

How Fast was Highly Pathogenic Avian Influenza Virus Spreading within Turkey Flocks During the 2015 H5N2 Epidemic in the United States?

Amos Ssematimba, Sasidhar Malladi, Thomas J. Hagenaars, Joseph T. Weaver, Peter Bonney, Kelly A. Patyk, David A. Halvorson, Carol J. Cardona

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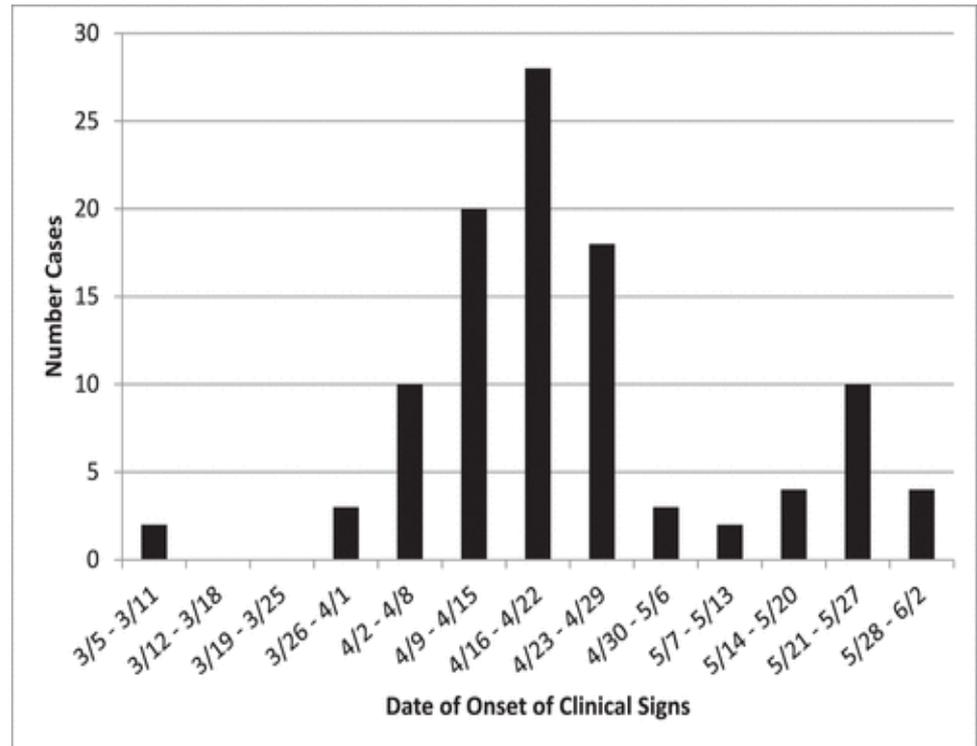
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United States
Department of
Agriculture

MN Turkey Epidemic Curve and Details

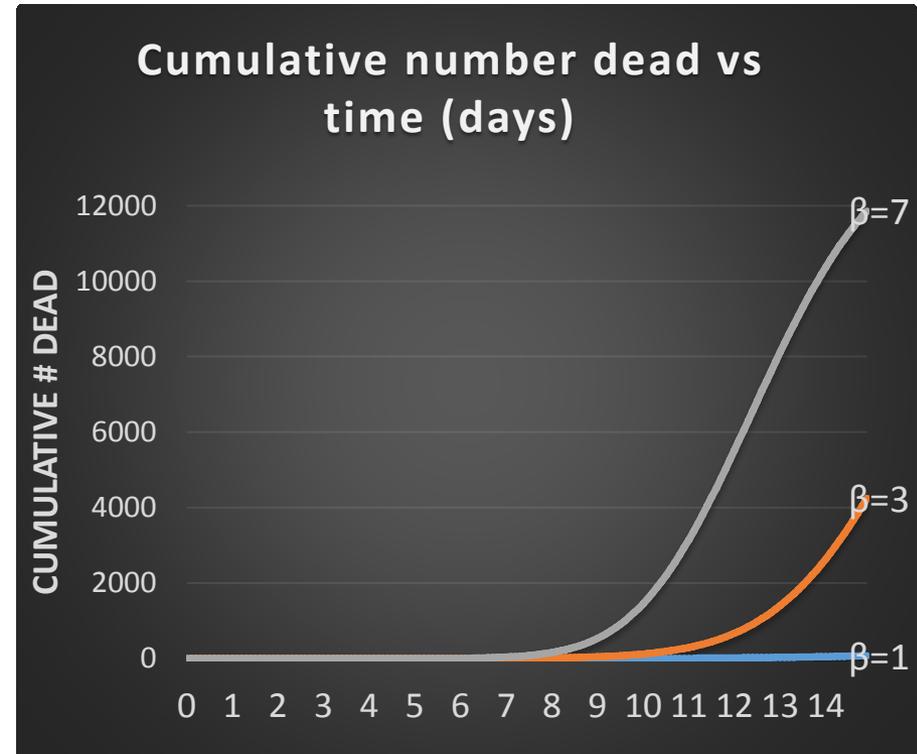
- Outbreak affected 104 commercial turkey operations in Minnesota
- Estimated total impact on U.S. economy was ~USD 3.3 billion (Greene J.L. (2015), Congressional Research Service)



Source: Dargatz et. al., Avian Diseases 60(2):467-472. 2016

Impact of Transmission Parameters on Disease Dynamics

- Within-flock transmission dynamics inform disease control measures
- β : adequate contact rate or transmission parameter = mean number of birds infected by each infectious bird per unit time: determines disease spread rate
- R_0 : basic reproduction number = β x infectious period



Why Estimate β and R_0 ?

- Within-flock β and R_0 inform
 - Secure poultry supply risk assessments
 - Evaluation of active and passive surveillance protocols
 - Between-premises disease spread models
- Thus far β estimates from U.S outbreak data were unavailable, and estimates from other countries were used
- Although β has been previously estimated from experimental data, extrapolation to commercial flocks is not straight forward



Estimation Approach

Back-calculation of mortality data from the outbreak



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Data Preparation

- Ideally, estimation of β requires data on number of newly infected birds (C), Susceptible (S), Infectious (I), and total number of birds (N) at different time points- yet only mortality is observed in the field
- Through back-calculation, we estimate these 4 variables from mortality data assuming fixed latent and infectious periods
- Once C, S, I & N are obtained, β is estimated using accepted GLM-based approaches



The Statistical Approach

- β and its 95% C.I. were estimated using Generalized Estimating Equations using the GENMOD procedure in SAS
- An exchangeable correlation structure was used and “flock” was the repeated subject
- R_0 was then calculated as the product of the estimated β and the set (deterministic) infectious period



Parameters Used

- Default scenario: 1 day latent and 4 days infectious period based on inoculation studies using EA/AM HPAI H5N2 virus turkey field isolate were used
- For purposes of sensitivity analysis, the latent period was adjusted to 2 days in the back-calculation procedure



Results

Estimated β and R_0 using infectious period of 4 days with latent period of 1 day for default scenario and 2 days for sensitivity analysis

	β (95% CI)	R_0 (95% CI)
Default scenario	2.2 (1.6 – 3.0)	8.8 (6.4 – 12.0)
Sensitivity analysis	6.6 (3.8 – 11.2)	26.4 (15.2 – 44.8)

Possible Limitations for Back-calculation

- Back-calculation with GLM-based estimation studies are limited by
 - The assumption of deterministic latent and infectious periods
 - Ignoring between-bird variation
 - Using whole integers for these durations e.g., not considering the exact moment of infection
- Alternative approaches are being explored e.g., forward simulation and curve-fitting



Concluding Remarks

- Back-calculation is a computationally efficient method that uses accepted GLM-based procedures to obtain reasonable estimates for β
- β is a key parameter in a number of modeling analyses for decision support and active surveillance
- Developing multiple methods to estimate β will improve the accuracy of within-flock HPAI spread models results
- Timely access to outbreak data is critical for future analyses





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