# *Echinococcus multilocularis* surveillance in Great Britain: an assessment of the costs and effectiveness of different diagnostic tests

Animal & Plant Health Agency

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**The parasitic tapeworm *Echinococcus multilocularis*** is the causative agent of alveolar echinococcosis, which can affect both dogs and humans. Treatment for AE is complex, often requiring surgery in addition to expensive lifelong anthelmintics. *Echinococcus multilocularis* can be found across Europe, however, Great Britain currently holds disease-free status.

## Introduction

In the life cycle of *Echinococcus multilocularis* (EM), the intermediate host (typically microtine rodents) ingest eggs which develop and enter the liver from the small intestine, maturing into metacestodes. Definitive hosts (primarily foxes, dogs and cats) consume the intermediate hosts, the metacestodes mature in the upper intestine and start producing eggs, which are excreted in faeces, continuing the cycle. If humans ingest the eggs, metacestode development can occur in the liver, causing alveolar echinococcosis (AE) and while dogs usually act as definitive hosts like foxes, infection with alveolar echinococcosis can also occur in animals.

Great Britain (GB) is EM free but risk of incursion exists from improperly checked animals, such as from pets, or from wild animals introduced (e.g for rewilding). Should the pathogen enter the country the estimated 357,000 red foxes serve as a potential wildlife reservoir.

The current EM surveillance programme in GB involves annual testing of faeces from red fox carcasses collected from across GB, using an egg sieving/flotation and PCR diagnostic method. This screens for the presence of EM in order to provide proof of freedom from disease in the red fox population at 1% prevalence with 95% confidence. Preventative measures include anthelmintic treatment required for any dogs entering the country.

The purpose of this analysis is to showcase the best surveillance option to stakeholders by utilising a model to estimate the number of years until detection (YTD) of EM for several diagnostic tests, and to provide a comparison of the economic costs or benefits of alternative diagnostic tests compared to the current egg sieving/flotation method. The YTD was estimated based on results of a mathematical simulation model that predicted the time until first detection in a red fox by simulating population biology and disease transmission in a definitive red fox host population and intermediate field vole host population.

## Methods

### Diagnostic tests compared

- SVT/EGG FLOTATION (Current approach)
- IST (Intestinal Scraping technique)
- SCT (Sedimentation and Counting Technique)
- qPCR
- ELISA
- SCT-EFSA*

*SCT parameterised using the lower test sensitivity recommended by EFSA

### Parameterisation and economic analysis

The economic analysis portion of this work used a modified cost-benefit approach, collating data from various parameters broadly divided into costs and benefits. The data collected included:

- Annual cost of surveillance
- Cost of required worming
- Cost of treatment (humans and dogs)
- Estimated annual case number (humans and dogs)

These parameters then combined with a modelled output of years until detection for each of the diagnostic tests to produce an overall financial cost to first detection.

Subsequently, scenario analysis estimated the number of years required to recoup the total surveillance costs (to first detection) varying the cost of human treatment, annual incidence, and additional deworming costs.

The percentage difference in costs was calculated by multiplying the cost of surveillance and national deworming of dogs by YTD and adding the estimated value of incurred healthcare costs from the parasite pre-detection.

### How spread was modelled

- Introduction of the disease was simulated in a single fox territory in the centre of the arena.
- Carcass collection was simulated
- Surveillance data replayed at random after historical data ran out.
- The surveillance program is convenience-based. Variation in number of carcasses collected at each location
- Output data was simulated for 50 years and measured monthly.
- A range of prevalence rates between (0-~40%) was included in the simulation experiment, to reflect differences in the local host population and carcass collection time.
- YTD was then calculated using estimated sample number required to confirm prevalence, test sensitivity and test throughput.

## Results

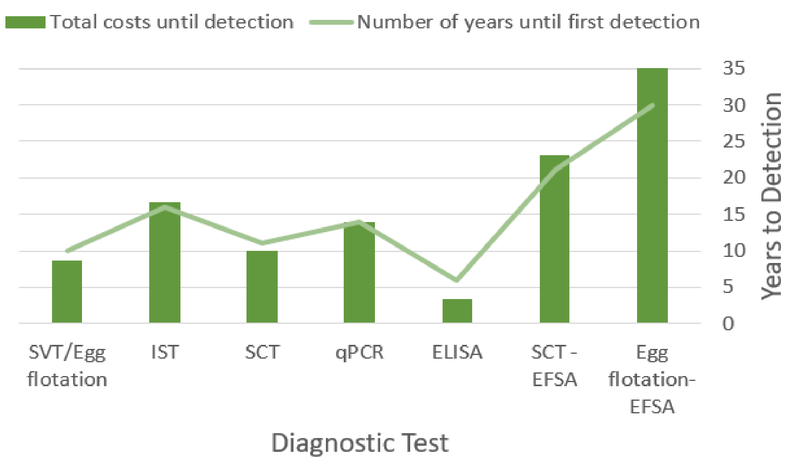


Figure 1: Number of years until detection (line) and total cost of surveillance up to the year of detection (bars), for each diagnostic test assessed.

**The ELISA is the most effective test, with the current GB approach coming second, but why?**

**Pros:**
- **High test sensitivity**
- **High throughput**
- **Less costly at point of use**
- **Detection of pre-patent infections**

**Cons**
- **Lower specificity**
- **No commercial kit available so set up and validation may be expensive.**

| Test | Number of years until first detection | No. of additional years to detection compared to current test | Percentage change |
|---|---|---|---|
| SVT/Egg flotation | 10 | 0 | 0.00 |
| IST | 16 | +6 | 113.77 |
| SCT | 11 | +1 | 19.00 |
| qPCR | 14 | +4 | 75.88 |
| ELISA | 6 | -4 | -75.88 |
| SCT - EFSA | 21 | +11 | 208.64 |

## Conclusion

**The results indicate that the ELISA may be a more effective diagnostic test for surveillance of EM in Great Britain as well as a potentially more economic option. The results also show current approach remains effective compared to other diagnostic tests. However, there may be caveats to this statement such as kit availability and additional costs such as: cost of infection in other animals and cost of emotional impact of the disease as well as comorbities among others, which fall out of the scope of this assessment.**

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