Within-flock mortality during the high-pathogenicity avian influenza (H7N7) epidemic in the Netherlands in 2003 : implications for an early detection system.

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Introduction

An important requirement for the development of a large epidemic is delayed detection of the index case and a high density of poultry farms in an area. Often, index cases are detected 1-3 weeks after onset of clinical signs (Capua and Marangon 2000; Elbers et al. 2004). Experiences show that a HPAI epidemic in a high density poultry area is very difficult to control, especially if the detection of the infection is delayed (Zanella et al. 2001). Clinical signs of avian influenza (AI) are difficult to distinguish from a large range of other poultry diseases, which implies that the time needed for ultimate detection of a new infection would provide time for the virus to spread quickly. This points out a considerable risk, because in times without AI outbreaks in a free country there will be a tendency not to report AI-suspect situations by the farmer or veterinary practitioner because of the low specificity of clinical signs for detection of AI. Because of delayed detection, the virus has often spread to other flocks before control measures are established, especially in poultry dense areas. Therefore, there is an absolute need for implementation of adequate early detection systems (EDS) to prevent delayed detection. During the 2003-epidemic - and up to June 2005 – a temporary EDS was set up. Every poultry farmer was obliged to notify mortality of 3% or more per week to the VA. Furthermore, there was an obligatory consultation by a practitioner when a reduction in feed or water intake of more than 20% was observed.

Objective

In the aftermath of the 2003-epidemic, the Dutch Ministry of Agriculture, Nature and Food Quality asked for an evaluation of the temporary EDS. Specifically, the notification threshold of 3% mortality per week was put up for debate because waiting for cumulative mortality to be higher than 3% per week might not be a sensitive decision. The evaluation would be used to set up requirements for a permanent EDS for poultry in the Dutch Animal Health and Welfare Act (DAHWA).

Methods

Investigation Form

Farmers of infected flocks were interviewed by the VA using a standardized investigation form (SIF). A SIF consisted of questions concerning demographic information of the poultry farmer (name and address), unique herd number, flock type, number of birds starting production and starting date of production, date of birth of birds, number of birds present at time of inspection, and a history-taking : describing the clinical situation and clinical signs seen by the poultry farmer in the last one to two weeks. Furthermore, using the production and administration charts of the farmer, the number of birds that died per day in the week before an increase in mortality was seen in a particular poultry barn, and the number of birds that died in the first days after start of increased mortality, were documented on the SIF.

Flocks

From 240 H7N7-infected flocks that were detected on the basis of clinical signs (Elbers et al. 2005), a total of 192 poultry flocks were available for analysis with proper mortality data : 124 layer flocks with organic or free-range production (birds housed as one group with individual contact possibilities); 55 layer flocks with birds housed in cages; 9 turkey flocks; 4 broiler flocks. Daily mortality data were not available from all flock types for all the same days. For instance, for layer flocks with birds housed in cages, daily mortality data was available from 30, 39, 48, 49, 55, 55, 19 and 5 flocks for respectively time = -4, -3, -2, -1, 0, 1, 2, and 3 days since increased mortality.

Statistical Analysis

Daily mortality data documented on the SIF were used to calculate a mortality proportion per day : number of birds that died on a particular day in a barn divided by the number of birds that started production in that barn. Since mortality increases exponentially during a HPAI outbreak, a non-linear regression model was used (SAS 1999) : mortality proportion per day = • • $e^{(\bullet * Time)}$, with time in days since increased mortality (0, 1, 2,…). We averaged the daily mortality in the days before the start of increased mortality in order to have one baseline mortality for time=0, representing the "normal mortality" in the poultry flock without AI-infection. If time=0, than $e^{(\bullet * Time)}$ = 1, and the model estimates •, the baseline mortality per day. With the mortality data on day 1, 2, 3,… we are able to estimate the regression coefficient •, which measures the slope or increase in mortality per time unit. The analysis was stratified by age-categories of the poultry involved since this might be a factor influencing the mean mortality proportion per day. This was not possible for broilers: the 4 flocks in our data set were all approximately 6 weeks of age and ready for slaughter.

Results

Mortality increased exponentially and the original threshold of 3% mortality was reached within 2-3 days after the start of increased mortality. The increase in mortality per day is approximately two-times higher for organic layer flocks compared to layer flocks with birds in cages (Table 1). There was no evidence for an influence of age on increase of mortality over time for the layer flocks. However, the increase in mortality per day was approximately two-times higher for older turkey flocks (• 16 weeks of age) compared to younger turkey flocks (• 11 weeks of age) (Table 1).

Table 1. Estimated regression coefficients (with accessory 95% confidence intervals) for modeling within-flock mortality with a non-linear regression model : mortality proportion = • • $e^{(\bullet * Time)}$, with time in days since increased mortality (0, 1, 2,…).

Poultry type	Number of flocks	Estimated regression coefficients •	(95% C.I.)	•	(95% C.I.)	R^2
Layers (organic)	124	0.003	(0.0001 – 0.005)	2.25	(2.03 – 2.47)	0.75
Layers (caged)	55	0.0008	(0.00013 – 0.001)	1.19	(0.96 – 1.42)	0.50
Turkeys						
age • 11 weeks	3	0.001	(0 - 0.003)	1.38	(0.73 – 2.03)	0.92
age • 16 weeks	6	0.001	(0.0003 - 0.002)	2.35	(1.94 – 2.75)	0.99
Broilers	4	0.002	(0 - 0.004)	0.83	(0.55 – 1.12)	0.86
Total	192					

Discussion

In this study we assessed and modeled within-flock mortality of layer, turkey and broiler flocks during the H7N7-epidemic in the Netherlands in 2003. Comparing the increased mortality due to AI-infection to the normal baseline mortality per day in poultry flocks we make the following recommendations to set new notification thresholds with respect to mortality in the DAHWA: a) (organic) layer flocks with group-housed facilities, broiler flocks and turkey flocks • 11 weeks of age : • 0.5% mortality/day for two consecutive days; b) layer flocks with birds housed in cages: • 0.25% mortality/day for two consecutive days; c) turkey flocks • 16 weeks of age : • 1% mortality/day for two consecutive days. These thresholds should be interpreted on the level of the barn in which the clinical problems started, and not on the flock level because in the latter case,

detection will be delayed. Notification of increased mortality to the veterinary authorities should take place on the second day of increased mortality. Mortality data in our study are comparable to case reports of other HPAI-outbreaks around the world. The significantly higher increase in mortality per day for poultry flocks in which birds are held as one group (turkeys and organic and free-range layers) compared to the layer flocks with birds housed in cages has a logical background: poultry kept as one group have much more mutual contact possibilities compared to layers housed in cages. In such a situation, transmission of infection will be much faster. The clearly slower increase in mortality per day for young turkeys compared to older turkeys was also observed during the recent high-pathogenicity AI subtype H5N1 outbreaks in March 2006 in Israel (pers. comm. dr. E. Berman). However, there is no explanation for this observation, in general younger birds die quicker from HPAI compared to older birds.
Since there was limited data available from turkey and broiler flocks, we should be careful with the interpretation of those results. For instance, we would have expected that the increase in mortality per day for broiler flocks would be comparable to the turkey and organic and free-range layer flocks because of the identical contact structure between birds in a broiler flock. The very small number of broiler flocks in our data set might contribute to this phenomenon.
Mortality as a clinical sign has a high sensitivity for detection of HPAI-outbreaks (Elbers et al. 2005). However, increased mortality may be caused by a range of other poultry diseases. Due to presumed non-optimal specificity of the proposed thresholds, poultry farmers might hesitate to notify increased mortality to the VA. Indeed, this happened in 2003 in the Netherlands : in the first few infected flocks during the H7N7-epidemic in 2003, increased and progressive mortality was seen day after day by poultry farmers, but none of them, nor the poultry practitioners involved, notified the VA and a huge epidemic developed (Elbers et al. 2004). After the 2003-epidemic the EDS continued to be in operation, but there seems to be a small basis for it in practice: some poultry farmers still ignore to notify a critical disease situation. In many cases this is done with the argument that a notification will harm them economically because of isolation of the farm for a couple of days. Therefore, there is a definite need to facilitate the notification process. It might be anticipated that transparent information on the notification process and what farmers might expect from it in terms of laboratory testing and duration of isolation of the farm would facilitate the notification process. Furthermore, use of PCR-diagnostics with a test result within 24hours, without costs for farmers should be promoted to exclude AI in suspect clinical situations in order to minimize negative economical consequence for farmers and to stimulate notification by farmers and veterinary practitioners.

References

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