Assessing the risk of rabies re-introduction into the United Kingdom from Eastern European countries

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Keywords

Rabies, risk assessment, pet-trade, Europe

1   **Abstract**

2   There is a public concern of rabies re-introduction to the UK, given the recent changes in pet trade

3   with parts of Eastern Europe and an increase in the movement of puppies. A previously developed

4   quantitative risk assessment (QRA) for rabies introduction into the UK was modified in order to

5   assess the risk from only Eastern European Union member states. The model estimates the annual

6   probability of rabies entering the UK and also the expected number of years between rabies

7   introductions. The change in risk between the original model and the updated model is then

8   assessed. While the risk has increased compared to the previous assessment, the risk still remains

9   low, with a case expected every 317 years (5th and 95th percentile, 193 and 486 years, respectively)

10 and an annual risk of 3.41 x 10^{-3} (5th and 95th percentile, 2.05 x 10^{-3} and 5.17 x 10^{-3}, respectively).

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Introduction

Rabies is a zoonotic viral disease that is transmitted through saliva via a bite from an infected animal, with dogs usually being the main transmitter to humans. The United Kingdom (UK) is officially rabies free and has been since 1970, with the exception of a case(s) in quarantine (King et al., 2004). Rabies, however, continues to occur in Eastern European countries, thereby posing a risk to the UK via the movement of companion animals (e.g. cats and dogs) from this region to the UK.

In 2010, a quantitative assessment of the risk of rabies reintroduction to the UK via the non-commercial movement of companion animals was developed (Goddard et al., 2012). This assessment provided a quantitative estimate of risk under the implementation of the EU Pet Movement Policy (EU PMP) (European Commission Regulation No 998/2003) and the previous GB specific movement policy, PETS. Two risk estimates were provided namely, the annual probability of importing at least one infected pet and the number of years between rabies introductions.

The EU PMP has now been implemented in the UK since 2012. Since this time, there has been an increase in the number of pets moving under the EU PMP which may have an influential impact on the current risk of rabies entry into the UK. These recent changes are:

1) An increase in the movement of pets travelling from Eastern Europe to the UK.
2) An increase in the movement of puppies (both illegal and legal) and trade of rescue dogs.

Within this assessment, we update the original QRA to include these two aspects. The defined risk question is therefore: "*What is the change in likelihood of rabies introduction into the United*

1   *Kingdom from the Eastern EU since adopting the existing harmonised community rules for non-*

2   *commercial pet animals?*"

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4   **Methods**

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6   The model presented here uses the same methodology as described in Goddard et al. (2012), with

7   updated data from a specified set of countries. As previously, countries were categorised into risk

8   groups, defined as: Group 1, no reported cases of rabies in cats and dogs during 2012-2014; Group

9   2, less than or equal to 5 total cases reported in cats and dogs during 2012-2014; Group 3, greater

10   than 5 cases reported in cats and dogs during 2012-2014. The threshold of 5 remained for this

11   assessment to enable a direct comparison between results. The countries in the Eastern part of the

12   EU are of primary concern here and so the model focuses on those countries. It was agreed, that the

13   countries to be included within the risk assessment were: Bulgaria, Czech Republic, Estonia,

14   Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The current and previous

15   grouping, per country listed is shown in Table 1.

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17   In brief, the model identifies the various stages of the importation process whereby a cat or dog

18   infected with rabies virus but not yet showing clinical signs of infection could enter the UK. Given

19   full compliance with the EU PMP, it was assumed that any animal displaying 'suspect' clinical

20   signs of rabies before entry would be detected and removed. The parameters that were updated

21   within the model include the probability a companion animal from country group j is infected, the

22   probability an animal passes import checks from country group j and the maximum number of

23   companion entries per year under the EU PMP. In order to update these parameters, data for the

24   rabies incidence per country, pass rates at border control and the number of imports per country per

year, were obtained. The model updates for each parameter is shown in Table 2, Table 3 and Table 4. All other parameters, such as vaccination, remained unchanged.

The harmonized EU PMP was fully implemented in the UK in January 2012. Data from the 3-year period, 2012-2014 was used. While data for 2015 was not included, it was considered that the overall trend, per country, follows the same pattern as 2012-2014.

Data to inform the various parameters were obtained from various sources. The number of pet imports between 2012 and 2014 was extracted from the Pets database held at the Animal & Plant Health Agency (APHA) Carlisle, whereby pets were presented for entry to the UK with documentation from a listed country. The incidence of rabies from the selected Eastern European countries in cats and dogs was also obtained (Rabies Bulletin Europe, 2016) and the number of passes/failures at border control was obtained from the APHA imports team in Carlisle.

As in the previous model, each simulation was run for 50,000 iterations, which was sufficient to allow convergence. Furthermore, in order to allow for a direct comparison between the models, the original model was updated to include only those countries classed in our definition of Eastern EU. In the absence of data, and in order to assess the effect of illegal animals/puppies entering the UK, the compliance level was modified to 0%. In doing so, it is assumed to reflect importation of puppies, which are too young to be vaccinated and illegal animals entering the UK, which are presumably also not vaccinated. In order to represent a possible worst-case, it is assumed that the same number of animals enter illegally and unvaccinated as enter legally; it is acknowledged that this is likely to be an overestimate but a useful proxy of the 'maximum' risk in the absence of other information.

Results

The results from all runs of the model (i.e., the original with Eastern EU only and the updated model) is shown in Table 5 and Table 6. The two principal results are the annual probability of importing at least one infected cat/dog (Table 5) and the number of years between rabies introductions (Table 6). The 5th and 95th percentiles, which represent the uncertainty associated with the model results, are also provided. The mean probability shows very little change between the original model and the updated model. The real change is seen in the years between rabies cases, whereby, currently 1 case every 317 years (5th and 95th percentile, 193 and 486 years, respectively) would be expected, compared to 842 years (5th and 95th percentile, 608 and 1,146 years, respectively) previously. While this is still a relatively small risk, it is nevertheless a large increase compared to the original model. This is due to an increase in the numbers of animal imports from these Eastern EU countries, despite a reduction in rabies incidence (for example, Bulgaria, previously a group 3 country, is currently group 1 (Table 1). Should all animals enter illegally or fail to follow compliance with the regulations, then the risk increases to a case every 186 years (5th and 95th percentile, 111 and 290 respectively).

Discussion

The updated model estimates the change in risk of rabies introduction to the UK from pets entering from Eastern European Union countries. There is a clear increase in risk from these countries, compared to the assessment completed in 2012, which is likely due to a large increase in the number of animals entering the UK compared to previous years.

While the risk of rabies entry has increased, it is still nevertheless relatively low, with an expected case every 317 years. To investigate the effect of illegal entry, a worst-case assumption was made; the model was re-run assuming zero-compliance and hence all animals being imported illegally, with the same number of imports as before since no data on illegal imports were available. Unsurprisingly, should all animals enter illegally or fail to comply with vaccinations, then the risk increases further. Should data become available about the expected number of illegal animal movements, then a more accurate estimation of risk can be calculated. This risk would combine the risk from both legal and illegal entry and would reflect the numbers in each category.

The data used to estimate the probability that an imported animal is infected were based on rabies incidence data in the various countries. The model thus assumes that all categories of imported animal have the same probability of infection. If more data on incidence become available, the probability could be categorised to reflect for example, species and regional variation as well as whether or not the animal was originally stray and the surveillance system in country. This would result in a more accurate estimate of risk, reflective of the proportions in these categories.

The number of pet movements from Eastern European Union countries over a three-year period (2012-2014) were provided by APHA. While trends may remain similar, exact numbers per country of origin will be required in order to fully parameterise the model. This will have a large impact on the potential for any future adaptations and applications of the model.

Conclusion

The risk of re-introducing rabies into the UK from Eastern EU countries via non-commercial pet animals has increased in recent years but still remains relatively small. This increase results from an

1   increase in the number imports and occurs despite an overall reduction in rabies incidence within

2   these countries.

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1   Table 1: Group number for the original model and the updated model

Eastern European Union	Previous group	New group
Bulgaria	3	1
Czech Republic	1	1
Estonia	2	1
Hungary	2	2
Latvia	3	2
Lithuania	3	2
Poland	3	3
Romania	3	3
Slovakia	1	2
Slovenia	2	1

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1   Table 2: Maximum yearly number of rabies cases in each country group, for data between 2012 and

2   2014

Country Group	Maximum Annual Cases
Group 1	0
Group 2	4
Group 3	117

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1   Table 3: Number of companion animals passing entry checks into the United Kingdom between

2   2012 and 2014

Country Group	Number presented	Number passing checks
Group 1	4766	4394
Group 2	20383	19501
Group 3	19732	18724

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1   Table 4: The maximum number of companion animal entries to the United Kingdom via the EU

2   PMP between 2012 and 2014

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Country Group	EU PMP
Group 1	1496
Group 2	7712
Group 3	7329

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1   Table 5: Annual probability of rabies introduction to the UK

Model	Compliance Level	5th Percentile	Mean	95th Percentile
Original - Eastern EU only	100%	8.73×10^{-4}	1.23×10^{-3}	1.64×10^{-3}
Updated Model	100%	2.05×10^{-3}	3.41×10^{-3}	5.17×10^{-3}
Updated Model	0%	3.44×10^{-3}	5.84×10^{-3}	8.93×10^{-3}

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1   Table 6: Expected number of years between rabies introductions to the UK

Model	Compliance Level	5th Percentile	Mean	95th Percentile
Original - Eastern EU only	100%	608	842	1,146
Updated Model	100%	193	317	486
Updated Model	0%	111	186	290

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