.80	0.79	0.5	0.97	1.58	0.74	0.64	1.19	0.40	0.56

AMR, Antimicrobial resistance; CA, Companion animal; E, Equine; FP, Food producing; SPC, Summary of product characteristics

cost of AST or problems of taking samples for AST; price or other economic factors; and finally, the farmer has already tried to treat with antibiotics themselves, and now wants 'stronger' antibiotics.

AST: frequency

Overall AST before starting treatment was frequently undertaken by 37.8 per cent of practitioners, but 9.8 per cent never request such tests, and 44.3 per cent only on a seldom basis prompted by poor response or complicated cases. Independent of main practice type, over four times the number of vets (4.61, 95% CI 4.06 to 5.24, $P < 0.001$) responded 'Seldom (poor response or complicated case)' compared with 'In most cases' (Table 6).

Dichotomising the response variable into: In most cases/Always when feasible/Regularly (disease status herd/flock) versus Seldom (poor response or complicated case)/Seldom (randomly)/Never (ie, frequently, compared with less frequently), showed that veterinarians from Sweden requested AST significantly more often ($P < 0.001$) compared with the six other countries. The odds of performing sensitivity testing frequently increased, on average, by 2.86 times (95% CI 2.05 to 3.99, $P < 0.001$) comparing Sweden with Germany, whilst compared with Spain, practitioners in Sweden were, on average, 15.64 times (95% CI 10.64 to 22.98, $P < 0.001$) more likely to frequently perform AST. Compared to other countries, the odds of responding to the question as performing sensitivity testing frequently was less in Spain compared with each of the other six countries although this difference was not significant in all cases. There was an increased odds of equine practice veterinarians claiming to perform sensitivity testing frequently compared to other veterinary practice types. The odds of performing sensitivity testing frequently increased, on average, by 1.31 times (95% CI 2.00 to 1.71, $P = 0.047$) comparing equine practitioners with FP practice veterinarians, whilst compared with CA veterinarians the odds of performing sensitivity testing frequently increased, on average, by 2.14 times (95% CI 1.66 to 2.75, $P < 0.001$) for equine practitioners.

Antibiotic sensitivity testing: factors influencing their use

Respondents were asked which factors influence their decision to perform sensitivity testing with a choice of up to three different answers from four possible options and a free text option. Overall,

the most important factor was 'poor response to initial antimicrobial therapy', and this was mirrored in the responses from veterinarians in the seven countries and both CA and FP practitioners. Equine practitioners gave very similar weightings to poor response to initial therapy and prior experience of poor response. Owner request was generally the least quoted factor with the exception of the Czech Republic (Table 7).

Of 837 free text answers, the most frequent reasons cited were very precise, such as specific disease cases, for example, mastitis, otitis externa, sepsis, deep pyoderma, urinary tract diseases, recurrent infections, 'atypical' or 'odd' pathology. Other reasons cited included: before using critically important antibiotics, practice policy, or situations where cytology suggests a need. Factors cited limiting the use of sensitivity testing were, sampling difficulties, the urgency of the situation, concerns regarding the clinical relevance of in vitro tests and owners being unwilling to pay for such testing.

Respondents also answered a question intended to explore what the incentives might be to encourage more widespread use of AST. They could choose up to three different answers from six options with a free text option. Overall, more rapid results and cheaper tests were the two main incentives. Addition of a recommendation to perform sensitivity testing on the SPC of the product was seen as the least important factor. Some differences were observed in the responses of the seven countries, in particular, in Germany rapid testing was cited by a lower proportion of respondents as being an important factor, and in the Czech Republic respondents cited more regularly that the availability of support to help interpret the results from AST was important (Table 8).

From the 312 respondents who specified other factors that would lead to them doing more AST, the most frequently cited were technical factors, such as the: need for more reliable laboratory results (eg, high-quality tests, testing on specific antibiotics used in animals rather than humans); need for accurate in-house test kits; need for easier sampling methods; ways to send samples. Other factors cited were more social and educational, such as a better understanding of the animal owners about the necessity to do sensitivity testing. Finally, it was suggested that there would be wider use of AST if there were recommendations to do so in more of the clinical guidelines, and if such tests were made compulsory by law prior to the use of certain antibiotics. Respondents also noted the difficulty when treating critically ill

TABLE 5: Percentage of practitioners answering how often they take into account responsible use warnings – per type of practice and per country

	All responses	CA practitioners	FP animal practitioners	E practitioners	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK
Always	17.8	15.4	14.8	22.3	10.1	11.4	7.3	12.5	34.3	38.9	18.6
In most cases	62.0	64.3	57.7	63.4	60.4	65.7	63.8	64.0	54.2	56.0	69.0
Seldom	15.6	14.2	19.2	9.5	22.9	20.0	20.4	19.6	11.2	3.1	11.4
Never	4.6	6.1	8.3	4.8	6.6	2.9	8.5	3.9	0.3	2.0	1.0

CA, Companion animal; E, Equine; FP, Food producing

TABLE 6: Frequency of sensitivity testing reflecting differences according to type of practice and country (expressed as a percentage of the total number of responses in the relevant practice type or country)

	Frequency	All responses	CA practitioners	FP animal practitioners	E practitioners	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK
Frequently	In most cases	9.7	10.3	6.5	14.9	4.8	8.3	3.8	17.0	3.0	34.0	6.2
	Always when feasible	3.8	3.4	3.3	7.4	2.2	0.2	1.5	8.6	4.3	4.3	5.2
	Regularly (disease status herd/flock)	24.3	18.8	34.2	28.4	22.9	19.4	19.9	29.8	11.2	39.7	28.3
Less frequently	Seldom (poor response or complicated case)	44.3	51.1	32.8	37.9	44.5	58.3	51.5	36.0	56.1	18.6	47.2
	Seldom (randomly)	8.1	7.3	10.9	5.0	11.5	8.3	11.5	6.2	4.9	1.1	7.2
	Never	9.8	9.1	12.3	6.4	14.1	5.5	11.8	2.4	20.5	2.3	5.9

CA, Companion animal; E, Equine; FP, Food producing

TABLE 7: Reasons to perform sensitivity testing according to the type of practice and country (expressed as a percentage of the total number of responding veterinarians in the relevant practice type or country)

Factor	All responses	CA practitioners	FP animal practitioners	E practitioners	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK
Poor response to initial therapy	84.8	89.9	77.6	76.6	89.4	89.0	86.8	82.1	85.1	83.4	85.3
Owner request	13.8	13.6	15.7	8.9	7.5	40.0	12.8	15.5	16.8	11.4	9.0
No knowledge of animal/farm	33.3	25.4	48.2	18.8	36.6	44.0	27.4	46.1	25.4	41.7	32.7
Prior experience of poor response	20.8	18.1	26.7	81.2	26.4	34.2	14.5	41.0	13.5	16.8	13.7

CA, Companion animal; E, Equine; FP, Food producing

animals given the urgent need to start treatment and the likely time lag to receive the results.

Discussion

The survey was not based on a random selection of practitioners, but instead relied on practitioners volunteering to answer the survey. This may have introduced a degree of bias into the results with those replying more likely to be interested in antibiotic resistance, and so more likely to prescribe antibiotics responsibly. Additionally, by explaining within the survey what 'responsible use' means may have influenced the responses. The low response rate in some countries, possibly attributable to the language issue, means that the representativeness of the survey results must be treated with caution. Nonetheless, to our knowledge, this is the first Europe-wide survey on this subject, and the results add to the currently available information on how veterinarians decide which antibiotic to use once they have decided that antibiotic therapy is necessary, and suggest that there are some differences between the countries whose responses were studied in more detail. Some national research has been done on factors influencing prescribing behaviour, such as for cattle practitioners in Ireland (Gibbons and others 2013) and in Italy (Busani and others 2004).

The survey indicates which information sources and factors practitioners value the most when deciding on which antibiotic to prescribe. Some of the factors are potentially interlinked, for example, practice policies may be based on principles of responsible use, but also take into account the price. Whilst there are some differences between the different types of practitioners, the magnitude of these are such that they suggest that the same approaches can be used when trying to influence the prescribing behaviours of the different types of practitioners.

The survey identified overall that the most important sources used to inform antibiotic prescribing were published literature, training and the veterinarian's own experience. This is similar to a study in Belgium looking at understanding veterinary practitioners' decision-making process (Vanderweerd and others 2012), where colleagues, laboratories, experience and the internet, rather than scientific databases or peer-reviewed literature, were identified as main sources. Based on this, the provision of continuing professional development training with a focus on antibiotics is likely to be an effective way in which to influence changes in prescribing behaviours. Further, the

publication in veterinary journals of general articles on antibiotic resistances, as well as articles setting out real-life examples of antibiotic-prescribing challenges and providing updates on clinical developments, is also likely to be an effective tool. However, research on physicians shows that more study is needed to determine which sort of didactic approaches have the most chance to produce the desired changes. Several studies (Gray 2006, Robertson and Jochelson 2006) show that passive teaching and educational materials are generally seen as ineffective, although they may form part of a successful multifaceted change strategy. It is advised that teaching approaches need to be aimed at identified learning needs, to be interactive, sequenced and multifaceted interventions with feedback to prescribers. These points should be taken into consideration when developing any new materials, and suggest that the development of interactive on-line training tools could be effective. As yet no coordinated European training provision exists. This may be an area where through their action plan the Commission can provide the necessary stimulus. Whilst general training on antibiotic resistance can be delivered on an EU-wide basis, specific training on prescribing for particular cases needs to be delivered on a national or regional basis to take into account the different resistance patterns and any differences in the available medicines. It is acknowledged that it is very difficult to ensure suitable training reaches all veterinarians, and it is also probably unrealistic to believe that all those who receive training will adjust their antibiotic prescribing. Therefore, additional measures, such as transparency and monitoring of antibiotic prescribing, are likely to be required.

Official information, such as public assessment reports, were not ranked as an important information source. Given that these reports contain essential information on areas, such as pharmacokinetics, pharmacodynamics and AMR, suggests that practitioners are either not aware of them or do not find the information in them particularly helpful.

The SPC is another information source which contains important information to help practitioners when prescribing any veterinary medicine. The survey results suggest practitioners generally refer to the label and PIL rather than the SPC, and that the term SPC is not universally understood. This suggests that in some countries communication is required to ensure that veterinarians are aware of what SPCs are, their value, and know where to find them. Most regulatory authorities now publish SPCs on their website, and a consolidated list

TABLE 8: Factors given which could increase sensitivity testing according to the type of practice and country (expressed as a percentage of the total number of responding veterinarians in the relevant practice type or country)

Factor	All responses	CA practitioners	FP animal practitioners	E practitioners	Belgium	Czech Republic	France	Germany	Spain	Sweden	UK
Cheaper testing	68.3	73.5	60.6	58.8	61.2	69.4	68.9	71.1	69.0	68.0	67.9
Easy access to labs	31.1	27.8	37.3	32.1	29.1	33.3	32.2	37.8	40.6	22.6	21.0
Rapid results	71.0	67.6	76.7	74.5	78.9	72.2	74.7	48.5	73.3	69.7	75.9
Support to interpret results	16.0	16.8	15.0	14.0	17.6	41.7	13.1	25.9	16.5	15.4	11.4
SPC recommending susceptibility testing	9.5	10.3	8.7	7.4	9.7	8.3	9.5	11.0	8.9	9.4	8.3
Advice in guidelines/formulary	17.0	17.3	18.0	11.9	15.4	13.9	16.0	11.6	11.6	30.6	17.6

CA, Companion animal; E, Equine; FP, Food producing; SPC, Summary of product characteristics

of these can be found on the HMA website at <http://mri.medagencies.org/Veterinary/product-information>

According to the survey, the most important factors, overall, influencing prescribing habits were sensitivity test results, their own experience, a consideration of the risks of antibiotic resistance development and ease of administration. This is largely consistent with an earlier Irish study (Gibbons and others 2013) which also found experience and ease of administration were important factors influencing prescribing habits. This suggests that generally those veterinarians who answered the survey do take into account factors which are important in terms of responsible use, and hence, it is likely their behaviours can be influenced by giving more attention to messages on responsible use, and linked to this the potential risks posed by antibiotic resistance. Additionally, this supports the importance of guidelines on responsible antibiotic use, for example, European Platform for Responsible Use of Medicines in Animals (EPRUMA) guidelines in English, Swedish, German (EPRUMA 2008) are important tools, as suggested by previous studies (Ungemach and Müller-Bahrdt 2006). The majority of veterinarians indicated they follow responsible use warnings, though some are influenced not to do so by owner request. In a study investigating prescribing behaviour in cattle veterinarians in Ireland which examined the decision on whether or not to prescribe antibiotics, and then subsequent to this the decision on which antibiotic to prescribe, several non-clinical issues were found to influence the decision on whether or not to prescribe antibiotics; such as the owner; the fear of being blamed should antibiotic therapy prove necessary later on and the potential legal consequences (Gibbons and others 2013). Also a Belgian study recognises the influence of the owner and veterinarian perceptions that they want immediate action (Vanderweerd and others 2012). This suggests that there is a need to recognise these factors and effectively communicate to animal owners on the problems with antibiotic resistance and the reasons why it is important that their veterinarian prescribes antibiotics responsibly. It is also important that veterinarians insist on prescribing the most appropriate antibiotic and are not unduly influenced by owner preference. Additionally, any advertising of antibiotics, in particular, those aimed at people who can't prescribe antibiotics, should not place undue emphasis on economic factors and should reinforce the importance of their responsible use.

Overall, practitioners answered that relative to other groups of factors, economic factors are less important, contrary to common perception. Of the economic factors, price was generally considered to be the most important, although withdrawal period was also a key factor presumably because the use of products with shorter withdrawal periods reduces farmers' losses due to discarded produce, for example, milk, and avoids additional costs associated with having to keep animals for longer prior to slaughter. In other studies (Gibbons and others 2013), it was found that the cost of the medicine is among the issues most frequently considered by Irish cattle veterinarians when choosing an antibiotic. Of the countries studied in detail, there was no relationship between the importance given to profit margin and the regulations in place within countries regarding linkage between prescribing and supply of antibiotics.

The initial choice of antibiotics was predominantly empirical rather than being based on AST, with infrequent users of AST generally reserving such tests for cases of poor responses to previous antibiotics but also to complicated cases. There are significant differences between the frequency of performing sensitivity testing between the different types of practitioners, and for the seven different countries studied. The extent of use of AST is likely to be influenced by the attitudes of veterinarians and, to some extent, animal owners in each country. This may be a reflection of the position of the veterinarian in different countries; in countries where the position of the veterinarian is stronger, for example, through farm contracts or through sector-agreed guidelines, it is likely to be easier for them to convince the farmer of the value of performing these tests. The survey responses also indicate that when the use of AST is strongly recommended in national guidelines, it is performed more regularly. For example, in the German responsible use guidelines, AST is strongly recommended in certain treatment cases and before changing antibiotic therapy. Several

countries, such as France, Germany and The Netherlands are currently investigating making AST before certain treatments with antibiotics obligatory, such as before the prescription of antibiotics which are critically important for use in humans. We suggest other countries might also consider more strongly recommending the use of AST, or making it obligatory in certain situations. The FVE leaflet advises veterinarians to perform sensitivity testing as much as possible before prescribing antimicrobials and always before prescribing critically important antimicrobials, such as fluoroquinolones, and third- and fourth-generation cephalosporins (FVE 2012). Campaigns and information sessions to increase awareness on the importance of AST are also considered to be an important means to increase their use.

It would be anticipated that the frequency of sensitivity testing would be linked to their availability, quality and price, and with policy and culture in the country concerned. The survey indicates that the two most important factors which could influence a greater uptake of testing are the ability to get rapid results and at lower cost. In some countries, another factor would be access to help to interpret the results of AST. A common remark concerned validity and efficiency of AST. Respondents suggested a need for reliable test results relevant to the clinical situation which are directly relevant to the antibiotics used to treat animals rather than those more usually used to treat people. Tests to monitor sensitivity in animal samples are generally not regulated in Europe. Sensitivity tests are performed both by private as well as public laboratories which are not always specialised in such testing for veterinarians. Diagnostic licensing for AST is not harmonised across Europe. There is a need to develop recommendations for standard and simple sampling methods for target pathogens/diseases/animal species, and sample transport, together with a programme of training for veterinarians. Further efforts are also needed to demonstrate how the minimum inhibitory concentrations (MIC) correlates to clinical efficacy of the various antibiotics in the field and for these to be standardised between laboratories (Doern and Brecher 2011, Schultz and others 2012).

There is clearly a need for future innovation and development of practical sensitivity tests which provide at a reasonable cost rapid and meaningful results, and a need to consider carefully whether there is a case for more harmonisation and regulation in this sector.

This study has identified a number of common factors that influence veterinarian prescribing practices across Europe which should help inform optimum information channels and areas for interventions and investment to maximise appropriate prescribing and minimise risk of resistance emergence.

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