Small animal disease surveillance: pruritus and pseudomonas skin infections

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ABSTRACT

- Presentation for pruritus comprised 2.2 per cent of cat and 3.8 per cent of dog consultations, between January and April 2018.
- The dorsal parts of the body were the most frequent location for pruritus in cats (27 cent). In dogs, pruritus most commonly affected the ear (37 per cent).
- *Pseudomonas aeruginosa* antimicrobial susceptibility data was available from 37,673 clinical canine isolates, and 1,830 clinical feline isolates. Where a sampling site was recorded, ears were the most commonly recorded site for dogs (71.1 per cent of *P. aeruginosa* isolates), whereas oronasal samples were most common in the cat (36.6 per cent).
- For dogs, 65.4 per cent of *P. aeruginosa* isolates were sensitive to all tested antimicrobials; and for cats 72.6 per cent. Tested isolates were most commonly resistant to fluoroquinolones in both dogs (25.0 per cent of tested isolates) and cats (17.7 per cent). Five canine isolates were found to be resistant to all tested antimicrobials; no such isolates were found in cats.

About this report

This report is the sixth in a series by the Small Animal Veterinary Surveillance Network (SAVSNET).

In the first section, we focus on surveillance for pruritus in the SAVSNET network of veterinary practices and present both the overall prevalence and the spatial distribution of pruritus across GB, from April 2017 to April 2018. Next, we describe confirmed cases of *Pseudomonas* infections using data collected by SAVSNET from collaborating veterinary laboratories across the UK. Further, we update the temporal trends of pruritus, as well as gastroenteric and respiratory disease, using as baseline the data from April 2016 to April 2018. The final section summarises some recent developments pertinent to companion animal health, namely *Salmonellosis* in cats in Sweden and the United States of America (USA) and *Campylobacter* in dogs in the USA. We also present a clinical summary on Pseudomonas otitis infections in cats and dogs in the UK.

Key words: disease surveillance, pruritus, pseudomonas, skin, otitis, fluoroquinolone

1. Syndromic surveillance of pruritus

The skin can be a marker of general health. In companion animals, most skin lesions occur due to diseases primarily affecting the skin, however, some reflect important systemic disease. Pruritus is a common clinical sign, often because of hypersensitivities and infectious dermatoses, but occasionally due to underlined systemic disease. Therefore, early recognition of skin lesions and pruritus can maximise patient outcomes (Vogelnest, 2017).

This report used electronic health records (EHRs) collected between January and April 2018 for 341044 consultations including 98 979 from cats (29 per cent) and 242 065 from dogs (71 per cent), and using the main presenting complaint (MPC) recorded by practitioners for each booked consultation within the SAVSNET network. Presentation with pruritus, comprised 2.2 per cent of cat (n=2195) and 3.8 per cent of dog consultations (n=9249). Compared to our previous report on pruritus from 2016, in 2018 we observed a decrease of the percentage of consultations for pruritus in both cats and dogs (3.6 in cats and 6.5 in dogs, respectively, between January 2014 and June 2016) (Sánchez-Vizcaíno et al., 2016).

Veterinary practitioners' participating in SAVSNET also completed short questionnaires for 435 cats and 1981 dogs, randomly selected from the consultations where the main complaint was pruritus. Based on this questionnaire, the most common location of the pruritus in cats was the dorsal body (27 per cent) and in dogs, the ears (37 per cent) (Table 1A). Overall, 43 per cent of the cats and 45 per cent of the dogs had pruritus for less than a month. However, in 14 per cent of the cats and dogs, the

pruritus had a duration between 3 months and one year, and in 19 per cent of the cats and 21 per cent of the dogs, the pruritus was recorded as being over one year in duration.

The most commonly prescribed medications against pruritus in cats were systemic-glucocorticoids and anti-parasitic drugs (35 and 22 per cent, respectively). In contrast, in dogs the most commonly prescribed medications were topical-antimicrobials and topical-glucocorticoids (22 and 17 per cent, respectively) (Table 1B).

2. Spatial distribution of pruritus

We calculated the percentage of consultations for pruritus from April 2017 to April 2018 in each 10 km gridded cell for those areas of GB where the SAVSNET collects data. We used the results from the 2016 surveillance report on pruritus (3.6 per cent of the cat and 6.5 per cent of the dog consultations), to set a threshold for increased risk of pruritus per 10 km gridded cell (Sánchez-Vizcaíno et al., 2016). We graded the spatial "risk" for pruritus as:

i) Low, if the proportion of pruritus consultations was less than 75 per cent of this threshold (<2.7 per cent for cats, <4.9 per cent for dogs);

ii) Average, if the proportion of pruritus consultations was within 25 per cent of this threshold (2.7-4.5 per cent for cats and 4.9-8.1 per cent for dogs); and

iii) High, if the proportion of pruritus consultations was greater than 25 per cent above the threshold (>4.5 per cent for cats and >8.1 per cent for dogs).

Figure 1 shows the distribution of the spatial risk for pruritus for each season from April 2017 to April 2018. Overall, and in all seasons, the most common risk category for pruritus was low (47 per cent to 49 percent of the area grids covered by SAVSNET for cats, and 49 per cent to 52 per cent in dogs). In cats, cells deemed high risk were a slightly more frequent in spring and summer (24 per cent and 23 per cent of the areas where SAVSNET is present), compared to autumn and winter (22 per cent and 20 per cent). In dogs, 20 percent of the areas where SAVSNET is present had a proportion of consultations for pruritus above the threshold both in summer, autumn and winter, compared to 17 per cent in spring (category “high” risk in Figure 1). The majority of areas with a high proportion of consultations for pruritus in cats and dogs, across all seasons, appeared to be in urban areas and closer to the coast. SAVSNET intends to investigate further the risk factors for increased risk of pruritus. The technical specification and code used to reproduce these data are available from the authors on request.

Laboratory-based investigation of *Pseudomonas aeruginosa* infections in companion animals

Bacterial culture and phenotypic antimicrobial susceptibility data produced between 2011 and 2017 (inclusive) was summarised from four veterinary diagnostic laboratories. *Pseudomonas aeruginosa* antimicrobial susceptibility data was available from 37,673 clinical canine isolates, and 1,830 clinical feline isolates. For isolates where a sampling site was recorded (98.7 per cent of canine isolates, and 97.0 per cent of feline isolates), the ear was the most commonly recorded site for dogs, encompassing 71.0 per cent (95 per cent credible interval, CI, 70.6-71.5, n=26,772) of *P. aeruginosa* isolates. Conversely, for cats *P. aeruginosa* was most commonly isolated and susceptibility tested from oronasal samples, encompassing 36.6 per cent (CI 34.4-38.8, n=670) of *P. aeruginosa* isolates. Comparatively, ear samples comprised 13.9 per cent (CI 12.3-15.5, n=255) of feline isolates, and oronasal samples 5.3 per cent (CI 5.0-5.5, n=97) of canine isolates.

Different protocols and interpretation guidelines were utilised between laboratories contributing data to this dataset; hence, results should be interpreted with some caution. Due to a wide variety of antimicrobials tested, results were summarised to class-level, with 'intermediate' results being interpreted as being sensitive to the antimicrobial in question. For dogs, 65.4 per cent (CI 64.8-66.0) of *P. aeruginosa* isolates were sensitive to all tested antimicrobials; 30.6 per cent (CI 30.1-31.2) were resistant to one or two antimicrobial classes, and 4.0 per cent (CI 3.7-4.2) resistant to three or more antimicrobial classes (hence, 'multi-drug resistant'). For cats, 72.6 per cent (CI 67.1-78.0) of isolates were sensitive to all tested antimicrobials; 23.1 per cent (CI 18.0-28.3) resistant to one or two antimicrobial classes, and 4.3 per cent (CI 1.8-6.8) were deemed multi-drug resistant. Five canine isolates were found to be resistant to all tested antimicrobials; no such isolates were found in cats.

Table 2 displays a summary of antimicrobial class-level resistance in dogs and cats. Tested isolates were most commonly resistant to fluoroquinolones in both dogs (25.0 per cent of tested isolates, CI 24.5-25.5) and cats (17.7 per cent of tested isolates, CI 13.0-22.3), consistent with a previous canine survey (Martín Barrasa et al., 2000). Figure 2 shows the percentage of tested isolates displaying phenotypic fluoroquinolone resistance by year (2011-2017), suggesting a slight, but inconsistent, decrease in *P. aeruginosa* resistance incidence in this period for these canine ear clinical isolates. Though rare, phenotypic carbapenem resistance was observed in this sample. Although carbapenems are rarely (if ever) prescribed to companion animals in the UK (Buckland et al., 2016; Singleton et al., 2017), previous research has suggested that fluoroquinolone use might co-select for carbapenem resistance of relevance to both animal and human health (Haenni et al., 2017). Resistance to aminoglycosides or polymixins classes, commonly indicated as appropriate first-line otitis therapies, was relatively uncommon in this population. It should be noted however that phenotypic susceptibility tests are not reliable indicators for predicting topical antimicrobial therapy success.

3. Update on the temporal trends of the main syndromes in companion animals

The observed prevalence time series for three key MPCs, pruritus, gastroenteric and respiratory disease from April 2016 to April 2018 are shown in Figure 3, together with a seasonal trend line (dark grey line). The trend line was calculated using a Bayesian Binomial generalised linear model with a linear trend accounting for known reporting bias over time, and a periodic Gaussian process capturing seasonal temporal correlation and over-dispersion in a data-determined way (Rasmussen and Williams, 2006). The model was trained on observed weekly prevalence from 2014 to 2018 to calculate a smoothed prevalence trend line summarised as 95% and 99% credible intervals, CI (light grey shading). Extreme prevalence observations are highlighted in orange (tail probability between 1% and 5%) and red (tail probability less than 1%). The technical specification and code used to reproduce these data is available from the authors on request.

These results show that many weeks in 2018, as indicated by red and orange points in Figure 3, had an unusually high prevalence of gastroenteritis in cats and respiratory disease in both species, relative to what would be expected given the previous three years of observations. These results also highlight seasonal prevalence fluctuations in all cases, the shape of which is clearly specific to the MPC in either species. For example, in dogs, pruritus peaks in August, gastroenteritis in February, and respiratory disease in September, whereas in cats pruritus also peaks in August, with less distinct seasonality for the other two MPCs.

4. Global perspective

Salmonellosis in cats in Sweden and United States of America (USA). Two separate outbreaks remind of the importance of salmonella in certain groups of cats. The Swedish Veterinary Medicine Agency (SVA) reported unusually high numbers of cats testing positive for salmonella during the first few months of 2018. The likely source of infection was wild birds. In addition, about 10 people, the majority children of pre-school age, had also been infected with similar Salmonella types, and in some cases, there was a confirmed connection to cats with salmonellosis. Separately in the USA, a batch of a commercial raw food was withdrawn after it was identified as a source of a salmonella outbreak in cats, in which two kittens died. People are reminded of the need for hygiene around garden bird feeders, and also around the use and preparation of raw feeds (Arsevska et al., 2017).

Campylobacter in dogs in the USA. The United States Centre for Disease Control (CDC) investigated an outbreak of human campylobacter infection involving 113 patients, from 17 states and 23 hospitalisations since 2016. The vast majority of patients reported having contact with puppies in the week before disease, particularly those coming from one pet store chain. Almost one quarter of affected humans worked in the same pet store chain. Sequence analysis of isolates from cases and in-

contact puppies showed they shared the same bacterial strain, although there was no description of the precise species involved. The involved campylobacter isolate was also multidrug resistant.

Dogs, especially younger dogs, are known to frequently carry campylobacter (Parsons et al., 2010). The major species carried by dogs (*C. upasliensis*) differs from that most frequently implicated in human disease (*C. jejuni*). However, this outbreak is a reminder of the potential for dogs and puppies to carry zoonotic campylobacter. The CDC also highlighted the need for responsible use of antibiotics in pets. More information at: https://www.cdc.gov/campylobacter/outbreaks/puppies-9-17/index.html

5. Conclusion

This is the sixth Small Animal Disease Surveillance report. We highlight the importance of pruritus in GB companion animals, and in particular infection with *Pseudomonas* due to its potentially severe nature and zoonotic potential. Researchers can contact the authors to access the anonymised data for research purposes. SAVSNET welcomes your feedback.

Update on *Pseudomonas otitis* in companion animals

The organism. *Pseudomonas spp*. are gram-negative rod-shaped bacteria. They are ubiquitous in nature, particularly in aquatic habitats such as water, but also soil, decaying vegetation and on animals. *Pseudomonas aeruginosa*, the most clinically significant member of the family, is not a commensal of the normal canine ear but is an opportunistic pathogen. Colonisation of the skin occurs when trauma or infection destroys the fibronectin coat surrounding host cells. This is common in immunocompromised animals or in cases where chronic antibiotic therapy has destroyed normal bacterial flora. The pathogenicity of *Pseudomonas* is dependent upon the presence of virulence factors such as elaborated toxins, adhesins on the outer membrane that form part of the fimbriae responsible for binding to host proteins, and the outer polysaccharide capsule which protects the bacteria from immune attack.

Pseudomonas spp. are common pathogens in cases of canine otitis externa, particularly in chronic disease. Infection never occurs in a normal ear and is always secondary to an underlying primary cause, notably allergy, endocrine disease and the presence of hyperplastic or neoplastic lesions within the ear canal. In ear disease in man, *Pseudomonas* infection is associated with exposure of the ear canal to water. In dogs, genetic homology between otic and environmental isolates is consistent with a waterborne source of infection for some dogs, and cross contamination with other humans and animal members within some households for others.

Diagnosis. The diagnosis of *Pseudomonas* otitis is made based on history, clinical signs, otoscopic examination, otic cytology and confirmatory culture and susceptibility. Typically, the ear is painful rather than pruritic, due to ear canal ulceration, oedema and hyperplasia. The discharge is generally muco-purulent, haemorrhagic and malodorous. Most *P. aeruginosa* strains produce one or more pigments, including pyocyanin that gives the discharge a green-yellow colour. Despite this quite characteristic appearance, veterinarians should still perform cytology on every case to help establish the type of infection involved. A sample of discharge can be taken for cytology from the junction of the horizontal and vertical canal using a cotton swab, rolled onto a glass slide, heat fixed and stained using a modified Romanowsky-type stain (modified Wright's stain or DiffQuik). The presence of rods with an inflammatory infiltrate is significant but not definitive for *Pseudomonas spp*., as both gram positive and gram-negative bacilli appear blue with this stain. A bacterial culture is essential for speciation, together with antimicrobial susceptibility to help determine appropriate therapy.

Treatment. The two most important factors in the therapy for *Pseudomonas* otitis are thorough ear cleaning and the selection of suitable antimicrobial drugs. Ear cleaning is useful to break up the mucoid discharge and allow increased contact of antimicrobial agents with the ear canal epithelium. Many ear cleaners, especially those that contain lactic acid, acetic acid or chlorhexidine, also have antimicrobial activity against *Pseudomonas spp*.

Edetate disodium dehydrate (EDTA), enhanced by a tromethamine (tris) buffer, acts to damage the walls of gram negative bacteria such as Pseudomonas spp. Products that contain tris EDTA have been shown to potentiate the activity of antibiotics such as aminoglycosides, making them important components of any treatment regime for *Pseudomonas otitis*. More than 40% of otic *P. aeruginosa* isolates are biofilm-producing organisms. As such, these sessile bacteria are likely to be more resistant to antibiotics than their planktonic counterparts. Clinical studies have shown that topical otic antibiotics reach levels 100-1000 times higher compared to the antibiotics given systemically, making this the route of choice for drug administration. Responsible antibiotic usage dictates licensed products containing aminoglycoside (framycetin and gentamicin) and polymyxin B should be first choice antibiotics where appropriate. Veterinarians can use licensed products containing fluoroquinolones (marbofloxacin, orbifloxacin) where sensitivity is confirmed and where resistance exists to first line drugs. Other antibiotics, which constitute an off licensed use of topical medication should be reserved for severe cases with compromised animal welfare and where no other medication appears suitable based on culture and susceptibility.

Further reading:

NUTTALL, T., COLE, L.K. Evidence-based veterinary dermatology: a systemic review of interventions for the treatment of *Pseudomonas* otitis in dogs. (2007) *Vet Dermatol*, **18**,2 69-77

PATERSON, S., WATYSKIEWICZ, W. (2018) A study to evaluate the primary causes associated with Pseudomonas otitis in 60 dogs. *Journal of Small Animal Practice*. **59,** 4 238-242

PYE, C.C., YU, A.A., WEESE, J.S. (2013) Evaluation of biofilms production by Pseudomonas aeruginosa from canine ears and the impact of biofilm on antimicrobial susceptibility in vitro *Vet Dermatol* **24,** 2 446-9

PYE, C.C., SINGH, A., WEESE, J.S. (2014) Evaluation of the impact of tromethamine edetate disodium dehydrate on antimicrobial susceptibility of Pseudomonas aeruginosa in biofilm in vitro. Vet Dermatol. **24,** 2 120-4

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References:

Arsevska, E., Singleton, D., Sánchez-Vizcaíno, F., Williams, N., Jones, P.H., Smyth, S., Heayns, B., Wardeh, M., Radford, A.D., Dawson, S., Noble, P.J.M., Davies, R.H., 2017. Small animal disease surveillance: GI disease and salmonellosis. Vet. Rec. 181, 228. https://doi.org/10.1136/vr.j3642

Buckland, E.L., O'Neill, D., Summers, J., Mateus, A., Church, D., Redmond, L., Brodbelt, D., 2016. Characterisation of antimicrobial usage in cats and dogs attending UK primary care companion animal veterinary practices. Vet. Rec. 179, 489. https://doi.org/10.1136/vr.103830

Haenni, M., Bour, M., Châtre, P., Madec, J.-Y., Plésiat, P., Jeannot, K., 2017. Resistance of Animal Strains of Pseudomonas aeruginosa to Carbapenems. Front. Microbiol. 8, 1847. https://doi.org/10.3389/fmicb.2017.01847

Martín Barrasa, J.L., Lupiola Gómez, P., González Lama, Z., Tejedor Junco, M.T., 2000. Antibacterial susceptibility patterns of Pseudomonas strains isolated from chronic canine otitis externa. J. Vet. Med. B Infect. Dis. Vet. Public Health 47, 191–196.

Parsons, B.N., Porter, C.J., Ryvar, R., Stavisky, J., Williams, N.J., Pinchbeck, G.L., Birtles, R.J., Christley, R.M., German, A.J., Radford, A.D., Hart, C.A., Gaskell, R.M., Dawson, S., 2010. Prevalence of Campylobacter spp. in a cross-sectional study of dogs attending veterinary practices in the UK and risk indicators associated with shedding. Vet. J. Lond. Engl. 1997 184, 66–70. https://doi.org/10.1016/j.tvjl.2009.01.009

Rasmussen, C.E., Williams, C.K.I., 2006. Gaussian processes for machine learning, Adaptive computation and machine learning. MIT Press, Cambridge, Mass.

Sánchez-Vizcaíno, F., Daly, J.M., Jones, P.H., Dawson, S., Gaskell, R., Menacere, T., Heayns, B., Wardeh, M., Newman, J., Everitt, S., Day, M.J., McConnell, K., Noble, P.J.M., Radford, A.D., 2016a. Small animal disease surveillance: respiratory disease. Vet. Rec. 178, 361. https://doi.org/10.1136/vr.i1815

Sánchez-Vizcaíno, F., Singleton, D., Jones, P.H., Heayns, B., Wardeh, M., Radford, A.D., Schmidt, V., Dawson, S., Noble, P.J.M., Everitt, S., 2016b. Small animal disease surveillance: pruritus, and coagulase-positive staphylococci. Vet. Rec. 179, 352. https://doi.org/10.1136/vr.i5322

Singleton, D.A., Sánchez-Vizcaíno, F., Dawson, S., Jones, P.H., Noble, P.J.M., Pinchbeck, G.L., Williams, N.J., Radford, A.D., 2017. Patterns of antimicrobial agent prescription in a sentinel population of canine and feline veterinary practices in the United Kingdom. Vet. J. 224, 18–24. https://doi.org/10.1016/j.tvjl.2017.03.010

Vogelnest, L.J., 2017. Skin as a marker of general feline health: Cutaneous manifestations of systemic disease. J. Feline Med. Surg. 19, 948–960. https://doi.org/10.1177/1098612X17723246

Tables

Tables 1A and 1B: Number and percentage of cats and dogs* with pruritus. A. main anatomical part affected, B. main treatment prescribed. Results are for randomly selected animals visiting the SAVSNET veterinary premises in the Great Britain, from January 2018 to April 2018.

A.

Anatomical part	Cat*	Dog*
Dorsal body	205 (27%)	337 (10%)
Ears	104 (14%)	1206 (37%)
Face	130 (17%)	310 (9%)
Feet/limbs	56 (7%)	585 (18%)
Tail	110 (15%)	259 (8%)
Ventral body	115 (15%)	439 (13%)
Other	36 (5%)	160 (5%)
Sum	**756 (100%)**	**3296 (100%)**

B.

Treatment	Cat*	Dog*
Systemic-antimicrobial	89 (12%)	325 (8%)
Systemic-glucocorticoid	257 (35%)	469 (12%)
Topical-antimicrobial	64 (9%)	843 (22%)
Topical-glucocorticoid	51 (7%)	656 (17%)
Anti-parasitic	158 (22%)	164 (4%)
Ear-cleaner	18 (2%)	384 (10%)
Shampoo	6 (1%)	215 (6%)
Other	57 (8%)	595 (15%)
None	24 (3%)	177 (5%)
Sum	**724 (100%)**	**3828 (100%)**

* The same animal could present with more than one clinical sign per consultation. The same animal can also have more than one administered treatment per consultation.

Table 2: Number and percentage of canine and feline *Pseudomonas aeruginosa* clinical isolates originally isolated from ear samples tested as being resistant to a number of antimicrobial classes. Data originates from four UK-based veterinary diagnostic laboratories, recorder between 2011 and 2017 (inclusive). 95% CI = 95% credible interval.

Antimicrobial class	**Canine**		**Feline**	
	Number of isolates tested	**Percentage resistant (95% CI)**	**Number of isolates tested**	**Percentage resistant (95% CI)**
Aminoglycosides	26772	8.4 (8.1-8.7)	255	5.1 (2.4-7.8)
Amphenicols	584	2.1 (2.0-2.3)	6	2.4 (0.5-4.2)
Carbapenems	4421	0.2 (0.1-0.2)	46	1.2 (0-2.5)
Extended-spectrum penicillins	14355	3.6 (3.4-3.8)	140	4.3 (1.8-6.8)
First- / second-generation cephalosporins	868	3.2 (3.0-3.4)	10	3.9 (1.5-6.3)
Fluoroquinolones	26769	25.0 (24.5-25.5)	255	17.7 (13.0-22.3)
Fusidic acid	1000	3.7 (3.5-4.0)	9	3.5 (1.3-5.8)
Lincosamides	67	0.2 (0.2-0.3)	2	0.8 (0-1.9)
Macrolides	64	0.2 (0.2-0.3)	2	0.8 (0-1.9)
Narrow-spectrum penicllins	9	0.0 (0.0-0.0)	0	NA
Nitrofurantoin	2	0.0 (0.0-0.0)	0	NA
Polymixins	26531	1.3 (1.2-1.4)	252	2.4 (0.5-4.2)
Potentiated penicillins	959	3.4 (3.2-3.7)	9	3.5 (1.3-5.8)
Potentiated sulphonamide	151	0.5 (0.4-0.6)	3	1.2 (0-2.5)
Tetracyclines	40	0.1 (0.1-0.2)	0	NA
Third- / fourth-generation cephalosporins	578	0.2 (0.1-0.2)	3	0.0 (0.0-0.0)

Figures

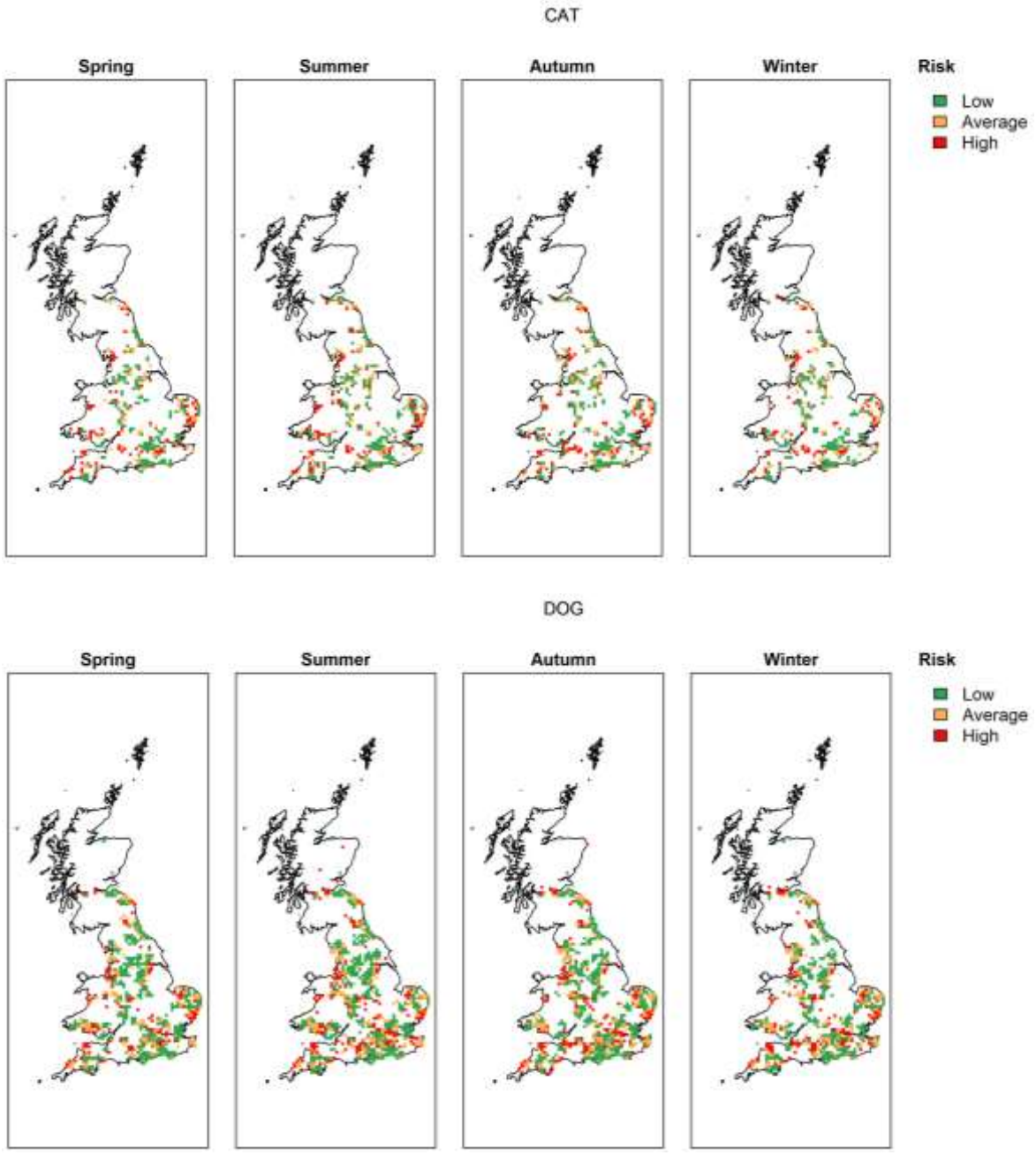

FIG 1: Spatial risk for pruritus in cats and dogs in Great Britain, from April 2017 to April 2018. The spatial risk has been categorised as low, average and high, and calculated based on a threshold set by the average percentage of consultations for pruritus from 2014 to 2016 (Sánchez-Vizcaíno et al., 2016).

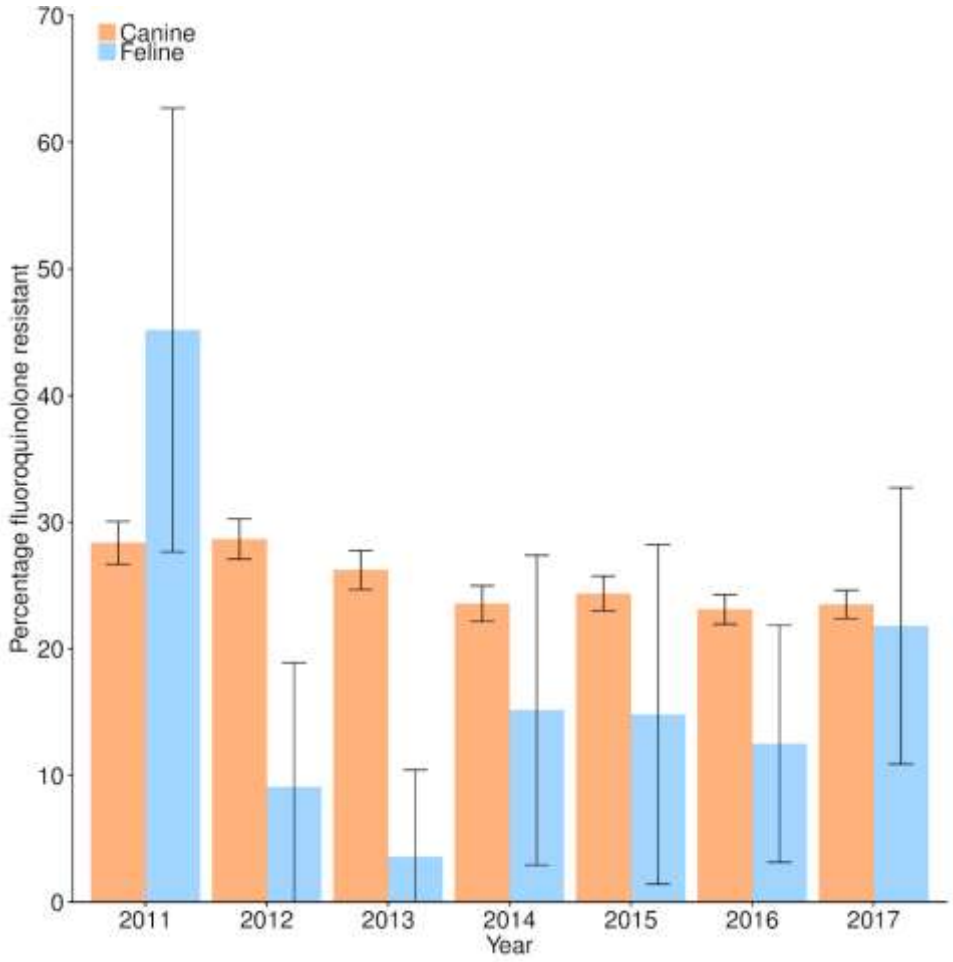

FIG 2: Summary of the percentage of tested *Pseudomonas aeruginosa* isolates originally isolated from canine and feline clinical samples displaying phenotypic fluoroquinolone resistance by year (2011-2017). Data summarised from four veterinary diagnostic laboratories.

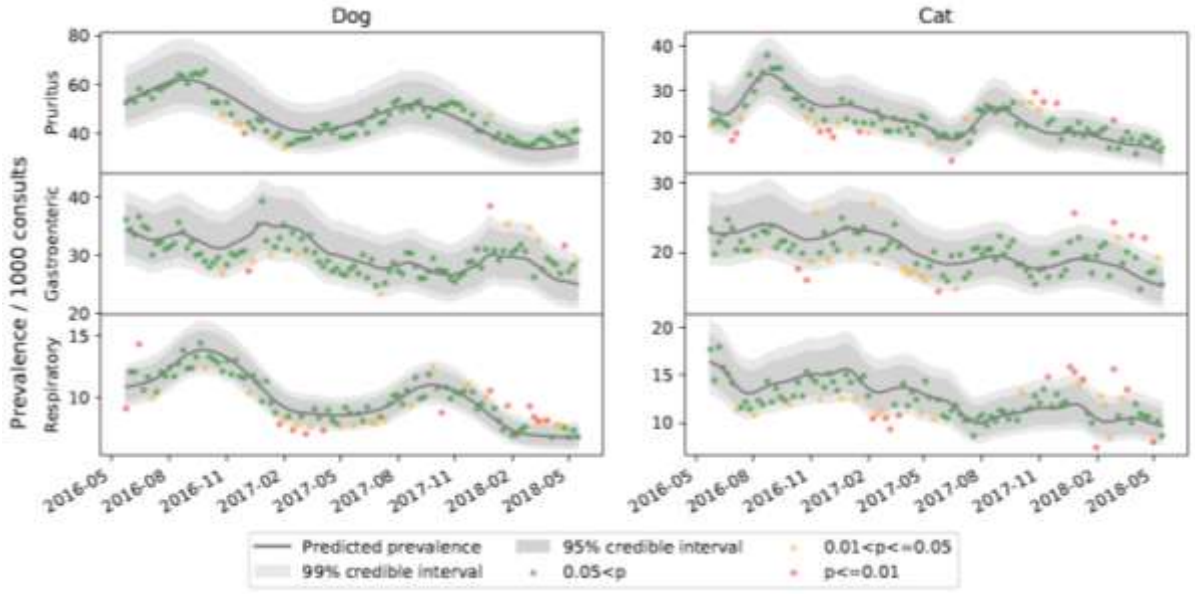

FIG 3: Observed prevalence for pruritus, gastroenteric and respiratory disease in cats and dogs attending SAVSNET-participating practices from April 2016 to April 2018 and predicted trends for May 2018. Red points represent the extreme outliers (outside the 99% credible interval, CI), orange points represent the moderate outliers (outside the 95% CI but within the 99% CI), and green points represent the average trend (within the 95 % CI).