

Papers

Antibacterial prescribing patterns in small animal veterinary practice identified via SAVSNET: the small animal veterinary surveillance network

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In this study, data from veterinary clinical records were collected via the small animal veterinary surveillance network (SAVSNET). Over a three-month period, data were obtained from 22,859 consultations at 16 small animal practices in England and Wales: 69 per cent from dogs, 24 per cent from cats, 3 per cent from rabbits and 4 per cent from miscellaneous species. The proportion of consultations where prescribing of antibacterials was identified was 35.1 per cent for dogs, 48.5 per cent for cats and 36.6 per cent for rabbits. Within this population, 76 per cent of antibacterials prescribed were β -lactams, including the most common group of clavulanic acid-potentiated amoxicillin making up 36 per cent of the antibacterials prescribed. Other classes included lincosamides (9 per cent), fluoroquinolones and quinolones (6 per cent) and nitroimidazoles (4 per cent). Vancomycin and teicoplanin (glycopeptide class), and imipenem and meropenem (β -lactam class) prescribing was not identified. Prescribing behaviour varied between practices. For dogs and cats, the proportion of consultations associated with the prescription of antibacterials ranged from 0.26 to 0.55 and 0.41 to 0.73, respectively.

ANTIBACTERIALS are used in human and veterinary healthcare for the treatment of, and prophylaxis against, bacterial infections. Antibacterial resistance is an increasing problem, particularly in human healthcare, and this affects both disease morbidity and mortality, with significant financial implications (Gould 2009, Wilcox 2009). There are concerns that the use of antibacterials in animals may be contributing to resistance in human beings. This led to a call for the use of quinolones and cephalosporins to be restricted in animals (Report of the Chief Medical Officer 2008). A recent request to the European Parliament's Agriculture and Rural Development committee to consider a proposal inviting member states to restrict vet-

erinarians' ability to dispense certain antibacterials in non-acute cases was recently rejected (Anon 2011).

Since the principal driver for the selection of resistant bacterial populations is antibacterial use, the use and stewardship of antibacterials is becoming of increasing importance in human and veterinary healthcare (Gould 2009, Charani and others 2010). To ensure appropriate stewardship, current practices must be defined, and where interventions are put in place, their outcomes need to be measured. In recognition of the importance of this issue, the World Health Organisation has focussed World Health Day 2011 on antimicrobial resistance under the banner 'No action today, no cure tomorrow'.

In the European Union, prescribing of antibacterials for use in animals must be by a veterinary surgeon (all antibacterials are in the POM-V category in the UK). Prescription of antibacterials for companion animals takes place at an individual practice level and therefore there is no central body collating data on prescriptions. The data available are from the Veterinary Medicines Directorate (VMD), which publishes information on the overall tonnage of antibacterial products sold in the UK, and where possible, on the amounts sold for individual species (Goodyear 2010). In its latest report, 2009 sales of therapeutic antimicrobials totalled 402 tonnes (44 per cent tetracycline, 19 per cent β -lactam, 18 per cent trimethoprim/sulphonamides, 10 per cent macrolides, 5 per cent aminoglycoside, <1 per cent fluoroquinolone and the remaining 5 per cent of other miscellaneous products). Eighty-seven per cent of products sold were for use in food animals only, 8 per cent were for companion (non-food) animals only, with the remaining 5 per cent licensed for both food and non-food animals. Between 2008 and 2009, there was an 8 per cent increase in the amount of antimicrobials sold for use in dogs only.

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TABLE 1: Trade names of antibacterials contributing to the free text search, together with their class and group used for subsequent analysis

Class	β-Lactam	F & Q*	Tetracycline	Aminoglycoside	Lincosamide	Trimethoprim/ Sulphonamide	Nitroimidazole	Macrolide	Other
Group	AMOX/ampicillin	CEFO/cecin	TE/etracycline	SP/ramycin	LIN/Comycin	TMPS	ME/ronidazole	TYlosine	Duphapen+Strept [†] Neopen [†]
Trade name	Amoxycare Amoxypen Betamox Clamoxyl Duphamox	Amfipen Ampicare Ampicillinvet Depocillin Nisamox Noroclav Synulox	Cefaseptin Cephacare Cephorum Ceporex Rilexine Therios	Convenia Enrox Enroxil Fenoflox Ibafin Marbocyl	Alamycin Engemycin Oxycare Ronaxan	Ornicure [†] Amikim ^{†‡} Devomycin [†]	Stomorgyl [§] Lincocin Lincosject	Antirobe Clinacin	Duphatrim Strinacin Norodine Tribriksen Trimacare Trimedoxine Trinacol

*Fluoroquinolone and Quinolone class

†Not used in this population of dogs, cats or rabbits

‡Not licensed for use in dogs, cats or rabbits

§Also contains metronidazole

¶Clavulanic acid potentiated amoxicillin

Where products are available for more than one species, and where there is a high degree of weight variability within that species as with dogs, a defined daily dose cannot be calculated; and therefore, a conversion from tonnage to the number of animals treated cannot be calculated. As such, the VMD report while valuable, is not able to define the number of animals treated or the conditions from which they were suffering. In addition, the VMD report does not identify prescription of antibacterial products that are not licensed for animal use.

The aim of this study is to describe the antibacterial prescribing patterns in a population of 16 small animal veterinary practices using data collected via the Small Animal Veterinary Surveillance Network (SAVSNET), a new and near real-time animal disease surveillance system.

Materials and methods

SAVSNET was set up in 2008 to meet a deficiency in companion animal surveillance (Radford and others 2010). SAVSNET's ethos is to use highly cost-effective information technology solutions to capture ethically approved data from veterinary surgeons in private practice. Sixteen veterinary practices (two in Wales, the remainder in the UK, with a combined total of 32 premises) that record their clinical data using the Premvet (Vet Solutions) practice management system were recruited to the SAVSNET project, following a faxed invite to all suitable Premvet users. Ethical approval for data collection requires that all owners at participating practices are informed about the project via posters and other promotional material in the waiting area, and are then given a clear opportunity to opt out and exclude their data from the project. Data were only collected from consultations carried out by a Member of the Royal College of Veterinary Surgeons, and only from consultations where owners presented animals for the investigation of disease (both initial and follow-up consultations), chosen for each practice based on their own unique consultation codes. As such, the data generally exclude consultations addressing prophylactic treatment such as vaccinations and puppy checks. Where owners consent, the data captured from consultations include age, sex, breed, postcode, clinical free text and treatments. When owners opt out, SAVSNET only knows a consultation took place. All data are securely transmitted within 24 hours of the consult taking place and stored on a secure server pending analysis.

Free text searching

In order to identify drugs prescribed during consultations (both injected in consultation and dispensed for oral administration by owners), the clinical record for the consult was scanned using the SEARCH function in Microsoft Excel 2007 (Microsoft Corporation) for a list of antibacterials (Table 1). This list was initially populated with antibacterial products listed on the NOAH database as licensed for systemic use in dogs, cats or rabbits, together with those available from Norbrook, which is not a member of NOAH. To validate this approach, 200 records were manually checked by a veterinary domain expert (MRCVS, PhD in infectious diseases) identifying one false positive (no antibiotic given) and five false negatives (clindacil, alamycin, oxytetracycline, amikin and one spelling mistake). These antibacterials were added to the search terms, and a further 200 records were manually checked consisting of 123 records predicted not to have antibacterials and 77 predicted to have antibacterials by the scanning approach. All these checks were correct. The final list of antibacterials used in the free text searching is shown in Table 1, together with how they were grouped for subsequent analysis and what class of antibacterial each group belonged to (Veterinary Medicines Directorate 2011).

In order to identify the potential prescription of those antibacterials important in human medicine that are not licensed for veterinary use, additional free text searches were carried out for vancomycin and teicoplanin (glycopeptide class), and imipenem and meropenem (β-lactam class).

To further validate the search approach, 100 records from those animals predicted to have been prescribed one or two antibacterial groups based on free text searching were manually checked by a veterinary domain expert and found to be correctly assigned in 100 and 85 per cent of consultations, respectively. Reasons for the 15 inaccuracies in those animals predicted to have been prescribed two antibacterial

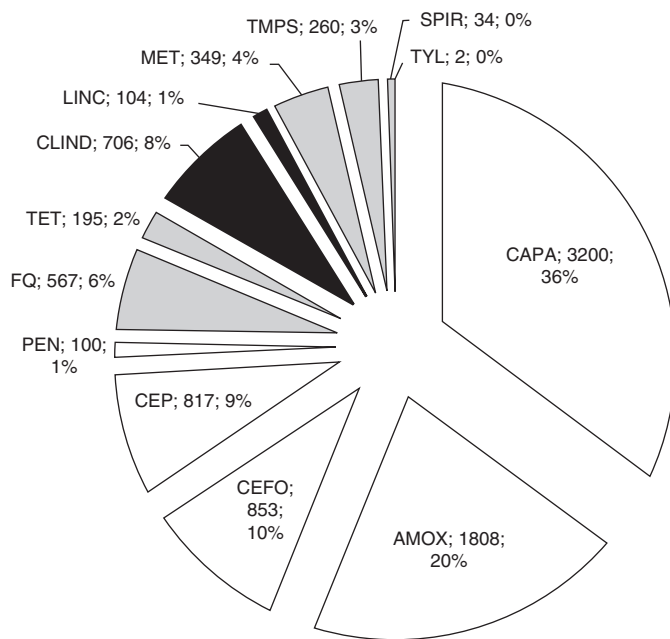


FIG 1: Total number (per cent) of predicted prescriptions of each antibacterial group amongst a total population of 21,891 dogs, cats and rabbits. White segments combine to represent the β -lactam class. Black segments combine to make the lincosamide class

groups were future plans to change treatment depending on response ($n=7$, eg, 'if x doesn't work change to y'); swapping because of a suspect adverse reaction ($n=4$); recording previous suspect adverse reactions ($n=2$); a change of mind ($n=1$) and a comment on why an antibacterial was not used ($n=1$).

All 10 animals predicted to have been prescribed three antibacterial groups were also manually checked. Three inaccuracies were identified involving one suspect adverse reaction, one consult involving two animals and one description of future plans.

In order to explore the effect of tentative diagnosis on treatment choices within this cohort of veterinary surgeons, antibacterial prescribing behaviour for four diseases that were identifiable using free text searching was calculated and compared with the total population. These were abscess, diarrhoea (searched for 'diarrhoea' excluding 'no diarrhoea' and 'or diarrhoea'), cystitis and cough. The proportion of consultations that were correctly identified as belonging to each of these four disease groups was 82 per cent (95 per cent CI 73 to 88), 91 per cent (84 to 95), 100 per cent (96 to 100) and 90 per cent (83 to 94), respectively. False positives were generally associated with the phrases like 'no cough', 'cough stopped/improved/free' or 'stop if diarrhoea', 'no more diarrhoea', 'diarrhoea resolved', 'no (two spaces) diarrhoea' or 'no/not abscess', 'abscess unlikely', 'prevent abscess', and 'abscess might form'.

Data analysis

All data analysis was carried out in Microsoft Excel 2007 and Stata 9.2 (Statacorp). Contingency tables were analysed with Fisher's exact test in Stata 9.2, which implements an algorithm described by Mehta and Patel (1986) to extend the procedure from 2×2 tables to $r \times c$ tables.

The association between the prescription of antibacterials and age in cats, dogs and rabbits was analysed using logistic regression includ-

ing age as a continuous variable, species as a categorical variable and an interaction term. The association between prescription of antibacterials and veterinary practice was also analysed using logistic regression including anonymised practice ID and species as categorical, independent variables together with an appropriate interaction term.

Results

Between 10 May and 8 August 2010, data from 27,007 consults were collected. Of these, 714 owners elected to exclude their data from the database and opted out (2.6 per cent). A further 2467 consults contained no free text so they were unlikely to represent sick animal consults and were excluded. Of the 23,826 remaining, 967 (4 per cent) were identified as repeats containing identical free text, possibly representing additional sales to the same animal, and were excluded so that each consult was only represented once.

The remaining data set contained 22,859 records, of which 69 per cent (15,727) were from dogs, 24 per cent from cats (5587) and 3 per cent from rabbits (577) (Table 2). The remaining consults were made up of various species including rodents (2 to 552 per cent), avians (1 to 178 per cent) and miscellaneous exotic species (1 to 128 per cent).

The proportion of consults involving systemic antibacterials was 35.1 per cent for dogs (5519 of 15,727 consults), 48.5 per cent for cats (2708 of 5587) and 36.6 per cent for rabbits (211 of 577), with cats significantly more likely to be prescribed antibacterials than dogs, rabbits and other species (Fisher's exact $P<0.001$) (Table 2). The proportion of consults predicted to have been prescribed 0, 1, 2 and 3 antibacterial groups (as defined in Table 1) in a single consultation is shown in Table 2.

In the total population of dogs, cats and rabbits, clavulanic acid-potentiated amoxicillin (CAPA) (36 per cent), amoxicillin (20 per cent) and cefovecin (10 per cent) were the most frequently prescribed antibacterial groups (Fig 1). Together, the β -lactam class made up 76 per cent of all antibacterials prescribed. In this population, vancomycin and teicoplanin (glycopeptide class), and imipenem and meropenem (β -lactam class) were not found.

In Fig 2, the use of antibacterials is further broken down by species. For dogs, the most common antibacterial used was CAPA (16 per cent of all canine consults or 42 per cent of canine consults involving antibacterials).

For cats, the most common antibacterials used were amoxicillin (16 per cent of all feline consults and 30 per cent of feline consults involving antibacterials), cefovecin (13 per cent of all feline consults and 24 per cent of feline consults involving antibacterials) and CAPA (14 per cent of all feline consults and 26 per cent of feline consults involving antibacterials).

For rabbits, overwhelmingly, the most commonly used antibacterial was fluoroquinolone (31 per cent of all rabbit consultations and 84 per cent rabbit consultations involving antibacterials).

Of the 543 animals predicted to have been prescribed two groups of systemic antibacterials, the most common combinations were amoxicillin/CAPA (20 per cent, 108/543), clindamycin/lincomycin (15 per cent), amoxicillin/clindamycin (10 per cent) and amoxicillin/metronidazole (9 per cent) (Fig 3). Where two antibacterials from the same class were prescribed together (amoxicillin/CAPA and clindamycin/lincomycin), domain expert reading of the free text field showed this was generally where one product was injected in the consult and the other was dispensed as tablets for follow-up treatment (data not presented).

Veterinary domain expert analysis of the free text field for the four most common combinations of antibacterial group is shown in Table 3. The percentage of correctly identified consults based on these free text searches ranged from 90 to 100 per cent. Clindamycin/lincomycin and amoxicillin/clindamycin were most commonly used for bite wounds, abscesses and

TABLE 2: Breakdown of consults by species and number of antibacterial classes

Species	Number of antibacterial groups: n (%; 95% CI)		1	2	3	Total
	0	1, 2 or 3				
Canine	10,208 (64.9%; 64.2-65.6)	5519 (35.1%; 34.3-35.9)	5194 (33.0%)	322 (2.0%)	3 (0.0%)	15,727 (100%)
Feline	2879 (51.5%; 50.2-52.8)	2708 (48.5%; 47.1-49.8) *	2487 (44.5%)	217 (3.9%)	4 (0.1%)	5587 (100%)
Rabbit	366 (63.4%; 59.3-67.4)	211 (36.6%; 32.6-40.6)	207 (35.9%)	4 (0.7%)	0 (0.0%)	577 (100%)
Other	603 (62.3%)	365 (37.7%; 34.6-40.8)	348 (35.9%)	16 (1.6%)	1 (0.1%)	968 (100%)
Total	14,056 (61.5%)	8803 (38.5%)	8236 (36.0%)	559 (2.4%)	8 (0.0%)	22,859 (100%)

* Cats significantly more likely to be prescribed antibacterials than dogs, rabbits and other species (Fisher's exact $P<0.001$)

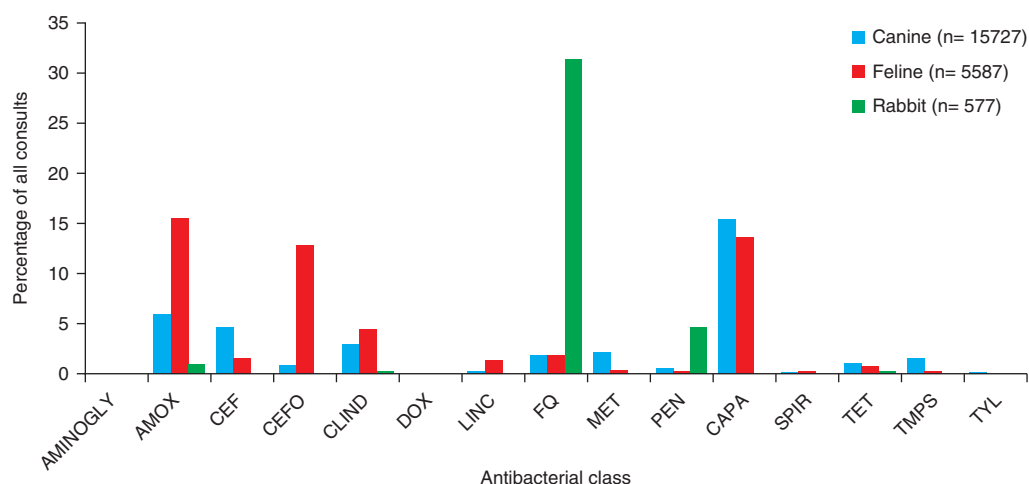


FIG 2: Percentage of all consultations associated with a prescription of each antibacterial group in cats, dogs and rabbits. For each species, the bars add up to the proportion of consultations receiving antibacterials as shown in Table 2

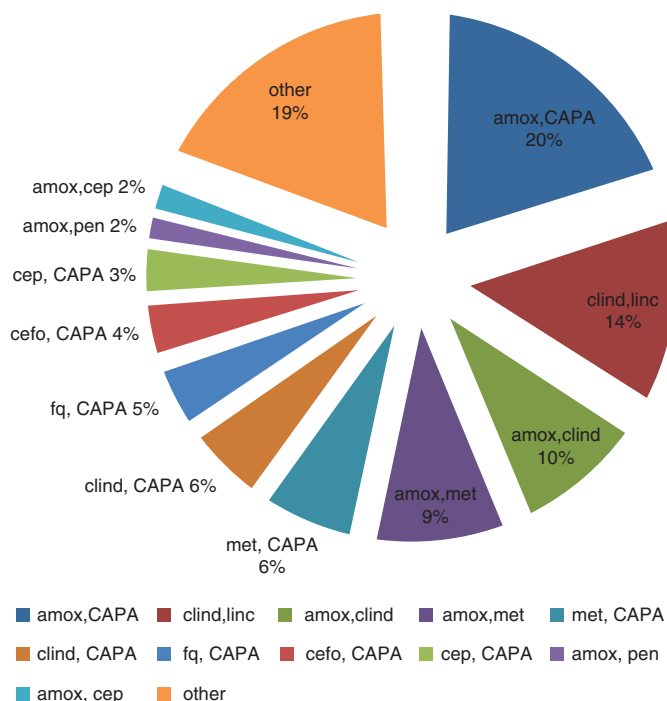


FIG 3: Breakdown of common antibacterial combinations prescribed, among a population of 543 consultations predicted to receive two antibacterial groups

dental disease. The amoxicillin/metronidazole combination was used most frequently for gastroenteritis (vomiting and diarrhoea). Amoxicillin/CAPA was used in a much more diverse range of conditions.

Effect of age on antibacterial use

For cats, the probability of receiving antibacterials decreased with age (slope log odds significantly less than zero, $P < 0.001$) (Fig 4). The same was also true for dogs (slope log odds significantly less than zero, $P < 0.001$) although the effect was significantly less than that seen in cats ($P = 0.001$). For rabbits, the slope log odds was not significantly different from zero.

Effect of practice on antibacterial usage

When antibacterial use was explored at the level of practice, the increase in antibacterial use in cats compared with dogs in the total population was found to be consistent across all contributing practices, with 1.16 (practice N) to 1.74 (practice A) times more cat consultations being associated with the prescription of antibacterials than dog consultations (Fig 5). However, there was some considerable variation in the proportions of cats and dogs being prescribed antibacterials among the 16 practices. For dogs, the proportions ranged from 0.26 (practice A) to 0.55 (practice P), whereas for cats, these proportions ranged from 0.41 (practice B) to 0.73 (practice P). All practices prescribed antibacterials to a greater proportion of cats than dogs (overall odds ratio = 1.740; 95 per cent CI 1.635, 1.852). This parameter was remarkably consistent across all the practices included in this study. While an interaction term between practice and species marginally improved the fit of the model ($P = 0.0346$), a series of pairwise comparisons between practices found only a small number of differences.

Furthermore, within each practice, the types of antibacterial groups prescribed to both dogs and cats showed considerable variability (Fig 6).

Differences in choice of antibacterial group associated with certain clinical conditions identified in the free text

The predicted use of antibacterial groups associated with four marker diseases (abscess, diarrhoea, cystitis and cough) is shown in Table 4. Perhaps as expected, the proportion of animals receiving antibacterials was consistently higher than in the total population, and was highest for the disease category abscess (90 per cent for both cats and dogs). Interestingly, the increased use of antibacterials seen in the total population in cats compared with dogs was only maintained for cough.

TABLE 3: Classification of the consultations associated with the four most common antibacterial group combinations based on domain expert analysis of the clinical free text

Amoxicillin/CAPA (n=108/100%)*		Clindamycin/lincomycin (n=79/100%)		Amoxicillin/clindamycin (n=52/90%)		Amoxicillin/metronidazole (n=50/98%)	
Diarrhoea and/or vomiting±haemorrhage	27	Fight/bite wound/cat bite abscess	22	CBA/abscess	12	Diarrhoea/colitis±haemorrhage	28
Abscess (bite, anal gland, foot)	27	Abscess	13	Fight/skin wound/laceration	17	Vomiting and diarrhoea±haemorrhage	9
Cough/sneezing/nasal disch/epistaxis	10	Dental/dental disease/tooth abscess	12	Mouth/gingivitis/dental	7	Vomiting	4
Cystitis	5	Skin infection/wound	9				
Ripped nail/toe trauma/infection	5	Anal gland infection/abscess	6				
Skin trauma/wound	5						
Other	29	Other	16	Other	4	Other	4
Unknown	0	Unknown	1	Unknown	4	Unknown	4
One antibacterial	0	One antibacterial	0	One antibacterial	5	One antibacterial	1

* Number of identified consultations by free text analysis/percentage of correctly identified consultations as determined by domain expert
CAPA Clavulanic acid-potentiated amoxicillin

TABLE 4: Use of antibacterials in disease syndromes identified by free text searching (for method of search, see text)

Number of antibacterial groups	Abscess		Diarrhoea		Cystitis		Cough		Total	
	Dog, n=168	Cat, n=218	Dog, n=601	Cat, n=137	Dog, n=96	Cat, n=157	Dog, n=844	Cat, n=127	Dog, n=15217	Cat, n=5587
0	17	22	241	65	13	37	447	52	10208	2879
1	134	160	327	65	78	111	376	74	5194	2487
2	17	34	33	7	5	8	20	1	322	217
3	0	2	0	0	0	1	1	0	3	4
Prescribed antibacterials (%)	90	90	60	53	86	76	47	59	35	48

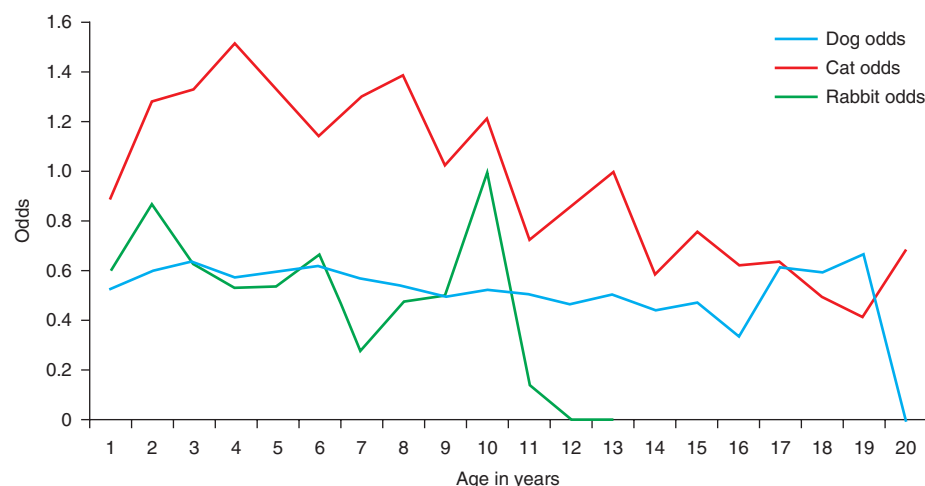
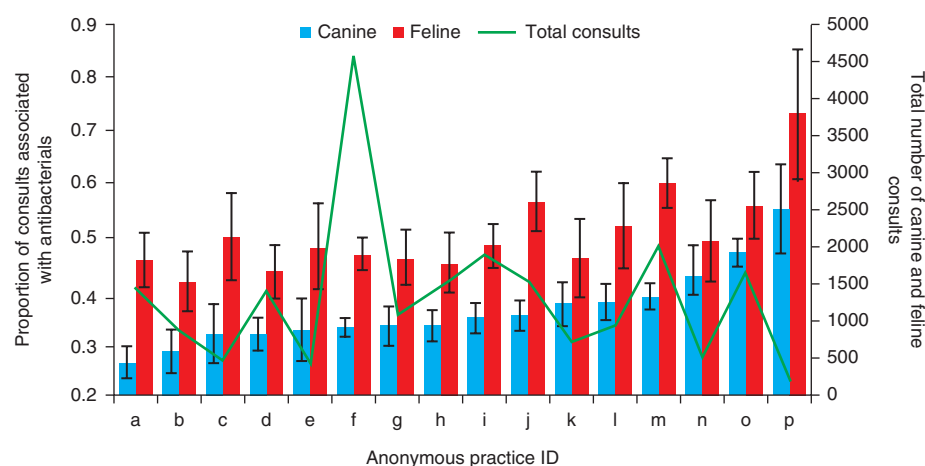


Fig 4: The effect of age expressed as odds, on the predicted prescribing behaviour of antibacterials in dogs, cats and rabbits

FIG 5: The variation in antibacterial prescribing behaviour in each of the 16 contributing practices ($\pm 95\%$ confidence intervals)

Based on cases identified using these free text searching protocols, the proportion of cases in each disease category receiving each antibacterial group was calculated (Fig 7a, b). Those antibacterial groups with a shift in pattern of prescription of greater than 10 per cent are indicated by an asterisk. The change in pattern appeared greater for dogs than cats. For dogs, clindamycin and CAPA were prescribed proportionally more for abscesses, amoxicillin and metronidazole were used more in cases with diarrhoea and CAPA was used more for cystitis. In cats, amoxicillin, clindamycin and CAPA were prescribed proportionally more for abscesses and cefovecin more for cystitis.

Discussion

Antibacterials represent a vital therapy used by medical and veterinary practitioners. The increasing development of antibacterial resistance in animals and human beings has led to legitimate concerns about antibacterial stewardship in these populations (Gould 2009, Charani and others 2010). Currently, there is limited data on the use of these products, in particular in companion animals, due to lack of quality survey data, which, when available, are usually confined to those based on sales figures (Goodyear 2010). While beneficial,

this type of data have some limitations and may not always give information on the types of animals being dispensed individual products, their species, age or clinical presentation, or the combinations in which individual drugs are used. There are also limited opportunities to capture variation in clinical practice, something at the heart of clinical benchmarking.

In this paper, we have explored the use of data collected by SAVSNET as a means to survey antibacterial prescribing in a cohort of small animal practitioners. Ethical permission to collect these data means that as well as identifying the antibacterials prescribed in each consultation, the authors have been able to obtain clinical data relevant to each prescription. This has allowed us to look at antibacterial prescribing practices in this population, and provides a baseline against which further studies and interventions may be judged. Although we cannot yet say how representative these practices are as a whole for the country, collection of these data should provide the profession with additional tools to monitor its use of antibacterials, which is vital in the process of maintaining responsible antibacterial stewardship.

This large survey of the 'vet-visiting' population suggested that clinical case load as measured by animal consultations was made up of 69 per cent dogs and 24 per cent cats. This is in contrast to recent studies suggesting that approximately equal numbers of cats and dogs are kept in the UK (Murray and others 2010). This raises interesting questions about ownership of cats and dogs, in particular the degree to which owners of dogs and cats seek out healthcare for their pets and the degree to which owners are aware of disease in their dogs and cats. Within this population, it was clear that cats were significantly more likely to be prescribed antibacterials than dogs (48.5 per cent compared with 35.1 per cent of cat and dog consultations, respectively), largely associated with an increased use of amoxicillin and cefovecin in this species. This is in contrast to a previous study in a mainly referral hospital, which reported prescribing rates of 30 and 24 per cent for dogs and cats, respectively (Rantala and others 2004). The reasons for this difference warrant further study but may suggest that cats are perceived to present more frequently with diseases/syndromes in which bacterial infection plays a major role.

Within this total population of dogs, cats and rabbits, 76 per cent of the antibacterials prescribed were from the β -lactam class, consistent with other data (Watson and Maddison 2001, Rantala and others 2004, Danmap 2009), and including the most common group in our study, CAPA, making up 36 per cent of all the antibacterials prescribed. The preponderance of CAPA gave conflicting results when compared with previous studies, agreeing with some (Watson and Maddison 2001, Danmap 2009) but disagreeing with others (Rantala and others 2004), possibly reflecting the largely referral case load of the latter study. Other classes reported by us included the lincosamides

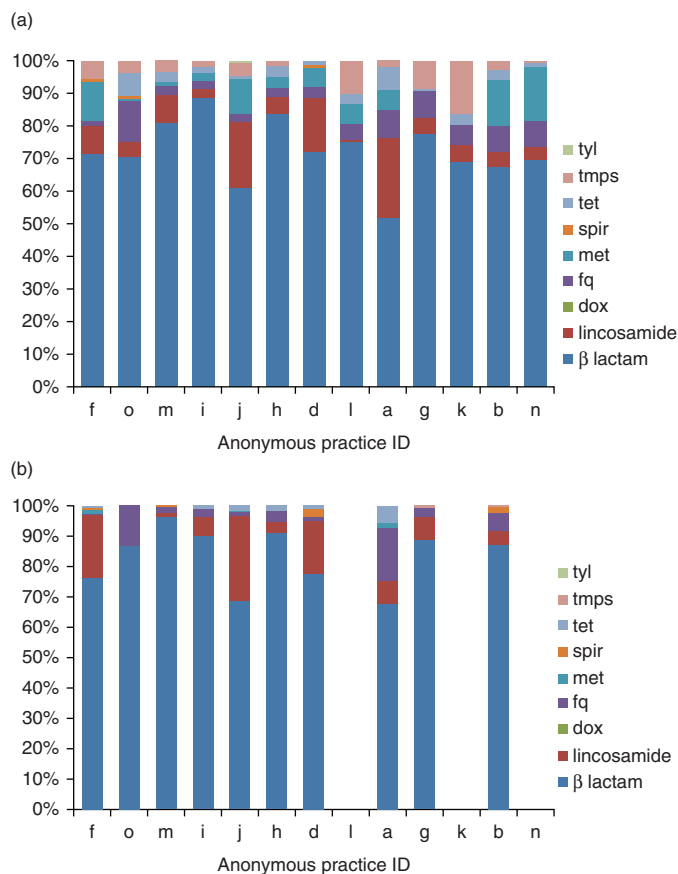


FIG 6: The prescribing of individual antibacterial classes by anonymised practices, for those practices see more than 100 (a) canine and (b) feline consults

(9 per cent), fluoroquinolones and quinolones (6 per cent), nitroimidazoles (4 per cent), trimethoprim/sulphonamides (3 per cent) and tetracyclines (2 per cent). This compares with sales figures of antibacterials in the total animal population in the UK of 44 per cent tetracycline, 19 per cent β -lactam, 18 per cent trimethoprim/sulphonamides, 10 per cent macrolides, 5 per cent aminoglycoside, <1 per cent fluoroquinolones and quinolones and the remaining 5 per cent of other miscellaneous products (Goodyear 2010). Although it is not possible to break down these sales data by species, it is likely that since 87 per cent of the products sold are licensed only for food animals, the differences in classes largely reflect differences in antibacterials used in cats and dogs (this study) and food-producing animals.

For cats and to a lesser extent dogs, there was a significant association between age and the odds of being dispensed antibacterials, with consults involving young animals more likely to result in the dispensing of antibacterials. The reasons for this warrant further analysis but may reflect a greater proportion of disease where antibacterials are felt appropriate in younger animals and a greater proportion of non-infectious disease in older animals (eg, cancer, renal disease, osteoarthritis) for which clearly antibacterials are generally inappropriate. As well as monitoring treatments, one of the main reasons for developing SAVSNET is to allow us to assess the disease burdens in companion animal populations, and how these are affected by risk factors such as age, breed, sex and postcode. Understanding what is happening in the two extremes of this age demographic will provide new insights into how these products can be most efficiently targeted in veterinary practice.

An absolute strength of SAVSNET is to provide data to practitioners on the disease and treatment profiles of their own practice, and allow them to anonymously compare these with those of their peers and to national averages. In the context of this paper, it was clear that dispensing behaviour varied considerably between the 16 practices that contributed data. For dogs, the proportion of consults associated with antibacterials ranged from 0.26 to 0.55, whereas for cats,

these proportions ranged from 0.41 to 0.73. In addition, there was considerable variability in the proportion of antibacterial classes used, although in all practices, β -lactams still made up the majority class of antibacterials in both cats and dogs. The authors hope this type of data could provide meaningful clinical audit to the practising veterinary professional in this sector. Clearly, the results presented here cannot determine the appropriateness of the antibacterials prescribed in individual cases, and there may be very good population demographic and disease reasons why one practice in this study may use more antibacterials than another. However, data such as these do provide a benchmark for practices to consider their own use of antibacterials to ensure their ongoing efficient use. These data also provide an opportunity to monitor the effect of future interventions on antibacterial dispensing both nationally and locally.

As well as exploring risk factors like age, species, and practice, SAVSNET allows us to start to explore how antibacterials are used for certain syndromes. Here, this syndromic data were captured by searching the clinical free text for those syndromes with clear identifiers (abscess, diarrhoea, cystitis and cough). It is important to state that this type of analysis is not seeking to identify the prevalence of these conditions in the vet-visiting population, because free text searching for conditions of low prevalence will likely result in many false negatives due to the variation in clinical language used by vets to record data in the clinical notes. However, the authors believe that for certain conditions like those presented here, free text searching is a sufficiently reliable way to identify a cohort of patients suffering, or likely to be suffering, from a particular condition. In this study, veterinary domain expert analysis suggested free text searching had an accuracy of 82 per cent for abscess (95 per cent CI 73 to 88), 91 per cent for diarrhoea (84 to 95), 100 per cent for cystitis (96 to 100) and 90 per cent for cough, with the false positives often being associated with clinicians recording that a particular syndrome was absent (eg, 'no cough'). For the four syndromes studied, it was clear that there was a shift in the dispensing of antibacterials compared with the overall population. In general, these tended to follow data sheet guidelines for the use of specific antibacterials; for example, the use of clindamycin to treat abscesses in cats and dogs and the use of cefovecin to treat cystitis and abscesses in cats. Some antibacterial groups were seemingly used off label, although in this study the numbers were low, and it will be interesting to monitor this trend further.

As well as prescribing behaviour, another important component of antibacterial use is to consider to what extent these products are prescribed following bacterial culture and sensitivity testing. The recording of these data in clinical practice is likely to be inconsistent so is unlikely to be amenable in the short term to the kind of surveillance reported here. However, increasing use of standardised electronic reporting of such results may mean these valuable data become tractable to such analysis in the future. Another approach to surveying resistance data is to capture this directly from the labs undertaking the tests and this type of surveillance represents the second arm of the SAVSNET surveillance initiative (Radford and others 2010).

The results described here are difficult to compare with existing data based on tonnage because of the different units used. The authors report antibacterial prescribing, which currently cannot be equated to amount of active ingredient (weight), because they have limited information on dose, frequency or duration. Equally, because of the high degree of weight variability within species like dogs, a conversion from tonnage of active ingredient sold, as reported by some national authorities (eg, Danmap 2009, Goodyear 2010), to a defined daily dose and the number of animals treated cannot easily be calculated. In future studies, it will be important to use dose, frequency and duration to allow more precise reflection of the total product prescribed.

Although this study clearly shows the large volumes of data that can be collected and analysed, certain limitations remain. These were partly associated with acquiring data in disparate formats via other parties, including consults without free text and those that contain duplicated free text (13 per cent of available submitted data). The precise role of these consults in the SAVSNET

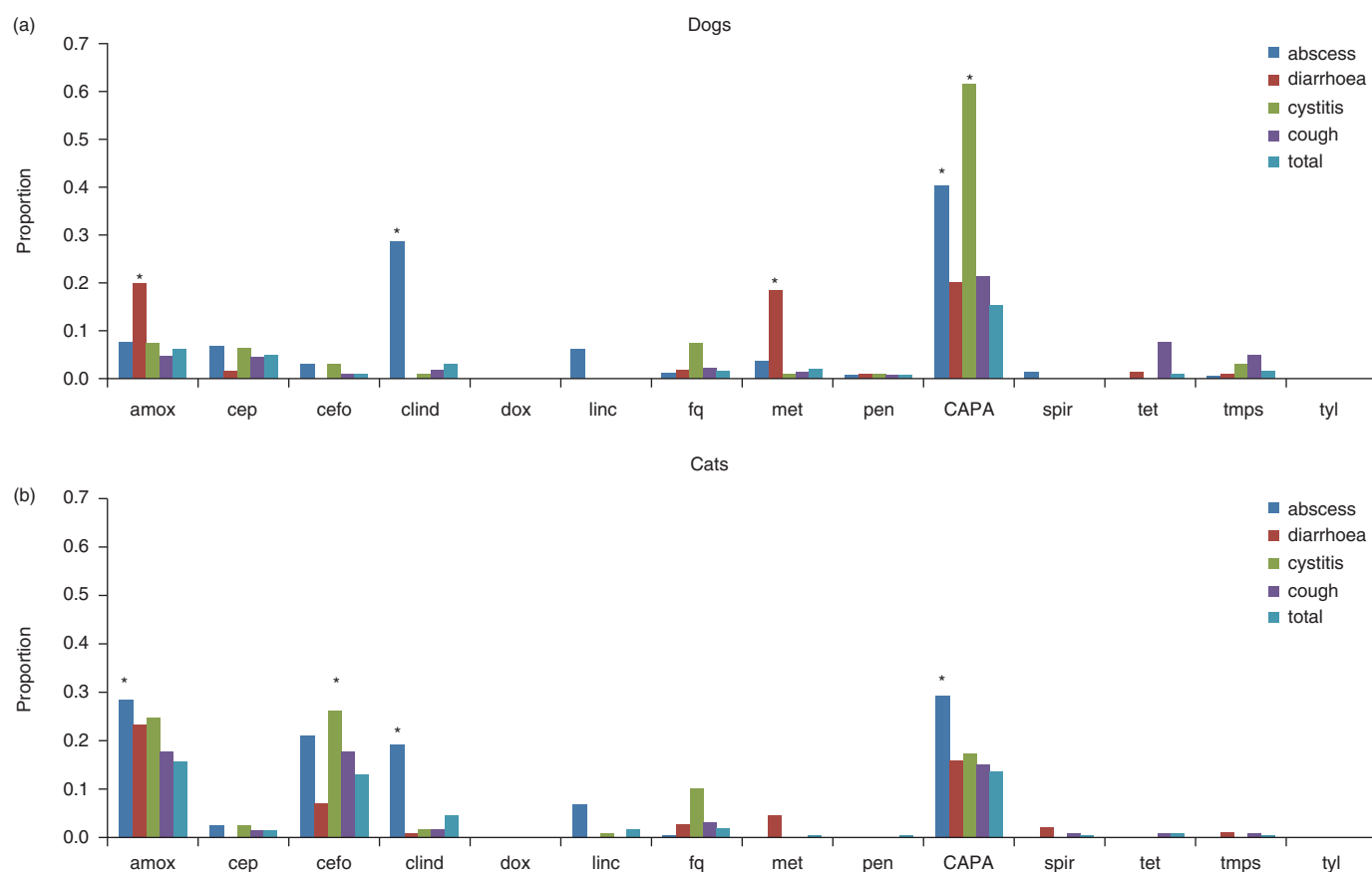


FIG 7: Proportion of A (canine) and B (feline) consultations associated with the prescription of individual antibacterial groups by disease category (abscess, diarrhoea, cystitis, cough) and in the total dog or cat populations. Those syndromes/columns marked by asterisks indicate a >10% swing in the proportion of the given antibacterial compared with the total population for that species

database needs to be clarified, as they clearly may have an impact on the figures reported. In addition, antibacterial prescription was predicted by computer searching the single block of text submitted with each consult to SAVSNET. As well as the veterinary surgeons' comments provided as free text, this block also currently contains the treatments prescribed, inserted automatically following selection from drop down menus. Such free text searching is clearly subjected to error. However, false negatives are minimised by the use of drop down menus, which prevent typing errors associated with the manual inputting of text, and also because recording antibacterials in this way is how practices ultimately charge for dispensed products. False positives, however, may occur if veterinary surgeons refer to named antibacterials in their clinical notes. In this study, veterinary domain expert analysis showed that accuracy was high where a single antibacterial group was predicted. However, false positives were more common for those consults predicted to involve two or three antibacterial groups. That said, for surveillance purposes, it was felt the degree of accuracy obtained was sufficient for ongoing analysis, especially as the vast majority of animal consults were only associated with a single antibacterial. Clearly, in future studies, it would be beneficial if the information relating to prescribing behaviour could be received separately from other clinical free text.

In conclusion, SAVSNET allows the collection of ethically approved surveillance data, which over time could develop into a benchmark on the prescribing of antibacterials in private veterinary practice. This benchmark would allow identification and feedback regarding trends in the use of these products both at the national level in peer-reviewed publication and locally via anonymised returns to data providers. These data are especially timely as national and international bodies are seeking to increase the data they have on veterinary antimicrobial use (European Surveillance of Veterinary Antimicrobial Consumption: http://www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&murl=menus/regulations/regulations).

jsp&mid=WC0b01ac0580153a00). Challenges remain including a need to ensure the data are representative of spatial and practice variability, and to understand how these data relate to that collected using different methodologies. However, collection of this type of data is vital for the veterinary profession to ensure appropriate antibacterial prescribing, especially in the current climate largely focussed on concerns of resistance.

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Antibacterial prescribing patterns in small animal veterinary practice identified via SAVSNET: the small animal veterinary surveillance network

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