Challenges involved in the collection of appropriate data for the completion of disease outbreak risk assessments

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Summary

Risk assessment is an essential tool used to aid the control of disease outbreaks. Without this, key risk pathways may not be identified resulting in potential spread of disease. The devastating effects of this can ripple through society, affecting the economy, and trade, along with considerable impact on animal health and potentially human health also.

The World Organisation for Animal Health (WOAH, founded as OIE) highlighted that risk analysis, which includes risk assessment, is not consistently used across all member states, with some low-income countries making policy decisions without prior risk assessment. This could be caused by a lack of staff and risk assessment-related training, poor funding in the animal health sector, and lack of understanding regarding the use and application of risk analysis. However, to complete effective risk assessment high-quality data must be collected, and other factors such as geographical conditions, use (or not) of technology, and varying production systems all influence the ability to collect these data. Demographic and population-level data can be collected during 'peacetime' in the form of surveillance schemes and national reports. Having these data before an outbreak occurs better equips a country for controlling or preventing disease outbreaks.

In order for all WOAH member states to meet risk analysis requirements an international effort must be made for cross-working and the development of collaborative schemes. Technology can play an important role, and low-income countries must not be left behind in the efforts to protect animal and human populations from disease.

Keywords

Data – Disease outbreak – Peacetime – Risk assessment – Surveillance.

Introduction

Disease outbreaks in animal populations can be devastating and a targeted response to eradicate or contain the spread of an outbreak is essential. However, national policy decisions made during an outbreak under severe time and resource constraints may be delayed or incorrect, resulting in inefficient control of the outbreak [1]. Additionally, some countries are better prepared than others to conduct outbreak response; for example, due to proactive investment in resources, or having time and personnel available for such an event. Unfortunately, diseases do not respect national borders, particularly with increases in globalisation and, without an effective global response, the threat of future disease incursions along with uncontrolled spread will likely remain. This can be seen with the numerous mutations of severe acute respiratory syndrome coronavirus 2 more commonly known as SARS-CoV-2 in individual countries that quickly spread globally [2], while the historical cases of rinderpest and smallpox show that a united international response can lead to eradication of some diseases [3].

In many countries risk assessment is considered a fundamental tool utilised in animal disease outbreak response. This paper aims to identify necessary data requirements for international and national risk assessments as part of disease outbreak response. The main risk pathways covered in this paper include transmission routes such as live animal trade, and wildlife contacts; other routes such as the trade of animal products have not been included. The possibility to gather data proactively to give the best head-start to the rapid risk assessment process will also be discussed. We also aim to highlight the challenges and potential solutions available for countries that may have limited resource to establish data collection and risk assessment processes.

What is risk analysis?

One tool to provide a robust scientific basis for decision making during an outbreak is risk analysis, which the *Aquatic Animal Health Code* of the World Organisation for Animal Health (WOAH, founded as OIE) defines as comprising of:

- hazard identification
- risk assessment
- risk management
- risk communication [1], as seen in Figure 1.

The risk assessment component involves:

- collating epidemiological and biological information in a framework to aid in tasks such as the identification of outbreak sources;
- highlighting areas of concern regarding onward spread;
- assessing the probability, or risk of introduction or spread; and
- providing evidence for effectiveness of potential mitigation measures.

Risk management uses the results of the risk assessment alongside social, economic and political considerations to identify, select and implement measures that can be applied to reduce the risk level [1].

Within risk assessment the probability (or likelihood) of an event occurring is defined as an estimation of how likely it is that a given event will occur within the defined parameters. Risk refers to both the probability that a hazardous event will occur and the magnitude of the consequences that may result if such an event does occur. While risk analysis in the field of animal health has always been conducted in some form it was not until the 1990s that specific methodologies were developed, and it was recognised as its own discipline. Arguably, the publication of the first edition of the WOAH Handbook on Import Risk Analysis for Animals and Animal Products in 2004 helped to raise the profile of risk analysis [1].

Risk assessments come in many forms, ranging from quantitative methods that can incorporate complex mathematical modelling to rapid qualitative assessments that use categorical measures to express likelihood or risk. It is these rapid assessments that lend themselves more to the fast-paced requirements of disease outbreak response (both within and between countries), where resources, time, data, and mathematical expertise may be limited. In any case, most animal health risk assessments have the same core methodology; determining potential pathways of pathogen transmission in a specified population and assigning likelihood levels to each step of a risk pathway, resulting in an overall risk level to guide policy decisions [4].

The accuracy, and therefore the usefulness, of any risk assessment will rely on the quality of the available data to populate the risk pathways. This requires the risk assessor to locate and process potentially large volumes of data, both qualitative and quantitative. Lack of data, reduced accessibility to data sources and ineffective means to search and collate data are just some examples of areas that could be detrimental to the risk assessment process. The lack of data will inherently increase the uncertainty in any risk assessment results, but a rapid qualitative assessment can still provide a useful description of the estimated likelihood. This is based on current evidence along with a description of the uncertainty, and being informative for making policy decisions. An illustration of how data feeds into the risk assessment process is given in Figure 2.

Data requirements

The type of data required for a risk assessment is guided by the risk question. In the case of an <u>international</u> disease outbreak a risk question may be ‘what is the risk that *Disease X* may be introduced into *Country Y* via the importation of *Animals Z*?’. For <u>national</u> disease outbreaks, a risk question may be ‘what is the risk of spread of *Disease X* within *Country Y* via transport of *Animals Z* from farm to slaughter?’. Some of the data needed can be collected before a new outbreak occurs, or between endemic outbreaks; known as ‘peacetime’.

Examples of proactive, or ‘peacetime’, data sources

Table I summarises the type of data that could lead to an effective risk assessment being carried out during national- and international-level disease outbreaks providing evidence on which to base policy decisions. As can be seen from the table, data that can be gathered in advance include animal movements, herd size/farm structure, contact structures and mitigation effectiveness. Pathogen specific data can be collected proactively but may not be relevant if specific pathogen strains show differences which could affect the outcome of the risk assessment. Data which could only be collected during an outbreak includes number of cases etc., and susceptible species (in the case of a new or re-emerging disease). However, animal movements and management systems practiced across the globe would not be useful data unless there is an outbreak on an international level. Even in the event of such an outbreak, however, unless a link exists between the countries (such as trade) this data may not be necessary to obtain.

A large proportion of the data collected via the sources stated in the table will be available in scientific publications. This is a low-cost data source, though relies on a level of technological capability and memberships with scientific journals if articles are not open access. To optimise literature review for risk assessment purposes, employee training in systematic review methodology may be required.

Contact structures

Knowledge on potential contact routes between wild animals and livestock are essential to better understand the transmission dynamics and possible source of infection. To establish contact patterns, successful contacts (i.e., a contact relevant for disease transmission) must be identified.

The definition of a successful contact varies based on the pathogen:

- rabies requires direct entry into the bloodstream, usually through a bite from a rabid animal; and
- anthrax transmission requires the ingestion of spores from contaminated environments [5].

Production systems (and biosecurity within the system) are highly variable and can dictate contact structures between, and within, species [6]. The probability of contact (and duration of contact) between individuals is heterogenous, and transmission pathways are not always singular [5]. In low-income countries it is common for multispecies herds to be kept, along with poor husbandry practices [7]. Farms with low biosecurity and/or weak infrastructure provide opportunities for livestock to interact with wildlife, which may be vehicles for disease transmission [6]. Extensive grazing, especially on shared or common land, could therefore be hazardous to livestock.

Trade and livestock markets are hot-spots for enabling disease transmission. This route was found to be the main transmission pathway in early stages of the 2001 foot and mouth disease (FMD) outbreak in the United Kingdom before the implementation of a standstill policy [8].

Example of effective data collection tools/schemes

To minimise uncertainty surrounding risk assessment outputs, sufficient data are required. For this reason, it is essential for countries to enable the rapid and accurate collection of outbreak-related epidemiological information. Currently, individual countries are responsible for sourcing data for risk assessments.

The cattle tracing system is a database that livestock owners in Great Britain update when any cattle are born, die, or are moved [9]. This enables each animal to be traced from birth to slaughter utilising physical identifiers (such as ear tags). Other European Union member states also utilise ear tagging for cattle tracing. Such tracing schemes are enable animals which have been in contact with other infected animals or moved from an infected premise to be located.

In 2013, Indonesia's national animal health and production information system (iSIKHNAS) was created by the governments of Indonesia and Australia and is now utilised across 95% of all districts within the country [10]. The system utilises short message service (better known by its acronym 'SMS') communication between different personnel and authorities generating a 'paper trail' of each case that is held on a central system. The data recorded in each 'case' include laboratory results, species, geographic location, and other information [10].

Well-designed data collection tools/schemes enable trends to be assessed to better understand a country's disease status, and for the early detection of any developing biological threats. There is strong evidence to suggest that early detection of emerging diseases reduces the overall size of the outbreak [11].

Responsibility for coordinating data collection

Infectious disease outbreaks can result in long-term impacts including on an animal health/welfare, public health, and social and economic level. Trade suspensions, animals culled, and economic disruption are just a few examples of potential impacts due to animal disease outbreaks.

Due to the scale of the effects, and the speed required to tackle widespread disease, it might be reasonable to assume that governments should be responsible for data collection: in the United Kingdom for example, it is the responsibility of a government assigned veterinary officer to compile information regarding contacts, source, and spread, in the case of a disease on a premises. However, farmers and tradespeople who are directly involved with the animals, should also have responsibility for collating and disseminating information regarding the health and management of their animals.

Ideally, government and industry work together in tackling disease presence. The iSIKHNAS tool shows how the Indonesian government can, with farmer and other professionals' participation, effectively source epidemiological information. This is only possible through the collaboration of governments, farmers, and veterinary professionals.

Challenges

Lack of risk analysis on global scale

It is acknowledged that some countries have better established systems in place to obtain and collate data than others, as well as better training and knowledge in conducting animal health risk assessments. The WOAH Performance of Veterinary Services (PVS) tool, generated in 2006, can be used to evaluate degrees of compliance in developing and in-transition countries to the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) and WOAH standards. The PVS tool found a large proportion of low-income countries were not meeting all WOAH obligations regarding risk analyses and were not consistently basing risk management decisions on risk assessment [7].

Reasons for the lack of compliance with the SPS Agreement and WOAH standards were identified as follows:

- a lack of scientific evidence resulting in blanket import bans;
- lack of staff or loss of trained staff;
- lack of data processing;
- lack of formal policies or protocols to indicate when to conduct a risk assessment; and
- political interference preventing risk assessment outcomes to be incorporated in risk management measures [7].

The PVS study concluded that the use of international risk assessment in developing countries is extremely rare, because the volume of traded goods is not sufficient to justify the resource required to implement the process [7]. Another belief is that government decision-makers are not familiar with risk assessment concepts in the context of identifying emerging hazards within a country, and the consequences on various stakeholders [7].

Pre-reporting constraints

Data reports are frequently biased, incomplete, and regularly delayed [12], and causes often occur prior to the data recording process. Legal and political differences have the potential to prevent adequate data recording and/or sharing. The WOAH acknowledged that member countries have varying levels of political measures and constraints regarding veterinary border inspections and harmonisation of legislation and regulations [13]. The joint action ‘Towards the European Health Data Space’ conducted research analysis within the public health sector, identifying data sharing practices across Europe. Within this, seven legal barriers for data sharing were identified. The themes of these legal barriers included a lack of shared definitions or interpretations of data management processes, and a lack of harmonisation in derogations and requirements between countries [14]. Other identified barriers included ‘trust and transparency’, ‘data’, ‘infrastructure’, ‘resource’, and ‘ethical’. This lack of data sharing can result in countries to be forced into using inadequate data sources. For example, scientific papers regarding FMD in Africa include a large amount of personal communication sources [15] which may be due to a lack of shared knowledge across the continents’ governing bodies.

A lack of data could result in underreporting. Underreporting may result in seemingly sporadic incidences, and inaccurate classification, leading to ineffective disease management. Low density of health facilities with poor communication systems, and a lack of qualified staff are causes for underreporting in low-income countries on a government level [12, 16]. Similar countries also identify poor disease awareness by livestock owners, and a distrust of governmental authorities as a cause for underreporting [12].

Flexibility and usefulness of data-collection strategies are key for resource poor countries [12], as a single strategy may not be applicable to all countries due to challenges unique to each country or state. For example, in the United States Virgin Islands more than half of the registered farms did not have a computer for farm use in 2018, and some computer users did not have internet access [17]. In the same year only a fifth of all farms were participants in government farm programmes [17], which may have been related to technological inaccessibility. Despite the findings of the PVS, and agency implemented projects (such as the Food and Agriculture Organization of the United Nations run project to aid in highly pathogenic avian influenza H5N1 control), the resources required to effectively combat disease outbreaks in low-income countries are often insufficient.

Animal owners/managers may resort to traditional 'know-how' for controlling disease, and be unaware of the effects that their contribution to surveillance could make on their livelihoods [12]. Therefore, willingness of the premises owner to register the data may require incentives to do so, alongside public education surrounding the importance of data recording. Focus groups would be one way of demonstrating the advantage of a data collection system with regards to preventing and/or containing disease outbreaks. Once owners have been engaged, sessions could also be held to gauge opinion on the most practical method for data collection given the amenities available.

Decision making and policy

Risk assessment is only one factor involved in the overarching risk management, and policy-based decisions that are not influenced by risk assessment in some ways are not unusual in the context of a new or emerging outbreak. In outbreak scenarios, decisions must be made quickly, whilst evidence is still being gathered. Due to this it has been demonstrated that policymaking amid a human disease pandemic is influenced by political factors and demands on the public health systems [18]. It can be assumed that the same can be said for the animal health sector, within reasonable means, including pressures on trade and livestock owners. Prior beliefs on epidemiological patterns and historical memory of earlier outbreaks may influence the decision-making process for outbreak-related policy.

Surveillance challenges

Diseases that do not cause clinical signs or have non-specific symptoms in target species, such as *Salmonellae* (other than those that are species specific), or lay dormant for a long period of time, like bovine spongiform encephalopathy, are difficult to detect and trace. These 'silent' diseases require active surveillance schemes which are costly to the country. History has also shown challenges in passive surveillance: analysis after an outbreak of classical swine fever (CSF) in pigs in the Netherlands in 1997 estimated that the time between introduction in the country and diagnosis of CSF in the primary outbreak was approximately six weeks, which was concluded to be a main reason why the outbreak was so severe [19]. Additionally, they estimated that the disease had already spread to 39 herds before the first measures to stop the spread had been implemented, after which the distribution of the most likely routes of transmission changed markedly.

Member countries have reported to the WOAH a lack of laboratories for identification of biological agents and surveillance continuation [13]. In attempts to combat this the WOAH twinning programme was implemented in 2006, where pairings are made between a WOAH Reference Centre and a Candidate Centre in a developing or in-transition country to provide support and training to the candidate [20]. The twinning project between the Animal and Plant Health Agency and the Central Veterinary Diagnostic and Research Laboratory (CVDRL) in Kabul began in 2012 and after eight years within the twinning programme the CVDRL now successfully conducts various serology tests for ongoing brucellosis and mycoplasmosis investigations in Afghanistan [21].

Conclusions

It is recognised that data sourcing and sharing is not consistent across the globe [22] and the WOAH identifies that risk analysis is an area that is lacking in some member countries [13]. Reasons for this include the lack of suitably trained individuals, lack of resources, and geographical-based challenges. The WOAH is committed, however, to addressing these deficiencies by running programmes to support such countries.

'Peacetime' is the ideal period to channel work and resources into improving data collection schemes, and sharing information between neighbouring states or countries. Work is being undertaken by individual WOAH member countries to reach the required risk assessment capabilities [10, 23], though more surveillance work and collaborative schemes are required before every member country will be achieving the standards. To generate meaningful risk assessment, characteristics unique to each country must be considered alongside pathogen-based data. Utilising technology is essential to reach all corners of the globe, as well as appropriate training of individuals completing surveillance and risk assessments. The development of these areas may help to improve risk assessment across all WOAH member countries, and aid in a global protection against disease.

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Table I

Examples of data sources for data collection in advance of and during outbreaks for effective risk assessment, including at a basic level and a high-quality level. The list is not exhaustive

Recommended data	When to collect (peacetime or during outbreak)	National or international risk question	Formal data sources	Informal data sources (limited resource)
Outbreak data (number of outbreaks, cases, deaths etc.) within home country	Outbreak	National	– WOAH WAHIS website – National surveillance schemes – Databases, field vets	– Veterinarians across the country/surveys – Farmers across the country/surveys
Outbreak data outside home country	Outbreak	International	– WOAH WAHIS website	– External contact
Susceptible species	Outbreak or peacetime	National and international	– WOAH WAHIS website – Pathogen research work/experiments	
Animal movements within country	Peacetime or outbreak	National	– Databases, field vets – Transport registers? – Slaughter registers?	– Field vets – Trade/slaughter etc. surveys
Animal movements between countries	Peacetime	International	– Databases, field vets – Transport legislation – Border control legislation	– Field vets – Tradespeople surveys

Commercial/management (herd size, farm structure) within home country	Peacetime	National	– Databases, expert opinion – Government records – Population study	– Expert opinion – Farm owner surveys – Veterinarians
Commercial/management (herd size, farm structure) outside home country	Outbreak	International	– Cross working/intergovernmental schemes	
Livestock demographics within home country	Peacetime	National	– Databases – Government records – Surveillance schemes	– Field vets – Surveys
Livestock demographics outside home country	Outbreak	International	– Cross working/intergovernmental schemes	
Pathogen survival	Peacetime (outbreak if specific strain is involved)	National and international	– Lab studies/research – Expert opinion – Data from other countries	– Expert opinion
Mitigation effectiveness	Peacetime	National and international	– Longitudinal studies – Case studies – Lab studies/research	– Expert opinion – Field vet/farmer etc. surveys and opinions
Transmission dynamics	Peacetime (outbreak if specific strain is involved)	National and international	– Longitudinal studies – Lab studies/research – Case studies – Mathematical modelling	– Expert opinion – Field vet/farmer etc. surveys and opinions

Dose-response	Peacetime (outbreak if specific strain is involved)	National and international	– Lab studies – Data from other countries	– Expert opinion
Contact structures	Peacetime	National and international	– Mathematical modelling – Case studies – Farm management records	– Farm surveys

WAHIS: World Animal Health Information System
WOAH: World Organisation for Animal Health

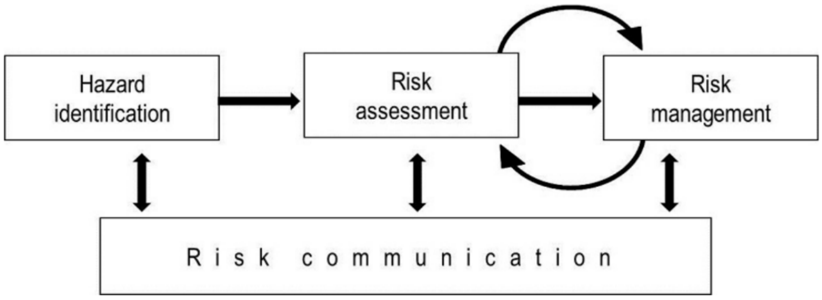

Figure 1

The four components of risk analysis, taken from the Chapter 2.1. Import risk analysis of the WOAH *Aquatic Animal Health Code* [1]

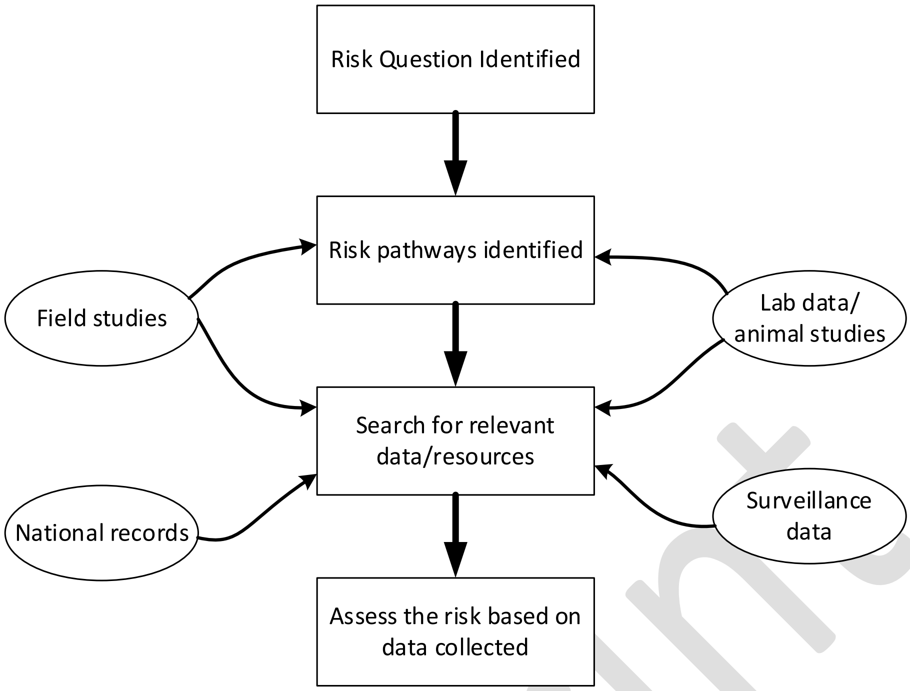

Figure 2

Outline of the risk assessment process including in the identification of data requirements and potential data sources