Preventive Veterinary Medicine 95 (2010) 175–185

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Comparing national and global data collection systems for reporting, outbreaks of H5N1 HPAI

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ARTICLE INFO

Article history:
Received 9 October 2009
Received in revised form 19 March 2010
Accepted 25 March 2010

Keywords:
H5N1 HPAI
Global database
Disease surveillance
Statistical analysis
Spatial scale

ABSTRACT

Determining if outbreak data collected by regional or international organizations can reflect patterns observed in more detailed data collected by national veterinary services is a necessary first step if global databases are to be used for making inference about determinants of disease maintenance and spread and for emergency planning and response. We compared two data sources that capture spatial and temporal information about H5N1 highly pathogenic avian influenza outbreaks reported since 2004 in four countries: Bangladesh, Egypt, Turkey, and Vietnam. One data source consisted of reports collected as part of each country's national veterinary services surveillance program, while the other data source included reports collected using the Emergency Prevention System for Priority Animal and Plant Pests and Diseases (EMPRES-i) global animal health information system. We computed Spearman rank-order correlation statistics to compare spatial and temporal outbreak distributions, and applied a space–time permutation test to check for consistency between the two data sources. Although EMPRES-i typically captured fewer outbreaks than detailed national reporting data, the overall similarity in space and time, particularly after 2006, reflect the ability of the EMPRES-i system to portray disease patterns comparable to those observed in national data sets. Specifically, we show that the two datasets exhibit higher positive correlations in outbreak timing and reported locations after 2006 when compared to December 2003 through 2006. Strengthening the capacity of global systems to acquire data from national and regional databases will improve global analysis efforts and increase the ability of such systems to rapidly alert countries and the international community of potential disease threats.

Published by Elsevier B.V.

1. Introduction

H5N1 Highly Pathogenic Avian Influenza (HPAI) is an example of a zoonotic disease with large scale impacts on animal production, livelihoods, economies, wildlife, and public health (Rushton et al., 2005). The local severity of this disease has resulted in the establishment of national surveillance systems in several countries, while interest in larger scale outbreak patterns (e.g., regional or continental) has driven development of global information systems to collect, store and analyze outbreak information. One global system is the Emergency Prevention System for Priority

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0167-5877/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.prevetmed.2010.03.012

Animal and Plant Pests and Diseases (EMPRES-i) global animal health information system (Martin et al., 2007b) developed by the Food and Agriculture Organization (FAO) of the United Nations. EMPRES-i has been tracking H5N1 HPAI since December 2003.

Global animal health information systems such as EMPRES-i serve many purposes. For instance, they improve access to outbreak data for disease analysis and support notification activities by monitoring and summarizing the global status of priority animal diseases and zoonoses, including H5N1 HPAI. Effective notification of disease outbreaks and the capacity for understanding potential spread to new areas is an essential pre-requisite for successful containment and control of epidemic diseases (Ben Jebara, 2004; Martin et al., 2007b; Pittman et al., 2007), including emerging zoonoses such as H5N1 Highly Pathogenic Avian Influenza (HPAI) and other transboundary animal diseases. From a public health perspective notification of animal outbreaks with a known zoonotic potential enables health authorities to warn at-risk populations of behaviors that should be avoided and implement control measures that can prevent human morbidity and mortality (Reed et al., 2003; Webster and Hulse, 2004). From an animal production point of view endemic diseases and epidemics in livestock negatively impact food security and the livelihood of the poorest, along with affecting international trade (Thiermann, 2004; Zepeda et al., 2005; Doyle and Erickson, 2006; Pinto et al., 2008). In some cases spill over of disease between livestock and wildlife populations might also be prevented if an outbreak notification system is in place and proper actions taken. Another important purpose served by global databases is that of providing a central source of data that may be analyzed to improve understanding of disease patterns and ecological mechanisms underlying disease spread and maintenance, and to identify how these mechanisms vary across countries and regions (Cecchi et al., 2008).

Information on several priority animal diseases (e.g., foot and mouth disease, Rift Valley fever, African swine fever, and rinderpest) is gathered through EMPRES-i (Martin et al., 2007a), and among them H5N1 HPAI was selected for this study for a variety of reasons. First, the dataset is relatively large, with 4860 outbreak reports between December 2003 and April 2009 covering the areas of interest; second, there were national data sets for H5N1 HPAI available from several countries for comparison to EMPRES-i; and third, H5N1 HPAI is a high priority animal disease globally, as indicated by the wide spread impacts noted above.

In addition to global databases several countries have implemented surveillance programs resulting in national databases, often containing more detailed information than global systems, maintained by each country's national veterinary service. National databases are built and populated using different technologies than EMPRES-i, for example, the use of digital pen systems and Short Message Service (SMS) Gateway technologies are increasing the capacity of national surveillance programs to collect disease data from the field and transmit it to a national database in real time. Additionally, in some countries where national surveillance systems have been developed for H5N1 HPAI outbreak data are recorded at a finer spatial resolution than in EMPRES-i. Further, national databases tend to be more complete than EMPRES-i in terms of the number of outbreaks reported. In particular, in countries where H5N1 HPAI is endemic, such as Indonesia and Vietnam, national veterinary services are not required to report details of every outbreak to the OIE under the immediate notifications and follow-up reports in response to an exceptional disease event agreement, but instead maintain their own internal outbreak databases. Thus national databases may provide information about outbreaks that is unavailable in a global database. National databases maintained by each country's veterinary services were used in this study for its comparison to EMPRES-i data. When making our comparisons we assumed that national databases were more comprehensive in terms of the information and details regarding the number of outbreaks. Indeed, there were always more records in the national databases than in EMPRES-i for the time periods we compared.

For a system to be effective in improving the understanding of disease spread patterns and determinants the data on which the system relies must reflect those patterns in space and time. With this criterion in mind, the primary objective of this study was to determine the degree of concordance in spatial and temporal outbreak patterns of H5N1 HPAI between national veterinary services outbreak data, hereafter called "national" data, and EMPRES-i data and to determine both the extent of agreement and the degree to which that agreement has changed over time.

Specifically, we compare H5N1 HPAI outbreak data from national and EMPRES-i databases for four countries: Bangladesh, Egypt, Turkey, and Vietnam. These countries were chosen because they had a relatively large number of H5N1 HPAI outbreaks reported in both national and EMPRES-i data sources. Outbreak reports from these four countries constitute approximately 26% of all EMPRES-i H5N1 HPAI outbreaks reported between December 2003 and April 2009. Additionally, national data sets from these countries were available for at least some portion of this same time period. Indonesia and Thailand, which together represent an additional 44% of the EMPRES-i H5N1 HPAI data set, were also considered for this study, but were not used because there were political obstacles to using data from Indonesia, and national outbreak data from Thailand had already been directly integrated into EMPRES-i.

This is the first study we are aware of comparing agreement between national and global databases for an animal disease. Results of this analysis may help determine the extent to which EMPRES-i data might be used to develop an understanding of spatial and temporal dynamics of H5N1 HPAI at country, regional, and global scales.

2. Materials and methods

2.1. Data collection systems

EMPRES-i was developed to enable tracking and analysis of priority animal disease outbreaks across the globe. The system collects and stores information from multiple sources which can be classified as formal and informal. Formal data sources include reports from the