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Influenza in horses, birds, and humans

By Jonathan M. Naylor, DVM

Influenza is a common and sometimes fatal disease of horses, humans, birds, and swine. In horses, recent advances in vaccination technology, coupled with new diagnostic tests and new information about the course of the disease, allows veterinarians to better diagnose, treat, and control this disease. Avian influenza has been prominent in the news with outbreaks in poultry in Asia and North America. Due to concerns about the spread of the virus to humans, these outbreaks were controlled by the depopulation of hundreds of poultry flocks with devastating economic consequences. Although free-living aquatic birds are the primary reservoir of influenza A viruses, they occasionally spill over and adapt to poultry and other domestic birds, as well as to mammals such as pigs, horses, and humans. In these species, the viruses can cause devastating pandemics with widespread mortality, as seen with the so-called Spanish influenza of 1918-1919 that caused the deaths of at least 20 million people worldwide.¹ This issue of *Large Animal Veterinary Rounds* addresses concerns about the role of avian influenza in the possible development of a human pandemic and new information about equine influenza in horses.

Fowl plague, now known to be avian influenza, was first described in 1878. The causative RNA-based influenza A virus was first isolated from a chicken in 1902, but the human influenza A virus was not isolated until 1933. Influenza viruses can be divided into groups A, B, and C, based on the antigenic characteristics of the nucleoprotein, a protein present inside the virus. All avian strains, as well as swine and equine disease-causing strains are type A. Humans can be infected with strains of type B and C as well, although type C influenza viruses rarely cause pandemics. The genome of the influenza A virus is made up of 8 distinct RNA fragments that encode 10 proteins. Two of these, hemagglutinin (H) and neuramidase (N), are expressed on the surface of the virus. Both protrude from the virion and are the main targets of the protective immune response in the host animal. Over time, this immunological pressure has led to the selection of a number of antigenic variants of these proteins. There are now 15 distinct recognized serotypes of H and 9 serotypes of N proteins. The nomenclature of influenza A viruses is based on the antigenic makeup of their H and N proteins. Influenza A viruses are thus designated H1N1, H5N7 etc.

Free-living aquatic birds are reservoirs for all H and N serotypes of influenza virus (Figure 1). In these animals, the viruses cause asymptomatic enteric infections and large amounts of virus are shed into the water during the fall and spring migrations. Occasionally, these viruses spill over into other species and a few serotypes have successfully established themselves in poultry, pigs, horses, and humans. New introductions into a species are of particular concern, since they have the potential to cause devastating pandemics in immunologically-naïve host species.¹

Interspecies contagion

Influenza viruses are highly contagious and spread explosively in a susceptible population. As the recovering population becomes immune to the virus, antigenic variants of the H and N proteins are



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selected by a process called antigenic drift. This gradual drift is due to the small changes in antigenic structure that occur as the result of random errors during the synthesis of viral RNA, which is error prone. For example, the hemagglutinin of equine viral influenza A changes at the rate of about 0.3 to 1 amino acid/year, depending on the strain.² Human influenza A viral hemagglutinin mutates at least 3 times more rapidly. These mutations help the virus evade the immune system and invade new hosts. Since these variants are neutralized inefficiently by the immunity to the original virus, they can cause new outbreaks of infection and disease.

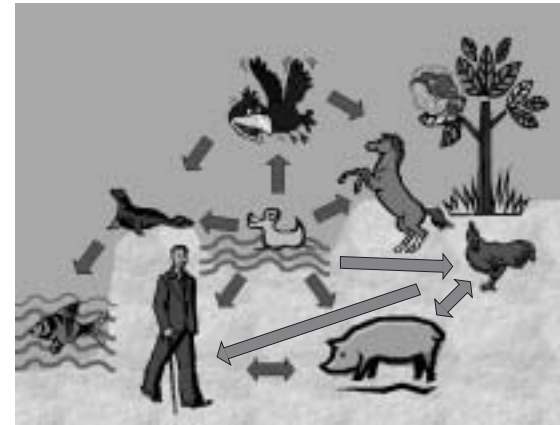
More serious pandemics are caused by unique serotypes of virus to which the host population has little or no immunity. Emergence of these antigenically new viruses is said to be by “antigenic shift.” These usually represent new introductions of virus into a susceptible species. For instance, viruses might be transmitted from poultry to humans or from aquatic birds to horses. Since the influenza virus spreads efficiently only in the species to which it has become adapted, it can only cause widespread and serious disease in a new host if it acquires the ability to spread from one individual of the new species to another. The H5N1 virus that emerged in poultry in Hong Kong in 1997 resulted in human disease only when it was transmitted from poultry to humans. It did not acquire the ability to pass directly from human to human. Adaptation to spreading in a new species, however, can happen rapidly. When the new virus infects a host already infected with another influenza virus, the genomic fragments of the 2 viruses re-assort. Some of the resulting hybrid viruses or reassortants possess the antigenic make-up of the newly-introduced virus, but retain genomic fragments from the other parent virus that allow it to spread and cause disease in the new host species. Such viruses spread rapidly, causing pandemics, often associated with high mortality. The 1957 Hong Kong (H3N2) and 1968 Asian (H2N2) pandemics are believed to have been the result of such reassortants between avian viruses and well-established human ones.¹

There were concerns during the 1997 Hong Kong outbreak (and during the more recent incidents in Asia and British Columbia) that similar genetic reassortment between bird and human viruses might result in novel viruses that could spread directly between people. Since humans would not be immune to these viruses, this could have resulted in a new and devastating human pandemic.¹ The outbreaks were bought under control with a slaughter of birds and new regulations restricting the sale and movement of live birds.

The opportunity for reassortment is usually limited because different influenza lineages are restricted to certain species by differences in virulence factors or by geographical barriers. However, pigs are unusual in that they are susceptible to infection with influenza viruses from both birds and humans. In pigs, influenza viruses of different lineages can meet and reassemble to produce new viruses. Reassortment

Figure 1: “Habitat” of influenza A viruses.

Ecological and phylogenetic studies suggest that wild waterfowl are the principal reservoirs for influenza A viruses, which occasionally are transmitted to other host animals such as horses, pigs, and chickens, leading to influenza outbreaks among these species. Pigs can serve as hosts for both human and avian viruses acting as a genetic “mixing bowl” for influenza viruses. Some of the viruses may become established in these new hosts and cause epidemics and epizootics. Viruses are transmitted among these new host animals (eg, between humans and pigs or between chickens and humans, as occurred in 1997 in Hong Kong). Modified from reference 1.



can also occur between avian viruses. For example, in Hong Kong in 1997, genetic reassortment in avian influenza viruses within birds produced a new subtype (H5N1) that was highly virulent for both birds and mammals. One variant resulted in 75% mortality in 3 avian flocks in Hong Kong. Another variant, which was highly lethal to chickens, was transmitted to people from poultry. There were 6 deaths in 18 infected people and fears of epidemic, since the H5N1 virus was antigenically very different from pre-existing human strains. However, this subtype appeared to spread to people mainly from poultry rather than person to person and so was not a well-adapted human pathogen.

Avian influenza

In birds, the influenza virus multiplies in either the respiratory or the alimentary tract and fecal-oral transmission is common. Although there are exceptions, avian influenza viruses tend to divide into either highly pathogenic or avirulent strains. Virulent avian influenza subtypes are either H5 or H7. Signs of a virulent influenza virus infection in birds (ie, fowl plague or avian influenza), include: depression; listlessness; ruffled feathers; swelling around the eyes; cessation of egg laying; respiratory signs including excessive lacrimation and sinusitis; edema of the head, face, neck, and legs; cyanosis of unfeathered skin, particularly the combs and wattles; diarrhea; and nervous system disorders.¹

Highly pathogenic avian influenza is a reportable disease. The present outbreak of avian influenza in British Columbia is caused by a H7N3 influenza A virus. The virus is different from those causing recent outbreaks of avian influenza in poultry in the USA or Hong Kong. High- and low-pathogenic forms exist, the high-pathogenic form can cause nearly 100% mortality, while birds infected with the low-pathogenic form often recover. Laying hens and fattening turkeys are most frequently affected. Wild birds, particularly waterfowl, are better adapted to this virus; they may show no clinical signs and can act as vectors. There have been 2 cases of human influenza associated with the avian strain. As in Hong Kong, both occurred in people in close contact with poultry. Both people recovered. There is concern that co-infection with the current dominant human influenza A virus could lead to reassortment and a new epidemic strain. This risk is being mitigated by the slaughter of birds. In addition, public health services are reinforcing the desirability of thoroughly cooking chicken and eggs prior to consumption (the virus is killed at temperatures above 72°C). People in close contact with high-risk birds are advised to wear protective clothing, be vaccinated against human influenza (to reduce the risk of co-infection and re-assortment), and to take antiviral drugs.³

Equine influenza

In recent times, all equine influenza outbreaks in the northern hemisphere have been caused by variants of 1 lineage of the equine influenza virus: the equine-2 influenza A virus (H3N8). Equine-1 influenza A virus (H7N7) has not been isolated from horses since 1978.¹ Within the H3N8 subtype, there are 2 distinct virus lineages – American and Eurasian. Both lineages circulate in North America and are genetically and antigenically distinguishable. The American lineage can be further subdivided, based on mutations in the H gene, into a series of viruses belonging to the Kentucky strain, a series belonging to a Florida strain, and a series belonging to a South American strain. Equine influenza viruses mutate more slowly than the current dominant human virus so these different strains, with different antigenic properties, provide a mechanism for perpetuating the influenza virus in the population. For example, viruses belonging to different strains caused sequential outbreaks of influenza in Kentucky.²

Equine influenza is highly contagious; one experiment, mixing 10 infected horses with 40 naïve horses in a group-housing environment, resulted in all becoming infected in 24 hours.⁴ However, in individual housing situations, spread takes longer, eg, approximately 30 days to travel through a racetrack.⁵ The incubation period is 1 to 3 days, the infectious phase lasts for about 10 days in naïve horses and immunity lasts at least a year. The virus cannot survive outside the body for a long period of time. It is transmitted either by

aerosolization and inhalation, direct transfer of nasal secretions between horses, or by fomites including hands, grooming equipment, common watering areas, and vehicles.

Influenza is endemic in the horse population, although horses in Iceland, Australia, and New Zealand are currently free of this disease. In the last 15 years, the largest outbreaks of equine influenza have occurred in China;^{6,7} in one Chinese outbreak, 8% of affected horses died, although in the others, the rate of mortality was around 1%.^{8,9}

Influenza can infect horses of any age,¹⁰ but in North America, outbreaks have not been described in the literature for brood mares and are rare in foals prior to movement to a sale barn. Most outbreaks occur at training stables, racetracks, or in young horses exposed in sale barns or at shows. These situations have in common the fact that horses are younger and there is a high degree of mixing and movement of animals giving opportunities for transmission of influenza to naïve horses. Also, outbreaks tend to occur at specific times in a given geographic area eg, during racing season.⁵

Clinical signs

Clinical signs of influenza virus infection include fever, up to 41°C, a dry cough, and a serous or mucopurulent nasal discharge. The virus infects ciliated epithelium of both the upper respiratory tract and the bronchus.¹¹ Fever, cough, tachypnea, tachycardia, or mucopurulent nasal discharge can last for as little one day or persist for up to 2 to 3 weeks postinfection. Experimental infection in naïve horses produced signs of disease within 36 hours of infection. Fever did not begin to return to normal until 7 to 8 days postinfection and lasted for about 11 days.^{12,13} Partial or complete anorexia, weight loss, and enlarged submandibular lymph nodes are other common signs (Table 1).^{10,12,14} Pneumonia, edema, and pulmonary consolidation can develop in naïve horses. Pneumonia develops in about 4 days and spontaneously resolves by 28 days postinfection. Abnormal lung sounds can be heard in all quadrants and, in one study, wheezes followed by crackles were the most commonly auscultated abnormality. Hemogram changes include a mild lymphopenia during the first week of infection, a transient neutropenia followed by neutrophilia, with an elevated fibrinogen concentration (up to about 8 g/L). Clinical signs have been demonstrated to be more severe if the horse continues to be exercised.¹² Resolution of clinical signs occurred by about 14 days post-challenge to an aerosolized virus, but airway inflammation persisted for 3 weeks.¹² Secondary bacterial infection of the nasopharynx is also common¹⁰ and may progress to bacterial pneumonia or pleuropneumonia. Fatalities are assumed to be mainly due to secondary bacterial invasion of the lungs, but influenza can be a primary cause of mortality in rare cases. Signs are more severe in immunologically-naïve horses and may be difficult to detect in horses with a well-developed, pre-existing immune response. Another clinically important

Table 1: Clinical signs observed in yearling quarter horses experimentally infected with equine influenza virus and either rested or exercised daily following challenge. There were 4 horses in each group (from Gross et al).¹²

Clinical Sign	Number showing sign		Days post-challenge	
	Exercise	Nonexercise	Exercise	Nonexercise
Anorexia	4	3	2-9	3-8
Depression	3	1	4-9	2
Mucopurulent nasal discharge	4	4	1-17	2-16
Coughing	4	4	1-13	1-12
Fever (>38.5°C)	4	4	1-11	1-11
Tachycardia (>30/min)	4	4	1-14	1-14
Abnormal lung sounds	4	4	1-18	2-15
Weight loss*	4	4	4-28	4-17

*Decrease in bodyweight when compared with weight on Day 0.

feature of influenza is its rapid spread, particularly in group-housing situations.

In horses showing clinical signs consistent with influenza virus infection, diagnosis can be made by paired serology, virus isolation, or use of an immunoassay for influenza A nucleoprotein. The immunoassay (Directigen Flu A, Becton-Dickinson) was originally designed for use in humans, but has been evaluated in 2 equine studies published at similar times.^{15,16} In one study, approximately two-thirds of horses showing clinical signs of influenza during an outbreak, seroconverted; in the other, the percentage was higher. In both studies, in horses that seroconverted, the influenza immunoassay was positive in half of the cases, while virus isolation was positive in only 7% to 41%. The immunoassay appeared to have a very low false-positive rate.¹⁵ The immunoassay is much quicker than a culture, taking about 15 minutes, and requiring no specialized equipment other than purchase of the kit. Both virus isolation and the immunoassay are used on samples collected with cotton swabs, 15 to 30 cm long. The shorter swabs can be vigorously rubbed against the nasal meatus. Swabs are then placed in a small amount of phosphate-buffered saline fluid and this fluid is used in the assays. While seroconversion may be the most reliable means of detecting infection, it requires at least two serum samples, typically obtained two weeks apart, and so is more retro-

spective in nature. It can be negative if the horse is sampled later in the disease process, since antibody concentrations may have peaked. It is also likely that methods used to detect seroconversion in routine diagnostic laboratories are less sensitive than those used in one of the reports cited above.

Treatment

Treatment for affected horses is typically rest for 1 to 4 weeks, followed by gradual reintroduction to work. Rest reduces the severity of clinical signs.¹² Nonsteroidal anti-inflammatory drugs may be used to control high fever. Antibiotics speed the removal of secondary bacterial colonization from the upper airways and are specifically indicated when secondary bacterial invasion of the lungs takes place. General guidelines for initiating systemic antibiotic therapy include the presence of adventitious lung sounds: wheezes, squeaks, and crackles, or other clinical signs that persist for > 10 days (bag off the horse if any doubt exists about the condition of the lungs). Signs of persistent fever, coughing, tachypnea, or nasal discharge are particularly likely to indicate bacterial secondary invasion when there is no day-to-day improvement after 7 days from the onset of signs.¹² Abnormal lung sounds that have a cranioventral, rather than a generalized distribution, are also more likely to indicate bacterial bronchopneumonia. Some

veterinarians will want to treat earlier and this may speed the resolution of signs associated with bacterial invasion, but in naïve horses, signs may persist due to viral attack. Others will argue that these guidelines will result in the treatment of some horses who would spontaneously recover. The most common secondary invader is *Streptococcus equi zooepidemicus*.

Control of influenza virus infection should be targeted to the high-risk groups and involves a mixture of surveillance and vaccination. Surveillance of horses at racetracks may allow the detection of early cases of influenza. Particular attention should be paid to younger horses and those with frequent contact with other horses (eg, exercise ponies). Point-of-care diagnostic tests allow the rapid detection of the influenza virus in suspect horses.^{15,16} Restricting movement and following basic hygiene precautions can slow the spread of disease. Vaccination in the face of an outbreak (eg, when 5% to 10% of horses are affected) may be effective, although there is no documentation to support this.⁵

At present, there are both killed-influenza virus vaccines and a cold-adapted, temperature-sensitive, modified-live intranasal vaccine. Although earlier reports indicated that some equine, killed-influenza virus vaccines were ineffective,¹⁷ recent reports with modern killed vaccines are much more encouraging.^{5,13} Following a single dose, the modified-live intranasal vaccine protected horses against inhalation challenge with equine influenza viruses from both American and Eurasian groups.¹⁸ Similarly, some killed vaccines have been shown to be effective in recent experimental challenge study models¹³ months after vaccination. Other studies indicate that immunity wanes and is less protective 6 to 12 months following vaccination.

One authority recommends that vaccination be particularly targeted to racehorses and other younger horses (<4 years old) likely to be frequently mixed, (eg, horses going to sales or shows).⁵ The timing of vaccinations may also offer additional benefits. Horses should have completed their vaccination program 2 weeks prior to moving to locations where they are mixed with other horses. If a horse is in a high-risk environment and more than 6 months has elapsed since an influenza vaccination, the horse can be given a booster vaccination.⁵ Up-to-date vaccination does not guarantee the absence of signs, but signs should be milder and shorter.

Summary

Influenza A has caused epidemic disease in poultry, people, horses, and swine for over a hundred years. At present, it is wreaking severe economic damage to the poultry industry in British Columbia and a worldwide monitoring and control program is in place to reduce

the likelihood that a new human pandemic will arise. In naïve horses, influenza still produces severe upper and lower respiratory tract signs, but effective vaccines exist to mitigate its effects.

Guest Editor: **Dr. Vikram Misra**, is a Professor of Virology and Head of the Department of Veterinary Microbiology at the Western College of Veterinary Medicine, University of Saskatchewan.

References

1. Horimoto T, Kawaoka Y. Pandemic threat posed by avian influenza A viruses. *Clin Microbiol Rev* 2001;14:129-149.
2. Lai ACK, Chambers TM, Holland RE Jr, et al. Diverged evolution of recent equine-2 influenza (H3N8) viruses in the Western Hemisphere. *Arch Virol* 2001;146:1063-1074.
3. <http://www.hc-sc.gc.ca/english/diseases/flu/avian.html#2>
4. Lunn DP. Equine influenza virus: pathogenesis, epidemiology, and immunity. Proceedings: 22nd Annual ACVIM Forum, Minneapolis, 2004.
5. Townsend HGG. Strategic use of equine vaccines. Proceedings: 22nd Annual ACVIM Forum, Minneapolis, 2004.
6. Cui-ZhengYing, Li-WanKun, Zhang-GuoSheng, Chen-YiXia, Lu-Wang-Yin, Zhong-DongQing. Epidemiological studies, diagnosis and isolation of the pathogen in an outbreak of influenza in horses in Gansu. *Chinese J Vet Sci Technol* 1995;25(8):32-33.
7. Guo Y, Wang M, Kawaoka Y, et al. Characterization of a new avian-like influenza A virus from horses in China. *Virology* 1992; 188(1):245-255.
8. Yang-GuoYong, Fang-ZhiHui, Que-ChengGong, Li-XiWen, Jian-JunLin, Yang-GY, Fang-ZH, Que-CG, Li-XW, Jian-JL. Prevalence and control of equine influenza. *Chinese J Vet Med* 1995;21:8-11.
9. Shortridge KF, Chan WH, Guan Y. Epidemiology of the equine influenza outbreak in China, 1993-94. *Vet Rec* 1995;136:160-161.
10. Sarasola P, Taylor DJ, Love S, McKellar QA. Secondary bacterial infections following an outbreak of equine influenza. *Vet Rec* 1992;131(19):441-442.
11. Sutton GA, Viel L, Carman PS, Boag BL. Study of the duration and distribution of equine influenza virus subtype 2 (H3N8) antigens in experimentally infected ponies *in vivo*. *Can J Vet Res* 1997;61:113-120.
12. Gross DK, Hinchcliff KW, French PS, et al. Effect of moderate exercise on the severity of clinical signs associated with influenza virus infection in horses. *Equine Vet J* 1998;30:489-497.
13. Townsend HGG, Lunn DP, Bogdan J, Griffin S, Holland R, Barnett C. Comparative efficacy of commercial vaccines in naïve horses: serologic responses and protection after influenza challenge. *Am Assoc Equine Pract* 2003;49:227-229
14. Wilkins PA. Lower airway diseases of the adult horse. *Vet Clin North Am* 2003;19:101-121.
15. Chambers TM, Shortridge KF, Li PH, Powell DG, Watkins KL. Rapid diagnosis of equine influenza by the Directigen FLU-A enzyme immunoassay. *Vet Rec* 1994;135:275-279.
16. Morley PS, Bogdan JR, Townsend HGG, Haines DM. Evaluation of Directigen Flu A assay for detection of influenza antigen in nasal secretions of horses. *Equine Vet J* 1995;27:131-134.
17. Morley PS, Townsend HGG, Bogdan JR, Haines DM. Efficacy of a commercial vaccine for preventing disease caused by influenza virus infection in horses. *J Am Vet Med Assoc* 1999; 215:61-64.
18. Chambers TM, Holland RE, Tudor LR, et al. A new modified live equine influenza virus vaccine: phenotypic stability, restricted spread, and efficacy against heterologous virus challenge. *Equine Vet J* 2001;33:630-636.

Abstract of Interest

A new modified live equine influenza virus vaccine: phenotypic stability, restricted spread, and efficacy against heterologous virus challenge.

CHAMBERS TM, HOLLAND RE, TUDOR LR, ET AL.
LEXINGTON, KY

Flu Avert IN vaccine is a new, live attenuated virus vaccine for equine influenza. We tested this vaccine in vivo to ascertain: (1) its safety and stability when subjected to serial horse to horse passage, (2) whether it spreads spontaneously from horse to horse and (3) its ability to protect against heterologous equine influenza challenge viruses of epidemiological relevance. For the stability study, the vaccine was administered to 5 ponies. Nasal swabs were collected and pooled fluids administered directly to 4 successive groups of naïve ponies by intranasal inoculation. Viruses isolated from the last group retained the vaccine's full attenuation phenotype, with no reversion to the wild-type virus phenotype or production of clinical influenza disease. The vaccine virus spread spontaneously to only 1 of 13 nonvaccinated horses/ponies when these were comingled with 39 vaccinates in the same field. For the heterologous protection study, a challenge model system was utilized in which vaccinated or naïve control horses and ponies were exposed to the challenge virus by inhalation of virus-containing aerosols. Challenge viruses included influenza A/equine-2/Kentucky/98, a recent representative of the 'American' lineage of equine-2 influenza viruses; and A/equine-2/Saskatoon/90, representative of the 'Eurasian' lineage. Clinical signs among challenged animals were recorded daily using a standardized scoring protocol. With both challenge viruses, control animals reliably contracted clinical signs of influenza, whereas vaccinated animals were reliably protected from clinical disease. These results demonstrate that Flu Avert IN vaccine is safe and phenotypically stable, has low spontaneous transmissibility and is effective in protecting horses against challenge viruses representative of those in circulation worldwide.

Equine Vet J 2001;33:630-636.

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