



# Antibiotics used most commonly to treat animals in Europe

N. De Briyne, J. Atkinson, L. Pokludová, S. P. Borriello

**The Heads of Medicines Agencies and the Federation of Veterinarians of Europe undertook a survey to gain an insight into European prescribing of antibiotics for animals, in particular to highlight the diseases for which antibiotics are most commonly said to be prescribed and which different classes, including human critically important antibiotics (CIAs). The survey was completed by 3004 practitioners from 25 European countries. Many older antibiotics (eg, penicillins, tetracyclines) are cited most frequently as the prescribed classes to treat the main food producing species. The frequency of citation of non-CIAs predominates. CIAs are mostly frequently cited to be prescribed for: urinary diseases in cats (62 per cent), respiratory diseases in cattle (45 per cent), diarrhoea in cattle and pigs (respectively 29 per cent and 34 per cent), locomotion disorders in cattle (31 per cent), postpartum dysgalactia syndrome complex in pigs (31 per cent) and dental disease in dogs (36 per cent). Clear 'preferences' between countries can be observed between antibiotic classes. The use of national formularies and guidance helps to drive responsible use of antibiotics and can significantly reduce the extent of use of CIAs. A more widespread introduction of veterinary practice antibiotic prescribing policies and monitoring obedience to these should ensure more widespread compliance with responsible use guidelines.**

## Introduction

Considerable attention is being given to antibiotic resistance regarding public and animal health, with the EC, the Heads of Medicines Agencies, the Federation of Veterinarians of Europe and a number of Member States and veterinary organisations all issuing strategies and/or action plans (HMA 2010, European Commission 2011, *Éco antibio France* 2012, FVE 2012). The Heads of Medicines Agencies/Federation of Veterinarians of Europe conducted a survey (De Briyne and others 2013) of European veterinary surgeons to establish their antibiotic prescribing habits and factors influencing these. A key aim of this survey was to identify the factors most influential in determining prescribing behaviours in order to inform best strategies to influence the desired change. Veterinarians who answered this survey were also asked at the same time to say which antibiotics they most commonly prescribed and for what purposes, in order to give a greater insight and EU perspective into the use of antibiotics in animals beyond that offered by national animal antibiotic prescribing data that is published by certain countries for example, Denmark publishes DANMAP, 2012, and the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) reporting of antibiotic sales.

While the latest ESVAC reports presented data on the sales of veterinary antimicrobial agents (Grave and others 2012, ESVAC 2013), they provide little information on the diseases for which the antibiotics are being prescribed. Such information is essential if measures to support the responsible use of antibiotics, particularly of critically important antibiotics (CIAs), are to be effective.

## Materials and methods

A survey was completed by 3004 practitioners from 25 European countries. Details on the survey approach are described by De Briyne and others (2013). In the survey questions, veterinarians were asked to specify the five indications for which they most commonly prescribe antibiotics, providing free text responses information including the species and antibiotic. They were not asked to rank their answers.

The data were analysed first at species level (subject to there being at least 500 responses per species), then subdividing this as appropriate (eg, cattle/calves), secondly by indication and thirdly by antibiotic class. Analysis was done at a country level for Belgium, France, Germany, Spain, Sweden and the UK, as the number of responses was considered sufficiently large to be meaningful, and to be nationally representative, and when sufficient data (at least 50 responses per species per country) were available.

Antibiotics were considered in two groups: CIAs and others. For this report CIAs are based on the WHO categorisation of antibiotics (WHO 2011) in terms of their importance in human medicines and include (fluoro)quinolones, third and fourth generation cephalosporins, macrolides and glycopeptides.

Species, indications and antibiotics were free-choice answers. Some responses gave animal information beyond the species, for example by specifying calves. Responses for a single species were pooled. In regard to indications, different names for basically the same indications were used for example, diarrhoea, neonatal diarrhoea, dysentery. These were pooled into therapeutic areas. In terms of antibiotics some responses named specific active substances, some specific products and some the class. Where the response only indicated cephalosporins it

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**N. De Briyne**, DVM,  
Federation of Veterinarians of Europe,  
Avenue Tervueren 12, Brussels 1040,  
Belgium

**J. Atkinson**, BPharm,  
**S. P. Borriello**, PhD, FRCPath,  
Veterinary Medicines Directorate,  
Woodham Lane New Haw, Addlestone,  
Surrey KT15 3LS, UK

**L. Pokludová**, PhD, MSc,  
Institute for State Control of Veterinary

Biologicals and Medicines, Brno, Czech  
Republic

E-mail for correspondence:  
[nancy@fve.org](mailto:nancy@fve.org)

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was assumed that the split between first and second generation cephalosporins versus third and fourth generation cephalosporins would follow the same distribution as responses where the precise information was provided. Citations of quinolones and fluoroquinolones were grouped as '(fluoro)quinolones'. Most people listed one antibiotic per indication, but some listed several antibiotics for one species-indication for example, 'cattle-mastitis- polypeptide/tetracycline/aminoglycoside', this was considered to be three different antibiotic/species/indication combinations as all antibiotics were interpreted separately even if they were known to be regularly used in combination.

## Results

In total 3004 respondents completed the questionnaire, which in total gave 15,740 'species-indication-antibiotic' results, shown to species level in Table 1.

The 'other' species included rabbits, rodents, birds, ducks and a number of exotic species. Data were only analysed for cattle (including calves), pigs, horses, dogs and cats.

## Cattle

Of the 4166 valid 'species-indication-antibiotic' entries received 741 were for calves.

The most commonly mentioned indications to administer antibiotics to cattle are shown in Table 2. Among the 8 per cent

'others' were, in order of times mentioned, perioperative (including caesarean-section), sepsis, infection, peritonitis, traumatic reticulitis, wounds, abscess, urinary, meningitis, nephritis, eye disease and abortion. Where percentage figures are specified these relate to the frequency of citation which does not reflect relative frequency of use. The frequency of percentage citation of different antibiotics and their classes used is also shown in Table 2. For example, this shows for mastitis that 78 per cent of the time veterinarians said they would use non-CIAs, mostly penicillins (41 per cent) and first and second generation cephalosporins (12 per cent), while 22 per cent of the time CIAs were specified, mostly third and fourth generation cephalosporins (11 per cent) and macrolides (6 per cent). For respiratory diseases, use of CIAs was mentioned in 45 per cent of the time (macrolides 27 per cent and (fluoro)quinolones 13 per cent). For diarrhoea polymyxins were mentioned most frequently (44 per cent).

Where calf-specific data were available, two indications: diarrhoea (57 per cent) and respiratory (27 per cent), covered 84 per cent of the 'species-indication-antibiotic' entries (Table 2).

In the total population of cattle (including calves), the relative mentions of CIAs to non-CIAs was 26 per cent compared to 74 per cent. The antibiotic classes mentioned most frequently were penicillins (34 per cent), third and fourth generation cephalosporins (10 per cent), macrolides (9 per cent) and aminoglycosides (9 per cent). There

TABLE 1: Number of indications—antibiotic paired results received per animal species (in bold: species data analysed in this paper)

Animal species Food producing animals	Number of indications— antibiotic responses	Animal species Companion animals	Number of indications— antibiotic responses
<b>Cattle (and calves)</b>	<b>4166</b>	<b>Dogs</b>	<b>3885</b>
<b>Pigs</b>	<b>512</b>	<b>Dogs and cats</b>	<b>2418</b>
Small ruminants	253	<b>Cats</b>	<b>2348</b>
Poultry	151	Others	278
Fish	41		
<b>Horses (including foals)</b>	<b>1678</b>		
Donkey	10		

TABLE 2: The antibiotics mentioned and frequency with which they were mentioned for the top five indications where antibiotics are said to be prescribed for cattle and calves.

Therapeutic area	Percentage mentioned	Percentage critically important antibiotics (CIAs) v percentage other antibiotics	Frequency of citation of the different classes of antibiotics (top 5)
Mastitis	40%	<b>CIAs:</b> 22% Non-CIAs: 78%	Penicillins 41%, 1st and 2nd generation cephalosporins 12% <b>3rd and 4th generation cephalosporins 11%</b> Aminoglycosides 10% <b>Macrolides 6%</b>
Respiratory disease	22% (27%)	<b>CIAs:</b> 45% (44%) Non-CIAs: 55% (56%)	<b>Macrolides 27%</b> , (28%) Phenicols 22%, (19%) Tetracyclines 19%, (18%) <b>(Fluoro)quinolones 13%</b> , (12%) Penicillins 7%
Diarrhoea	14% (57%)	<b>CIAs:</b> 29% (26%) Non-CIAs: 71% (74%)	Polymyxins 40%, <b>(44%)</b> <b>(Fluoro)quinolones 20%</b> , (18%) Penicillins 13% (13%) Aminoglycosides 9%
Uterine	8%	<b>CIAs:</b> 21% Non-CIAs: 79%	<b>3rd and 4th generation cephalosporins 8%</b> (8%) Penicillins 37%, <b>3rd and 4th generation Cephalosporins 18%</b> , Aminoglycosides 16%, Tetracyclines 16%, 1st and 2nd generation cephalosporins 7%
Locomotion	8%	<b>CIAs:</b> 31% Non-CIAs: 69%	Penicillins 33%, Tetracyclines 24%, <b>3rd and 4th generation cephalosporins 22%</b> , <b>Macrolides 9%</b> , Aminoglycosides 9%
Other	8% (16%)	<b>CIAs:</b> 13% (10%) Non-CIAs: 87% (90%)	Penicillins 60%, (55%) Aminoglycosides 12%, (18%) <b>3rd and 4th generation cephalosporins 8%</b> , Lincosamides 7%, (12%) Tetracyclines 4%

Figures in brackets relate to calves only. Other figures relate to all cattle including calves.

TABLE 3: Overview of antibiotics cited most commonly as being prescribed for use in cattle, pigs and horses per country

Number of valid species-indication-antibiotic combinations	Total all countries (%)						Belgium (%)			France (%)			Germany (%)			Spain (%)			Sweden (%)			UK (%)		
	Cattle	Pigs	Horses	Cattle	Pigs	Horses	Cattle	Pigs	Horses	Cattle	Pigs	Horses	Cattle	Pigs	Horses	Cattle	Pigs	Horses	Cattle	Pigs	Horses	Cattle	Pigs	Horses
3rd and 4th generation cephalosporins	10	2	9	19	3	15	9	0	9	23	4	9	11	0	14	0	0	0	6	-	0	6	-	11
Macrolides (Fluoro)Quinolones	9	10	1	9	9	3	10	13	1	5	9	1	10	13	2	0	0	1	13	-	1	13	-	1
Other Antibiotic Classes	7	8	3	11	5	5	6	4	4	14	12	4	13	7	2	0	0	1	1	-	1	-	-	4
1st and 2nd generation cephalosporins	6	0	0	3	0	0	7	0	0	3	0	0	3	0	0	0	0	0	12	-	0	12	-	0
Aminoglycosides	9	3	19	8	9	13	12	7	20	7	3	26	8	8	27	6	15	14	14	-	15	14	-	18
Lincosamides	1	2	0	3	3	0	1	1	0	2	2	0	1	3	0	0	0	0	0	-	0	0	-	0
Penicillins	34	33	37	28	23	32	25	28	42	31	23	45	29	31	32	84	61	32	32	-	61	32	-	24
Phenicol	5	2	0	5	3	0	4	2	0	5	1	0	8	2	0	0	0	10	10	-	0	10	-	0
Pleuromutilin	0	4	0	0	5	0	0	0	0	0	2	0	0	10	0	0	0	0	0	-	0	0	-	0
Polymyxin	8	10	0	7	14	1	12	16	0	1	10	0	2	10	0	0	0	0	0	-	0	0	-	0
Potentiated sulphonamide	2	9	20	2	6	25	3	11	16	3	6	12	3	0	15	2	15	2	2	-	15	2	-	27
Tetracyclines	8	17	6	5	20	4	10	17	6	4	27	1	12	15	5	7	2	10	7	-	2	10	-	11
Other	1	<1	5	<1	0	2	1	1	2	2	1	2	0	1	3	1	5	3	0	-	5	0	-	4

(-): Insufficient responses (&lt;50) from the relevant country and hence the data are not given

were differences between countries in the antibiotics veterinarians said they use (Table 3). Penicillins are the antibiotic class most frequently mentioned in all countries particularly in Sweden where this class by far predominates the others (84 per cent). The use of CIAs was specified more frequently for Germany (42 per cent v 26 per cent average), while no use was cited for Sweden.

### Pigs

The most commonly mentioned indications of the 512 valid 'species-indication-antibiotic' entries received, where antibiotics were said to be administered to pigs, are shown in Table 4. Among the 9 per cent 'others' were (in order of times mentioned) urinary or urogenital infections, Erysipelothrix, wounds, infection, Glasser disease, actinobacillosis, sepsis, Porcine Reproductive and Respiratory Syndrome, and footrot.

Respiratory and diarrhoeal conditions were mentioned most frequently (>60 per cent) for antibiotic prescribing in pigs. For respiratory diseases, 88 per cent of the treatments mentioned were non-CIAs, mostly tetracyclines (47 per cent) and penicillins (21 per cent). For diarrhoea, the proportion of CIAs mentioned was higher at 34 per cent, polymyxins (30 per cent), macrolides (22 per cent) and (fluoro)quinolones (12 per cent).

In the total population of pigs (including piglets), the relative mention of use of CIAs to non-CIAs was 20 per cent compared with 80 per cent, with penicillins (33 per cent), tetracyclines (17 per cent), polymyxin (mostly colistin) (10 per cent), macrolides (10 per cent), potentiated sulphonamides (9 per cent) and (fluoro)quinolones (8 per cent) (Table 3).

### Horses

The most commonly mentioned indications of the 1678 valid 'species-indication-antibiotic' entries received, to treat horses with antibiotics are shown in Table 5. Among the 15 per cent 'others' were (in order of times mentioned) uterine diseases (5 per cent), ocular diseases (3 per cent), gastrointestinal diseases (3 per cent), peritonitis (2 per cent), dental diseases (1 per cent).

In the total population of horses (including foals) the relative mentions of use of CIAs to non-CIAs was 13 per cent (mostly third and fourth generation cephalosporins) compared with 87 per cent, with penicillins (37 per cent), potentiated sulphonamides (20 per cent) and aminoglycosides (19 per cent). The 5 per cent 'others' antibiotics is mostly composed of metronidazole (predominantly for gastrointestinal disorders/diarrhoea), chloramphenicol, fusidic acid (both mostly to treat ocular diseases) and rifamycin (mostly to treat respiratory disease) (Table 3).

### Cats

The most commonly mentioned indications, of the 2348 valid 'species-indication-antibiotic' entries received, to administer antibiotics to cats are shown in Table 6. Among the 3 per cent others were fever or infection of undefined origin, gastrointestinal diseases, liver disease and eye disease.

In the total population of cats, penicillins (37 per cent), tetracyclines (14 per cent), third and fourth generation cephalosporins (14 per cent) and (fluoro)quinolones (13 per cent) are the most mentioned (Table 7). Of the antibiotics mentioned, 30 per cent were CIAs and 70 per cent non-CIAs. The less than 1 per cent 'others' is mostly rifampicin and polypeptide (for eye disease and otitis).

### Dogs

The most commonly mentioned indications, of the 3885 valid 'species-indication-antibiotic' entries received, where antibiotics were administered to dogs are shown in Table 8. Among the 10 per cent 'others' are perioperative, tick-borne diseases, prostatitis and anal sacculitis, infections or fever of undefined origin and eye disease.

In the total population of dogs, penicillins (33 per cent), first and second generation cephalosporins (21 per cent) and (fluoro)quinolones (11 per cent) are mentioned most frequently as being prescribed (Table 7). In total, of the antibiotics mentioned, 16 per cent were CIAs and 84 per cent were non-CIAs.

TABLE 4: The antibiotics mentioned and frequency with which they were mentioned for the top four indications where antibiotics are said to be prescribed in pigs

Therapeutic area	Percentage mentioned*	Percentage critically important antibiotics (CIAs) v percentage other antibiotics used for treatment	Frequency of use of the different classes of antibiotics (top 5)
Respiratory disease	31%	<b>CIAs: 12%</b> Non CIAs: 88%	Tetracyclines 47%, Penicillins 21%, <b>Macrolides 10%</b> , Potentiated sulphonamides 8%, Phenicol 5%
Diarrhoea including Colibacillosis Dysentery	31% (8%) (4%)	<b>CIAs: 34%</b> Non-CIAs: 66%	Polymyxin 30%, <b>Macrolides 22%</b> , <b>(Fluoro)quinolones 12%</b> , Potentiated sulphonamides 11%, Pleuromutilin 7%
<i>Streptococcus suis</i> infection including Arthritis Lameness Meningitis Postpartum dysgalactia syndrome (PPDS)	17% (4%) (2%) (1%) 12%	<b>CIAs: 5%</b> Non-CIAs: 95%	Penicillins 81%, Lincosamide 5%, Potentiated sulphonamides 4%, <b>3rd and 4th generation Cephalosporins 3%</b> , Aminoglycosides 4%
Others	9%	<b>CIAs: 31%</b> Non-CIAs: 69%	Penicillins 41%, <b>(Fluoro)quinolones 21%</b> , Potentiated sulphonamides 21%, <b>3rd and 4th generation Cephalosporins 7%</b> <b>Macrolides 3%</b>
		<b>CIAs: 14%</b> Non-CIAs: 86%	Penicillins 56%, Aminoglycosides 12%, Tetracyclines 12%, <b>Macrolides 7%</b> , <b>(Fluoro)quinolones 5%</b>

\*Percentages in brackets are part of the percentage mentioned of each therapeutic area.

## Discussion

The survey was not based on a random selection of practitioners, but instead relied on practitioners volunteering to answer the survey. It is therefore accepted that this may have biased the study. The uncertainties in the data, linked to the need to classify responses, mean the information needs to be treated with caution and is not suitable for statistical analysis. The responses cannot be used as a quantitative measure of the indications for which antibiotics are most commonly used nor the relative use of the different antibiotics. However, the data

do provide a broad insight into the different classes of antibiotics that are used for different indications.

This survey complements the ESVAC reports (Grave and others 2012, ESVAC 2013). Although the third ESVAC report gives a good overview on the sales of antibiotics for animals in 25 EU countries; it does not give an insight into the species or indications for which they are prescribed. The results mirror those of ESVAC showing that certain antibiotic classes are preferred in certain countries; in addition the results show differences in preferred antibiotics according to the

TABLE 5: The antibiotics mentioned and frequency with which they were mentioned for the top five indications where antibiotics are said to be prescribed for horses

Therapeutic area	Percentage mentioned*	Ratio critically important antibiotics (CIAs) v other antibiotics used for treatment	Frequency of citation of the different classes of antibiotics (top 5)
Skin diseases Including wounds and abscesses	31% (25%)	<b>CIAs: 4%</b> Non-CIAs: 96%	Penicillins 46%, Potentiated sulphonamides 25%, Aminoglycosides 18%, Tetracyclines 5%, <b>3rd and 4th generation cephalosporins 3%</b>
Respiratory disease including sinusitis, <i>Streptococcus equi</i> and <i>Rhodococcus equi</i>	27%	<b>CIAs: 18%</b> Non-CIAs: 82%	Penicillins 30%, Potentiated sulphonamides 29%, <b>3rd and 4th generation cephalosporins 13%</b> , Aminoglycosides 10%, Tetracyclines 7%
Locomotion disorders Including arthritis lymphangitis	10% (5%) (4%)	<b>CIAs: 9%</b> Non-CIAs: 91%	Penicillins 42%, Aminoglycosides 31%, Potentiated sulphonamides 10%, Tetracyclines 10%, <b>3rd and 4th generation cephalosporins 7%</b>
Perioperative	9%	<b>CIAs: 6%</b> Non-CIAs: 94%	Aminoglycosides 42%, Penicillins 39%, Potentiated sulphonamides 11%, <b>3rd and 4th generation cephalosporins 4%</b> , <b>(Fluoro)quinolones 2%</b>
Infections (fever of undefined origin and others, including sepsis and infection)	8%	<b>CIAs: 17%</b> Non-CIAs: 83%	Penicillins 28%, Aminoglycosides 23%, Tetracyclines 16%, Potentiated sulphonamides 13%, <b>3rd and 4th generation cephalosporins 13%</b>
Others	15%	<b>CIAs: 22%</b> Non-CIAs: 78%	Penicillins 25%, Aminoglycosides 19%, <b>3rd and 4th generation cephalosporins 15%</b> , <b>(Fluoro)quinolones 7%</b> , Chloramphenicol 6%, Metronidazole 6%, Fusidic acid 4%

\*Percentages in brackets are part of the percentage mentioned of each therapeutic area.

**TABLE 6:** The antibiotics mentioned and frequency with which they were mentioned for the top five indications where antibiotics are said to be prescribed for use in cats.

Therapeutic Area	Percentage mentioned <sup>a</sup>	Percentage critically important antibiotics (CIAs) v percentage other antibiotics used for treatment	Frequency of use of the different classes of antibiotics (top 5)
Skin diseases including: Wounds and abscesses (Pyo)dermatitis	42% (39%) (3%)	<b>CIAs:</b> 24% Non-CIAs: 76%	Penicillins 51%, <b>3rd and 4th generation cephalosporins 16%</b> , Lincosamides 11%, <b>(Fluoro)quinolones 8%</b> , 1st and 2nd generation cephalosporins 8%
Respiratory disease	24%	<b>CIAs:</b> 16% Non-CIAs: 84%	Tetracyclines 50%, Penicillins 28%, <b>(Fluoro)quinolones 11%</b> , 1st and 2nd generation cephalosporins 4%, <b>3rd and 4th generation cephalosporins 3%</b>
Urinary tract infection	16%	<b>CIAs:</b> 62% Non-CIAs: 38%	<b>(Fluoro)quinolones 49%</b> , Penicillins 25%, <b>3rd and 4th generation cephalosporins 13%</b> , 1st and 2nd generation cephalosporins 9% (Remaining classes 1% or less)
Periodontal disease	14%	<b>CIAs:</b> 38% Non-CIAs: 62%	Penicillins 21%, <b>3rd and 4th generation cephalosporins 21%</b> , Lincosamides 19%, <b>Macrolides 14%</b> , Metronidazole 12%
Perioperative	1%	<b>CIAs:</b> 19% Non-CIAs: 81%	Penicillins 75%, <b>3rd and 4th generation cephalosporins 9%</b> , <b>(Fluoro)quinolones 9%</b> , Aminoglycosides 6% (no other classes cited)
Other	3%	<b>CIAs:</b> 25% Non-CIAs: 75%	Penicillins 41%, <b>(Fluoro)quinolones 15%</b> , Metronidazole 10%, <b>3rd and 4th generation cephalosporins 8%</b> , 1st and 2nd generation cephalosporins 7%

<sup>a</sup>Percentages in brackets are part of the percentage mentioned of each therapeutic area.

species and for the same indication in different countries. This may be due to differences in availability of medicines, in routes of administration authorised, different patterns of infectious diseases, different production systems or differences in veterinary prescribing behaviour.

Many older antibiotics (ie, penicillins, tetracyclines, potentiated sulphonamides, etc, which are not CIAs) are still the ones which veterinarians most frequently say they would use to treat the main food producing species.

In a recent survey on antibiotic prescribing habit and influencing factors (De Briyne and others 2013), the most important factors over all influencing a veterinarian to prescribe a certain antibiotic were sensitivity test results, their own experience, a consideration of the risks of antibiotic resistance development and ease of administration. In addition, the importance of guidelines or policies promoting responsible antibiotic use was mentioned as being important. Such national policies appear to be reflected in these results for example, the very low number of times CIAs were mentioned by veterinarians in Sweden. There is evidence to suggest that guideline on antibiotic prescribing at a practice level lead to changes in prescribing patterns. For example, antibiotic use was studied over a period from 1995 to 2004 in a small animal veterinary teaching hospital in Canada in order to gauge the impact of antimicrobial use guidelines (Weese 2006). Overall a significant decrease in prescriptions during the study period was seen.

More than half of antibiotics mentioned are for mastitis and respiratory disease in cattle, for respiratory disease and diarrhoea in pigs and for skin diseases and respiratory diseases in horses. CIAs were mostly mentioned for respiratory diseases in cattle, urinary and periodontal diseases in cats, diarrhoea in cattle and pigs, locomotion disorders in cattle and postpartum dysgalactia syndrome complex in pigs and dental disease in dogs. These are the therapeutic areas which need to be targeted if the total amount of CIAs or total antibiotics used is to be reduced.

Antibiotics defined as CIAs were mentioned in 30 per cent of the treatments of cats, 26 per cent in cattle, 20 per cent in pigs, 16 per cent in dogs and 13 per cent in horses. Their implied high use in cats, particularly compared with dogs, is likely to be primarily due to the use of a long acting third generation cephalosporin (cefovecin) for reasons of convenience. The most frequently cited CIAs differed according to species. In cattle there was a similar proportion of the three different

classes of CIAs, while in pigs macrolides and (fluoro)quinolones predominated, in horses it was mainly the third and fourth generation cephalosporins, it was this class plus (fluoro)quinolones in cats and mainly (fluoro)quinolones in dogs. The proportion of cited use of quinolones versus fluoroquinolones cannot be ascertained from the survey data, although the ESVAC report (ESVAC 2013) indicates that in food producing species the total sales of fluoroquinolones exceed those for quinolones by a factor of almost 3.

This report indicates that there will be variation in CIA use between countries. This is consistent with the third ESVAC report (ESVAC 2013) where the percentage of sales of the most important CIAs varies considerably between countries (range 0.3–19.7 per cent). This variation may not be entirely due to preferences, but may also be a reflection of availability of antibiotics and/or alternative approaches. (eg, vaccines or zinc oxide to treat diarrhoea in piglets).

Europe has no single market for veterinary medicines, resulting in different antibiotics and alternatives authorised in different EU countries. Countries with more livestock or companion animals overall have a greater availability of veterinary medicines. The prescribing cascade (European commission Directive 2004/28, art 10–11) permits under certain circumstances the use of veterinary medicines containing antibiotics authorised in another country. It may be that veterinarians in some countries need to be made more aware of this possibility, as well as there being simple procedures in place in countries to enable veterinarians to import such products. It has been suggested that in future the Commission may seek to restrict the use of the cascade as a mechanism to improve the control of antibiotics. While the nature of these potential restrictions is not yet known, if they were to cover all classes of antibiotics this could limit treatment options, particularly in countries where only a small number of products are authorised. In such circumstances, an unsuitable antibiotic choice may be the consequence, for example, a broad spectrum one when a narrow spectrum one is the better option, so acting contrary to the goal of ensuring responsible use. A single market for veterinary medicines would increase the range of antibiotic products available as well as the number of alternatives to antibiotics in many countries.

For cattle the predominant citation of antibiotics was for the control of mastitis in dairy cows, where antibiotic treatment may be given

TABLE 7: Overview of antibiotics cited most commonly as being prescribed in cats and dogs

Number of valid species-indication-antibiotic combinations	Total all countries (%)		Belgium (%)		France (%)		Germany (%)		Spain (%)		Sweden (%)		UK (%)	
	Cats	Dogs	Cats	Dogs	Cats	Dogs	Cats	Dogs	Cats	Dogs	Cats	Dogs	Cats	Dogs
Critically important antibiotic classes														
3rd and 4th generation cephalosporins	14	1	24	4	14	1	13	2	16	2	0	0	20	<1
Macrolides	3	4	5	6	3	8	2	1	5	5	0	0	2	2
(Fluoro)quinolones	13	11	15	14	10	11	24	16	28	13	5	6	4	4
Other antibiotic classes														
1st and 2nd generation cephalosporins	7	21	3	26	11	28	2	20	5	20	1	10	3	19
Aminoglycosides	1	4	1	1	0	4	5	3	1	3	0	3	0	2
Fusidic acid		3		0		<1		0		1		13		4
Lincosamides	8	6	8	5	11	3	2	4	1	2	4	18	15	9
Nitroimidazole (metronidazole)	2	7	1	9	2	8	2	2	5	11	1	2	<1	10
Penicillins	37	33	30	28	27	30	45	45	31	31	84	34	48	36
Polymyxin		2		1		1		1		1		4		2
Potentiated sulphonamide		3		2		2		4		4		3		4
Tetracyclines	14	5	13	4	21	4	3	2	7	6	4	6	7	8
Other	<1	<1	0	0	<1	0	2	0	1	<1	<1	<1	<1	0

Empty cell=antibiotic not cited for that species/country

for clinical or subclinical mastitis. Dry cow therapy has traditionally used intramammary antibiotic therapy immediately after the last milking of lactation. It is likely that the extent of use of antibiotics to control mastitis could be reduced if there was wider awareness and application of best practice guidance such as the Responsible Use of Medicines in Agriculture guideline (RUMA 2005). The use of antibiotics during lactation to control clinical mastitis and to reduce pain and inflammation is recognised as essential on welfare grounds, however such use should follow strict prescribing practice accompanied by regular bacterial isolation and sensitivity testing. Furthermore, good stockmanship, biosecurity and good milking hygiene are also extremely important in preventing mastitis.

Of the CIAs used in cattle, third and fourth generation cephalosporins are cited most frequently, for example, they are specified in 22 per cent of locomotion cases. The reason for the use of these classes rather than a non-CIA, especially in dairy cattle, may be the very short withdrawal period (zero days for milk in some cases).

For pigs the reported predominant use of antibiotics was for respiratory disease (mostly tetracyclines and penicillins) and diarrhoea (mostly polymyxins and macrolides). In contrast DANMAP reports that in the case of diarrhoea in weaners tetracycline use predominates. A Belgian study in fattening pigs (Callens and others 2012) reported the most frequently prescribed antibiotics as colistin (30.7 per cent), amoxicillin (30.0 per cent), doxycycline (9.9 per cent) and trimethoprim-sulphonamides (13.1 per cent). Moreno (2012), found in pig finishing systems in Spain that percentages of animals exposed to antibiotics were high (90 per cent in finisher farms and 54 per cent in farrow-to-finish farms); with for example, colistin (61 per cent and 33 per cent) and doxycycline (62 per cent and 23 per cent) followed by amoxicillin (51 per cent and 19 per cent). This contrasts with the findings for Belgium and Spain: 23 per cent and 31 per cent penicillins, 20 per cent and 15 per cent tetracyclines, 14 per cent and 10 per cent polymyxins (mostly colistin) and 6 per cent and 0 per cent potentiated sulphonamides, respectively. These differences may be due to the different approaches to data collection but equally different breeds and different housing systems may be important contributors. However, all studies indicate a low use of CIAs compared with other antibiotics.

Some countries introduced a ban or restriction on the use of certain antibiotics in pigs. Examples are Denmark who restricted the use of quinolones since 2002 and introduced a voluntary ban on use of third and fourth generation cephalosporins in 2010, and The Netherlands who voluntarily banned third and fourth generation cephalosporins since 2012. However, this study shows that in other countries these classes of antibiotics, and particularly the (fluoro) quinolones, continue to be selected relatively frequently as antibiotics of choice.

Different regulations also apply in Europe regarding the use of zinc oxide. A notable effect on weaning diarrhoea through addition of high levels of zinc oxide (2000–3000 ppm) has been reported (Holm 1996). Zinc oxide is allowed as a feed additive in Europe, and is considered by the European Food Safety Agency (EFSA) as safe for animal and consumer safety at the maximum allowed concentration (150–250 ppm). Interestingly, studies have shown that zinc oxide might promote the spread of antimicrobial resistance via co-selection or other mechanisms (Bednorz and others 2013). Since 2005 Denmark authorised zinc oxide as a veterinary medicine which allows practitioners to use it at 2250 ppm. Feed containing zinc oxide is by far the most important medicated feed in Denmark (around 95 per cent) (FCEC 2010). Other countries which also permit the use of zinc oxide at the higher concentrations include Sweden, Spain and the UK.

Disease prevention is essential. Key points for disease prevention are to limit pig-to-pig contact, to limit 'stress' and to ensure good hygiene and good nutrition. In the Responsible Use of Medicines in Agriculture guidelines for pigs (RUMA 2004), advice is given on how to responsibly use antibiotics in pigs. Other countries such as the Netherlands (Royal Dutch Veterinary Association 2012) provide more detailed guidelines, indicating first, second and third choice antibiotic treatments for particular bacterial infections in pigs.

The issue with horses is more complex as some horses are kept as food producing animals, some as companion animals and some for sport, and often they are switched between these categories during their lifetime. The category of a horse influences the treatment

**TABLE 8: The antibiotics mentioned and frequency with which they were mentioned for the top five indications where antibiotics are said to be prescribed for use in dogs**

Therapeutic area	Percentage mentioned*	Percentage critically important antibiotics (CIAs) v percentage other antibiotics used for treatment	Frequency of use of the different classes of antibiotics (top 5)
Skin disease including: <i>(pyo)derma</i> otitis wounds Urogenital infection	52% (36%) (9%) (7%) 11%	<b>CIAs: 10%</b> Non-CIAs: 90%  <b>CIAs: 27%</b> Non-CIAs: 73%	1st and 2nd generation cephalosporins 35%, Penicillins 31%, <b>(Fluoro)quinolone 9%</b> , Potentiated sulphonamides 8%, Lincosamides 8% Penicillins 55%, <b>(Fluoro)quinolone 26%</b> , 1st and 2nd generation cephalosporins 9%, Potentiated sulphonamides 6%
Respiratory disease	10%	<b>CIAs: 16%</b> Non-CIAs: 84%	Penicillins 45%, Tetracyclines 26% <b>(Fluoro)quinolones 13%</b> , 1st and 2nd generation cephalosporins 8%
Gastrointestinal disease	10%	<b>CIAs: 7%</b> Non-CIAs: 93%	Metronidazole 37%, Penicillins 31%, (Potentiated) sulphonamides 14%, Aminoglycosides 7%, <b>(Fluoro)quinolones 5%</b>
Dental disease	7%	<b>CIAs: 36%</b> Non-CIAs: 64%	<b>Macrolides 34%</b> , Metronidazole 31%, Lincosamides 20%, Penicillins 10%
Others	10%	<b>CIAs: 18%</b> Non-CIAs: 82%	Penicillins 35%, Tetracyclines 19%, <b>(Fluoro)quinolones 17%</b> , 1st and 2nd generation cephalosporins 11%, Lincosamides 4%

\*Percentages in brackets are part of the percentage mentioned of each therapeutic area.

options. Horses held as companion animals and declared as not for food production, can be treated with a much wider range of veterinary medicines as medicine residues in food would not be a consideration. In this survey all horses treated, whatever their category, were included. The predominant citation of use of antibiotics was said to be to deal with skin diseases and respiratory conditions. The frequency of citation of CIAs use varies between countries with, for example, 23 per cent in Belgium and 2 per cent in Sweden.

The most frequently cited antibacterial classes for horses were penicillins followed by potentiated sulphonamides. A survey looking into antibiotic prescribing practice in UK equine veterinary practice (Hughes and others 2013) showed that potentiated sulphonamides were most commonly prescribed, which is consistent with the findings for the UK. Preferences in antibiotic class between European countries have been noted by others (Scicluna and others 2013) and can most likely be explained by the presence of, and adherence to, certain formularies or guidelines. Hughes (Hughes and others 2013) found (fluoro)quinolones and third and fourth generation cephalosporins accounted for 1 per cent and 3 per cent of prescriptions respectively. In the UK survey these classes were cited more frequently (4 per cent and 11 per cent).

Equine veterinary organisations have increasingly become aware of the need to prescribe responsibly and further guidelines on responsible use in the equine sector are being developed, for example, Protect ME (Bowen and Slater 2012) and Formularium Paard (Royal Dutch Veterinary Association 2011). It is hoped the advent of these recent guidelines further improves responsible use of antibiotics in the equine sector.

The predominant mentioned use of antibiotics in cats was for skin, respiratory, urinary and periodontal diseases. In dogs this was for skin diseases and urogenital disorders. Overall, CIAs were cited more frequently as being used in cats than in dogs (respectively 30 per cent and 16 per cent). Penicillins are the most commonly cited class of antibiotics in both cases. The survey results do not allow a differentiation between the use of penicillin alone or as potentiated penicillin. However, the third ESVAC report (ESVAC 2013) reveals that where tablets are used, in most countries the use of amoxicillin in combination with clavulanic acid predominates. Compared with other species, the cited use of third and fourth generation cephalosporins, especially cefovecin, in cats is high (14 per cent), this is probably because it

provides antibiotic cover for up to 14 days, which is convenient for the owner while assuring the veterinarian that the animal will receive a full course of therapy. Increased use of third generation cephalosporins in cats has been reported in the UK after the authorisation of cefovecin (Mateus and others 2011). According to a study in the UK only 3.5 per cent small animal practices reported to have an antimicrobial use policy (Moreno 2012). Guidelines have been published on responsible use of antibiotics in companion animals (eg, FECAVA 2012, Royal Dutch Veterinary Association 2013).

As with other species, 'preferences' can be observed. For example, for cats (fluoro)quinolones were cited more regularly in Spain and tetracyclines are cited more in France than in Sweden. As in all other species, mention of use of CIAs in cats and dogs is much lower in Sweden than in the other countries studied. While it is problematic to draw comparisons when different methods are used there was an even lower rate of only 2.8 per cent reported for use of (fluoro)quinolones in dogs in a Finnish Veterinary Teaching Hospital (Rantala and others 2004). Interestingly in this report departures from Finnish guidelines on prescribing antibiotics were observed. These were however justified due to the presence of staphylococcal resistance, highlighting the importance of including appropriate flexibility when guidance is prepared. Also of interest is the conclusion in the cited study that antimicrobial drugs were being used excessively after surgical procedures, and for treating acute gastrointestinal disturbances and small wounds and traumas, suggesting there is further scope for improvement in antibiotic prescribing even in countries where use is already low.

In conclusion, this survey gives an insight into which antibiotics are most likely used for the most common indications in different species. The report shows clearly the variation in approach between countries, which may in part be due to preferences, national custom and practice, but may also be a reflection on availability of antibiotics and alternative approaches. More guidelines for responsible use are being developed for the different species across Europe. However, currently only a relatively small number of veterinary practices report they have an antimicrobial use policy in place. A more widespread introduction of veterinary practice antibiotic prescribing policies and monitoring compliance sensitive to these should ensure more widespread compliance with responsible use guidelines.

While further, better designed surveys of antibiotic use could be developed these will have drawbacks and hence in order to have a true and accurate picture of the different extents and circumstances of use of antibiotics by veterinarians across the EU it will be necessary to develop an appropriate continuous system of information capture, something that the Commission and ESVAC are considering.

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# Antibiotics used most commonly to treat animals in Europe

N. De Briyne, J. Atkinson, S. P. Borriello and L. Pokludová

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