

ORIGINAL ARTICLE

Risk of Introduction in Northern Vietnam of HPAI Viruses from China: Description, Patterns and Drivers of Illegal Poultry Trade

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Summary

Poultry movement is known to contribute to the dissemination of highly pathogenic avian influenza (HPAI) viruses. In Northern Vietnam, the illegal trade of poultry from China is a source of concern and is considered as responsible for the regular introduction of new H5N1 viruses. The general objective of this study was to get a better understanding of this illegal trade (organization, volume, actors involved and drivers) to propose adequate preventive and control options. The information was also used to qualitatively evaluate the risk of exposure of susceptible poultry to HPAI H5N1 virus introduced from China by illegally traded poultry. We found that the main products imported from China are spent hens, day-old chicks (DOCs) and ducklings; spent hens being introduced in very large number. The drivers of this trade are multiple: economic (especially for spent hens) but also technical (demand for improved genetic potential for DOC and ducklings). Furthermore, these introductions also meet a high consumer demand at certain periods of the year. We also found that spatial dispersion of a batch of poultry illegally introduced from China is extensive and rapid, making any prediction of possible new outbreaks very hazardous. Finally, a risk mitigation plan should include measures to tackle the drivers of this trade or to legally organize it, to limit the threat to the local poultry sector. It is also essential for traders to be progressively better organized and biosecure and for hygienic practices to be enforced, as our study confirmed that at-risk behaviours are still very common among this profession.

Introduction

The highly pathogenic avian influenza H5N1 (HPAI H5N1) virus was first detected in Vietnam in 2001, and the first epidemic in poultry was declared in late 2003 (FAO, 2011). Since this first major epidemic, several other waves of outbreaks have occurred in the country (Pfeiffer et al., 2007; Minh et al., 2009). All the 6 HA clades of the HPAI H5N1 viruses identified in Vietnam since 2001 have precursor viruses isolated previously in mainland China and Hong Kong SAR (Wan et al., 2008). This confirms the

regular introduction of viruses into Vietnam from these regions. The detection of clade 7 viruses from chickens seized at the border with China (Davis et al., 2010) is further evidence indicating that illegal trade of poultry from China is a cause of regular introductions into Vietnam of new viruses emerging in China. There have been regular communications about these illegal imports of live poultry from China, especially at the border of Lang Son province (see Fig. 2 for localization), either in reports from international agencies and projects (Vu, 2009; FAO, 2011) or in local newspapers (Tran, 2007). De Haan et al. (2011) also

mentioned the port of entry of Lang Son province for the illegal poultry trade from China and described the value chain of Chinese spent hens intended for illegal export.

Thus, the risk of introduction of H5N1 viruses via the illegal poultry trade from China is recognized but information is still lacking in regard to the extent of this trade, its organization in space and time as well as the poultry types involved. Without this information, it is difficult to assess the role of this trade in the epidemiology of the HPAI H5N1 disease in Vietnam and to propose adequate control and preventive measures. Furthermore, the recent sanitary crises in China with the emergence of the new virus H7N9 (WHO, 2013) have highlighted the need to better understand the drivers and pathways of illegal poultry trading to identify specific measures to help decrease the risk of disease spreading at regional level.

The present study aimed at (i) identifying the type of poultry imported and the actors involved in this trade, (ii) identifying a possible seasonal pattern for these imports, (iii) identifying the main drivers underlying this trade. This information was then used to qualitatively evaluate the risk of exposure of susceptible poultry in Vietnam to HPAI H5N1 virus introduced from China by illegally traded Chinese poultry.

Materials and Methods

Questionnaire and study site

Two questionnaires were developed, tested and administered by a Vietnamese researcher. One was targeted at traders and the other at farmers. The questions were related to the total amount of poultry bought by each informant, the monthly distribution of Chinese poultry yearly traded by each trader, the trading connections of the informants (where or to whom traders and farmers were selling and buying their poultry and in what proportion) as well as general information about trading practices (number of journeys to China per year for a trader and the duration of transport), reason for buying Chinese poultry and possible at-risk behaviour (disinfection or not of the cages, storage of the birds before selling, farmers' behaviour in case of disease. . .). The area of interest was the border between Vietnam and China in Lang Son province (Fig. 2).

Identification of key informants and selection of traders and farmers

To identify and select the traders to be interviewed, one or two key informants were first contacted in the provinces located in the Red River Delta and North West administrative regions. Most of those key informants were in charge of animal movements in the local or provincial veterinary services. Key informants were generally aware of the illegal

trade in their area but often had limited power to control it. In some of the provinces contacted, the key informants were able to provide a list of traders' contacts. We then contacted these traders to collect general information about their activity to roughly identify different trader profiles. We then selected traders for face-to-face interviews with the objective of getting a good representation of the different types of traders involved in the illegal poultry trade with China in that region. Our objective was to personally interview 10 traders. From the results of the traders' interviews, farmers raising poultry from China were then identified and 10 were selected for interview.

Study population

Following the selection procedure described above, a list of around 50 traders known to be involved in poultry trading from China was built. Some traders were clearly identified and could be contacted by phone for the first general, informal interview. Information about traders importing poultry from China was obtained from Bac Giang, Bac Ninh, Hai Phong and Ha Tay provinces. No information could be gathered from Lang Son province. Then, a selection was made, including both direct importers and provincial traders, according to the initial information collected by phone. Three initially selected traders refused to be interviewed and had to be replaced. Face-to-face interviews were then organized in the province of origin of the 10 selected traders (6 in Bac Giang, 2 in Bac Ninh, 1 in Ha Tay and 1 in Hai Phong province). Following interviews with traders, 10 farmers were identified and interviewed in four different provinces (3 in Bac Giang, 1 in Ha Tay, 5 in Hung Yen and 1 in Thai Nguyen).

Risk assessment framework

The risk assessment is the component of risk analysis that estimates the likelihood of occurrence and the magnitude of consequences of any given hazard. Hazard identification consists in identifying the pathogenic agents which could potentially produce adverse consequences associated, in our context, with the importation of a commodity. Risk assessment needs to be flexible to deal with the complexity of real-life situations. No single method is applicable in all cases (OIE, 2013). We applied the commonly accepted framework for risk assessment related to the introduction of disease derived from the OIE Terrestrial Animal Health Code (OIE, 2013). Our objective was limited to evaluating the likelihood of exposure of poultry susceptible to HPAI H5N1 viruses released by illegally traded Chinese poultry. Thus, having identified the hazard, we studied the risk of release before conducting the exposure assessment.

Due to the difficulty in collecting data about illegal trade, only a preliminary qualitative assessment was targeted. A qualitative risk assessment ends with a qualitative estimation of the risk being studied usually into four categories: negligible, low, medium and high (Zepeda Sein, 1998). We first built an event tree (Vose, 2000) of the main steps leading to the release and exposure of the hazard in our context, separately for the import of poultry intended for consumption and poultry intended for breeding. The likelihood of each of these events was then estimated before they were combined to obtain the final estimation of the likelihood of exposure using a combination matrix for independent events (Wieland et al., 2011) (Table 1). To estimate the likelihood of each event, different parameters were considered as proposed by the OIE guideline (OIE, 2013). For the release assessment, the main parameters to consider were (i) an estimation of the prevalence of the HPAI H5N1 in China as well as an evaluation of the quality of the monitoring system by which these data were obtained; (ii) the volume of poultry trade from China to Northern Vietnam; (iii) the efficiency of border control. For the exposure assessment, the main parameters to consider were (i) the absence or not of clinical signs in the case of infection in the birds being illegally imported; (ii) the identification of animals, people or fomites possibly exposed to the hazard; (iii) the measures that may limit the exposure of susceptible animals; and (iv) the destination and use of the source of hazard or contaminated products.

Results and Discussion

Identification of the actors involved in this illegal trade

Based on the interviews results, three main types of traders involved in the illegal trade of Chinese poultry were identified:

- 1 Importing traders: traders importing poultry directly from China (4 were interviewed).
- 2 Large-scale provincial traders: traders buying poultry from the importing traders and selling mainly to other traders in different provinces (1 interviewed).
- 3 Small traders: traders buying mainly from big provincial traders (5 interviewed).

Table 1. Combination matrix used to combine two risk estimates that are independent of each other (Wieland et al., 2011)

| Event 2 | Negligible | Low | Moderate | High |
|------------|------------|----------|----------|----------|
| Event 1 | | | | |
| Negligible | Negligible | Low | Low | Moderate |
| Low | Low | Low | Moderate | Moderate |
| Moderate | Low | Moderate | Moderate | High |
| High | Moderate | Moderate | High | High |

Only two of the traders were exclusively trading poultry from China, the others were also trading Vietnamese poultry.

From the initial informal interviews with key informants and with traders, we learnt that:

- 1 There were only a few importing traders in each province. We estimated there were around 10 in each of the 4 studied provinces.
- 2 The importing traders are persons with strong local political support.
- 3 Once the importing trader has made an agreement with an exporting trader in China, they rely on transporters on foot or on motorbike to cross the borders (Tran, 2007). At this stage, the transporters can be stopped by the police and the commodities can be seized, but most of the birds finally enter Vietnam. All birds are then gathered somewhere in Vietnam before being sent by truck or motorbike to their final destination (mainly to other traders who will then distribute them to farmers, markets or restaurants).
- 4 Birds can still be confiscated on the way to their final destination, but very often, drivers hired by the importing traders succeed in avoiding problems by paying bribes to the officials at the checkpoints or at the market places.
- 5 Importing traders pay for the birds only after checking their sanitary conditions by visual inspection once in Vietnam.
- 6 The number of small provincial traders involved in this illegal trade is decreasing due to greater control by local veterinary services.

Poultry category and estimated volume imported

According to our interviews, the main poultry categories imported, in volume, are spent hens (SH), day-old chicks (DOC) and ducklings (D). To give an indication of the quantity of birds being imported from China, the annual quantity imported by the 4 importing traders interviewed are presented in the Table 2. It is difficult to obtain a global estimation of the quantity imported by all illegal traders, and this was clearly not an objective of our study – and only non-referenced sources can be quoted. From an unpublished survey conducted in 2009 and quoted in Nguyen (2010), we learnt that at the border of Lang Son province, it is estimated that around 10–15 tons of spent hens are imported per day, 30 000 to 40 000 heads of DOCs and 50 000 heads of ducklings. In Quang Ninh province, the estimations are around 50 tons of spent hens per day and around 10 000 heads of DOCs per day. According to the data we have directly collected, these figures seem plausible or even underestimated (1.6 kg per bird multiplied by 23 million spent hens, imported by one of the traders interviewed and divided by 365 days gives a

Table 2. Distribution of the poultry imported by species and production type for the 4 interviewed importing traders

| Bird category | Spent hens | DOC | Duckling | Duckling (Muscovy ducks) | Day-old goose | Total |
|---|----------------|---------------|---------------|--------------------------|---------------|----------------|
| Total number birds imported (number. of importing traders interviewed involved) | 23 016 000 (2) | 1 744 000 (2) | 1 024 000 (2) | 42 000 (1) | 6 000 (1) | 25 832 000 (4) |
| Average number of transports per year and per trader (max) | 25 (60) | 17 (60) | 22 (60) | 8 (10) | 1 (3) | |

total of around 100 tons per day for the biggest of the importing trader interviewed).

Identified driving forces for illegal poultry trade

Different reasons for importing poultry from China have been identified. For spent hens, the financial motive is probably very strong for the importing traders: five of 6 traders declared that this meat poultry from China was less expensive than that from Vietnam. De Haan et al. (2011) reported that spent hens are bought in China at around 15 000–17 000 Vietnamese Dong (VND) per kg and then sold as meat chickens and sometimes even sold as local Vietnamese chickens at high prices, as reported by traders interviewed (up to 80–90 000 VND/kg). Indeed, local Vietnamese chickens are preferred by consumers to industrial chicken broilers, and the consumers can hardly tell the difference between spent hens and local chickens, once dressed. Furthermore, the meat is as tough as local chicken meat (Nguyen, 2010), and restaurants can increase their profits by buying Chinese spent hens at a lower price. The origin of the poultry is not promoted by the traders or the sellers: all traders who answered the question related to information about the origin of the birds declared that the consumers were not informed that poultry originally came from China. Thus, despite expenses along the commodity chain (transport, bribes, storage) also described by De Haan et al. (2011), the benefits must remain significant for the traders. The import of spent hens for meat consumption is also motivated by the high demand at certain periods of the year (see following section on seasonality).

The import of DOCs and ducklings from China seems to be more related to a specific demand of Vietnamese poultry farmers for improved genetic potential rather than a financial interest. Indeed, Chinese animals are reputed to have better performance characteristics than Vietnamese DOCs and ducklings, probably because the private Vietnamese hatcheries do not provide good sanitary and genetic guarantees. It was also reported by Phan Dang et al. (2010) that Vietnamese supply was insufficient for local demand. Thus, some of the farmers interviewed reported that laying hens from China produce more and bigger eggs and the resulting spent hens are heavier. Furthermore, 4 of the traders interviewed declared that DOCs and ducklings from China were

more expensive than animals from Vietnam, one said they were of a similar price and one they were less expensive.

Seasonality of Chinese poultry trading

The import of Chinese poultry occurs all year long, but there is some variation in the quantity imported according to the seasons. According to all the traders interviewed, this seasonal variation does not change from one year to another. The mean seasonal distribution (in percentage) of the three main categories of Chinese imported poultry is presented in Fig. 1. The seasonal variations can easily be explained by the demand of Vietnamese poultry farmers and consumers.

The annual relative share of the import of DOCs is greater during the period from August to November. Thus, birds imported at this time will be ready for sale around the Têt celebration (Vietnamese New Year in January or early February) to satisfy the high demand from Vietnamese consumers at a period during which chicken is a popular meal.

The peak in the import of spent hens is also connected to the Têt celebration. Nevertheless, this percentage has been calculated for only two traders, and the peak was only consequential for one of them. The other one, importing more than 20 million birds per year, presented a constant distribution of his import throughout the year with a slack period only during the hot season from May to August.

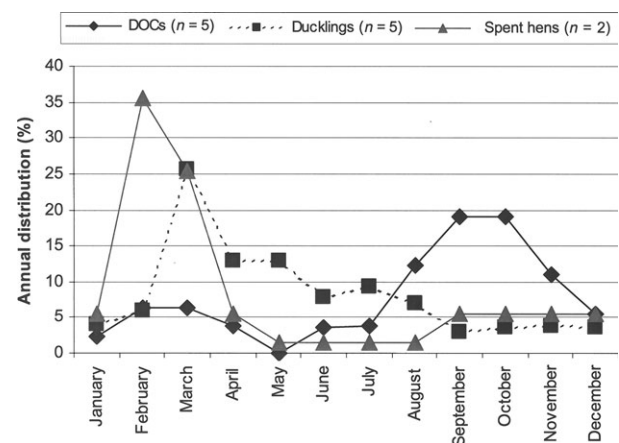


Fig. 1. Annual distribution of Chinese poultry purchase for the interviewed traders.

Seasonal tendency still needs to be validated even if the intensification of illegal import of chickens before the Vietnamese New Year has also been described by other sources (Tran, 2007).

The import of ducklings is higher around March and then until July (Fig. 1). February to May–June is the period of the first annual rice crop in Northern Vietnam and from June to September–October, the period of the second rice crop. It is well known that duck production is connected to rice production with the ducks being sent out to the rice fields just after rice transplantation for pest control or just after the harvest to scavenge weeds, crop residues, snails and fresh water crustaceans (Desvaux and Dinh, 2008). Thus, the import of duckling is connected to the rice production calendar. In Northern Vietnam, there are no more than 2 rice crops per year and the first rice crop involves a larger geographical area as not all plots of land are suitable for a second rice crop in the year.

Spatial spreading and risk management by traders and farmers

From the interviews, it appears that traders were illegally importing poultry from China not only at the border with Lang Son province, but also in the province of Quang Ninh (Fig. 2). Those two provinces share their borders with Guangxi province in China. From the questions related to the places where the importing traders were selling Chinese poultry, a map could be drawn showing the spatial dispersion of the birds (Fig. 2). It shows that from only two main ports of entry, Chinese poultry are sent on to most of the provinces in Northern Vietnam. Therefore, poultry imported without any sanitary control or guarantee can travel quite long distances.

The birds are either transported by motorbike (around 100 adults or 2000 DOCs or ducklings per motorbike and up to 500–700 adults if a trailer is used) or by truck (from 4000 to 6000 adults). According to the survey, the average transportation time is 4 to 5 h (min: 1–2 h, max: 7–8 h) by the traders.

Only 3 traders of 10 declared that they disinfected the material used to transport the poultry (cages and vehicle), and the others only used water for cleaning.

Seven of 10 traders declared that in normal circumstances, they needed to store the birds for several hours or days before selling them (mean: 7 h, min: 1 h, max: 2 days). The birds are stored either at their house or farm or at the selling place (market) where they can be in contact with other poultry (in 6 cases of 7). Six traders also declared they sometimes take unsold animals back to their house for 1–3 days prior to selling them at a cheaper price to the local markets or to farmers in their village. This practice supports a previous finding indicating that villages with



Fig. 2. Spatial distribution of live poultry imported from China.

poultry traders were more at risk of a H5N1 outbreak than others (Desvaux et al., 2011a).

Farmers' behaviour in the event of mortality at their farm varies according to the situation and the type of poultry involved. They either organize proper disposal of the dead birds (by burying or burning), or use the carcasses, especially the young ones, to feed other animals (dogs, pigs or fish, after cooking) or attempt to quickly sell off the remaining healthy birds if they are older. When disease is reported in the neighbourhood, farmers also reported action to protect their birds such as disinfection of the farms, limitation of visits into the house and farm, or preventive treatment of the birds with antibiotics and 'tonics'. These observations were consistent with findings from another field study conducted in another area of Northern Vietnam (Desvaux and Figuié, 2011b).

Qualitative risk assessment

The objective was to estimate the likelihood of exposure of poultry susceptible to HPAI H5N1 viruses released by illegally traded Chinese poultry.

The hazard under consideration in this study is HPAI H5N1 virus circulating in China.

Risk pathways

The steps leading to the release and direct or indirect exposure (via fomites) of Vietnamese poultry to HPAI H5N1 viruses excreted by poultry illegally introduced from China are detailed in a risk pathway (Fig. 3).

Release assessment

To estimate the probability that at least one batch of spent hens, DOCs or ducklings was infected, we considered that (i) China only declared around 100 outbreaks of HPAI H5N1 disease between 2003 and 2009 but, according to the FAO (FAO, 2011), not all cases are detected or reported, and the disease is considered to be endemic in the country despite the mass vaccination programme implemented (Martin et al., 2011); (ii) the illegal import of live poultry from China is a significant

trade, with the quantity of poultry imported without any sanitary control estimated at several thousand per day; (iii) veterinary controls at the borders have limited impact on this trade; (iv) spent hens are known to travel long distances within China before being exported to Vietnam and may have been exposed to HPAI H5N1 viruses during transport; (v) DOCs and ducklings are produced by breeders most probably vaccinated against the HPAI H5N1 (FAO, 2011).

The likelihood of a release of H5N1 viruses in Vietnam through the illegal trade of poultry can be estimated as high for spent hens and moderate for DOCs and ducklings.

Exposure assessment

To estimate the probability of exposure, we consider that:

- 1 Importing traders check the sanitary conditions of the birds before paying the exporting trader but that some birds may be infected without clinical signs:

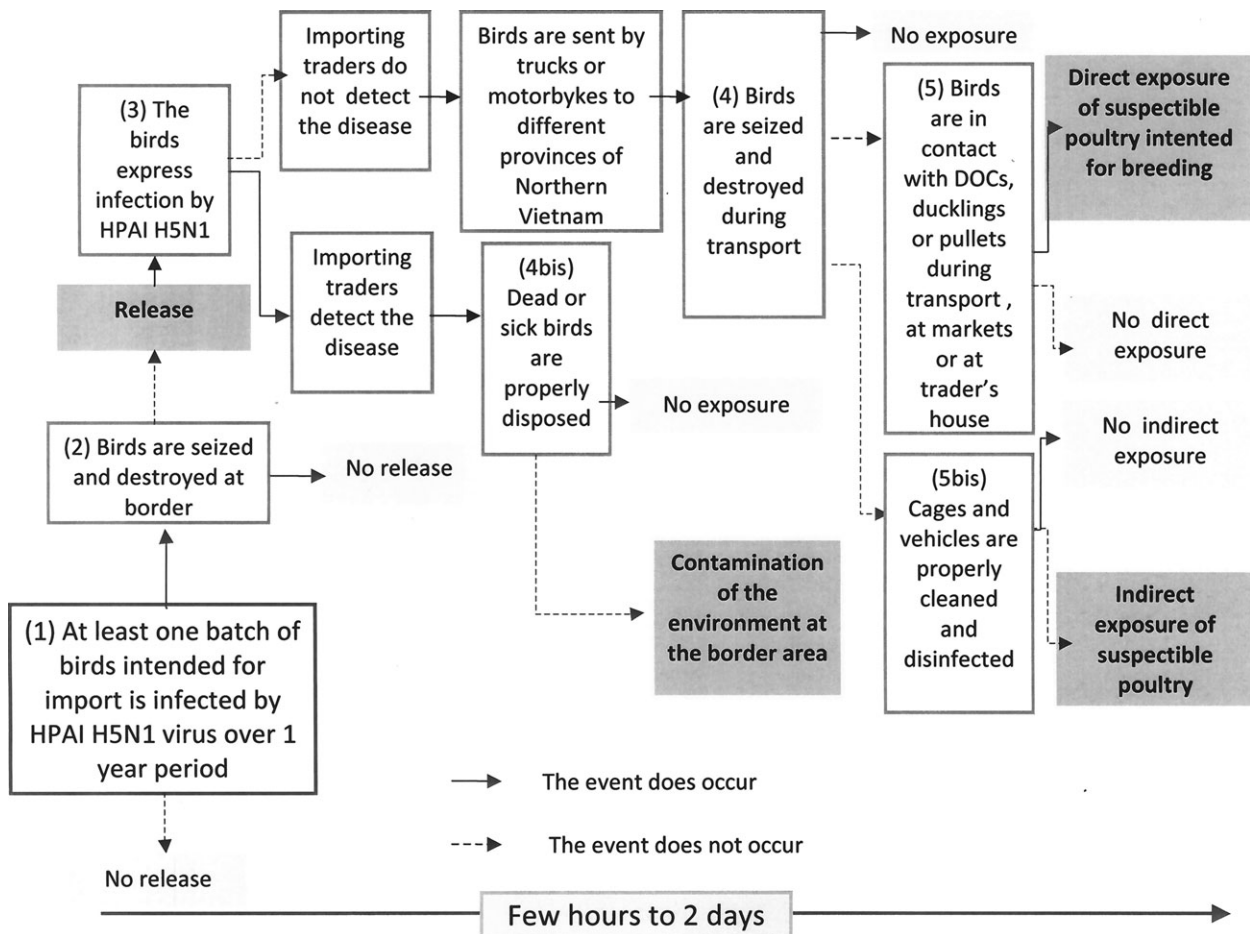


Fig. 3. Risk pathway and release and exposure assessment for the main types of poultry illegally introduced from China (spent hens, DOCs and ducklings).

- a The protection induced by the vaccination with an inactivated vaccine does not last for more than 3 to 4 months under field conditions (Desvaux et al., 2013). Thus, imported spent hens, which certainly received a vaccination against H5N1 in China during their production cycle, may still be protected against the clinical expression of the disease but probably not against infection (Pfeiffer et al., 2010; Tian et al., 2010).
 - b Young birds imported for breeding should normally be more susceptible to the disease and should express clinical signs if infected, but ducklings, as a reservoir species for avian influenza virus, may present some resistance to certain HPAI H5N1 strains (Pantin-Jackwood and Swayne, 2007; Swayne and Pantin-Jackwood, 2008).
- 2 The birds have already entered Vietnam when the visual inspection is conducted by the importing trader and we have no information on how any dead birds may be disposed of.
 - 3 Several middlemen are involved before the birds reach their final destination, each trip can last several hours, there is no proper disinfection of the cages or of the vehicles used to transport the birds and traders visit several farms or markets and trade birds of different origins. Thus, contact between flocks of different origins is frequent during transport or storage at traders' places.
 - 4 Spent hens are normally intended for consumption and thus have a limited chance of contaminating the local poultry population but:

- a The birds can be stored from 1 to several days at a trader's house.
 - b During storage at a trader's house, during transport or at the market places, the spent hens can be in contact with live poultry intended for breeding, from China or from Vietnam.
- 5 Fomites or water contaminated by infectious faeces can be a source of indirect transmission of the virus for a quite extended period of time, depending on the environmental conditions (Brown et al., 2007; Stallknecht and Brown, 2009).

Based on the risk pathways (Fig. 3) and the above elements, we found that the risk of direct or indirect exposure of susceptible poultry was qualitatively higher in the case of illegally introduced infected spent hens or ducklings compared to a batch of DOCs (Table 3).

Conclusions

The illegal trade of poultry from China unquestionably contributes to the epidemiology of the H5N1 HPAI disease in Vietnam by regular introductions of new avian influenza strains into the domestic Vietnamese poultry population. The study conducted here enabled a better understanding of this trade and provided some clues to limit the risk of virus introduction.

The qualitative exposure assessment conducted showed that the risk of direct exposure due to an infected batch of spent hens or ducklings illegally introduced from China was greater compared to the

Table 3. Estimation of the likelihoods of release and exposure

| Step | Risk category ^a | | | |
|----------|--|----------------|----------------|----------------|
| | SH | DOC | D | |
| Release | 1. Probability that at least one batch of poultry intended for illegal import is infected by the HPAI H5N1 over one year period | M | N | N |
| | 2. Probability that an illegal batch of birds is not seized and destroyed at border | H | H | H |
| | Release of HPAI H5N1 in Vietnam | H | M | M |
| | 3. Probability that infected poultry do not express the disease | M | N | M |
| | 4. Probability that an illegal batch of birds is not seized and destroyed during transport in Vietnam | M | M | M |
| Exposure | 5. Probability that local susceptible poultry intended for breeding is exposed to the virus excreted by illegally imported poultry, during transport, at markets place or at traders place | H | H | H |
| | Direct exposure of the susceptible poultry intended for breeding | H | M | H |
| | 5 bis. Probability that cages and vehicles is not properly cleaned and disinfected | H | H | H |
| Exposure | Indirect exposure of susceptible poultry | H | M | H |
| Exposure | 4bis. Probability that dead or sick birds is not properly disposed | No information | No information | No information |
| | Indirect exposure by environmental of the poultry population at border areas | Not estimated | Not estimated | Not estimated |

SH, spent hen; DOC, Day-old Chicken; D, duck.

^aN = negligible, L = low, M = medium, H = high.

introduction of an infected batch of DOCs. Considering the volume of poultry illegally introduced yearly from China (estimated to be of thousands of tons per year) and the spatial dispersion of the poultry illegally introduced, any prediction of the occurrence of new outbreak becomes a real challenge.

The study of drivers underlying this trade showed that apart from financial motivation for the importing traders, there is also (i) a farmers' demand motivated by technical aspects and (ii) consumer demand, especially at certain periods of the year such as the Têt celebration (lunar new year), that may not be satisfied by the national supply. Thus, efforts to stop this trade without tackling these issues will be in vain. Solutions have to be found to satisfy DOC and duckling demand with legitimate supplies of spent hens from China for consumption, if the birds are controlled and slaughtered directly. Secondly, traders being an obvious source of virus dissemination, efforts should be made to better control and supervise their working conditions. The poultry traders' profession needs to be better structured. Getting the poultry traders licensed could be an option as long as the licensing process guarantees that sanitary requirements are satisfied. Thus, a comprehensive solution should be sought by the Vietnamese government in collaboration with the private sector and with the support of international donors contributing to the global effort to control and prevent animal epidemics. Solutions such as installing cleaning and disinfection points in all the main live poultry markets, with standard approved cages to be used by all traders, might be a reasonable goal to achieve in the medium term. The results of this study are even more important when considering the threat caused by the new virus H7N9. This virus, which is highly pathogenic for humans, has the characteristic of circulating silently in birds (Kahn and Richt, 2013). This makes the improved biosecurity of live bird markets and trader awareness of good hygiene practices essential to limit the spread of the virus and new human contaminations.

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