Influenza Virus Threats to Swine Agricultural Workers: What Do We Know?

CEID
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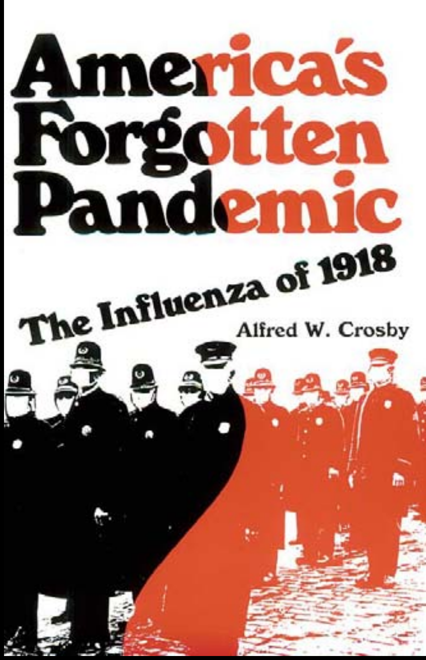
The Great Spanish Flu Pandemic of 1918-1919



- Sept 30- Oct 5th, Iowa's Cedar Rapids Swine Show – a flu-like illness spread to millions of swine across Iowa
- JS Koen, an inspector, Division of Hog Cholera Control of the Bureau of Animal Industry-
  - Rapidly spread through herds
  - Swine developed high temperatures, heavy coughs, drippy noses and eyes, many died

Swine Influenza

- Frequent epidemics among US swine populations
- Birds and swine often exchange influenza A viruses
- Among humans 50 cases of zoonotic swine influenza virus infections reported; 37 among civilians and 13 among military personnel
- Human-to-human transmission 46% (12 of 26)
- 14% (7 of 50) case fatality rate.
- Most civilian subjects (61%) reported swine exposure.

Myers KP, Olsen CW, Gray GC. Clin Infect Dis, 2007;44;1084-88.

Table 1. Demographic and Exposure Characteristics of 11 Patients Infected with Triple-Reassortant Swine Influenza A (H1) Viruses.

Patient No.	Age	Sex	State of Residence	Date of Illness Onset	Estimated Incubation Period	Exposure*	Ill Swine Present
1	17 yr	M	WI	Dec. 2005	3 days	Butchered a pig (direct contact)	Not known
2	7 yr	M	MO	Jan. 2006	Not known	Reported no contact with a pig (unknown contact)	Not known
3	4 yr	F	IA	Nov. 2006	7–10 days	Had contact with patient with suspected case of swine influenza (epidemiologically linked contact)	Yes
4	10 yr	F	OH	Aug. 2007	3–4 days	Exhibited swine at fair, handled pigs (direct contact)	Yes
5	36 yr	M	OH	Aug. 2007	3–4 days	Exhibited swine at fair, handled pigs (direct contact)	Yes
6	48 yr	F	IL	Aug. 2007	7 days	Visited fair, did not stop at pigpen (near vicinity)	Yes
7	16 mo	M	MI	Aug. 2007	7 days	Visited fair, came within 1 m of pigs (close proximity)	Yes
8	2 yr	M	IA	Nov. 2007	1–10 days	Lived on swine farm, came within 1 m of pigs (close proximity)	Yes
9	26 yr	F	MN	Jan. 2008	9 days	Visited live-animal market, came within 1 m of pigpen (close proximity)	Not known
10	14 yr	M	TX	Oct. 2008	3 days	Visited a swine farm, brought home and handled a pig (direct contact)	Yes
11	3 yr	M	IA	Feb. 2009	1–10 days	Visited swine farm owned by his family, touched pigs (direct contact)	Yes

* Direct contact refers to touching or handling a pig; close proximity refers to standing within 1.83 m (6 ft) of a pig, without known direct contact; near vicinity refers to presence of pigs on the premises but not in close proximity; epidemiologically linked refers to a person who is epidemiologically linked to another person with a confirmed or suspected infection; and unknown refers to unknown contact or unavailable contact information.

Shinde et. al. N Engl J Med 2009;360:2616-25

Swine Influenza Virus Infection of Pigs and People at a County Fair

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Introduction

Swine influenza virus (SIV) is a common cause of respiratory infection in swine. Previous sporadic human infections with SIV illustrate the zoonotic potential of the virus. Pigs can be infected with swine, human, and avian influenza viruses and thus potentiate cross-species influenza transmission and the formation of novel influenza viruses.

In August 2007, pigs being shown at an Ohio county fair were observed with influenza like illness including anorexia, lethargy, fever, and cough. Approximately 235 pigs were present at the fair with more than two thirds of the pigs in the facility affected. Approximately two dozen people at the fair developed influenza like illness simultaneously and sought medical care. The affected people had direct contact with the pigs or had family members who were in direct contact with pigs.

Family Farm

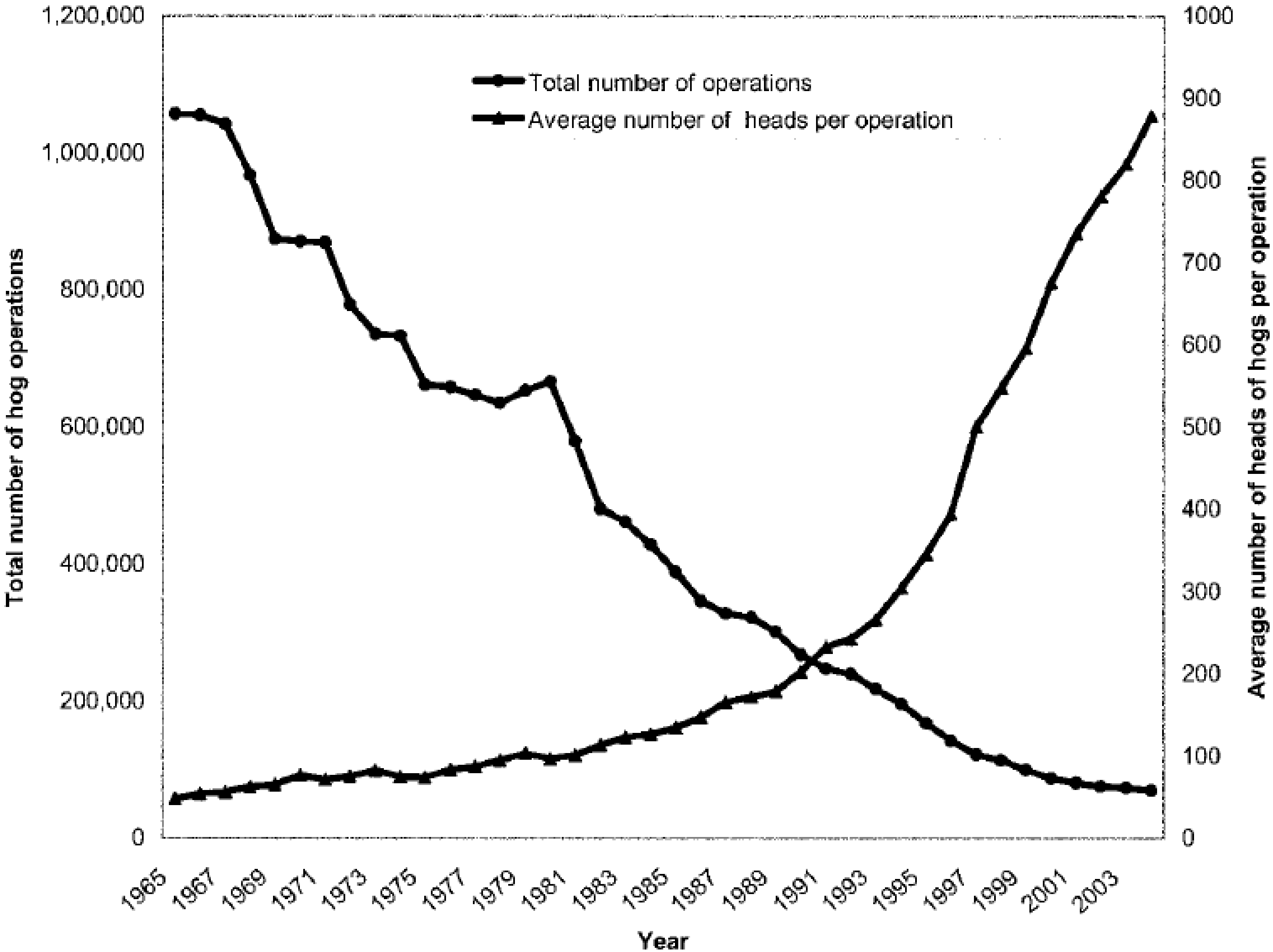


Figure 1. Trends in hog operations in the United States. Adapted from [23].




Intensive Swine Production & SIV

- SIV is endemic where modern production facilities are common
- Risk factors for sow-herd SIV seropositivity - pigs density, an external source of breeding pigs, total animals on the site, and closeness of barns
- Risk factors for finisher-herd SIV positivity - SIV positive sows, large herd size, high pig farm density, and farrow-to-finish type of farm.

Influenza Other Respir Viruses. 2008 May;2(3):99-105
Can J Vet Res. 2008 Jan;72(1):7-17

Putting Meat on the Table: Industrial Farm Animal Production, April 2008

- ….the continual cycling of swine influenza viruses and other animal pathogens in large herds or flocks provides increased opportunity for the generation of novel viruses through mutation or recombinant events that could result in more efficient human-to-human transmission of these viruses.

Mexican farm swine flu's 'ground zero': residents

Last Updated: Tuesday, April 28, 2009 | 8:37 AM ET [Comments4Recommend9]

The Associated Press

Residents in a Mexican community of 3,000 say they believe their town is ground zero for the swine flu epidemic, even if health officials aren't saying so.

A youth stands outside the home of a child who, according to Veracruz state Gov. Miguel Herrera, survived the swine flu, as he waits with others for Herrera's arrival to La Gloria village in Mexico's Veracruz state on Monday. (Alexandre Meneghini/Associated Press)

More than 450 residents of La Gloria say they're suffering from respiratory problems from contamination spread by pig waste at nearby breeding farms co-owned by a U.S. company.

Novel H1N1 Spread to Farms

- Canada - pigs
- Australia - pigs
- Chile – turkeys
- Ireland - pigs

http://www.corrections.com/news/article/22168

Fear over H1N1 detection brings down swine disease samples

Sep 25, 2009
DVM NEWSMAGAZINE

source dvm

The U.S. Department of Agriculture (USDA), concerned about a perceived drop in swine disease samples from pork producers, is urging veterinarians to continue monitoring herds for a variety of diseases, including the H1N1 influenza virus.

The problem with monitoring swine herds is that many producers fear what virus discovery in their herds would do, says Ed Curlett, USDA Animal and Plant Health Inspection Service (APHIS) spokesman.

The agency found that disease sample submissions in general, not just pertaining to H1N1, have decreased greatly from last year.

“Submissions are down because of fears of what could happen if they have the H1N1 virus,” Curlett says. “We’re trying to get the message out right now to producers that if there is a detection of the H1N1 influenza in their herd, once their animals recover they can move in commerce, they can go to slaughter. They won’t be penalized.”

Evidence of Swine Influenza Virus Infection Among Swine Workers

- Controlled, cross-sectional seroprevalence studies among 111 farmers, 97 meat processing workers, 65 veterinarians, and 79 control subjects using serum samples collected during the period of 2002–2004.
- Serum samples were tested using a hemagglutination inhibition assay against 6 influenza A virus isolates collected recently from pigs and humans: A/Swine/WI/238/97 (H1N1), A/Swine/WI/R33F/01 (H1N2), A/Swine/Minnesota/593/99 (H3N2), A/New Caledonia/20/99 (H1N1), A/Panama/2007/99 (H3N2), and A/Nanchang/933/95 (H3N2).

Myers KP, Olsen CW, Setterquist SF, Capuano AW, Donham KJ, Thacker EL, Merchant JA, Gray GC. Evidence of Swine Influenza Virus Infection Among Swine Workers. Clin Infect Dis 2006:42:14-20.

Table 1. Adjusted odds ratios of antibody against swine influenza virus, proportional odds model.

	Odd Ratios	
Risk factors	**Swine H1N1**	**Swine H1N2**
Occupation		
Farmers/controls	**35.3 (7.7-161.8)**	**13.8 (5.4-35.4)**
Meat processing workers/controls	**6.5 (1.4-29.5)**	**2.7 (1.1-6.7)**
Veterinarian workers/controls	**17.8 (3.8-82.7)**	**9.5 (3.6-24.6)**
Age	1 (1-1)	1 (1-1)
Gender		
Male/Female	2.9 (1.6-5.2)	2.3 (1.4-3.7)
Antibody to human virus		
H1N1	2.8 (1.6-5)	2.7 (1.6-4.5)

Myers KP, Olsen CW, Setterquist SF, Capuano AW, Donham KJ, Thacker EL, Merchant JA, Gray GC. Evidence of Swine Influenza Virus Infection Among Swine Workers. Clin Infect Dis 2006:42:14-20.

Preventing Zoonotic Influenza Virus Infection

- 49 swine industry workers and 79 non-swine exposed controls enrolled in a seroprevalence study
- Examined for antibodies with hemagglutination inhibition assay to swine and human influenza viruses.

Ramirez A, Capuano AW, Wellman DA, Lesher K, Setterquist SF, and Gray GC. Preventing Zoonotic Influenza Virus Infection. <u>Emerg Infect Dis</u>. 2006;12:997-1000

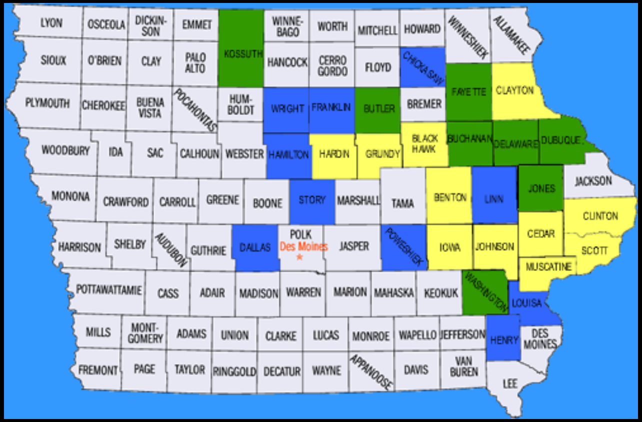
Table 2. Odds ratios for increased serologic response against swine H1N1 influenza virus by hemagglutination inhibition assay

Variable	n	Swine H1N1*			
		Titer ≥10, n (%)	Titer ≥20, n (%)	Bivariate OR (95% CI)	Multivariate OR (95% CI)
Age group (y)					
<29	40	3 (7.5)	1 (2.5)	1.2 (0.2–6.1)	3.5 (0.4–30.6)
29–42	46	3 (6.5)	1 (2.2)	Reference	Reference
>42	42	9 (22)	6 (14.6)	4.2 (1.1–16.8)†	6.1 (0.9–41.3)
Sex					
Male	63	13 (21)	7 (11.3)	8.4 (1.8–38.7)†	7 (0.9–52.1)
Female	65	2 (3.1)	1 (1.5)	Reference	Reference
Swine exposure					
Swine workers occasionally or never use gloves	34	12 (35.3)	7 (20.6)	21 (4.4–100.8)†	30.3 (3.8–243.5)†
Swine workers usually or always use gloves	14	1 (7.1)	0	2.8 (0.2–34.2)	2.4 (0.1–40.9)
Controls not exposed to swine	79	2 (2.6)	1 (1.3)	Reference	Reference
Smoked ≥5 packs of cigarettes in past year					
Yes	14	4 (28.6)	3 (21.4)	4 (1.1–14.5)†	18.7 (2.5–141.3)†
No	114	11 (9.7)	5 (4.4)	Reference	Reference

Ramirez A, Capuano AW, Wellman DA, Lesher K, Setterquist SF, and Gray GC. Preventing Zoonotic Influenza Virus Infection. Emerg Infect Dis. 2006;12:997-1000

Population-based Surveillance for Zoonotic Influenza A (NIAID R21)

- **Design** – 2-year prospective, controlled study of farmers who were occupationally exposed to swine or poultry (n=805); 29 counties in Iowa
- **Exposure questionnaires** – at enrollment, 12-months, and 24 months
- **Specimen collection** – Sera collection upon enrollment, at 12 months and 24 months; viral specimens and questionnaire when ill



Gray GC, McCarthy T, Capuano AW, Setterquist SF, Olsen CF, Alavanja MC, Lynch CF. Swine Workers and Swine Influenza Virus Infections. Emerg Infect Dis 2007;13:1871-78

Table 3. Enrollment - analyses of risk factors using proportional odds model, university controls as reference.

		Swine H1N1	Swine H1N2
		Adjusted OR (95% CI)	**Adjusted OR (95% CI)**
Swine exposure			
AHS - worked in swine production	**707**	**54.9 (13.0-232.6)**	**13.5 (6.1-29.7)**
AHS - Never worked in swine production	**80**	**28.2 (6.1-130.1)**	**6.9 (2.8-17.2)**
Non AHS - Controls	**79**	reference	reference
Age continuous	**866**	**0.97(0.96-0.98)**	---
Gender			
Male	**484**	**3.3(2.4-4.5)**	**3(2.2-4)**
Female	**382**	reference	reference
Received flu shot in the past 4 years			
Yes	**479**	**1.4(1.1-1.9)**	---
No/Unsure	**387**	reference	---
Human H1N1			
Positive	**347**	---	1.8(1.4-2.4)
Negative	**519**	---	reference

Gray GC, McCarthy T, Capuano AW, Setterquist SF, Olsen CF, Alavanja MC, Lynch CF. Swine Workers and Swine Influenza Virus Infections. Emerg Infect Dis 2007;13:1871-78

Swine Influenza

The message seems clear that swine influenza viruses

- SIV frequently infects persons exposed to pigs
- Can be transmitted from human-to-human
- May occasionally cause severe disease
- Swine shows may accelerate transmission among both pigs and man

Agricultural Confinement Workers

- Are often immigrants with English as their second language
- Often do not have ready access to medical care in their rural communities
- May shun contact with public health authorities due to questions regarding their immigration status

VECTOR-BORNE AND ZOONOTIC DISEASES
Volume 6, Number 4, 2006

Research Paper

Confined Animal Feeding Operations as Amplifiers of Influenza

ROBERTO A. SAENZ,[1] HERBERT W. HETHCOTE,[2] and GREGORY C. GRAY[3]

ABSTRACT

Influenza pandemics occur when a novel influenza strain, often of animal origin, becomes transmissible between humans. Domestic animal species such as poultry or swine in confined animal feeding operations (CAFOs) could serve as local amplifiers for such a new strain of influenza. A mathematical model is used to examine the transmission dynamics of a new influenza virus among three sequentially linked populations: the CAFO species, the CAFO workers (the bridging population), and the rest of the local human population. Using parameters based on swine data, simulations showed that when CAFO workers comprised 15–45% of the community, human influenza cases increased by 42–86%. Successful vaccination of at least 50% of CAFO workers cancelled the amplification. A human influenza epidemic due to a new virus could be locally amplified by the presence of confined animal feeding operations in the community. Thus vaccination of CAFO workers would be an effective use of a pandemic vaccine. Key Words: Influenza in birds—Influenza A virus—Swine—Zoonoses—Communicable diseases—Models—Theoretical. Vector-Borne Zoonotic Dis. 6, 338–346.

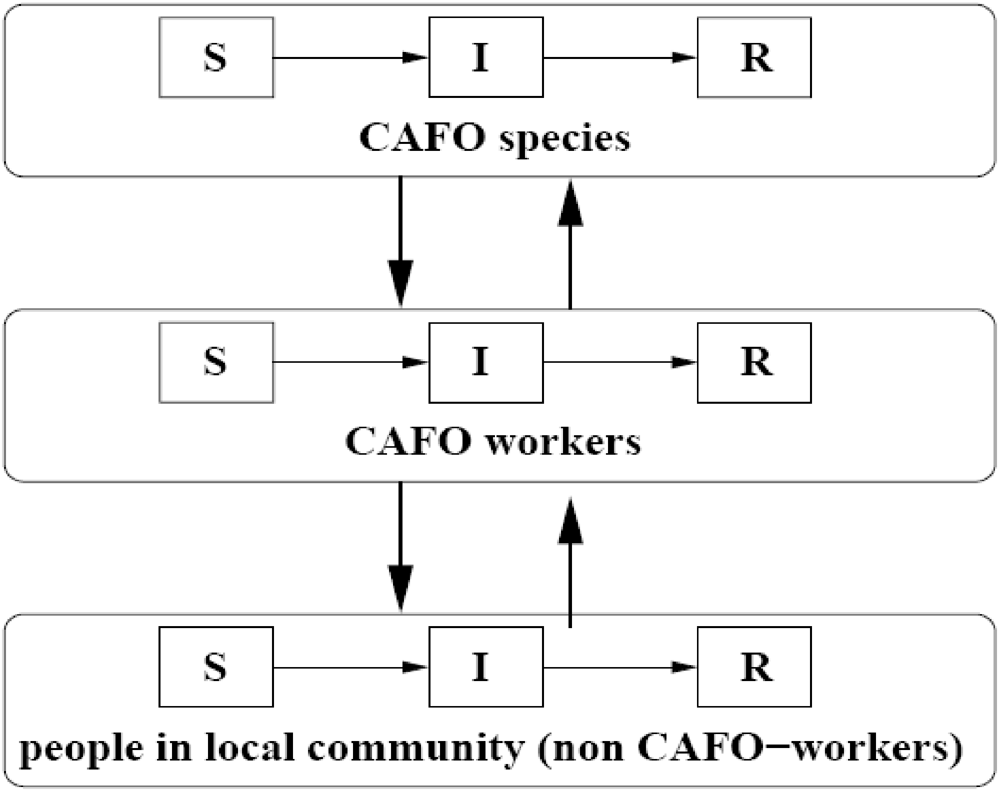


Figure 1. Transmission dynamics between the CAFO species, CAFO workers, and the rest of the local community. In each group susceptibles (*S*) become infected (*I*) and then removed (*R*) after recovery.

Saenz RA, Hethcote HW, Gray GC. Confined animal feeding operations as amplifiers of influenza. Vector Borne Zoonotic Dis, 2006;6:338-46 .

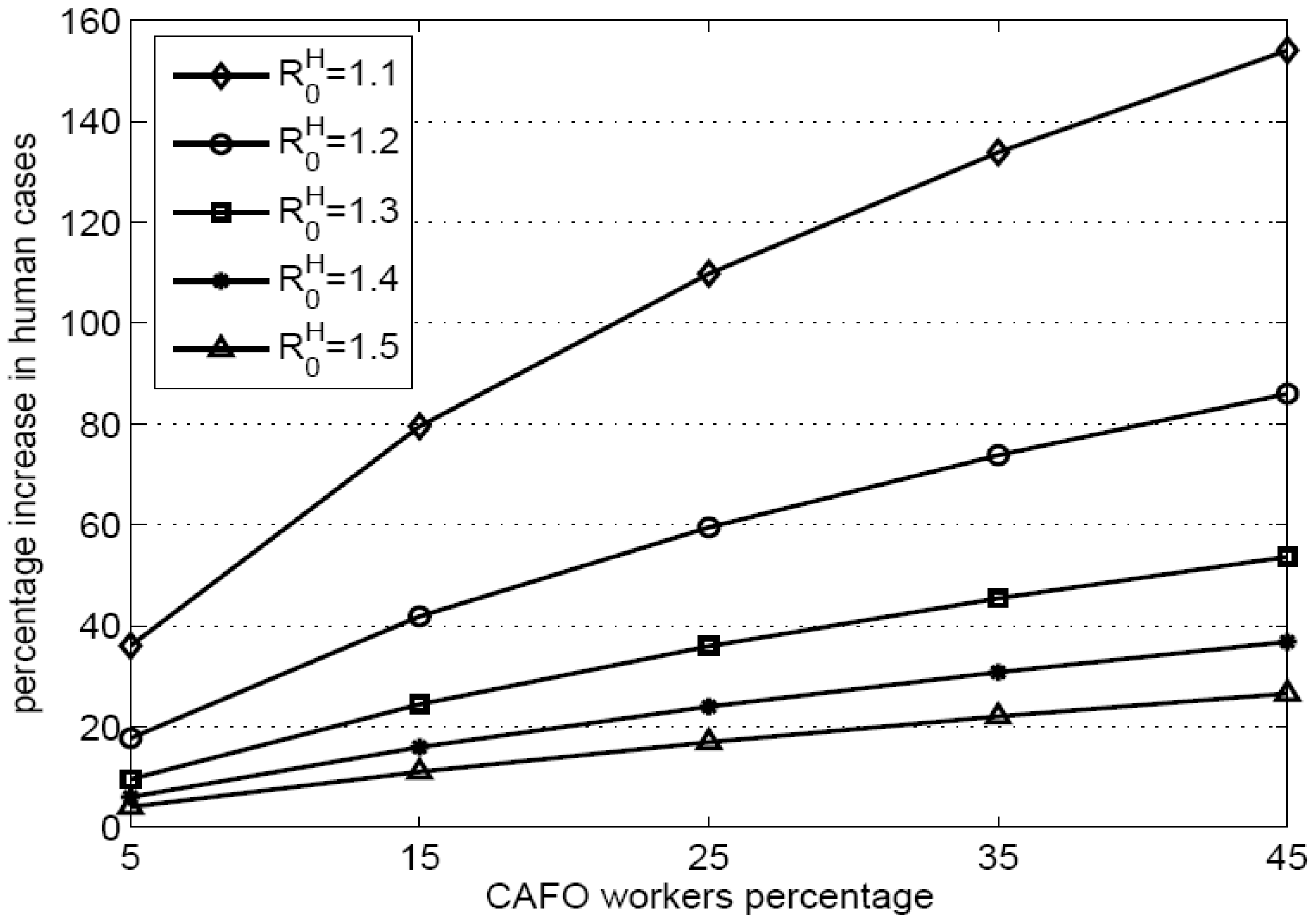


Figure 5. Percentage increases in the final size of the epidemic as a function of the percentage of CAFO workers in the community with R_0^H =1.1, 1.2, 1.3, 1.4, and 1.5. CAFO workers are 5%, 15%, 25%, 35%, and 45% of the local population.

Saenz RA, Hethcote HW, Gray GC. Confined animal feeding operations as amplifiers of influenza. Vector Borne Zoonotic Dis, 2006;6:338-46 .

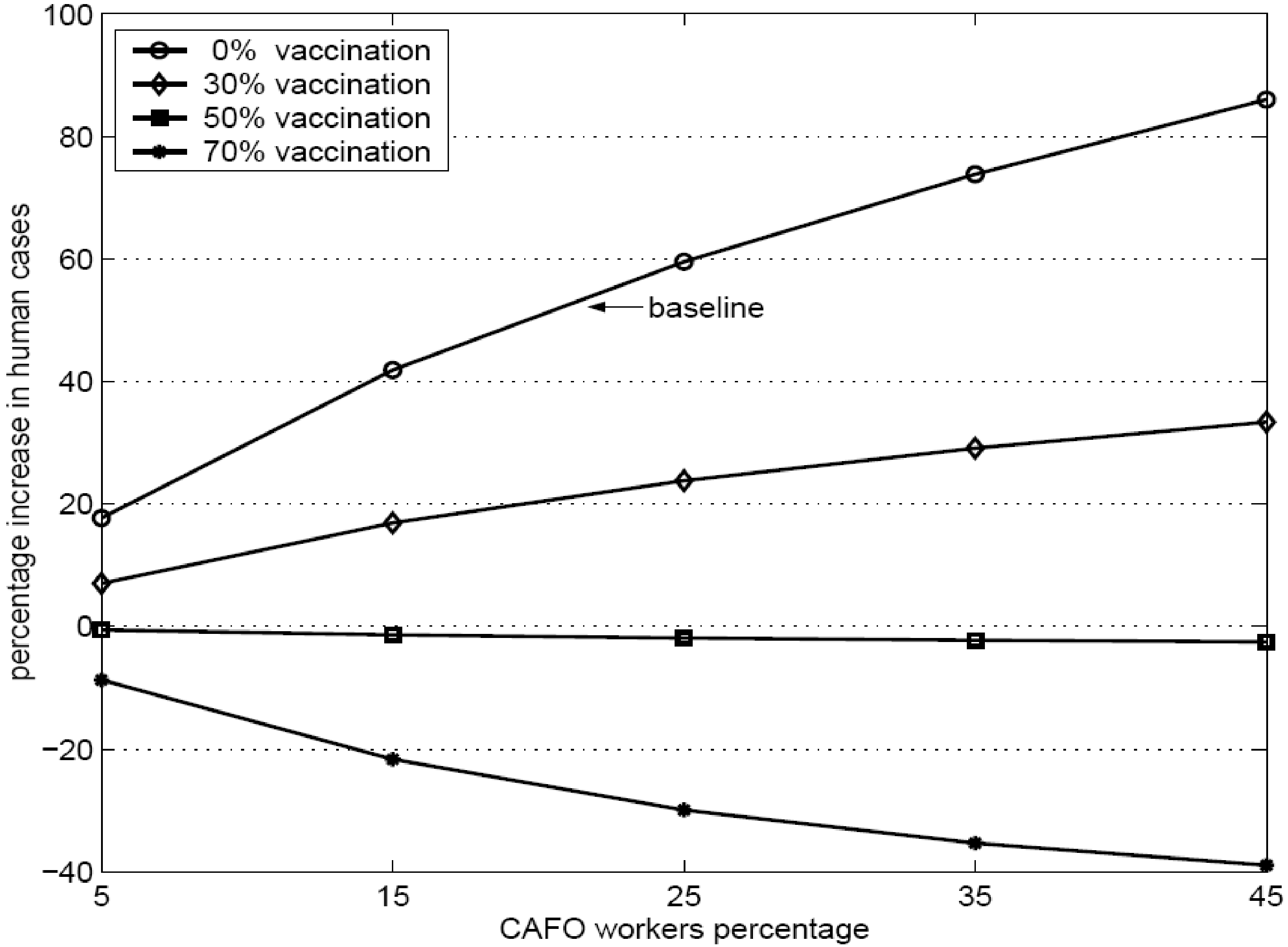


Figure 4. Percentage increases in the final size of the human influenza epidemic as a function of the percentage of CAFO workers in the community. The curves correspond to pre-epidemic successful vaccination of 0% to 70% of the CAFO workers. Local communities with 5%, 15%, 25%, 35%, and 45% of CAFO workers are considered.

Saenz RA, Hethcote HW, Gray GC. Confined animal feeding operations as amplifiers of influenza. Vector Borne Zoonotic Dis, 2006;6:338-46 .

If such risks are common knowledge why aren’t agriculture workers & veterinarians on the short lists for special disease preventions like vaccines?

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Pandemic influenza planning: Shouldn't swine and poultry workers be included?

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PERSPECTIVES

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COMMENTARIES

The Importance of Including Swine and Poultry Workers in Influenza Vaccination Programs

GC Gray[1] and WS Baker[1]

Sensing the threat of an influenza pandemic, many countries are developing influenza pandemic prevention and control strategies. Such plans often focus efforts on detecting outbreaks and protecting leaders, health-care workers, and outbreak responders. Considering recent research, we argue that prevention plans should also include swine and poultry workers. Ignoring these workers could result in an increased probability of generating novel viruses, as well as the acceleration of a pandemic's morbidity and mortality.

Zoonotic influenza A infections among swine and poultry workers

The key risk factors for human infections with swine or avian influenza virus is exposure to diseased pigs or birds.[2] Recent US epidemiological studies suggest that agricultural workers, including veterinarians, are at increased risk of zoonotic influenza virus infection. A 2002 study reported that modern swine workers were considerably more likely to have antibodies against new swine viruses, in comparison with controls not exposed to swine.[3] A recent study found that swine farmers, swine veterinarians, and pork-processing workers were significantly more likely to have elevated antibodies against swine H1N1 and H1N2 viruses, which could not be attributed to exposure to human H1 influenza virus or vaccines.[4] This same study showed that the adjusted

Facing pandemic influenza threats: The importance of including poultry and swine workers in preparedness plans[1]

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ABSTRACT Recent research has shown that poultry and swine workers, especially those with intense exposures, are at increased risk of zoonotic influenza virus infections. In multiple studies, US poultry workers and poultry veterinarians have evidence of previous infections with avian influenza virus. Similarly, US swine workers have strong evidence of previous and acute infections with swine influenza viruses. Mathematical modeling has demonstrated that such workers may accelerate the spread of pandemic viruses in their rural communities. Because these workers may contribute to the novel generation of viruses and serve as a bridging population in the cross-species sharing of influenza viruses, it seems prudent to include poultry and swine workers in influenza preparedness programs. Possible preventive and control interventions include special education programs to increase workers' use of personal protective equipment such as gloves, increased surveillance for influenza viruses among workers and their animals, recommendations that workers seek medical attention should they develop influenza-like illness, and workers' priority receipt of annual and pandemic influenza vaccines.

Key words: influenza, zoonosis, occupational exposure, communicable disease, emerging

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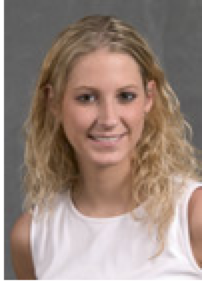
Public Veterinary Medicine: Public Health



A review of published reports regarding zoonotic pathogen infection in veterinarians

Whitney S. Baker, MPH, and Gregory C. Gray, MD, MPH

JAVMA, Vol 234, No. 10, May 15, 2009

•84% of seroepidemiological studies identified veterinarians at an increased risk of zoonotic pathogen infection

•Veterinarians may inadvertently serve as biological sentinels for emerging pathogens and could potentially spread zoonotic pathogens to their families, community members, and the animals for which they provide care.

Seropositivity of zoonotic pathogens among veterinarians

Pathogen	Species	Veterinariary Professionals	Controls	References
Hepatitis E virus	Human	26.4%	18.3%	Meng. J Clin Microbiol 2002; 40:117-22.
		33.3%	23.3%	Yan. Zhonghua Liu Xing Bing Xue Za Zhi 2007; 28:105-8.
		11.0%	2.0%	Bouwknegt. Epidemiol Infect; Pub Online by Cambridge Univ Press 20 June 2007.
	Swine	23.1%	16.5%	Meng. J Clin Microbiol 2002; 40:117-22.
Coxiella burnetii (Q-Fever)		12.9%	5.6%	Macellaro. Eur J Epidemiol; 1993; 9:216-16.
		10.5%	n/a	Valencia. Eur J Epidemiol 2000; 16:469-76.
		9.5%	n/a	Nowotny. J Infect Dis 1997; 176:1414-5.
		13.5%	3.6%	Abe. Eur J Epidemiol 2001; 17:1029-32.
Brucella spp .		4.5%	n/a	Omer. Epidemiol Infect 2002; 129:85-91.
		33.0%	5.0%	Ergonul. Int J Infect Dis 2006; 10:465-9.
		28.6%	n/a	Kumar. J Commun Dis 1997; 29:131-7.
		17.4%	2.6%	Thakur. J Commun Dis 2002; 34:106-9.
		8.2%	0.5%	Abo-Shehada. Int J Epidemiol 1996; 24:450-4.
		4.2%	0.0%	Lee. J Prev Med Pub Health 2007; 40:285-90.
	abortus	41.2%	1.0%	Agasthya. Indian J of Med Microbiol 2007; 25:28-31.
	canis	72.6%	56.9%	Monroe. J Clin Microbiol 1975; 2:382-6.
Influenza A virus	Swine H1N1	8.8%	n/a	Nowotny. J Infect Dis 1997; 176:1414-5.
	Avian H5	12.2%	0.0%	
	Avian H6	23.8%	0.3%	Myers. Clin Infect Dis 2007; 45:4-9.
	Avian H7	14.6%	0.0%	
Bartonella spp.		65.0%	n/a	Juncker-Voss. Berl Munch Tierarztl Wochenschr 2004; 117:404-9.
		15.0%	0.1%	Kumasaka. Rinsho Byori 2001; 49:906-10.
		45.0%	n/a	Chmielewski. Pol J Microbiol 2007; 56:33-8.
		7.1%	n/a	Noah. J Am Vet Med Assoc 1997; 210:342-4
Toxoplasma	*gondii*	54.7%	n/a	Nowotny. J Infect Dis 1997; 176:1414-5.
		53.0%	n/a	Juncker-Voss. Berl Munch Tierarztl Wochenschr 2004; 117:404-9.
Polyomavirus	Bovine	71.0%	0.0%	Parry. Arch Virol 1986; 87:287-96.
Norovirus	Bovine	28.0%	20.0%	Widdowson. J Med Virol 2005; 76:119-28.
Toxocara	*canis*	27.0%	2.0%	Deutz. Parasitol Res 2005; 97:390-94.
Chlamydia psittaci	Feline	8.8%	1.7%	Yan. Microbiol Immunol 2000; 44:150-60.

Zoonotic Influeza

In addition to our aggressive surveillance for novel influenza strains among humans and birds, we need to conduct surveillance for novel strains among swine, horses, and dogs.

The International Symposium on

Neglected Influenza Viruses

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Equine Influenza
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This meeting will bring together international scientists focusing on **swine**, **equine**, **canine**, and other **nonhuman mammalian influenza viruses** to explore what is known about these viruses through virologic studies, surveillance, epidemiology, prevention, control, and their implications for policy.

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For registration, abstract submission guidelines and full program details please visit https://www.isirv.org/events/The-International-Symposium-on-Neglected-Influenza-Viruses