The Epidemiology of Avian Influenza in the Mekong River Delta of Viet Nam

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— Abstract —

Between December 2003 and December 2012 a total of 4,349 commune-level outbreaks of highly pathogenic avian influenza (HPAI) H5N1 were recorded in domestic poultry flocks throughout Viet Nam. Throughout the same period there were 123 cases of HPAI H5N1 virus infection in humans, 61 of which were fatal.

The studies presented in this thesis are largely based on data collected from a prospective cohort study of domestic poultry in 157 flocks in the Mekong River Delta of Viet Nam between December 2008 and April 2010. The first research chapter (Chapter 3) provides a description of the components and design features of an animal health decision support system for use in Viet Nam. While not explicitly used for the prospective cohort study, the motivation for development of this system was to provide a means for recording and storing animal health data so as to minimise duplication of data collection efforts. A feature of the system is the inclusion of a flexible reporting tool that provides system users with the capability of developing reports to deal with virtually any animal health issue, not just avian influenza. The intent of this system is that it will allow the Vietnamese Department of Animal Health to identify and respond to existing and emerging threats to animal health in a timely and cost-effective manner.

Our descriptive analyses (Chapter 4) show that the overall incidence rate of influenza Type A and H5 virus infection in village poultry was relatively high throughout the 17-month follow up period of the prospective cohort study. This implies that interventions such as vaccination, movement controls and biosecurity measures need to be carried out continuously throughout the year rather than focusing only on the established high risk periods. Broiler ducks had an incidence rate of influenza H5 virus infection that was approximately four times greater than that of layer ducks and in-contact species. This indicates that broiler ducks should be the focus of disease surveillance and control strategies.

Survival analyses, accounting for the intermittent sampling of birds throughout the follow-up period of the prospective cohort study (by interval censoring) and for the hierarchical structure of the data set were used to determine the duration of immunity to H5N1 following vaccination (Chapter 5). After adjusting for the effect of known confounders and unmeasured variation at the flock level the duration of immunity to H5N1 following vaccination was estimated to be in the order of 56 (95% CI 51 – 61) days, considerably shorter than the duration of immunity previously reported in laboratory-based studies. A multilevel logistic regression analysis carried out to identify risk factors for influenza Type A virus infection in the prospective cohort study poultry population found that the relative contribution of unmeasured flock- and bird-level factors on influenza Type A virus infection risk were approximately equal (Chapter 6). Most of the significant fixed-effects were flock-level exposures indicating that interventions to reduce the maintenance and transmission of influenza Type A virus in domestic poultry in this area of Viet Nam should be applied at the individual bird and individual flock level.

Chapter 7 presents the results of a study of poultry movement events that occurred in the south of Viet Nam between September 2009 and June 2010. Poultry were more likely to be moved between communes with provincial roads and between communes with more than 1,000 poultry-owning households. Assuming a causal relationship exists between a commune-to-commune poultry movement activity and HPAI H5N1 risk, a conclusion from this study was that communes more likely to be connected to others as a result of movement should be targeted for disease control and surveillance.

The findings presented in each of these chapters of this thesis have broadened our knowledge of the epidemiology of not only the HPAI H5N1 subtype, but influenza Type A viruses in poultry in general. It should be stressed that the methodological techniques that have been used in this thesis can be applied to a wide range of animal health issues, not just HPAI H5N1.

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Nomenclature

AAHL	Australian Animal Health Laboratory
AFT	accelerated failure time
AI	avian influenza
ARAHIS	ASEAN Region Animal Health Information System
BSE	bovine spongiform encephalopathy
CI	confidence interval
Ct	(RRT-PCR) cycle threshold
CSF	classical swine fever
CSS	cascading style sheets
DAH	Department of Animal Health, Viet Nam
DEFRA	Department for Environment, Food and Rural Affairs, UK
DMS	database management system
DSS	decision support system
DVS	district veterinary station
EDR	estimated dissemination ratio
FAO	Food and Agriculture Organization of the United Nations
FMD	foot-and-mouth disease
FRD	field running duck
GIS	geographic information system
GUI	graphic user interface

HA	haemagglutinin
HPAI	highly pathogenic avian influenza
HI	haemagglutination inhibition
HTML	hyperText markup language
KML	keyhole markup language
LPAI	low pathogenic avian influenza
MARD	Ministry of Agriculture and Rural Development, Viet Nam
MRD	Mekong River Delta, Viet Nam
NA	neuraminidase
NLIS	National Livestock Identification System, Australia
NVDC	National Veterinary Diagnostic Centre, Viet Nam
NVSL	National Veterinary Services Laboratories
OIE	Office International des Epizooties
OR	odds ratio
RADAR	Rapid Analysis and Detection of Animal-Related Risks, UK
RAHO	Regional Animal Health Office, Viet Nam
ROC	receiver operating characteristic (curve)
RRD	Red River Delta, Viet Nam
PCR	polymerase chain reaction
RRT-PCR	real time reverse transcriptase polymerase chain reaction
SARS	severe acute respiratory syndrome
SDAH	Sub-department of Animal Health
SE	standard error
SISBOV	Serviço de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos, Brazil

SNA	social network analysis
TADinfo	Transboundary Animal Disease Information System
USDA	United States Department of Agriculture
WAHID	World Animal Health Information Database
WHO	World Health Organization

List of Publications

Long, N.V., Stevenson, M. and O'Leary, B. (2011) Decision Support Systems in Animal Health. Efficient Decision Support Systems — Practice and Challenges in Biomedical Related Domain. Edited by C.S. Jao. InTech, Rijeka, Croatia. ISBN: 978-953-307-258-6.

Long, N.V., Stevenson, M., Schauer, B., Diep, N.T., Quy, T.D., Tien, T.N., Phuong, T.T.T., Prattley, D. and Morris, R. (2013) Descriptive results of a prospective cohort study of avian influenza in the Mekong River Delta of Viet Nam. Transboundary and Emerging Diseases. doi: 10.1111/tbed.12055.

Long, N.V., Stevenson, M., Schauer, B. and Thuy, N.T. (2013) Risk factors for highly pathogenic avian influenza H5N1 vaccination failure in poultry in the Mekong River Delta of Viet Nam, 2008-2010. Presentation at the 13th International Symposium on Veterinary Epidemiology and Economics, 20 – 24 August 2012, Maastricht, The Netherlands.

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