Public Health Fact Sheet

Influenza: Pigs, People & Public Health

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Influenza A viruses (IAV) were first isolated from swine in the United States in 1930. Since that time, they remain an economically important cause of respiratory disease in pigs throughout the world and a public health risk. The clinical signs/symptoms of influenza in pigs and people are remarkably similar, with influenza-like illness (ILI) consisting of fever, lethargy, lack of appetite and coughing prominent in both species. Influenza viruses can be directly transmitted from pigs to people as "zoonotic" disease agents (pathogens that are transmitted from animals to humans or shared by animals and humans) and cause human infections. Conversely, influenza viruses from people can also infect and cause disease in pigs. These interspecies infections are most likely to occur when people and pigs are in close proximity with one another, such as during livestock exhibits at fairs, live animal markets, swine production barns, and slaughterhouses. Finally, pigs can serve as intermediaries in the generation of novel reassorted influenza viruses since they are also susceptible to infection with avian influenza viruses. These novel viruses may contain new combinations of gene segments from avian, human and mammalian influenza viruses with the potential to be transmitted to people. Importantly, reassortant viruses were the cause of the human influenza pandemics in 1957, 1968, and 2009, with different combinations of human, avian, or swine viruses in each event. Finally, replication of avian lineage IAVs in pigs may also allow them to adapt and efficiently infect mammals, ultimately leading to a virus with greater potential to transmit to, infect and cause disease in people even without reassortment with mammalian viruses.

Veterinarians can help pig producers design farms, develop management protocols, and devise personnel policies to minimize movement of IAV between pig populations. Protocols regarding the frequency and source of pig introductions into farms and the isolation and/or quarantine of newly introduced animals may have the potential to reduce the number of diverse IAVs in a pig population. Additionally, personnel policies such as those recommended below may assist in the prevention of interspecies transmission of influenza viruses. Therefore, veterinarians are uniquely positioned to provide advice and intervention strategies to minimize influenza disease risk that can afflict both swine and humans.

Background:

Influenza viruses exist in four "types," designated A, B, C, and D. Of these, only influenza A viruses are significant concerns for the health of pigs, whereas influenza A and B are of concern to people. There are a large number of different "subtypes" of influenza A viruses. These subtypes are classified by the hemagglutinin (H or HA) and neuraminidase (N or NA) proteins of the virus. These are also the proteins against which the host directs antibodies that can neutralize the virus, and are, therefore, the major target of vaccines. Of practical significance, antibodies against one IAV subtype provide limited cross-protection to IAV of different subtypes.

There are at least 18 different subtypes of hemagglutinin and 11 different subtypes of neuraminidase among influenza A viruses. Subtypes are distinguished by differences in their genetic sequences, which translate into differences in protein structure and antibody recognition sites, and potentially their infectiveness and pathogenicity. The combination of HA and NA subtypes are depicted by H and N designations, such as H1N1, H3N2, etc. In the course of history, relatively few HA and NA combinations have consistently circulated among pigs or people (predominantly H1N1, H1N2 and H3N2 in pigs, and H1N1, H2N2 and H3N2 in people). In contrast, virtually all of the possible influenza A virus subtypes exist among waterfowl, with the exception of subtypes H17, H18, N10, and N11 that have only been detected in bats. In birds, influenza viruses predominantly infect the gastrointestinal tract rather than the respiratory tract, which is the target organ in pigs, people, horses and other mammalian hosts of influenza viruses. The infections in waterfowl generally do not make the birds sick. In waterfowl, the viruses are shed in the feces and, ultimately, into lakes, ponds and other environments that are visited during migrations. These environments may also include farm grounds where livestock or poultry are raised.

IAVs carry 8 separate gene segments of ribonucleic acid (RNA), rather than on one single genetic molecule. In addition to undergoing genetic change through mutations in their RNA genes, the segmented genome of the virus has important implications for virus evolution. If two (or more) influenza viruses simultaneously infect cells in a single host, then these viruses can exchange RNA segments with one another during replication, thereby creating viruses with entirely new combinations of genes. This process, known as reassortment, was the basis for the emergence of viruses that caused influenza pandemics in the human population in 1957, 1968, and 2009. In 1957 and 1968, influenza viruses from waterfowl reassorted with the previously circulating human influenza viruses to create viruses with different hemagglutinin subtypes (from H1 to H2 in 1957 and from H2 to H3 in 1968). However, in 2009, the reassortment that generated the human pandemic virus was between viruses from a North American swine lineage termed "triple reassortant" and virus genes from a swine lineage known as "Eurasian avian." A change to a hemagglutinin against which the human population has no immunity ("antigenic shift") causes these periodic global pandemics. The 2009 H1N1 influenza pandemic revealed the importance of swine and humans to the global spread of influenza viruses. As a result of the recent pandemic, several important areas of research and surveillance were undertaken in the hopes of answering questions about influenza virus evolution, adaptation , and transmission.

So, how does this process of reassortment occur? In general, there is a functional "species" barrier to virus transmission between people and animals. This barrier exists, in part, because avian influenza viruses preferentially bind receptors expressed on bird enteric cells and human viruses preferentially bind receptors expressed on cells in the human respiratory tract. Pigs express some avian- and human-type receptors and that may allow infection with avian, human and swine influenza viruses. As such, pigs can serve as hosts in which avian viruses adapt to replicate in mammals. For example, in the late 1970s, an avian H1N1 virus of waterfowl-origin entered the pig population of Europe and soon became the dominant cause of influenza among European pigs. Subsequently, these avian H1N1 viruses were also sporadically detected in people in Europe and Asia, and ultimately contributed gene segments to the 2009 H1N1 human pandemic virus some 40 years later. Pigs are hypothesized to serve as the "mixing vessels" in which reassortment between avian and human influenza viruses can take place. To a lesser extent this occurs in other mammalian species such as dogs, even though no dog to human transmission events have been documented. The focus of such reassortment has historically been in Southeast Asia, the proposed "influenza epicenter," because cultural practices in this region bring pigs, people and waterfowl and other avian species into close contact with one another. However, it is now clear that influenza virus reassortment in pigs can occur anywhere in the world, as evidenced by the 2009 pandemic precursor viruses isolated from pigs in Mexico. Genetic mixing between IAV occurs frequently among swine, and other species. For example, interspecies transmission of influenza viruses from pigs to domestic turkeys has been recognized on numerous occasions. In contrast, transmission of influenza viruses between pigs and domestic chickens and other fowl, and vice versa, is very rarely reported.

Reducing interspecies transmission of influenza viruses

It is in the best interest of both human public health and swine health to minimize interspecies transmission of influenza viruses (i.e. from pigs to people, from people to pigs, from birds to pigs and from pigs to birds).

Interspecies transmission among pigs and people

Zoonotic transmission of IAV from pigs to swine workers may go unrecognized or be misdiagnosed as typical human influenza viruses because the seasonal patterns of human and swine influenza disease largely overlap (late fall through winter) and confirmatory diagnosis requires subtype-specific and/or genomic testing to distinguish seasonal from zoonotic influenza virus infection. Uniquely, however, many zoonotic influenza cases have been associated with exposure at agricultural fairs during the summer months. These cases typically occur in children exhibiting swine or among people of higher risk for influenza, making these cases easier to recognize and trace back to swine exposure. In addition, the impact of transmission of influenza viruses from people to pigs should not be underestimated. Human seasonal IAV have sporadically made incursions into pig populations around the world. Human seasonal H1N1 and H1N2 viruses were introduced into U.S. swine in the early 2000s and human seasonal H3N2 viruses have spilled over into pigs repeatedly since 1968, with recent incursions occurring during the 2000s in China and Europe and during the 2010s in the United States. And since 1998, H3N2, H1N2 and H1N1 viruses circulating and causing disease in swine in the United States have contained human influenza virus genes. The human pandemic H1N1 virus from 2009 continues to be repeatedly transmitted from people back to pigs.

The following steps are potentially useful measures to reduce transmission of influenza viruses between pigs and people in the swine industry:

Worker biosecurity: Provide clothing and boots for workers that are worn only within the pig housing units, thus eliminating the chance to carry IAV into housing units from external sources. No contact with swine from other sources or with poultry is recommended for at least a 24 hour period before entry, along with a full body shower in between.

Basic hygiene practices: Workers should change clothes prior to leaving swine barns for office facilities, food breaks or their homes. In addition, hand-to-face contact should be minimized and hand-washing stations should be available and used prior to leaving each room or area and before returning to office or break rooms. Influenza viruses are spread not just by inhalation of aerosolized virus, but also by eye and nose contact with droplets of respiratory secretions. During outbreaks of ILI in swine, proper use of respirators can mitigate risk of transmission from pigs to workers.

Sick-leave policies: To further reduce the chances for infection of pigs with human lineage influenza viruses, the farm owner should provide sick-leave policies for employees that encourage them to remain away from work when they are suffering from acute respiratory infections. People typically shed influenza viruses for approximately 3-7 days, with the period of peak shedding correlated with the time of most severe clinical illness. Influenza-like illness (ILI) is typically defined as fever, cough, congestion, sore throat, and muscle aches. Workers that exhibit ILI after working with ill swine should seek medical care and disclose the swine contact to the medical professionals.

Pursue alternative employment: People with medical conditions that predispose them to severe influenza illness are recommended to avoid contact with swine, whether at public venues or through occupational exposure.

Influenza virus vaccination of swine farm workers: The vaccines produced on a yearly basis for the human population contain only human, not swine, strains of influenza viruses. Nonetheless, vaccination of farm workers may reduce the amount of virus shed by infected people during human influenza outbreaks, and thereby limit the potential for human influenza virus infection of their pigs.

Ventilation & environmental conditions: Ventilation systems in containment production facilities should be designed to minimize re-circulation of air within animal housing rooms. This is important to reduce the exposure of pigs to viruses from other pigs, to reduce their exposure to human influenza viruses, and conversely, to reduce exposure of workers to swine influenza viruses. Stressful environmental conditions or too few air exchantges contribute to reoccurrence of disease outbreaks caused by endemic strains.

Influenza virus vaccination of pigs: While the IAV vaccines used in swine today may not induce sterilizing immunity, nor completely eliminate clinical signs of infection, vaccination of pigs can reduce the levels of virus shed by infected animals, and thus reduce the potential for human exposure and zoonotic infections.

Interspecies transmission among pigs and birds: The global reservoir of IAVs in waterfowl, the examples of infection of pigs with waterfowl-origin influenza viruses, the risks for reassortment of avian viruses with swine and/or human influenza viruses in pigs, and the risk for transmission of influenza viruses from pigs to domestic poultry (especially turkeys) all indicate that contact between pigs and both wild and domestic fowl should be minimized.

The following factors are potentially useful to reduce transmission of influenza viruses between birds and pigs:

- **Bird-proofing**: All doorways, windows and air-flow vents in swine housing units should be adequately sealed or screened to prevent entrance of birds.
- **Water treatment**: Do not use untreated surface water (because of waterfowl fecal contamination with influenza viruses) as either drinking water or water for cleaning in swine facilities. Likewise, it may be prudent to attempt to minimize waterfowl use of farm lagoons/ponds.
- **Separation of pig and bird production:** Do not raise pigs and domestic fowl on the same premises.
- **Feed security:** Keep pig feed in closed containers to prevent contamination with feces from birds and other peridomestic wildlife. Vigilance regarding the quality and origin of feed ingredients is recommended for feed security in general.

Note: These recommendations clearly cannot apply to production units in which pigs are raised outdoors. Outdoor housing places pigs at increased risk for infection with influenza viruses from multiple sources.

Suggested reading and references

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