



**QUALITATIVE RISK ASSESSMENT:
LOW PATHOGENIC NOTIFIABLE AVIAN
INFLUENZA (H5 AND H7) IN POULTRY EGGS FOR
CONSUMPTION**



Version 1

Prepared by:
Dr Mirzet Sabirovic
Simon Hall
Dr Andrew Paterson

Approved by:
Nigel Gibbens
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Executive Summary

The risk of introducing low pathogenic notifiable avian influenza (LPNAI) virus of the H5 or H7 subtype infection to a country which imports table eggs for human consumption from a country not known to be free from LPNAI is considered to be negligible (Table 1).

Table 1: Risk pathway and summary of release assessment

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| There is an indeterminable likelihood that LPNAI will be present in migrating waterfowl and other wild birds entering the territory of the exporting country |
| There is a low likelihood that LPNAI infection will be present in wild birds in the exporting country |
| There is a low likelihood that LPNAI would be introduced to a proportion of commercial laying hens flocks in the exporting country |
| There is a low likelihood that LPNAI would be introduced to a commercial laying hens flock and remain active and undetected |
| There is a low likelihood that a significant proportion of table eggs for human consumption would be produced by laying hens and collected for export before LPNAI infection is detected |
| There is a negligible likelihood that infected hens will produce table eggs for human consumption that are internally or externally contaminated with significant quantities of LPNAI virus sufficient to transmit infection |

The release assessment pathway contains several steps where the likelihood of LPNAI virus presence is successively reduced. Considered together, these successive risk reduction steps lead to an overall negligible likelihood that exported poultry table eggs produced for human consumption in accordance with international guidelines will have sufficient quantities of virus on the surface of egg shells to initiate LPNAI infection in susceptible species.

This assessment is also supported by practical experience. That is, no introduction of LPNAI to poultry operations in any country has ever been attributed to imports of infected table eggs.

1 Introduction

This qualitative risk assessment was undertaken to assist the process of identifying appropriate Sanitary and Phytosanitary (SPS) measures to manage the risk of importing LPNAI infection in poultry table eggs for human consumption. According to the SPS Agreement, these measures must not be restrictive to trade while maintaining appropriate levels of protection (ALOP).

The ALOP for a country that considers itself free from LPNAI infection is that imported poultry or poultry products must present a negligible risk that LPNAI will become established in domestic and wild birds.

2 Risk question

“What is the risk of introducing low pathogenic notifiable avian influenza (LPNAI) virus of H5 or H7 subtypes to a country that imports table eggs for human consumption from a country not known to be free from LPNAI?”

3 Scope

This qualitative risk assessment deals with:

- LPNAI which includes all avian influenza viruses of H5 and H7 subtypes that are not HPNAI viruses, as defined in Article 2.7.12.5 of the OIE Code (OIE, 2004a);
- Poultry, defined by the OIE Code as ‘*all birds reared or kept for the production of meat or eggs for consumption...*’ (OIE, 2004a, p.299);
- Eggs which are fresh or chilled poultry table eggs which have not been heat treated or subjected to any other processing capable of destroying virus;
- Poultry table eggs which are produced for human consumption in accordance with the Codex Alimentarius Recommended International

Code of Hygienic Practice for Egg Products (CAC/RCP 15-1976)
(Codex Alimentarius Commission, 1976);

- Poultry table eggs for human consumption which are imported from a country believed to be free from highly pathogenic notifiable avian influenza (HPNAI) but not known to be free from LPNAI.

4 Hazard identification

The hazard of interest is LPNAI virus, as defined by the scope of this risk analysis. These viruses may undergo genetic mutation and become HPNAI viruses capable of causing severe outbreaks of disease in poultry.

Supporting evidence

Avian influenza (AI) virus is a single-stranded RNA virus. It is a member of the *Orthomyxoviridae* family (Swayne and Beck, 2004). The virus has two types of glycoprotein antigens (H – haemagglutinin; N – neuraminidase) located at the outer surface of the virus. To date, 15 haemagglutinin (HA) and 9 neuraminidase (NA) subtypes of the virus have been isolated from birds and may occur in any possible combinations (Capua and Alexander, 2002).

The OIE divides AI viruses into highly pathogenic notifiable avian influenza (HPNAI) viruses and low pathogenic notifiable avian influenza viruses (LPNAI) (OIE, 2004a) according to their ability to cause the disease in poultry. However, H5 and H7 viruses with multiple basic amino acids at the HA0 cleavage site can be HPNAI even if they fail to induce any disease signs in infected chicken (Alexander, 2004).

Historically, the HPNAI viruses of H5 and H7 subtypes have been associated with most severe outbreaks of avian influenza in poultry (Easterday and others, 1997) and are therefore of importance for international trade.

The AI viruses have a high mutation rate due to their single-stranded genomes “*which lack an error correction mechanism*” (Ferguson and Bush, 2004, p.12). On occasions, it has been demonstrated that LPNAI viruses have been introduced into commercial poultry and subsequently emerged as HPNAI viruses due to mutation (Tollis and Di Trani, 2002; Capua and others, 2002). The primary route of infection with AI in poultry is faecal-oral transmission.

5 Risk assessment

For the purpose of this qualitative risk assessment, the following terminology will apply:

| Term | Definition |
|--------------------|---|
| AI | Avian Influenza |
| LPNAI | Low Pathogenic Notifiable Avian Influenza of H5 and H7 subtypes |
| LPAI | Low Pathogenic Avian Influenza of other H subtypes, but not LPNAI |
| HPNAI | Highly Pathogenic Notifiable Avian Influenza of H5 and H7 subtypes. Avian influenza viruses that “ <i>have an intravenous pathogenicity index (IVPI) in 6-weeks old chickens greater than 1.2 or, as an alternative, cause at least 75% mortality in 4-to 8-week-old chickens infected intravenously. H5 and H7 viruses which do not have an IVPI or greater than 1.2 or cause less than 75% mortality in an intravenous lethality test should be sequenced to determine whether multiple basic amino acid motif is similar to that observed with other HPNAI viruses, the isolate being tested should be considered as HPNAI</i> ” (OIE, 2004a, p.299) |
| Poultry table eggs | Poultry eggs which have not been heat treated or subjected to any other processing capable of destroying virus; produced for human consumption in accordance with the Codex Alimentarius Recommended Code of Hygienic Practice for Poultry Processing (CAC/RCP 15-1976) (Codex Alimentarius Commission, 1976) |
| Exporting country | A country believed to be free from HPNAI but not known to be free from LPNAI through surveillance |

For the purpose of the release assessment section (Section 5.1) of this qualitative risk assessment, the following terminology will apply (OIE, 2004):

| Term | Definition |
|-------------------|--|
| Likelihood | Probability; the state or fact of being likely |
| Likely | Probable; such as well might happen or be true; to be reasonably expected |
| High | Extending above the normal or average level |
| Highly | In a higher degree |
| Low | Less than average; coming below the normal level |
| Negligible | Not worth considering; insignificant |
| Remote | Slight, faint |
| Would | To express probability; past of Will: expressing a wish, ability, capacity, probability or expectation |

5.1 Release assessment

This section considers the release assessment pathway. It assesses the likelihood of LPNAI virus presence at each successive step within the pathway that leads to production of poultry table eggs for human consumption which is destined for export from a country not known to be free from LPNAI.

5.1.1 There is an indeterminable likelihood that LPNAI infection will be present in migrating waterfowl and other wild birds entering the territory of the exporting country**Assumptions:**

- *LPNAI viruses are detected on a regular basis in migratory waterfowl and other wild birds;*
- *LPNAI viruses are detected on an irregular and unpredictable basis in migratory waterfowl and other wild birds;*
- *The proportion of LPNAI virus isolates is low compared to other LPNAI viruses isolates from migratory waterfowl.*

Supporting evidence

Wild aquatic birds, shorebirds and gulls are considered to be the natural host of AI virus without showing clinical signs of the disease (Suarez, 2000). In wild aquatic birds, the AI virus replicates in the cells lining the intestinal tract and is excreted in high concentrations in the faeces (up to $10^{8.7}$ 50% egg infectious doses/gram)(Webster, 1998). “*The complete host ecology of influenza is unlikely ever to be fully understood*” (Tollis and Di Trani, 2002, p.204) because of the complex interactions between the virus and the aquatic birds. The following examples indicate that the distribution of AI viruses varies to a great extent and their detection depends on the year and season.

Systematic surveillance of the presence of AI viruses, carried out from 1973 to 1986 and involving over 20,000 birds, resulted in AI virus isolation from 15% of duck and geese samples and from 2% of samples from other birds. These findings indicate that the AI virus is primarily present in migratory waterfowl (various authors cited in Capua and Alexander, 2002). The relative proportion of H5 and H7 subtypes among the AI virus isolates was not indicated.

Another study carried out from 1975 to 1999 involved 3299 migratory birds in the North Caspian region. In total, 344 subtypes of the AI virus were obtained.

The H5 subtype was isolated on two occasions (0,3%) (Lvov and others, 2001). The isolation of H5 subtype was only made in one year during the total observation period of 24 years.

AI virus was isolated from 12% of 3200 samples collected from 1900 migratory ducks in Sweden during 2002. Five different types of AI virus were identified, among them a low pathogenic H5N2 virus (Wallensten and others, 2004). The relative proportion of H5 and H7 subtype among the AI virus isolates was not indicated.

Twenty isolates (6,7%) of AI virus of eight different subtypes were obtained from 311 samples collected from free-living ducks trapped between 1999 and 2001 in Italy. Two samples (0,6%) yielded an H7N3 subtype. This was the first identification of this subtype of the AI virus in the region under study (Campitelli and others, 2004). The following year, this subtype was implicated in outbreaks of HPNAI in commercial poultry.

Twenty-two isolates (2,7%) of the AI virus of different H subtypes were obtained from 802 cloacal samples from ducks and coots collected from 1993 to 1998 in Italy. Overall seroprevalence to various AI viruses was higher in ducks (52,2%) compared to coots (7.2%). This study indicated a continuous circulation of LPAI virus of the H5 subtype in ducks during all sampling seasons. This study also suggested a significant antigenic diversity within at least some subtypes and raised the issue of deciding which reference subtype strains should be used as reference viruses for AI surveillance (De Marco and others, 2004).

10,945 samples collected from feral waterfowl from 1998 to 2002 in Taiwan yielded 232 (2,1%) AI virus isolates of seventeen different H subtypes. The H7 subtype was detected in samples collected from three consecutive years

(Cheng and others, 2004). The relative proportion of H7 subtype among the AI isolates was not indicated.

One hundred and eight isolates of AI virus of different H subtypes were isolated from waterfowl in Alaska from 1991 to 1994 (Ito and others, 1995). The H7 subtype was isolated on only one occasion (0,9%). In a study in Canada, AI virus was isolated from 60% of juvenile ducks before migration (Hinshaw and others, 1980).

There are numerous examples in the literature of different AI viruses being detected in wild aquatic birds. Historic surveillance data of wild aquatic birds indicate that the detection of LPNAI viruses is infrequent, unpredictable and proportionally low compared to other detected AI viruses. There is also no information regarding the extent that the antibody response against other types of AI viruses will have on the establishment and regular circulation LPNAI virus infection in wild aquatic birds.

5.1.2 There is a low likelihood that LPNAI infection will be present in wild birds in the exporting country

Assumptions:

- *The frequency of transmission of LPNAI infection from migratory waterfowl to local birds that share their habitat is irregular;*
- *There is a low likelihood that LPNAI infection will be established in wild birds in the exporting country.*

Supporting evidence

Data presented in section 5.1.1 indicate that AI tends to be detected in birds that use the major waterfowl flyways around the world. Infected waterfowl are more likely to be detected in late summer, particularly when young birds assemble for migration.

AI virus may be transmitted from migratory waterfowl to non-migratory lake and wetland birds and wild ducks due to shared habitat. One study suggested that AI circulation in these species occurs at low levels and is limited to a few subtypes compared to migratory waterfowl (De Marco and others, 2004). Another study (quoted in De Marco and others, 2004) also indicates that “*wild and domestic ducks differ with regard to the Influenza HA subtypes most frequently circulating in both groups*” (De Marco and others, 2004, p.206). However, this may not apply to all geographical areas (Alexander, 2004). This would mean that under certain circumstances non-migratory bird species may be infected with the same AI virus as migratory birds.

5.1.3 There is a low likelihood that LPNAI infection would be introduced to a proportion of commercial laying hens flocks in the exporting country

Assumptions:

- *Introduction of LPNAI virus into commercial laying hen flocks are irregular events that usually follow a failure of farm biosecurity;*
- *It is likely that LPNAI introductions mainly occur in laying hens operations that are located on major migratory flyways or have close contact with local wild birds that share habitat with migratory waterfowl.*

Supporting evidence

Most LPAI virus introductions into domestic poultry have been recorded in poultry operations located in areas that are on main migratory flyways for waterfowl (Banks and others, 2001; Halvorson, 2002). One hundred and eight introductions of the LPAI virus into domestic poultry have been recorded during the period of 25 years in Minnesota (USA). Twenty (18,5%) of these introductions have been LPNAI virus of H5 or H7 subtype (Halvorson, 2002)

none of them resulting in HPNAI outbreaks. On other occasions, it is considered that LPNAI viruses have been introduced into commercial poultry from wild birds reservoir and subsequently emerged as HPNAI viruses due to mutation (Tollis and Di Trani, 2002; Capua and others, 2002). AI virus introductions into domestic poultry appear to be more frequent in countries that still pursue practices such as *“surface storage of drinking water, rearing mixed species on the same farm, failure to build bird-proof food stores, construction of artificial ponds to attract waterfowl”* (Alexander, 2000, p.11).

Domestic poultry are considered to be aberrant (new) hosts for AI viruses. When introduced, the virus will replicate and occasionally cause disease (Suarez, 2000). On most occasions the disease may not transmit well enough to cause an epidemic (Suarez, 2000); on other occasions it may lead to widespread epidemics if not controlled (Alexander, 2004). However, in most cases, the introductions *“do not continue for long because of the control efforts or failure of the virus to adapt to the new host”* (Suarez, 2000, p16).

Following spread within flocks at the affected farm, the virus also has the ability to rapidly spread to other poultry farms (Capua and others, 2002). This is primarily caused by movements of humans or shared contaminated equipment. Webster (1998) considers that the AI outbreaks in chicken and turkeys in Pennsylvania (USA) in 1983 to 1984 and Mexico in 1993 *“could have been prevented if domestic poultry had been raised in ecologically controlled houses with a high standard of security and limited access”*.

5.1.4 There is a low likelihood that LPNAI would be introduced to a commercial laying hens flock and remain active and undetected**Assumptions:**

- *It is likely that such introductions will result in at least mild clinical signs, affecting production parameters that are monitored at commercial poultry farms supplying export markets;*
- *It is unlikely that LPNAI would be introduced to a commercial laying hens operations and remain active and undetected.*

Supporting evidence

Historic data indicate that the impact on production parameters in the affected poultry farms is one of the primary reasons for the detection of the introduction of LPNAI virus into commercial poultry. There is no data in the literature to indicate that LPNAI infection may occur in domestic poultry without causing any clinical signs whatsoever. Some studies consider that LPAI virus infection of layer hens may result in death losses (8%-10%) and a significant drop in egg production (75%-80%) (Dunn and others, 2003). Other studies indicated that the drop of egg production ranged from 3% to 30% (Mutinelli and others, 2003) and that egg production losses may occur within one to thirteen weeks ranging from 1,6% to 14,2% (Henzler and others, 2003).

It is considered (European Commission, 2000, p.13) that the severity of the disease produced by LPAI is “*greatly influenced by the strain of the virus, the species and age of host; the immune status of the host against the virus and particularly the presence of other infectious agents such as Pasteurella spp,*

Newcastle disease virus (including vaccine strains), avian pneumovirus, infectious bronchitis virus, E. coli and Mycoplasma spp, immunodeficiency conditions and environmental factors (such as excess ammonia, dust, hot or cold temperatures)”.

It is also considered that vaccination will increase the likelihood that AI infection will go unnoticed since there will be no clinical signs. However, vaccination is likely to further reduce quantities of LPNAI virus particles in faeces (Alexander, 2004).

5.1.5 There is a low likelihood that a significant proportion of table eggs for human consumption would be produced by laying hens and collected for export before LPNAI infection is detected

Assumptions:

- *It is likely that a proportion of eggs would be produced by laying hens while incubating LPNAI infection and collected for human consumption for export purposes;*
- *It is likely that the external contamination of egg shell surface would occur if in contact with infected faeces;*
- *It is likely that LPNAI virus shedding by affected laying hens would be reduced or eliminated after seroconversion.*

Supporting evidence

AI virus infection of domestic poultry will result in virus replication. Easterday and others (1997) consider that the incubation period may vary from a few hours to three days in individual birds and up to 14 days following the introduction of the virus into a poultry flock. Once the virus is introduced to poultry it is easily spread within a flock by direct contact with infected faeces.

According to Lu and others (2004), heavy virus shedding (90%-100% infected birds shedding) occurred between 4 and 7 days after the onset of the disease. A few birds (15%) continued to shed virus in faeces at 13 days post-disease onset. Halvorson (2002) considers that “*most viral shedding from infected poultry stops after seroconversion*” which usually takes up to 14 days (Ritchie and Carter, 1995) after infection. From the disease confirmation point of view, it has been suggested that LPNAI infection is often of short duration, therefore frequency of sample collection should be “*a minimum of once or twice a week to successfully isolate virus*” (Lu and Castro, 2004)

5.1.6 *There is a negligible likelihood that infected hens will produce table eggs for human consumption that are internally or externally contaminated with significant quantities of LPNAI virus sufficient to transmit infection*

Assumptions:

- *It is highly unlikely that LPNAI virus would be detected in table eggs for human consumption;*
- *It is likely that LPNAI virus would be detected in cloacal swabs for relatively short period of time;*
- *It is likely that LPNAI virus would not be detected on the surface of egg shells even if the eggs are produced by LPNAI infected hens;*
- *It is highly likely that hygienic practices for production of table eggs for human consumption would reduce a number of table eggs with visible faecal contamination for food safety reasons.*

Supporting evidence:

There is no evidence that AI virus is transmitted vertically (Marangon, 2003; Henzler, 2003) although Ziegler and others (1999) reported the isolation of virus from the oviduct in hens infected with H7N2 LPAI during the 1996-1998

Pennsylvania outbreaks. One study has also found “*a larger percentage of eggs (93%-97%) with detectable antibody when eggs were collected early in the disease outbreak*” (Henzler and others, 2003).

In experimental studies, LPNAI was recovered from cloacal swabs at 2-5 days (various authors cited in Lu and Castro, 2004) or up to 3 days post infection. The virus could not be isolated from cloacal swabs collected at 7 days post infection and thereafter (Lu and Castro, 2004). In another study, LPNAI virus was isolated from 100% of pooled cloacal samples at day 7 and 14% of pooled cloacal samples at day 13 after the onset of the disease. Nevertheless, at the peak of LPNAI infection (7 days after the disease onset) and thereafter during a field outbreak, no virus was isolated from eggshell swabs, albumen and yolk (Lu and others, 2004).

To minimise potential for faecal contamination for food safety reasons, the Codex Alimentarius Recommended International Code of Hygienic Practice for Egg Products CAC/RCP 15-1976 (Codex Alimentarius Commission, 1976) provides the following relevant guidance:

- 3.1.1 ...extreme care should be taken to protect eggs from contamination with [animal wastes], particularly those eggs that may be consumed without heat treatment.
- 3.2.1 Only eggs derived from healthy stock should be used in the production of egg products for human consumption.
- 3.2.2 Equipment and egg containers should not constitute a hazard to health. Containers which are re-used should be of such material and construction as will facilitate thorough cleaning, and should be so cleaned and maintained as not to constitute a source of contamination to the product.
- 3.2.3.2.1 [Throughout handling and storage it is essential that steps be taken to prevent:] Contamination of the shell with dirt, bedding materials...

- 3.2.3.3 Eggs should not be cleaned on the farm. If, exceptionally, they are cleaned on the farm, this should be done only with the approval of the official agency having jurisdiction which should be satisfied as to the method of cleaning employed...
- 3.2.4 Unfit eggs should be segregated during collection to the fullest extent practicable and should be disposed of in such a place and such a manner as will prevent contamination of other eggs or water supplies.

This qualitative risk assessment recognises a risk from faecally contaminated packaging materials which may be re-used on poultry farms in the importing country. However, this is outside the scope of this analysis and has not been considered.

5.1.7 Completion of release assessment

According to the OIE methodology, if the likelihood is assessed negligible at any step of the release assessment pathway and exposure assessment pathway the risk assessment may be completed at that step.

In our release assessment pathway, we have concluded that several risk reduction steps have resulted in a negligible likelihood of LPNAI virus presence on poultry table eggs for human consumption after application of hygiene practices for food safety reasons (Step: 5.1.6).

5.2 Risk estimation and conclusion

The risk of introducing LPNAI infection to a country which imports poultry table eggs produced for human consumption in accordance with international guidelines from a country not known to be free from LPNAI is considered negligible.

This conclusion is also supported by practical experience. That is, no introduction of AI (LPNAI or HPNAI) to poultry operations in any country has ever been attributed to imports of table eggs for human consumption.

In addition, “migratory bird flyways crossing...high density ...poultry farms concentrated in limited area of the country, and typical features such as live-bird markets and outdoor rearing of domestic poultry are considered as major factors for the introduction of AIVs and transmission from the wild aquatic bird reservoirs to land-based poultry” (Di Trani and others, 2004, p.382).

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