Institution: University of Liverpool		
Unit of Assessment: UoA6		
Title of case study: Small Animal Veterinary Surveillance Network (SAVSNET) research and surveillance initiative leading to behaviour change and improved companion animal health.		
Period when the underpinning research was undertaken: 2008-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Alan Radford	Professor	1999 to date
Peter-John Noble	Senior Lecturer	October 2002 to date
Gina Pinchbeck	Reader	May 2004 to date
Nicola Williams	Professor	November 2011 to date
Phil Jones	Lecturer in Epidemiology	2007 to 2018
Susan Dawson	Professor	1992 to date
David Singleton	PhD student then PDRA	August 2015- to date
Period when the claimed impact occurred: 2013-2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact (indicative maximum 100 words)

Surveillance and population health research in companion animals have been neglected globally. To fill this void we developed SAVSNET, the world's first comprehensive active surveillance system for companion animals. SAVSNET collects electronic health records at scale from UK veterinary practices and diagnostic laboratories, providing an essential research and surveillance resource. Our SAVSNET driven impacts are wide and varied and include:

- Detecting and quantifying a novel disease outbreak in the UK dog population, enabling a response to be mounted within weeks. SAVSNET is recognised by the UK government for its vital role in national disease preparedness and response.

- Demonstrating population inequalities in vaccine coverage, which underpinned organisational change in the People's Dispensary for Sick Animals Royal Charter and led to vaccination of 78,300 pets in 2018 alone.

- Significant evidence-driven improvement in antimicrobial stewardship in veterinary practices, recognised by Royal College of Veterinary Surgeons Knowledge (RCVSK) and underpinned by our research into veterinary antimicrobial prescribing patterns.

2. Underpinning research (indicative maximum 500 words)

Our Small Animal Veterinary Surveillance Network (SAVSNET) has provided the first comprehensive and functional surveillance system for companion animal health. The system uses electronic health records (EHRs) collected nationally at scale from a sentinel network of volunteer veterinary practices and laboratories across the UK. These data are harnessed for rapid and actionable surveillance and research into companion animal diseases, including zoonoses.

Following a pilot research phase (2008-2011) led by Radford and Dawson, SAVSNET Ltd. was formed as a joint venture between the University of Liverpool and the British Small Animal Veterinary Association. Research by the UoL SAVSNET group that has led to impact over the REF period has been focused in two main strategic areas:

Surveillance and control of infectious diseases

Using EHRs we established the first real-time syndromic surveillance system able to conduct integrated spatio-temporal analysis of data from a national network of veterinary premises for the early detection of disease outbreaks in small animals. The system can detect simulated outbreaks of varying spatial geometry, extent and severity [**3.1**]. Its real-world value was demonstrated in 2020 when the SAVSNET syndromic classification, combined with text mining of clinical narratives, was used to confirm, track and respond to a novel disease outbreak in the UK dog population, identifying the likely cause (canine enteric coronavirus) in six weeks [**3.2**].

Research on vaccine uptake identified key health inequalities and showed that owners living in areas of high deprivation were less likely to vaccinate their pets [**3.3**]. In commissioned research we also demonstrated that vaccine preventable diseases remain endemic across the UK.

Rapid and regular updates were published during the 2020 COVID-19 pandemic allowing monitoring and surveillance of the impact of the crisis on companion animal veterinary care and infectious diseases. This included impacts on vaccine uptake and vaccine preventable diseases in the UK pet population, as well as changes in the numbers and types of veterinary consultations [**3.4**].

Antimicrobial prescription (AMP) and resistance (AMR)

A strategic focus of research using SAVSNET data was (and remains) AMR and antimicrobial prescription by veterinary practitioners. We developed a semi-automated classification methodology to map practitioner-defined product descriptions. Using this, we showed that antimicrobial prescription was frequent in companion animals, and that prescription of highest priority critically important antimicrobials (HPCIAs) was increasing in cats, but that there was considerable variability associated with certain practice characteristics (such as RCVS accreditation) and preventive health-focused owner care decisions (for example vaccination and insurance status) [**3.5**]. The prescription and benchmarking methodologies developed by SAVSNET, combined with SAVSNET data collection tools, led to the first successful randomised controlled trial of behaviour change interventions to reduce antimicrobial prescribing in companion animals. We showed that an intervention comprising educational material, in-depth benchmarking and follow-up meetings led to significant reductions of 30-40% in canine and feline HPCIA prescription [**3.6**].

SAVSNET monitors antimicrobial resistance trends in companion animals utilising records from diagnostic laboratories. Using data on 37,500 clinical antimicrobial susceptibility tests (ASTs) on *Enterobacteriaceae,* we demonstrated spatial variation in AMR and multidrug resistance (MDR) risk as well as identifying animal-related factors associated with MDR. We also established a 'virtual biobank' to provide novel routes to retrieve important isolates for enhanced genotypic characterisation which enables us to identify gene variants that may be of significance to human and companion animal AMR infections and contributes directly to UK surveillance on AMR.

Our research using SAVSNET has led to improved methodologies to identify, quantify and describe disease in the pet population. It has highlighted issues around antimicrobial use by veterinary practices and developed a proven approach to reducing prescribing.

3. References to the research (indicative maximum of six references)

3.1. **Hale AC, Sánchez-Vizcaíno F, Rowlingson B, Radford AD, Giorgi E, O'Brien SJ and Diggle PJ** (2019). A real-time spatio-temporal syndromic surveillance system with application to small companion animals. Scientific Reports,9, 17738, doi: https://doi.org/10.1038/s41598-019-53352-6

3.2. **Alan D. Radford, David A. Singleton, Chris Jewell, Charlotte Appleton, Barry Rowlingson, Alison C. Hale, Carmen Tamayo Cuartero, Richard Newton, Fernando Sánchez-Vizcaíno, Danielle Greenberg, Beth Brant, Eleanor G. Bentley, James P. Stewart, Shirley Smith, Sam Haldenby, P.-J. M. Noble, and Gina L. Pinchbeck**. Outbreak of Severe Vomiting in Dogs Associated with a Canine Enteric Coronavirus, United Kingdom. (In press). Emerging Infectious Diseases. doi: https://doi.org/10.3201/eid2702.202452 (pre-publication available from November 2020).

3.3. Sánchez-Vizcaíno F, Muniesa A, **Singleton DA**, **Jones PH, Noble PJ**, Gaskell RM, **Dawson S** and **Radford AD** (2018). Use of vaccines and factors associated with their uptake variability in dogs, cats and rabbits attending a large sentinel network of veterinary practices across Great Britain. Epidemiology and Infection 146; 895-903. doi: https://doi.org/10.1017/S0950268818000754

3.4. **Singleton DA, Noble PJ, Brant B, Pinchbeck GL, Radford AD.** Social distancing impact on companion animal practice. Vet Rec. 2020 Jun 13;186(18):607-608. doi: http://dx.doi.org/10.1136/vr.m2271

3.5 Singleton DA, Radford AD, Pinchbeck GL, Dawson S, Jones PH, Arsevska E, **Noble P-JM, Williams NJ**, Sánchez-Vizcaíno F (2020). Owner, animal, veterinary practice, and

practitioner-related factors associated overall antimicrobial and HPCIA prescription in dogs and cats attending first opinion practices. Emerging Infectious Diseases. 26(8). doi 10.3201/eid2608.191786

3.6. Singleton DA, Radford AD, Noble P-JM, Williams NJ, Pinchbeck GL (In press). A randomised interventional study to reduce use of highest priority critical antimicrobial prescription in veterinary practice. Preprint: doi: https://doi.org/10.21203/rs.3.rs-48687/v1 (pre-publication available from August 2020).

4. Details of the impact (indicative maximum 750 words)

Our SAVSNET initiative has led to changes in policy and practice to improve the health of companion animals across the UK and to reduce the threat of AMR to animal and human health. The reputation of our research has seen SAVSNET grow to the point where 15% of UK practitioners and over 70% of commercial diagnostic laboratories now voluntarily contribute data. Our reputation has also led to SAVSNET being used as a model for developing similar national surveillance networks in countries including USA (**5.1**) and Portugal. The wide-ranging impact of SAVSNET was recognised by the BBSRC through the award of the 2019 Innovator of the Year Team Award for societal impact.

Surveillance and control of infectious diseases:

Almost 50% of adults own a pet. Despite this, a lack of surveillance and population health research in companion animals left this population acutely susceptible to the emergence of health threats. The SAVSNET initiative has filled this gap in the UK, and now plays a leading role in national companion animal surveillance and UK disease preparedness as recognised by government "***SAVSNET, through its real-time data collection and responsive data analyses, provides a unique and valuable resource that APHA considers an important component of the UK's national disease preparedness***" (**Head of Surveillance Intelligence Unit, APHA (**an agency of Defra), **5.2**). Our work was highlighted in the British Veterinary Association (BVA) report on the future of veterinary surveillance in the UK. Additionally, in partnership with the Animal and Plant Health Agency (APHA) SAVSNET publishes regular surveillance updates in the BVA Veterinary Record under their surveillance banner and APHA's Vet Gateway website directly signposts vets to the SAVSNET website (**5.2**). Our research is also valued by pharmaceutical companies; ***"SAVSNET provides unique insights and fills a very important gap in our knowledge of vaccine preventable disease in companion animals*** (**Senior Technical Manager, MSD, 5.3**). Four companies are currently commissioning data, and research output has been used to underpin vaccination campaigns.

The impact of our work was highlighted in the recent unprecedented outbreak of gastroenteric disease in dogs, starting late 2019. Using methodologies developed in SAVSNET we harnessed syndromic data from EHRs to track the outbreak in near-real time both temporally and spatially. We launched regularly updated owner and veterinary websites, including evidence-based case descriptions, treatment recommendations and biosecurity advice (**5.4**). This site was viewed 32,617 times from launch (29/1/2020) to 11/3/2020; 27,161 Twitter users saw our tweets, and 30,100 saw our Facebook posts. We launched case and control questionnaires and sample collection tools, and were able to determine the likely cause of the outbreak as a canine enteric coronavirus variant within 8 weeks. SAVSNET was the only source of information about this outbreak and were able "***to highlight the issue to Government; the issue was subsequently presented to the Veterinary Risk Group***" (**Head of Surveillance Intelligence Unit, APHA, 5.2**) enabling the government and professional bodies such as BVA to communicate accurate information to their members.

SAVSNET is also able to rapidly respond to government requests for data and expertise, for example "***providing valuable data in the early days of the COVID-19 pandemic about the potential for companion animals to act as hosts for the SARS-CoV-2 virus. This data contributed to the evidence base used to inform Government policy and advice relating to the role of companion animals in the COVID-19 pandemic***" (**Head of Surveillance Intelligence Unit, APHA, 5.2**).

Vaccination against key infectious diseases is a primary method of disease control. Our research showed that owners living in areas of high deprivation would be less likely to vaccinate

their pets, and also demonstrated that vaccine preventable diseases remain endemic across the UK. Supported by this evidence, the People's Dispensary for Sick Animals was able to change the Charitable Objects in its Royal Charter to include free or low-cost vaccination of pets belonging to owners in need, vaccinating 318,00 pets since 2016 (**5.5**). This modification is a particularly important outcome in the background of the 'recorded decline' in the number of pets being vaccinated in the UK, potentially threatening herd immunity. We are surveilling the impact of the COVID-19 pandemic on pet vaccination rates and vaccine preventable diseases (**5.3**).

Antimicrobial prescription and resistance (AMR)

The threat of AMR can only be tackled through improved surveillance and optimisation of use in humans and animals (World Health Organisation Global Action Plan). SAVSNET is uniquely able to collate and analyse data on antimicrobial prescription and AMR in companion animals in the UK.

Our data and research outputs are used by governments to understand antimicrobial use and AMR in companion animals, underpinning national plans. Findings on AMR were disseminated to both government and the veterinary profession via invited talks (e.g., Defra Antimicrobial Resistance Coordinating Group quarterly meeting, VMD Research & Development Symposium, UK Chief Veterinary Officer Surveillance Forum, BVA, BSAVA and the Small Animal Medicine Society). The Veterinary Medicines Directorate (an agency of Defra) included SAVSNET research output in the UK Veterinary Antimicrobial Resistance and Sales Surveillance reports for 2016, 2018 and 2019 which has been used by the VMD as a *"source of evidence informing work on antimicrobial resistance (AMR) and to help improve monitoring of antibiotic use and AMR in companion animals"*, and *"enabling access to companion animal antimicrobial resistance information and trend data to practising clinicians"* (**AMR Surveillance and Evidence Programme Manager, VMD, 5.6**). NHS Scotland integrated both antimicrobial prescription and AMR data from SAVSNET into the Scottish One Health Antimicrobial Resistance and Antimicrobial Use Reports 2018 and 2019, which underpin national and local AMR containment plans. This report was "***the first time, data on antimicrobial resistance and antimicrobial use in companion animals were available***" (**5.7**).

Our research has also had impact on veterinary antimicrobial prescribing. Our web-based portal/dashboard allows veterinary practitioners within SAVSNET to benchmark their antimicrobial use. To date 66% of over 300 practices participating in SAVSNET had accessed their portal. A survey of participating SAVSNET practices (64 responses) highlighted how SAVSNET benchmarking tools enable practices to make evidence-based changes to use antimicrobials more responsibly. Veterinary surgeons said they used SAVSNET *"in practice meetings to reduce convenia and baytril use",* and for *"comparison with other practices to make sure what we are doing seems appropriate"*

In 2017, we launched a new antimicrobial benchmarking tool, *mySavsnetAMR* available to all veterinary practices in the UK, enabling them to benchmark their antibiotic prescription against their anonymised peers. To date 31 practices (79 sites) are using *mySavsnetAMR.* The value of this scheme was highlighted by inclusion on the BSAVA/SAMSOC Guide to Responsible Use of Antibacterials: PROTECT ME, to which University of Liverpool staff also contributed. Further, *mySavsnetAMR* has been endorsed by RCVS-Knowledge who recognise the "***utility that mySAVSNETAMR brings to practices and the evidence base that it is developed from***" choosing to include it on their vetAUDIT website to facilitate *"**responsible prescribing of antibiotics which contributes to improvements in the quality of care and the One Health agenda**"* (**Executive Director, RCVSK 5.8**).

Based on our research and using SAVSNET benchmarking tools, we developed interventions, in collaboration with a large corporate veterinary group, to reduce antimicrobial prescribing. This comprised educational material, in-depth benchmarking and reflective meetings (**5.9**). These led to a significant change in prescribing behaviour demonstrated by a randomised controlled trial. In intervention practices, we demonstrated significant reductions in the prescription of HPCIAs of 40% in cats and 30% in dogs over an 8-month follow-up period (**5.10**). This ***"provided enough evidence for the initiative to be rolled out to the remaining practices***" and "***the trial highlighted the positive impact of having continuous access to data and benchmarking***

> ***tools on influencing behaviours and reducing the prescribing of antibiotics***" (Chief Veterinary Officer, **CVS (UK) Ltd**, **5.10**). We are now working with RCVSK to develop a toolkit using our benchmarking tools for use across the veterinary profession.
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> The value of veterinary practices participating in SAVSNET has been recognised by the RCVS as an award of points towards RCVS practice accreditation for contributing data towards professional benchmarking or clinical data collection, or data for future potential publication (**5.11**).
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> This combined body of work has demonstrated SAVSNET's impact leading to improved antimicrobial prescribing in companion animals, the recognised prerequisite to reduce overall selection pressure for AMR. Such improvements will both benefit animal and human health, and help safeguard antimicrobials for future use.

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1. Letter from Minnesota Department of Health and University of Minnesota on the establishment of a similar surveillance network based on SAVSNET, the first of its kind in the USA.

5.2. Letter from Head of Surveillance Intelligence Unit, APHA highlighting SAVSNET'S unique role in disease surveillance in the companion animal sector and providing specific recent examples where the data and expertise provided by SAVSNET have been able to support APHA and wider Government in for example the outbreak of vomiting in UK dogs and the role of companion animals as hosts for the SARS-CoV-2 virus. [Corroborator 1].

5.3. Letter from Senior Technical Manager, MSD Animal Health highlighting the unique insights SAVSNET provides on vaccine preventable disease in companion animals. Example of data use here: https://www.msd-animal-health-hub.co.uk/KBPH/vaccines/disease/canine-parvovirus

5.4 Web site for outbreak of gastroenteric disease https://www.liverpool.ac.uk/savsnet/dog-vomiting-potential-outbreak/.

5.5. PDSA 2018 annual report highlighting vaccination of pets (page 15) https://www.pdsa.org.uk/media/6782/12288-pdsa-annual-report-2018-low-res.pdf and letters from PDSA highlighting SAVSNET's role in changing their Charter to allow vaccination. [Corroborator 2].

5.6. Letter from Veterinary Medicines Directorate [corroborator 3] highlighting our contribution to the AMR policy and inclusion in annual UK VARRS reports 2016 - 2019.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/837171/PCDOCS-_1692007-v1-VARSS_2016_Report_-_watermarked.pdf AND https://www.gov.uk/government/publications/veterinary-antimicrobial-resistance-and-sales-surveillance-2018 AND https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936107/UK-VARSS_2019_Report__2020_.pdf

5.7. Letter from NHS Scotland demonstrating value of SAVSNET data on antimicrobial prescribing and antimicrobial resistance and inclusion of SAVSNET data in SONAAR reports 2018 and 2019 at https://hps.scot.nhs.uk/web-resources-container/scottish-one-health-antimicrobial-use-and-antimicrobial-resistance-in-2019/

5.8. Letter of support from Royal College of Veterinary Surgeons Knowledge highlighting use of SAVSNET and *mySavsnetAMR* on benchmarking antimicrobial use and audit web site (https://vetaudit.rcvsk.org/mysavsnet).

5.9. Webinar on AMR and use of the SAVSNET benchmarking portal and the use of mySavsnetAMR used in the randomised trial. https://savsnetvet.liverpool.ac.uk/savsnetamr/iv?ID=62.

5.10. Letter from CVS Group Plc, (largest integrated veterinary service in the UK) highlighting our impact on antibiotic prescribing behaviours in their practices and the value of SAVSNET benchmarking tools.

5.11. Royal College of Veterinary Surgeons accreditation scheme that allows practices to accrue points towards accreditation from participation in SAVSNET https://www.rcvs.org.uk/document-library/small-animal-modules/ (page 26).