Risk assessment of exotic disease incursion and spread

Hosting Institution: Wageningen Bioveterinary Research, Wageningen University & Research, the Netherlands,

M Cabral, R Taylor* and CJ de Vos

Abstract

This Technical Report describes the activities developed in the scope of the EU-FORA Fellowship, within the work programme of risk assessment (RA) of exotic disease incursion and spread, developed at Wageningen Bioveterinary Research (WBVR). The programme focused on the work carried out in the Generic risk assessment for introduction of animal diseases (G-RAID) project, which brings together a number of different generic RA tools from multiple European partners. The aim of the fellowship was to gain understanding of veterinary import risk assessment by using different RA tools and to learn how different algorithms can be used to calculate disease incursion risks. G-RAID's tools cover a wide range of RA methodologies; from purely qualitative, to semi-quantitative and fully stochastic quantitative methods, which allowed the fellow to understand a variety of algorithms used to produce the final risk estimate. The fellowship programme provided the fellow with the chance to learn in detail about how generic RAs are performed across Europe, understanding how to deal with the uncertainty and variability involved in RAs and the potential problems of data availability and reliability. The fellow made an inventory of publicly available databases on disease occurrence and international trade that could be used for import RA and assessed their quality and usefulness for the different generic RA tools. The programme also provided the fellow the opportunity to perform several import risk assessments using the RA tools of G-RAID. She completed a RA on African swine fever using the MINTRISK model developed by WBVR. Furthermore, she assessed the risk of foot and mouth disease introduction using the Rapid Risk Assessment Tool (RRAT) model developed by WBVR and the COMPARE model developed by the Animal and Plant Health Agency (APHA). To this end, the fellow completed a short-term visit to APHA, enabling her to have additional training in quantitative RA and to expand her professional network in this area.

---

* Animal and Plant Health Agency, United Kingdom.

The EFSA Journal is a publication of the European Food Safety Authority, an agency of the European Union.

Table of contents

1. Introduction

Increasing globalisation and international trade contribute to the rapid expansion of animal diseases. Introduction of exotic animal diseases into naive livestock populations can result in large-scale epidemics with serious economic and socio-ethical impact. Hence, preparedness is warranted to prevent, detect and control outbreaks of exotic animal diseases. If outbreaks are detected promptly, interventions can be made to reduce the size of the outbreak and mitigate its consequences.

Import risk assessments are useful tools to inform risk managers on exotic animal disease threats providing information on e.g. relevant pathways or regions most at risk. Results can be used to assign resources for prevention and surveillance to those pathways, regions or diseases that pose the highest risk or to identify targets for additional research.

In recent years, several generic risk models or frameworks have been developed that can easily be applied to assess the incursion risk for multiple diseases (De Vos et al., 2012; Simons et al., 2019; Taylor et al., 2019). In contrast to bespoke models, these generic risk assessment (RA) tools are not disease specific, but can be used for a range of diseases, allowing for a more rapid response to newly emerging or re-emerging diseases. Rapid risk assessments are needed to help risk managers prepare and respond swiftly to new disease events that pose a potential health threat to their territory.

The development of generic RA tools is faced with three major challenges: (i) the need for extensive and real-time data sets on global disease presence and movements of humans, animals and products, (ii) the use of algorithms to combine all input data into either a qualitative or a quantitative risk estimate and (iii) the validation of results.

The EU FORA fellow participated in the 'Generic approaches for Risk Assessment of Infectious animal Disease introduction' (G-RAID) project (GA/EFSA/AFSCO/2017/01-GA01), which brings together a number of different generic RA tools from multiple European partners, including Wageningen Bioveterinary Research (WBVR) and the Animal Plant Health Agency (APHA). The RA tools in G-RAID cover a wide range of RA methodologies; from purely qualitative, to semi-quantitative and fully stochastic quantitative methods, which allowed the fellow to understand a variety of algorithms used to produce the final risk estimate. The main aim of G-RAID is to compare and contrast the different tools and, where possible, propose areas for standardisation and validation of generic RA tools. The fellow contributed to these objectives by inventorying global databases on disease occurrence worldwide and international trade in animals and animal products. Furthermore, the fellow performed several risk assessments, using three different generic RA tools.

2. Description of work programme

2.1. Aims

The overall objective of the fellowship was to gain understanding of veterinary import RA by using different RA tools and to learn how different algorithms can be used to calculate disease incursion risks. To achieve this objective, the work programme was divided into three modules: (1) qualitative and quantitative RA through the lens of generic models; (2) impact of uncertainty in data inputs for RA; and (3) comparison and validation of different generic models.

By taking advantage of the wide range of RA models that are involved in the G-RAID project, the specific aims of the modules were:

1) To introduce the fellow to qualitative, semi-quantitative and quantitative RA with a focus on data requirements, algorithms and output, and how generic models can be used to prioritize, diseases, locations or pathways for risk management purposes. In particular, to understand the role of generic RAs and the different approaches to generic RA across Europe;

2) To clarify which publicly available databases are used for animal disease RA and to assess their quality and usefulness for the different generic models. To understand the concepts of variability and uncertainty;

3) To gain understanding of several generic models of G-RAID and to discern how different algorithms can be used to calculate the incursion risk. To gain a wide range of skills in relation to creating RAs, such as programming skills, working with large data sets and interpretation of results, by performing a RA from the sourcing of data up to the final production for a specific model.

2.2.   Activities/Methods

2.2.1.   Qualitative and Quantitative Risk Assessments through the lens of Generic Models

The initial task of the work programme was to further consolidate the European Food Safety Authority (EFSA) induction training, and to obtain an understanding of the basic principles of both qualitative and quantitative RA. This was achieved by using the resources available at WBVR, such as text books, scientific meetings, departmental seminars, course notes and practical sessions in both qualitative and quantitative RA.

The fellow started by studying guidelines and methods for animal health RA (Murray, 2004; Vose, 2008). More detailed understanding was provided through involvement in the G-RAID project. Seven generic RA tools, developed in four different European countries (the Netherlands, UK, Sweden and Finland), were included in the G-RAID project. The seven generic RA tools included two quantitative models (SPARE, COMPARE), four semi-quantitative tools (RRAT, MINTRISK, IDM, NORA) and one qualitative tool (SVARRA). Although all of these tools can be used to address the incursion risk of exotic livestock diseases, they were originally developed for different purposes ranging from immediate response to new disease events to prioritisation of diseases and horizon scanning. Therefore, input, algorithms and endpoints of the tools differed.

The fellow read the G-RAID report describing the generic RA tools, watched the Webinar on 'Rapid risk assessment tools for animal disease outbreaks' organized by EFSA (2017), had a 1-day training on MINTRISK, and had the opportunity to participate in a videoconference in which some of the generic RA tools of G-RAID were presented and discussed (SPARE, COMPARE and RRAT). In addition, the fellow contributed to the preparation of a 1-day symposium (SYMPOSIUM: Generic risk assessment for introduction of animal diseases, 2019) to disseminate results of the G-RAID project to risk managers and risk assessors. The fellow was particularly involved in the workshop on data sources for generic RAs.

Thus, the fellow was able to take advantage of the wide range of RA models available in G-RAID to gain knowledge of performing risk assessments, the differences between qualitative, semi-quantitative and quantitative risk assessments in terms of data requirements, algorithms and output, and how generic models can be used to prioritize diseases, locations or pathways for risk management purposes.

Finally, the fellow also worked on a bespoke model using the @Risk (Palisade Corp) add-in for Excel (@RISK for Risk Analysis). The objective was to perform a quantitative RA for the introduction of African swine fever (ASF) into the Netherlands, United Kingdom and Finland by legal import of live pigs. A scenario tree for the probability of introduction of ASF into the country of destination by the import of live pigs was developed. Data from COMEXT were used as an input for trade, OIE data were used to assess disease prevalence in source areas and a literature review was performed to estimate disease-specific parameters.

2.2.2.   Impact of Uncertainty in Data Inputs for Risk Assessments

Data required for animal RA relate to movement and disease occurrence. The first category provides information on how many animals/products etc. are moved from infected areas (area of origin) to the area under study (target area) regardless of whether or not they are infected, for each pathway considered. For some pathways, this will be related to trade flows. The second category provides information on disease occurrence in the areas of origin, which is then used to estimate the probability that animals/products etc. are infected upon arrival in the target area.

Several global databases exist providing information on international trade and disease occurrence and risk assessors have to decide which databases to use in their models. The choice of data set can have significant impact on model results, and therefore, the risk assessor needs to weigh up the pros and cons of each. Considerations for using different data sets include accessibility, quality of data, level of detail, scope of the information, accuracy, confidentiality and time spent to retrieve up-to-date data.

Global databases have different purposes and are under different legal frameworks, all with their own strengths and limitations. However, the lack of harmonization across the different data sources and the often insufficient resolution/detail hinder the ability to be used in analytical epidemiology and risk assessments. In addition, the uncertainty associated with the data poses additional challenges. One of the main issues with generic RAs is that the data sources must have a broad scope (e.g. multiple diseases or countries). This means that many detailed data sources (e.g. national statistics on animal movements) are not appropriate as the scope is too narrow whereas at the broader scale, the

lack of detail can lead to high uncertainty. The different purposes/modes of collecting the data can lead to fairly substantial differences between data sources that aim to provide similar information. As such, the choice of data source can have an impact on the model results. The lack of standardization between data sources also means it can be difficult to combine them in order to utilize them all.

Therefore, the fellow clarified which publicly available databases are used for animal RA and assessed their quality and usefulness for different generic models. The fellow reviewed different data sources available, with a particular focus on trade data, including COMEXT (Eurostat) (European Commission, 2019a), FAOSTAT (FAO) (FAOSTAT, 2019), TRACES (EU) (European Commission, 2019b) and COMTRADE (UN) (United Nations Statistics Division, 2019), and disease outbreak reports, including the WAHIS database (OIE) (OIE, 2019), EMPRES-i (FAO) (FAO, 2019), ADNS (EU) (European Commission, 2019c), HealthMap (Freifeld et al., 2008) and ProMed (Yu and Madoff, 2004). The criteria considered were the availability and accessibility of data, the quality of data, the reasons for its creation, the pros and cons of each data source and the potential issues when used in RA models.

The fellow completed this task by producing a report summarising the different data sources available, comparing the European and global data sources on aspects such as usability or reliability of the data and examining the impact of their uncertainty and reliability on the results of the bespoke model for ASF.

2.2.3. Comparison and Validation of Different Generic Models

The fellow had the opportunity to work with three generic RA tools.

The fellow used the Method for INTegrated RISK assessment of vector-borne diseases (MINTRISK) (de Vos-de Jong et al., 2016), a semi-quantitative RA tool developed at WBVR, and participated in the validation of generic RA tools for animal disease incursion based on a case study for ASF. The fellow collected data on ASF and performed the RA for ASF introduction for the Netherlands and Finland for the 2017 situation and for two hypothetical scenarios in which ASF cases were reported in wild boar and/or domestic pigs in Germany, in MINTRISK. Results were used for cross-validation with the other tools in the G-RAID project. The pathways considered were trade in live pigs and wild boar movements. The results will be published in a peer-reviewed paper drafted by the G-RAID Consortium.

In addition, the fellow had the opportunity to complete a RA for Foot and Mouth disease (FMD) introduction in the Netherlands and the UK, using a generic model developed at WBVR (the RRAT model) and a second developed at APHA (the COMPARE model) (Taylor et al., 2019). The fellow collected data on disease prevalence in source areas; pathway movements from source areas to the target areas; susceptible animals in the target areas; and FMD disease-specific parameters. Then, the fellow proceeded to perform the RA and to draft a paper to disseminate the results of the FMD case study for a joint WBVR/APHA publication in a peer-reviewed journal.

The fellow's work on the COMPARE model was possible through the participation in a short-term mission (STM) awarded by the Med-Vet-Net association (Med-Vet-Net Association for Zoonoses Research, 2009). The fellow visited the Department of Epidemiological Sciences at APHA to work with the Biomathematics and Risk Research workgroup. During this 2-week STM, the fellow was introduced to the COMPARE model by Dr Rachel Taylor. The aim of the fellow's visit was to understand the model's framework, algorithms and data requirements, and to practice running the model.

The STM also enabled the fellow to expand her professional network in the area of risk assessment. The fellow was introduced to both the Biomathematics and Risk Research workgroup and the Epidemiology workgroup in the Department of Epidemiological Sciences, attended department meetings and had the opportunity to participate in a meeting with the UK's Chief Veterinary Officer. Furthermore, the fellow presented her research topics in a meeting and attended presentations of different projects currently ongoing within the Department of Epidemiological Sciences. In addition, the fellow was able to consolidate her knowledge of spatial modelling in R.

3. Conclusions

The fellowship programme provided the fellow with expertise and experience in veterinary import RA through a 'learning-by-doing' approach. It provided the chance to learn in detail about how different generic RA tools for disease incursion are performed across Europe, as well as understanding how to deal with uncertainty and variability within RAs and the potential problems of data availability and reliability.

Most importantly, the programme provided the fellow with the opportunity of experiencing the whole process of performing RAs, with a focus on the introduction of infectious diseases. The

programme complemented the previously gained knowledge in the theory-based training programmes at EFSA, by providing the opportunity to get a thorough insight into a number of different generic RA tools from multiple European partners, particularly the ones developed by WBVR and APHA.

The activities proceeded in accordance with the work programme and the expected time frame in a stimulating scientific working atmosphere at the Department of Bacteriology and Epidemiology of WBVR. Through the daily exchange with experts of different veterinary epidemiology aspects, group meetings and the opportunity to participate in different seminars, the fellow was able to learn new methodologies, gain more expertise and start building a network in the European food safety community.

The fellowship also introduced the fellow to the 'One Health' concept, a collaborative, multisectoral, and transdisciplinary approach with the goal of achieving optimal health outcomes recognising the interconnection between people, animals, plants and their shared environment.

Finally, the EU-FORA fellowship provided a unique opportunity for expanding the fellow's network in the field of food safety RA during the induction training at EFSA and three further training modules hosted by the national food safety authorities in Vienna, Berlin and Athens, the placement at WBVR and the STM at APHA.

References

De Vos C, Hoek M, Fischer E, de Koeijer A and Bremmer J, 2012. Risk assessment framework for emerging vector-borne livestock diseases. Wageningen UR, Central Veterinary Institute.

EFSA (European Food Safety Authority), 2017. Webinar: Rapid risk assessment tools for animal disease outbreaks 2017. Available online: https://www.youtube.com/watch?v=KVmp9nOfZ50

European Commission, 2019a. COMEXT 2019. Available online: https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/focus-on-COMEXT

European Commission, 2019b. Trade Control and Expert System (TRACES) 2019. Available online: https://ec.europa.eu/food/animals/traces_en

European Commission, 2019c. Animal Disease Notification System (ADNS) 2019. Available online: https://ec.europa.eu/food/animals/animal-diseases/not-system_en

FAO, 2019. EMPRES Global Animal Disease Information System (EMPRES-i) 2019. Available online: http://empres-i.fao.org/eipws3g/

FAOSTAT, 2019. FAO Global Statistical Yearbook 2019. Available online: http://www.fao.org/faostat/en/

Freifeld CC, Mandl KD, Reis BY and Brownstein JS, 2008. HealthMap: global infectious disease monitoring through automated classification and visualization of Internet media reports. Journal of the American Medical Informatics Association, 15, 150–157.

Med-Vet-Net Association for Zoonoses Research, 2009. Available online: http://www.medvetnet.org/

Murray N, 2004. Handbook on import risk analysis for animals and animal products: quantitative risk assessment. Office International des Épizooties.

OIE, 2019. World Animal Health Information System 2019. Available online: http://www.oie.int/

Vose D, 2008. Risk analysis: a quantitative guide. John Wiley & Sons.

@RISK for Risk Analysis. Available online: https://www.palisade.com/risk/

Simons RR, Horigan V, Ip S, Taylor RA, Crescio MI, Maurella C, Mastrantonio G, Bertolini S, Ru G, Cook C and Adkin A, 2019. A spatial risk assessment model framework for incursion of exotic animal disease into the European Union Member States. Microbial Risk Analysis.

SYMPOSIUM: Generic risk assessment for introduction of animal diseases, 2019. Available online: https://www.wur.nl/en/show/SYMPOSIUM-Generic-risk-assessment-for-introduction-of-animal-diseases.htm

Taylor RA, Berriman AD, Gale P, Kelly LA and Snary EL, 2019. A generic framework for spatial quantitative risk assessments of infectious diseases: Lumpy skin disease case study. Transboundary and Emerging Diseases, 66, 131–143.

United Nations Statistics Division, 2019. United Nations Commodity Trade Statistics Database 2019. Available online: https://comtrade.un.org/db/help/uReadMeFirst.aspx

de Vos-de Jong C, van Roermund H, de Koeijer A and Fischer E, 2016. Risk assessment of seven emerging vector-borne animal diseases for The Netherlands: A structured approach.

Yu VL and Madoff LC, 2004. ProMED-mail: an early warning system for emerging diseases. Clinical Infectious Diseases, 39, 227–232.

Abbreviations

ADNS	Animal Disease Notification System
APHA	Animal and Plant Health Agency
ASF	African Swine Fever

EMPRES-i	FAO's EMPRES Global Animal Disease Information System
EU-FORA	European Food Risk Assessment Fellowship Programme
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FMD	Foot and Mouth disease
G-RAID	Generic risk assessment for introduction of animal diseases
MINTRISK	Method for INTegrated RISK assessment of vector-borne diseases
OIE	Office International des Epizooties
ProMED	The Program for Monitoring Emerging Diseases
RRAT	Rapid Risk Assessment Tool
TRACES	Trade Control and Expert System
UN Comtrade	United Nations Trade Statistics Database
WAHIS	World Animal Health Information System
WBVR	Wageningen Bioveterinary Research