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Airborne transmission of a highly pathogenic avian influenza virus strain H5N1 between groups of chickens quantified in an experimental setting

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ABSTRACT

Highly pathogenic avian influenza (HPAI) is a devastating viral disease of poultry and quick control of outbreaks is vital. Airborne transmission has often been suggested as a route of transmission between flocks, but knowledge of the rate of transmission via this route is sparse. In the current study, we quantified the rate of airborne transmission of an HPAI H5N1 virus strain between chickens under experimental conditions. In addition, we quantified viral load in air and dust samples. Sixteen trials were done, comprising a total of 160 chickens housed in cages, with three treatment groups. The first group was inoculated with strain A/turkey/Turkey/1/2005 H5N1, the second and third group were not inoculated, but housed at 0.2 and 1.1 m distance of the first group, respectively. Tracheal and cloacal swabs were collected daily of each chicken to monitor virus transmission. Air and dust samples were taken daily to quantify virus load in the immediate surroundings of the birds. Samples were tested by quantitative RRT-PCR and virus isolation. In 4 out of 16 trials virus was transmitted from the experimentally inoculated chickens to the non-inoculated chickens. The transmission rate was 0.13 and 0.10 new infections per infectious bird at 0.2 m and 1.1 m, respectively. The difference between these estimates was, however, not significant. Two air samples tested positive in virus isolation, but none of these samples originated from the trials with successful transmission. Five dust samples were confirmed positive in virus isolation. The results of this study demonstrate that the rate of airborne transmission between chickens over short distances is low, suggesting that airborne transmission over a long distance is an unlikely route of spread. Whether or not this also applies to the field situation needs to be examined.

1. Introduction

Highly pathogenic avian influenza (HPAI), caused by avian influenza viruses of subtype H5 or H7, is one of the most important poultry diseases worldwide (Alexander, 2007). The infection spreads rapidly among chickens and between flocks, causing high mortality rates and severe economic losses. Moreover, HPAI virus strains have caused infections in humans (Kalthoff et al., 2010) and are considered a risk for a human influenza pandemic. As a consequence, outbreaks of HPAI virus in poultry flocks need to be controlled quickly.

Control measures aiming to eliminate HPAI virus often include stamping out infected flocks, pre-emptive culling of flocks at risk to become infected, movement restrictions and bio-safety measures. These control measures may, however, not be sufficient to control a major epidemic in poultry dense regions (Capua and Marangon, 2003; Stegeman et al., 2004; Boender et al., 2007). Moreover, the costs associated with pre-emptive culling are high and the killing of large numbers of uninfected birds evokes ethical discussion in society. Consequently, improvement

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of the culling strategy, making it both more efficient and acceptable is needed.

To increase the effectiveness of control strategies, quantitative information of the possible routes of virus transmission between farms is essential. It has been demonstrated that the probability of between-flock virus transmission decreases with increasing distance between an infected and an uninfected flock (Boender et al., 2007), but the underlying mechanism of transmission still shows considerable gaps. Several routes are considered to be important during AI epidemics, such as movements of visitors, materials, and fomites, but, as shown for some other viral diseases (Gloster et al., 2010; Otake et al., 2010; Li et al., 2009) also airborne transmission has been hypothesised (Chen et al., 2010; Tsukamoto et al., 2007; Yee et al., 2009). Although some of the routes could be controlled by stringent hygienic measures, prevention of virus introduction via airborne route seems hardly feasible in commercial poultry industry. It is therefore important to establish the contribution of airborne infection in the between-farm spread.

During an AI epidemic it is difficult to quantify the rate of airborne virus transmission between farms. The rate at which such an epidemic evolves, the need for immediate implementation of control measures and the presence of other routes of transmission that can act as confounding factors hamper a thorough investigation during epidemic episodes. An alternative way to quantify airborne trans-

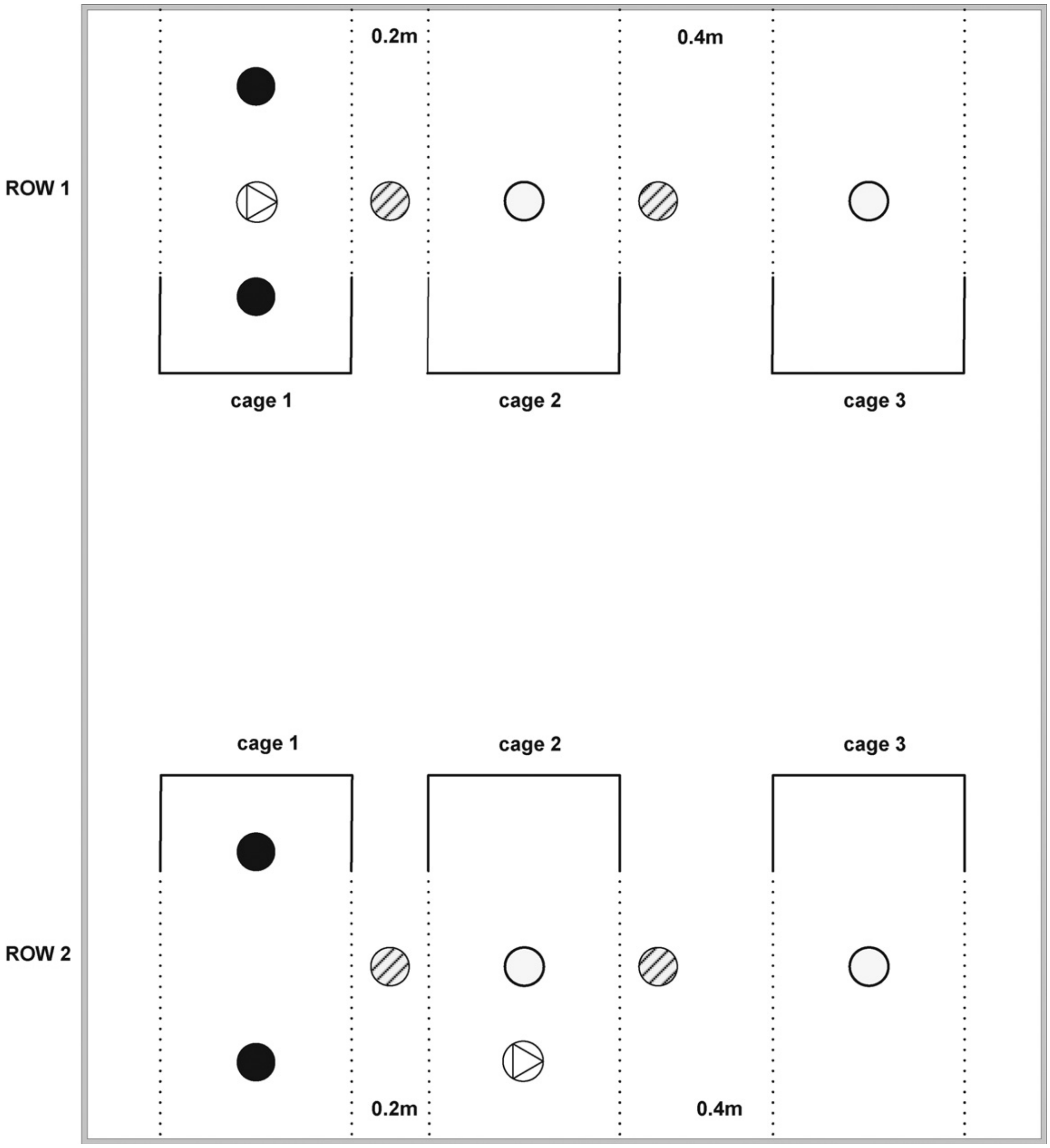

Fig. 1. Lay-out of the isolation room of the first experiment. ● represents the inoculated chickens; ○ represents the non-inoculated chickens; ▷ represents the location of air sampling; ◯ represents the location of dust sampling.