# Real-time syndromic surveillance in companion animals; integrating electronic health records to provide One Health messaging and feedback loops to practice

AD RADFORD[1]*, F SÁNCHEZ-VIZCAÍNO[1,2], S DAWSON[3], PH JONES[1], B HEAYNS[1], M DAY[4], S EVERITT[5], K MCCONNELL[5], DA SINGLETON[1], J TULLOCH[2], J NEWMAN[1], PJM NOBLE[3]

[1]Institute of Infection and Global Health and [3]Institute of Veterinary Science, University of Liverpool, Neston, UK;
[2]NIHR Health Protection Research Unit in Emerging and Zoonotic Infections, University of Liverpool, Liverpool, UK; [4]School of Veterinary Sciences, University of Bristol, Langford, UK; [5]BSAVA, Woodrow House, [1] Telford Way, Waterwells Business Park, Quedgeley, Gloucestershire GL[2] [2]AB, UK

*alanrad@liverpool.ac.uk

## Abstract

Illness in pet animals impacts both on their welfare, and that of their owners and wider public. Despite the size of these populations, they have become information-poor due to the historical lack of centralised data collection.

The Small Animal Veterinary Surveillance NETwork (SAVSNET) is collecting electronic health records (EHRs) at scale to better understand the real-world of companion animal clinical veterinary practice. SAVSNET has assembled a strong coalition of collaborators and data providers allowing the collection of real-time data from diagnostic laboratories (~80,000 test results/day) and a sentinel network of over 450 veterinary clinics (~5000 EHRs/day) across the UK.

The use of this unique and rich data source has rapidly grown. Key areas of current research include antimicrobial resistance mapping, description of antibacterial prescription, as well as real-time outbreak monitoring in both animal-only and "one health" settings. Using text mining approaches we are unlocking the surveillance value previously hidden in the clinical narrative of each EHR, opening new opportunities for surveillance (clinical signs, ticks), and pointing to a future that is less reliant on practitioner coding. Through the owner postcode, we are linking EHRs to other data sources and understanding the impact of climate and owner predicted deprivation on disease and treatment.

SAVSNET has created innovative and novel feedback loops that provide bespoke results to our data providers, increasingly in real-time. This allows for the first time practitioners partaking in this surveillance to benchmark their own data to other anonymous practices in the network, with key features including antibacterial prescription and syndrome mapping.

**Keywords:** *one health, syndromic surveillance; text mining; companion animal; electronic health records*

## Introduction

According to recent estimates, there are 11.6 million dogs and 10.1 million cats kept as pets in the UK, with 30% and 23% of households owning a dog and cat respectively (1). These animals suffer a wide range of important diseases that impact not just on their own welfare but that of their owners. Despite the size of these populations, they have historically developed in the absence of coordinated surveillance, likely reflecting, at least in part, a relative absence of notifiable/reportable diseases in these populations, leading to a similar lack of momentum at government level to instigate national surveillance programmes as exist more typically for farmed species.

**Figure 1.** Veterinary sites submitting data to SAVSNET 2014-2016.
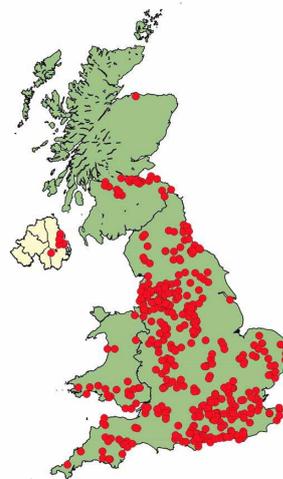


Evidence suggests that in countries with developed pet industries like the UK, a high proportion of owned pet animals attend a veterinary surgeon (2,3), suggesting that surveys of veterinary practices could be useful in estimating the demographics and disease profile of these populations. However, the fragmented nature of the companion animal industry has presented a challenge to the collection of these data. This is now being overcome as individual animal health records become digitised, making them more available for research. Although reliable estimates are not published, it is likely that the majority of pet animals in many developed countries now have an electronic health record (EHR). This has led to a rapidly growing interest in filling surveillance gaps in these populations by utilising novel, technology driven solutions based around the collection of large volumes of individual animal EHRs (4).

SAVSNET, the Small Animal Veterinary Surveillance Network, was established in 2008 as a joint venture between the British Small Animal Veterinary Association (BSAVA) and the University of Liverpool. It collects electronic health data in real-time from veterinary surgeons in practice, and receives routine downloads of diagnostic test results from commercial diagnostic laboratories throughout the UK. SAVSNET's research ethics foundation and its methodology mean it can collate these EHRs from disparate practices and laboratories across the country, making them available for research (5,6). Data supply has been maintained by limiting the additional workload of participating practices and providing real-time practice benchmarking.

Here we provide an update on SAVSNET and showcase novel solutions in clinical coding, text mining and benchmarking that now see SAVSNET at the centre of a growing research and surveillance network.

## Materials and methods

*Veterinary clinics:* EHRs were collected electronically in near real-time from volunteer veterinary practices using a compatible version of practice management system (PMS) namely RoboVet (Vetsolutions, Edinburgh) and Teleos (Birmingham). Each EHR contains the owner's postcode and a range of animal data including signalment, treatments and the clinical free text. At the end of each consultation, a syndrome tag is added by the attending practitioner allowing the EHRs to be used for real-time surveillance of key syndromes (Figure 2). These unique tags are compulsory, thereby avoiding coding bias. In addition, a more detailed questionnaire is randomly applied to approximately 10% of animals. As recruitment has progressed, large volumes of health data have become available, particularly since 2012, and SAVSNET now collects data from over 400 veterinary clinics in real time (Figure 1).

**Figure 2.** The unique SAVSNET window displayed at the end of each consultation allows a compulsory syndrome classification to be added by the practitioner to each EHR.
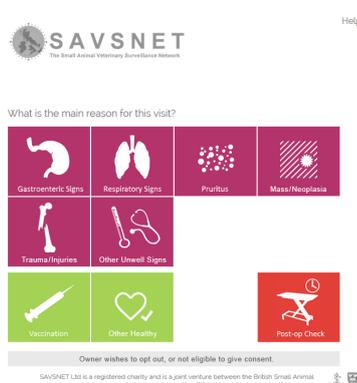


*Diagnostic laboratories:* Currently eight diagnostic laboratories in the UK submit test result data to SAVSNET, the majority of which arrives in near real-time. Laboratories are recruited by convenience initially focussing on the larger ones. Although it is not possible to accurately estimate the total potential size of these data, we estimate we are currently collecting over half of UK companion animal diagnostic testing. The record with each test result includes the submitting practitioner's postcode, the date of the test, the test performed and the result. Data is received for infectious diseases, serology, antimicrobial resistance and histology.

## Results

In total, EHRs are now available for almost 2,000,000 consultations (approximately 70% from dogs, 26% cats, 1% rabbits, 1% other species and 1% where the species was not noted). Compared to their carnivore cousins cats are generally older, more likely to be non-pedigree and more likely to be neutered.

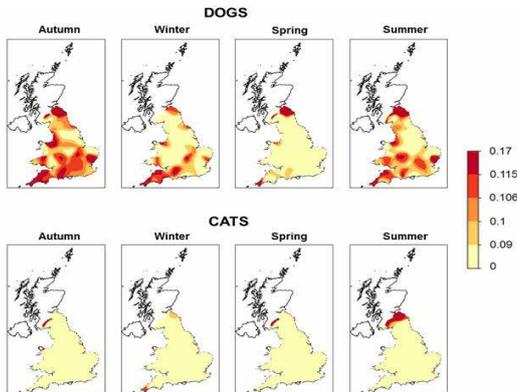Similar to the veterinary clinic data, EHRs from laboratories are also more common from dogs.

*Text mining, tick surveillance and babesia:* Following the recent introduction of *Babesia canis* into the UK (7), we have used EHRs to explore both tick activity and canine babesia diagnosis. Using a simple text mining approach, EHRs were identified containing the word tick. These were read by a domain expert to identify only those where a tick was observed by the attending practitioner. Plotted according to consult date, they highlight the seasonal spring rise in tick activity in the UK that coincided with the emergence of canine babesiosis (Figure 3A). Figure 3B shows the number of canine babesiosis cases notified to SAVSNET by diagnostic laboratories highlighting the endemic risk in the Chelmsford area and sporadic risk elsewhere likely associated with overseas travel.

**Figure 3.** (A) tick seasonality. (B) canine babesiosis diagnosis
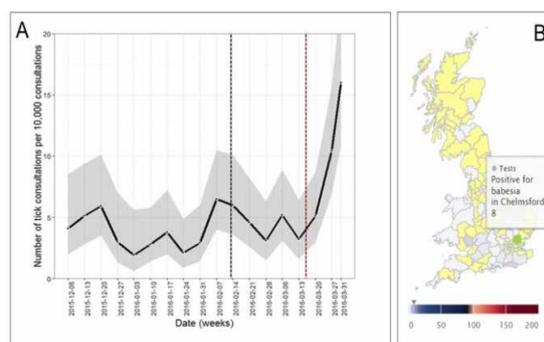


*Syndromic surveillance:* Compulsory practitioner syndrome coding of each EHR (Figure 2) allows us to map in space and time key syndrome indicators of population health such as gastrointestinal disease, respiratory disease and pruritus. In parallel, and building on earlier text mining approaches, we are developing a growing repertoire of tools to automatically identify to high sensitivity and specificity clinical signs referred to within the EHR (e.g. pyrexia, cough, vomit).
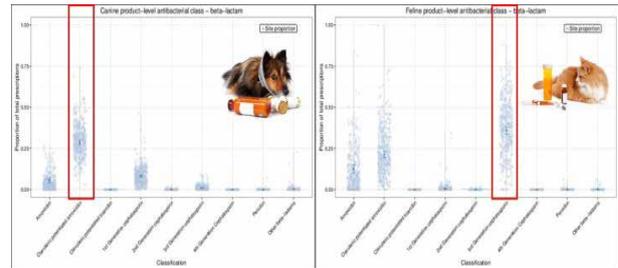
**Figure 4.** Kernel intensity ratio surface of England and Wales showing the relative risk of dogs and cats being presented with pruritus by season.



**Figure 5.** Beta-lactam prescribing in veterinary consultations monitored through their EHR.



This allows us for the first time to describe in real time, the use of antibactierials in the SAVSNET population of practices, and provides a feedback loop to practitioners through their benchmark site.

*Antibacterial prescription:* Antimicrobial resistance (AMR) has been described as one of the greatest current challenges to the future of both veterinary and human health, with antibacterial usage a key driver in AMR development. However, information on how antibacterials are dispensed, particularly in companion animals, has to date been limited, restricting the ability of the veterinary profession to respond to the challenge of AMR. Using the practitioner derived text-based product code attached to each EHR (e.g. 12x synulox 250mg tablets), and a novel text mining approach, we can now map these product codes semi-automatically to publically available product categorisation data such as available through the Veterinary Medicines Directorate Product Information Database for veterinary authorised products.

For both dogs and cats, approximately 17-19% of all consultations involved the dispensing of at least one antibacterial-containing product, 84-90% of which was veterinary-licenced. The most commonly dispensed antibacterial in dogs was clavulanic-acid-potentiated-amoxicillin (28.2%; 26.7-29.7) and cefovecin in cats (34.8%; 31.4-38.2) (Figure 5). Fluoroquinolones comprised 4.7% and 3.3% of dispensed antibacterials in dogs and cats respectively. During the particular study period, no vancomycin or teicoplanin (glycopeptides); meropenem or imipenem (carbapenems) containing-products were dispensed in any animal species.

*Feedback loops to practice:* Large volumes of validated health data provides an opportunity to feedback results of surveillance at a locally meaningful level to participating practices. The SAVSNET portal was launched in 2015 and provides a novel and valuable opportunity for practitioners to understand how their practice compares to others in the network. Current benchmarks include maps of client demographics and key performance indicators such as neutering frequencies. At the disease level practitioners can compare how common each of the syndromes are in their practice and how they change over time. Finally practitioners can compare their antibacterial use to their anonymised peers (Figure 6).

**Figure 6.** A screenshot from the practitioner portal providing feedback / benchmarking on antibacterial use.



## Conclusions

EHRs collected at scale from a decentralised network of practitioners and laboratories are providing new insight into a diverse range of animal and human health issues, in what might recently have been considered an information-poor environment. Surveillance data is now available online at liv.ac.uk/savsnet. Novel technologies, particularly around practice communication and text mining represent fertile areas for future development.

## References

1. **Murray** *et al.* *Vet Rec* 166, 163-168, 2010
2. **Asher** *et al.* *BMC Veterinary Research* 7, 74, 2011
3. **Lund** *et al.* *JAVMA* 214, 1336-1341, 1999
4. **O'Neill** *et al.* *Canine Genet Epidemiol.* 1, 2, 2014
5. **Sánchez-Vizcaíno** *et al.* *Vet Rec* 178(15), 361, 2016
6. **Jones** *et al.* *Vet J* 201(3), 412-8, 2014
7. **Swainsbury** *et al.* *Vet Rec* 178(7), 172, 2016

## Acknowledgements