One Health e-Surveillance for Early Detection of Gastrointestinal Disease Outbreaks

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INTRODUCTION

In human and animal health, conventional approaches to preventing and controlling gastrointestinal disease (GI) have not reduced the overall disease burden. In order to understand and mitigate shared GI aetiologies between humans and animals it is necessary to develop One Health Surveillance approaches that integrate data-sources contributed to by human and veterinary healthcare. One such approach is described here.

MATERIAL AND METHODS

Data collection

AEGISS2
(Ascertainment and Enhancement of Gastro-Enteric Surveillance System**)**

Electronic data relating to human GI

Phone calls made to the NHS111 medical triage service

Patients seeking medical advice about acute GI symptoms

Spatial and temporal information from patients

Data stored on AEGISS2 servers

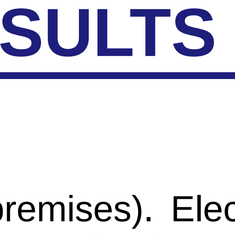
These data have only recently become available and were not used to fit the model

SAVSNET
(The Small Animal Surveillance Network**)**

Real-time veterinary electronic health records

Multiple veterinary clinics

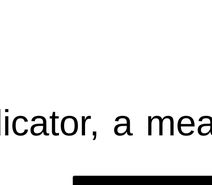
Owners consent by opt-out



Veterinarians update e-Health Records during consultations

All consultations are tagged with the syndrome by the attending vet

(~10% have additional questionnaires)



Consultations data sent to SAVSNET in real-time

Data stored on SAVSNET servers

Statistical analysis

Modelling: A Bayesian spatio-temporal mixed effects binary regression model was used to model the incidence of GI in dogs and cats as a proportion of all presentations. The model was fitted to data between 01/11/2014 and 15/11/2014 using a bespoke Markov chain Monte Carlo algorithm to generate samples from the predictive distribution of the underlying spatio-temporal incidence surface. These samples were then used to compute predictive probabilities for exceedance of policy-relevant relative risk thresholds; a high predictive probability at a particular time and place gives an early warning of a possible GI outbreak.

Model testing: To test if the model detects such outbreaks we created a data set with a fictitious premise having an excessive number of fake GI cases (Figure 1). The synthetic data is based on a typical premise in the SAVSNET dataset to ensure it reflects the characteristics of the genuine data. The outbreak is defined as the eight days from Monday, 03/11/2014 to Monday, 10/11/2014 inclusive. In the synthetic premise the consultations classified through SAVSNET like 'other unwell', 'post-op' and 'tumour' were converted to GI during this period.

The outputs from the model were then used to experiment with possible visualisations for reporting back to the practice (Figure 2).

RESULTS

Characteristics of study population

Data were collected from 102 UK veterinary practices (total of 197 premises). Electronic heath records were captured from 491,193 consultations (361,203 dogs, 129,990 cats) between January 2014 and July 2015. GI comprised 4.6% of canine and 3.6% of feline consultations, respectively.

Model outputs

The final model included as explanatory variables age, species, weekend indicator, a measure of deprivation, animal's breed classified as purebred or crossbred and longitude / latitude effects. Predictive probabilities for a relative risk threshold of 1.2 or more were all comfortably greater than 0.5 identifying the faked outbreak.

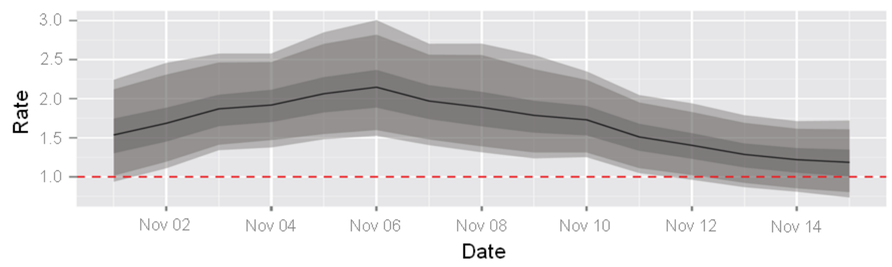


Figure 1. *Model outputs for one fictitious practice where a GI outbreak was faked between 03/11/2014 and 10/11/2014. The solid black line is the mean of the samples of random effects S_{it}, and the shaded areas are confidence interval areas. The inner, darkest region contains 50% of the samples. The red dotted line is drawn at the nominal S_{it} = 1 level.*

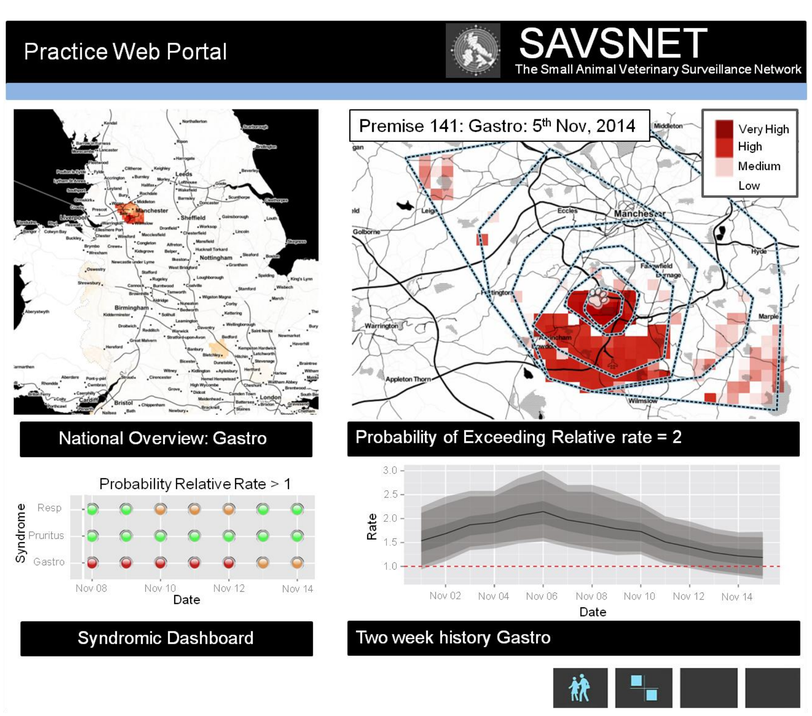


Figure 2. *Practice Web-Portal mock up showing the results obtained from a developed surveillance system for early detection of GI outbreaks in UK small animal practices.*

CONCLUSIONS

- This pilot study is the first demonstration of the **feasibility** of **real-time syndromic surveillance** in UK small animal practices.
- In future work, we intend to **adapt** the **model** to early **detection** of **human GI outbreaks**, and to **investigate** the possible **inter-dependence** of spatio-temporal variations in **GI risk** between companion **animals** and **people**. The model will be adapted to early detection of outbreaks for **other syndromes** such as respiratory disease, pruritus, etc.

ACKNOWLEDGEMENTS

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