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Influence of Exotic Bird and Wildlife Trade on Avian Influenza Transmission Dynamics: Animal-Human Interface

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Abstract: Legal and illegal global trade of exotic bird and wildlife facilitates dynamic disease transmission mechanisms that threaten livelihoods, international trade, livestock production and native wildlife populations. Disease outbreaks resulting from exotic bird and wildlife trade have caused substantial economic damage globally. Contacts between wildlife, poultry and humans facilitate inter-species disease transferences.

Key words: Avian influenza, wildlife trade, disease transmission dynamics, HPAI

Introduction

Cheap, fast and extensive transportation alternatives, ease of mobility across borders, human and livestock population increments, emergence of worldwide agro-food networks and changes in modern livestock production systems are coincident with an increased risk of zoonotic disease transmissions. The emergence of zoonotic diseases such as Nipah in 1999, Severe Acute Respiratory Syndrome (SARS) in 2002 and Highly Pathogenic Avian Influenza (HPAI) since late 2003 have heightened public awareness of linkages between wildlife, livestock production and human health.

For example, the recent HPAI epidemics in Italy, the Netherlands and Canada have shown that in densely populated poultry production zones the control of HPAI poses a substantial challenge, even for industrialized, integrated production systems with high-quality animal health services and strict bio-security measures. Industrialization of livestock production is synchronously occurring in developing countries, where intensive production is rapidly replacing traditional systems, most notably in Asia, South America and North Africa. A major consequence of modern industrial intensive livestock production systems is that they potentially allow the rapid selection and amplification of pathogens and concomitantly its dissemination over poultry populations in short periods of time. Without disregarding these health issues, only a comprehensively multifactor, evidence-based approach to disease risk management on industrial poultry farming can sustain a safe and affordable food supply.

Evidence suggests that non-domesticated waterfowl are the primary reservoir of Influenza A Viruses (IAV) and probably all influenza viruses of mammals have ancestral links to wild avian lineages (Webby and Webster, 2001). Positive HPAI diagnosis of wild birds in Asia, Europe and Egypt further prove this evidently close relationship. This short review article compiles evidence suggesting a relationship between wildlife trade and the increased risk of zoonotic disease transmission.

Exotic Bird and Wildlife Trade

Wildlife is a major source of income: Directly for consumptive or productive uses and indirectly for touristic and scientific uses. For instance, wildlife tourism is among the top cash-generating activities of Tanzania and Kenya, adding to an annual income of approximately half a billion USD. In the US, the total expenditures for wildlife-related activities was $101 billion in 1996 (Chardonnet *et al*., 2002). Trade of wild plants and animals around the globe is estimated to be in the order of roughly 350 millions units annually, without considering all potentially illegal transaction and movements that occur (WWF, 2001). The extent of wildlife trade is evidenced by data collected after the 2003 SARS outbreak in Guangzhou, China, where 838,500 wild animals were confiscated from live markets (BBC, 2003). In a single market survey conducted in Bangkok, Thailand during 25 weekends, over 70,000 birds of 276 species were sold (Round, 1990). Another survey on live wild animal trade was conducted along the Guangxi border between China and Vietnam during 1993-1996, resulting in 55 species unaccounted for in customs files, including 15 species of mammals, 10 species of birds, 29 species of reptiles and 1 species of amphibian; with many of them listed in China's species protection list (Yiming and Dianmo, 1998). The increasingly global scope of exotic bird and wildlife trade, couple with inexpensive, rapid and modern transportation options, temporary communal storage facilities and the functional dimension of markets as networking nodes rather than product endpoints dramatically increase the likelihood of cross-species transmission dynamics of the various infectious agents that every animal naturally hosts. Smolinski *et al.* (2003) demonstrates through a retrospective study that since 1980 over 35 new transmissible diseases emerged in humans; this amounts roughly to 1 every 8 months. This comes to no surprise for the newest zoonotic diseases: SARS corona virus is associated to small carnivore and bat trade (Bell *et al.*, 2004), whereas HPAI virus is associated with waterfowl migration and wildlife trade.

Moreover, HPAI virus H5N1 subtype was isolated from two mountain hawk eagles illegally imported to Belgium from Thailand (OIE, 2004). Trade is not the only factor to consider in disease transmission, as religious and cultural practices also influence this processes; for example, belief-based merit release of wild birds that have passed mixed-species live markets provides yet another way for introducing novel infectious agents into ecosystems (Karesh *et al.*, 2005). Furthermore, in 2007, two released scaly-breasted munias (*Lonchuria punctulata*) tested positive for HPAI H5N1 in Hong Kong (GovHK, 2007) and a caged songbird commonly known as black francolin also tested positive for HPAI in Pakistan (Karesh *et al.*, 2007). In a list of 1,415 human pathogens, close to 61% are known to be zoonotic and multiple host pathogens are twice as likely to be associated with an emerging transmissible disease of humans (Taylor *et al.*, 2001), while 77% of pathogens found in livestock are shared with at least another host species (Haydon *et al.*, 2002). In Asian countries, early efforts to control a HPAI virus epidemic resulted in culling more than 140 million chickens with considerable adverse implications to rural livelihoods, market economies, poultry exports and nutritional requirements (WHO, 2005). With regards to transmission dynamics between animals and humans, first, there needs to be a point of contact between them for the species barrier to be crossed; considering this point is critical in designing disease transmission mitigation strategies. Another practical approach to decrease dissemination risk would include minimizing intra-species contact: for example, a 1 day per month closure of retail poultry markets in Hong Kong moderately reduced H9N2 avian influenza infection rates in birds (Kung *et al.*, 2003).

The Animal-Human Interface: Disease Transmission Dynamics

Bio-security is defined as any practice or system that prevents the spread of infectious agents from infected to susceptible *animals*, or prevents the introduction of infected *animals* into a herd, region or country in which the infection has not yet occurred (Radostits, 2001). This only applies to *animals* but not poultry keepers and workers, as regardless of production system used, human involvement will always be present. Thus, livestock keepers and people in close contact with live birds are the most likely group to serve as bridge between IAV and communities at large, assuming the virus acquires human-to-human transmission capabilities. Saenz *et al.* (2006) showed, using a mathematical model, that if 15% of animal farming workers comprise a living community, they can serve as powerful disease amplifiers. The human influenza pandemics of 1918 [as H1N1 Spanish flu], of 1957 [as H2N2 Asian flu] and of 1968 [as H3N2 Hong Kong flu] all had an initial animal-human interface, with all three containing an avian component (Capua and Alexander, 2002).

Recently, H3N2 viruses of human origin have been isolated from pigs in Europe (Webby and Webster, 2001) and are now endemic in pigs in Southern China (Peiris *et al.*, 2001) where they co-circulate with regional H9N2 subtypes with the potential of reassortment with avian H5N1. For example, in 1999 IAV H9N2 was isolated from two flu-recovering farm girls in Hong Kong (Peiris *et al.*, 1999), further providing evidence that genetic changes can occur. Additionally, Myers *et al.* (2006) reported that swine keepers had higher H1 and H2 titre antibodies and greatly elevated risks of seropositivity vis-à-vis community benchmarks; whereas Bridges *et al.* (2002) states that the probability of carrying H5 antibodies increases as occupational contacts with birds increases. A 2003 Italian serology study found anti-H7 immunoglobulins in 38% of samples from poultry keepers when IAV-H7N3 was circulating (Puzelli *et al.*, 2005). A 2003 Dutch study noted an unexpectedly high number of transmissions of avian IAV subtype H7N7 to people directly involved in handling infected poultry and evidence for person-to-person transmission (Koopmans *et al.*, 2004); also in South China with IAVH5 as well (Wong *et al.*, 2006).

Highly pathogenic IAV, thus far, does not easily infect humans and it is only the Asian IAV-H5N1 that appears to have a ~60% fatality rate in infected humans. Increased exposure to situations were avian species are presently situated increases the likelihood of disease transmission, which could facilitate the emergence of a novel mutation-induced virus with human-to-human infection attributes, thus transforming itself from a controllable, purely animal disease into a human influenza pandemic of gargantuan proportions. Nutritional factors dealing with soil and plant mineral deficiencies may be involved in Asian IAV human infective abilities, as it is cleverly suggested in a series of elegant experiments done by Beck *et al.* (2003), in the US, where influenza-inoculated rats fed selenium deficient diets had increased virulence accompanied by viral genome changes in a segment previously thought to be relatively stable. Similarly, Maines *et al.* (2006), using a ferret model, concluded after several experimental designs that H5N1 viruses require further adaptive steps and factors to develop pandemic potential. Still, after much debate, frequent human interaction with sick birds remains the main issue.

According to Capua and Alexander (2007) the growing frequency of IAV detection in animals and therefore humans, may be due to substantial increases in poultry populations worldwide, improved telecommunications, heightened poultry oversight, enhanced laboratory diagnostic capacities and incentive-based disease reporting.

Conclusions: Mounting scientific evidence clearly suggest that wild birds are focal IAV reservoirs and that the relational contact with poultry, be it through backyard/garden farming or live bird markets, provides a propitious platform to transmit diseases. Traditional and non-traditional disease mitigation strategies, such as culling and vaccination, are almost impossible to apply to bird populations in the wild. Exotic bird and wildlife trade-as a source of income and food-has been implicated in increased disease transmission dynamics; however, it has been claimed that the transformation from lowly pathogenic IAV into highly pathogenic, deadly IAV strains is not due to fulminating wild bird carriers, but more so due to the highly intensive, genetically homogeneous, industrially dense conditions of contemporary animal factories.

Bio-security, as it is now defined, is the outcome of all activities undertaken by an entity to preclude the introduction of disease agents into an area that one is trying to protect. These cost-effective disease mitigation activities will substantially affect the projected worldwide growth and rearing modes of industrial livestock production systems to meet global protein demands in coming years; with the overall objective of decreasing the impact of disease outbreaks on trade, society, economy, livestock and human health, ecosystems and national food security.

Recommendations

Sprawling cities and major hubs associated with wildlife and exotic bird trade provide feasible control points to maximize the impact of governmental regulatory efforts against zoonotic diseases. Evidence-based disease mitigation strategies could include, among many others, surveillance of most susceptible wild bird species, sanitary regulation compliance, strengthening and enforcement of traditional disease control measures, exotic wild bird trader registration, development and implementation of quarantine procedures and creating mechanisms to shift costs of controlling outbreaks from the public to the animal and wildlife suppliers/vendors.

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Disclaimer[2]

Mr. Sigfrido Burgos is an international consultant at FAO. Ideas expressed in this article represent solely his personal opinions and views and are not necessarily endorsed by the international organization that currently employs him.

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