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Impacts of poultry vaccination on viruses of wild bird

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Spillover of viruses from farmed poultry into wild birds is a relatively new area of study at the livestock–wildlife interface. These transmission events can threaten the health of wild birds. There is growing evidence of transmission of vaccine viruses from poultry to wild birds, including attenuated vaccine strains of Newcastle disease virus and infectious bronchitis virus, and also spread of virulent viruses that may have evolved under the pressure of vaccine use, such as Marek's disease virus. Viral contaminants of poultry vaccines, including reticuloendotheliosis virus, may also be transmitted to wild birds and result in disease. New, vectored vaccines are less likely to directly spread to wild birds but this risk may rise as a result of recombination.

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Introduction

Global poultry production is increasing rapidly, with chicken meat forecast to become the largest meat sector worldwide from 2020 [1]. The potential for viruses in wild birds, which are often considered reservoirs of infection, to 'spillover' into poultry and cause disease has long been recognised. Thus biosecurity programmes in poultry operations have been developed to help prevent the direct or indirect transmission of pathogens from wild birds to poultry [2]. Virus transmission in the other direction (from poultry into wild birds) lacks the immediate economic consequences that viral incursions into commercial poultry can have and has not been as thoroughly considered. Consequently, fewer biosecurity measures are in place to prevent such transmission events. This is despite the massive scale of modern commercial poultry production which can enable large-scale contamination of the environment with infectious material through practices such as disposal or re-use of poultry litter [3] or through airborne dispersal of infectious agents from infected flocks [4]. Furthermore, an increased interest in free-range poultry production allows increased direct contact between wild birds and farmed poultry [2].

A developing awareness of the concept of 'one health', which recognises connections between animal, environmental and human health, including at the livestock-wildlife interface [5,6] has served to highlight the risks that poultry viruses may pose to the environment and to wild birds. The potential for spillover exists when the natural host range of a virus includes a domestic poultry species and a wild bird species. As viruses in wild birds are much less studied than those in poultry, the natural host ranges of many avian viruses are not well understood. Similarly, the degree of host susceptibility to disease caused by different viruses is often not known. However, some poultry viruses are known to have broad host ranges (e.g. avian paramyxovirus-1, also called Newcastle disease virus, NDV) and are thus a potential risk to a wide range of wild bird species [7]. Other poultry viruses have narrow host ranges (e.g. some avian herpesviruses). These may only be a risk to small number of wild bird species that are closely related to farmed poultry species, such as other Galliform or Anseriform birds [8,9]. Without appropriate surveillance programmes in wild bird populations, spillover events from poultry into wild birds are unlikely to be detected.

Vaccines, along with biosecurity programmes, are critical to the control of viral diseases in poultry. Table 1 summarises vaccines used for this purpose and also lists the genus and family names of each virus. These vaccines typically reduce clinical signs of disease but do not prevent virus infection [2]. Vaccination can have a profound influence on virus populations within commercial poultry flocks, and, by extension, viruses that may spillover into wild bird populations. Poultry vaccines may have an impact on wild bird viruses through the transmission of attenuated vaccines from poultry to wild birds; the transmission of virulent viruses that have evolved in response to the use of poultry vaccines; or through undetected viral contaminants within commercial vaccines being transmitted to wild birds. New, vectored poultry vaccines also have the potential to have an impact on wild bird viruses. These vaccines use a virus vector to express heterologous (foreign) proteins from other poultry pathogens. These four

Table 1

Commercially available viral vaccines used in farmed poultry.

Viral species	Avian species: Chicken	Turkey	Quail	Duck	Goose
DNA viruses					
Poxviridae					
Avipoxvirus					
Fowlpox virus	A	A			
Pigeonpox virus	A	A			
Quailpox virus			A		
Herpesviridae					
Alphaherpesvirinae					
Iltovirus					
Infectious laryngotracheitis virus	A, I, V[a]				
Mardivirus					
Marek's Disease virus	A	A	A		
Herpesvirus of turkey	A	A	A		
Duck enteritis virus				A	
Adenoviridae					
Aviadenovirus					
Group I: Inclusion body hepatitis virus	A, I				
Atadenovirus					
Group III: Egg-drop syndrome virus	I				
Parvoviridae					
Duck parvovirus					I
Goose parvovirus					A, I
RNA viruses					
Reoviridae					
Spinareovirinae					
Orthoreovirus					
Avian orthoreovirus	A, I				
Birnaviridae					
Avibirnavirus					
Infectious bursal disease virus	A, I, V[b]				
Picornaviridae					
Avihepatovirus					
Duck hepatitis A virus 1				A, I	
Tremovirus					
Avian encephalomyelitis virus	A, I				
Circoviridae					
Gyrovirus					
Chicken infectious anaemia virus	A, I				
Flaviridae					
Flavivirus					
Avian meningoencephalomyelitis virus		A			
West Nile virus					I
Coronaviridae					
Coronavirinae					
Gamacoronavirus					
Infectious bronchitis virus	A, I				
Orthomyxoviridae					
Influenzavirus A					
Influenza A virus	I, V[c]	I	I		
Paramyxoviridae					
Paramyxovirinae					
Avulavirus					
Avian paramyxovirus-1	A, I, V[a]	A, I			
Avian paramyxovirus-3		I			
Pneumovirinae					
Metapneumovirus					
Avian metapneumovirus	A, I	A, I			

Source: *Diseases of Poultry*, 13th edition, Edited by Swayne DE, Glisson JR, McDougald LR, Nolan LK, Suarez DL, Nair VL, Wiley-Blackwell; 2013. A: attenuated; I: inactivated; V[a]: vectored using herpesvirus of turkey (HVT) or fowlpox virus (FPV); V[b]: vectored using FPV; V[c]: vectored using HVT, FPV or Newcastle disease virus.