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Educating youth swine exhibitors on influenza A virus transmission at agricultural fairs

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Summary
Influenza A virus (IAV) is a major zoonotic pathogen that threatens global public health. Novel strains of influenza A viruses pose a significant risk to public health due to their pandemic potential, and transmission of influenza A viruses from animals to humans is an important mechanism in the generation and introduction of IAVs that threaten human health. The purpose of this descriptive correlational study was to develop real-life training scenarios to better inform swine exhibitors of the risks they may encounter when influenza A viruses are present in swine. Educational activities were implemented in five Ohio counties where exhibition swine had historically been shedding influenza A viruses during the county fair. A total of 146 youth swine exhibitors participated in the educational programme, and an increase in the knowledge base of these youth was documented. It is expected that educating youth exhibitors about exposure to influenza A virus infections in the swine they are exhibiting will result in altered behaviours and animal husbandry practices that will improve both human and animal health.

KEYWORDS
4-H youth development, agricultural education, influenza A virus, knowledge bases, public health, swine

1 | INTRODUCTION

Influenza A virus (IAV) is a major zoonotic pathogen that has altered the course of human history and continues to threaten global public health and economies worldwide. Annual respiratory disease caused by endemic seasonal strains of IAV significantly burdens the United States' healthcare system by hospitalizing nearly 200,000 people and causing an estimated 36,000 deaths each year (Smith et al., 2006). In contrast to seasonal IAV strains, novel strains of IAV pose a larger and more sombre risk to public health due to their pandemic potential. By introducing new viruses and viral gene segments into the human population, animal-to-human transmission of IAVs is an important mechanism in the emergence of novel IAVs that threaten public health (Reid & Taubenberger, 2003; Webster, 2002).

Due to its segmented RNA genome, IAV is prone to ongoing and sometimes rapid evolution occurring through both antigenic drift and antigenic shift. Unlike the gradual antigenic drift that occurs through accumulating mutations in the viral genome, a major antigenic shift resulting from genomic reassortment will allow for a swift emergence of a novel IAV. IAVs are capable of infecting many hosts including humans and swine. Pigs have been called "mixing vessels" for IAVs because swine-, human- and avian-lineage IAVs have reassorted in swine, possibly due in part to the receptors in their respiratory tract (Ma, Kahn, & Richt, 2008). Reassortment between IAV strains is common in North American swine populations, and a novel strain generation can occur if a pig is simultaneously infected with multiple IAVs (Ito et al., 1998). Novel IAVs which are produced via genetic reassortment in pigs could potentially be maintained in the swine population and/or transmitted to another host species, which makes swine a source for novel IAVs infecting humans (Webby, Rossow, Erickson, Sims, & Webster, 2004).

While zoonotic transmission of IAVs between pigs and people had been reported periodically (Myers, Olsen, & Gray, 2007) during the 20th century, the unprecedented number of zoonotic transmissions documented during the H3N2 variant IAV (H3N2v) outbreaks of 2011–2014 garnered attention from public and animal health officials. Close contact between host species, as occurs between swine and humans at livestock exhibitions, allows for zoonotic transmission of IAVs. With an estimated 150 million people attending agricultural fairs in North America each year (International Association of Fairs & Expositions, personal communication), more humans are likely exposed to swine at agricultural exhibitions than at any other livestock exhibitions. Fairs and exhibitions allow people who typically would not have swine exposure to have direct and indirect contact with pigs and their potentially zoonotic pathogens.

Unlike commercial swine production, agricultural fairs and exhibitions are unique animal concentration points where pigs from backyard and commercial production systems are comingled on one site for an extended period of time (3–10 days). Factor in the large number of people who are exposed to pigs at fairs, and it becomes apparent that the swine–human interface at fairs has increased potential for zoonotic transmission of IAV (Bowman, Sreevatsan, et al., 2012). During 2012, 306 cases of variant H3N2 (H3N2v) were documented (Jhung et al., 2013) with thousands more believed to have gone unreported (Biggerstaff et al., 2013). Most of the people who became infected with H3N2v had swine exposure at agricultural fairs and livestock exhibitions (Epperson et al., 2013). Data from the H3N2v outbreaks showed that children had higher risk of infection with H3N2v, which is particularly concerning because the vast majority of pigs are exhibited as part of youth agricultural education programmes (Epperson et al., 2013). While human-to-human transmission of H3N2v has been limited to date, people infected at fairs may serve as a pathway to transmit swine-origin IAVs in their local community (Saenz, Hethcote, & Gray, 2006).

Transmission of IAV between swine and humans is not unidirectional and also occurs when humans transmit IAV to swine. The repeated introductions of human-lineage IAVs into the swine population are believed to be responsible for the majority of the genetic diversity in current swine-lineage IAVs (Karasin, Carman, & Olsen, 2006; Karasin et al., 2006; Olsen, 2002; Vincent et al., 2009). As seen after the emergence of the 2009 H1N1 pandemic virus, novel IAVs introduced to the swine population dramatically impacted the financial stability of the pork industry due to export restrictions, increased health costs and decreased consumer confidence.

Ohio is unique in the ability to study zoonotic IAV transmission at fairs because an active IAV surveillance programme was established in Ohio during 2009 to monitor pigs at fairs. The results of this ongoing project show that, on an annual basis, approximately 25% of Ohio fairs have pigs shedding IAV by the conclusion of the fair (Bowman, Nolting, Nelson, & Slemons, 2012). Among the fairs where there are pigs shedding IAV, the estimated prevalence of IAV infection in the swine population is >66%, indicating the viral burden in these settings is high. Furthermore, the majority of IAV infections among swine at fairs are subclinical, making it difficult to identify and remove infected animals.

Agricultural education programmes serve as a way to introduce youth to swine production and establish an interest in the industry. Many of the youth who participate in these programmes pursue careers in agriculture, either in food production or in a subsidiary. Therefore, increasing awareness of the risks posed by zoonotic diseases to these youth programmes could improve animal and human health now and into the future. The work presented herein is part of a multistate, CDC pilot project to prevent transmission of variant influenza and other zoonotic diseases via partnership with youth agriculture organizations.

Impacts

- Influenza A viruses are transmitted between swine and youth at exhibition events.
- Swine exhibitor training increased the knowledge of youth regarding zoonotic disease.
- Altered behaviours will reduce risk improving both human and animal health.

2 | MATERIALS AND METHODS

Five Ohio counties were chosen for this study based on their previous participation in IAV surveillance in exhibition swine and for their total number of youth swine exhibitors. The study team coordinated with local county extension educators to add scenario-based training to already existing quality assurance programmes. The team also scheduled specific workshops in which swine exhibitors could participate in the research study. The research design and instrumentation was approved by The Ohio State University Institutional Review Board protocol number 2015B0007.

2.1 | Curriculum development

Real-life scenarios related to IAV in swine were previously developed by the Ohio Department of Health for use as tabletop exercises during zoonotic training sessions attended by public health professionals, emergency planning personnel, local agricultural extension educators and veterinary emergency responders. These scenarios, originally written for public health professionals, were modified into youth-appropriate curriculum highlighting swine management practices that should be implemented before, during and after agricultural fairs for the purpose of reducing the transmission of IAVs between pigs and people.

Scenarios were presented to youth swine exhibitors at educational training sessions weeks prior to the respective county fair, in conjunction with quality assurance training activities. Each educational session began with the administration of a pre-test to gauge prior knowledge of swine exhibitors on IAV and zoonotic transmission and to gather information regarding their IAV vaccination status and swine exposures. Exhibitors were then presented with IAV basic information and the risks presented by viral infection. After a brief PowerPoint introduction, students were divided into small groups to complete scenario activities. Upon completion of the scenarios, groups reported their thoughts to the group as a whole for each question (Appendix S1)

Following the group activity, participants received an overview of biosecurity procedures they should implement to reduce the risk of IAV transmission. To conclude the session, a post-test instrument was administered in the same manner as the pre-test and a question–answer period followed. Because the pre- and post-test instruments were voluntary, not all participants who completed the pre-test completed the post-test following instruction (Appendices S1–S3).

2.2 | Instrumentation

Pre- and post-tests were used to measure participant knowledge gained. The tests consisted of 20 statements regarding IAV in swine (Appendices S2, S3). Each item was rated on a five-point Likert-type scale to reflect the level of support respondents perceived for each statement (1 = no 2, 3; 4 = maybe; 5 = yes). No demographic information was collected to avoid obtaining consent.

2.3 | Validity and reliability of instrumentation

Content validity was established by a review of the instrument by a panel of five individuals who are experts in the areas of agricultural education, virology and early childhood development.

To establish reliability of the instrument, a pilot test was conducted during a field test with eight members of a 4-H club in a non-participating county in 2015. The pre-test instrument was administered and the members participated in the scenario-based training, followed by post-test administration. Because the pre-test and post-test instruments used Likert-type scales to measure gain of knowledge, Cronbach's alpha was used to estimate internal consistency. The estimated reliability of the pre-test instrument was determined to be 0.84, and the reliability of the post-test instrument was determined to be 1.0.

2.4 | Data analysis

Statistical analysis was conducted using IBS SPSS Statistics version 23. Descriptive statistics were calculated for the following pre-test statements because pre- and post-test scores should remain unchanged: (9) I get a flu vaccination each year, (10) My pigs have been vaccinated for IAVs, (11) I have more than one pig at home. Paired samples *t* test was used to determine whether or not there was a significant increase in knowledge based on the pre- and post-test scores. Linear regression was applied to determine whether pre-test scores, flu vaccination status, pig vaccination status and having more than one pig at home could account for variation in post-test scores.

3 | RESULTS

A total of 146 youth swine exhibitors participated in the training programme during the spring/summer of 2015. The participation varied among the five counties, with county C having the most participants ($n = 75$) and county E having the fewest ($n = 6$).

Of the 146 participants, 124 (85%) completed both pre- and post-tests during the training activity. The post-test mean score of 87.3 was significantly ($\alpha = 0.05$) higher than the pre-test score of 65.6 ($p < .001$; Table 1). Linear regression was used to calculate that 18% of the variance in post-test scores was accounted for by the pre-test score when controlling for human vaccine status (57/124 [46%]), swine vaccine status (34/124 [27%]) and more than one pig on the premise (90/124 [73%]; $p < .001$).

4 | DISCUSSION

In the present study, researchers were specifically concerned with developing materials considered to be a tool in Engerstrom's conceptual framework, based on the Activity Theory (Nardi, 1996). The tool, defined by Jonassen as anything used in the transformation process which shapes the way people think and act, in this study, was the scenario-based training model used to teach swine youth exhibitors about the risks associated with IAVs and the mitigation strategies used to prevent infection (Jonassen & Roher-Murphy, 1999).

The activity theory was supported in this current study with measurable perceived gain of knowledge by participants after completing hands-on activities in which they were actively engaged. To demonstrate one way viruses spread, a toy pig was covered with glitter prior to the training and then passed to each participant during the introduction. Following the circulation of the pig, participants were made aware of the glitter that had been left behind on their hands, clothes, faces and other belongings, which simulated the transmission of IAVs from pigs to humans and between humans. Participants grasped the concept of viral transmission through this demonstration, as indicated by the mean post-score increase of 1.54 on the question, "I know how IAVs spread between animals" ($p < .001$) and a 1.78 score post-test increase for the question, "I know how IAVs spread between animals and people" ($p < .001$).Following the administration of the tool, researchers investigated outcomes by measuring the prevalence of IAVs in swine compared to previous years. The five counties where training sessions were held had 60% tested pigs shedding IAV in 2013, 19.57% in 2014 and 0% in 2015 (year training occurred) as compared to IAV recovery rates of 31% in 2013, 30% in 2014 and 13.5% in 2015 for all fairs enrolled in swine surveillance (Bowman, unpublished data). Each year, samples were collected on the last day of the exhibition period, with no fairs requiring vaccination prior to the fair. In both 2014 and 2015, H3N2 was the predominate subtype shed from exhibition swine included in this study. Although this training tool is not the only variable that affects prevalence of pigs shedding IAV, it was notable considering the years of previous data.

Implementing swine exhibitor training in select counties led to an increase in the knowledge of youth regarding zoonotic disease as determined by significant increase in post-test scores as compared to pre-test scores. Data from this pilot study can guide educators in implementing future training activities for swine and other livestock exhibitors. The continuation of training programmes can be beneficial for improving animal and public health today and into the future.

TABLE 1 Knowledge scores at pre- and post-test assessments

Items	Knowledge scores (mean ± *SD*)			
	Pre-test score	Post-test score	*t*	*p*
1. I have heard of influenza A viruses	3.46 ± 1.68	4.56 ± 1.14	−5.8	<.001
2. I know pigs can get influenza A viruses	3.73 ± 1.46	4.77 ± 0.76	−6.85	<.001
3. I know what the "H" and "N" mean in the name of influenza A viruses	1.96 ± 1.43	3.77 ± 1.6	−8.23	<.001
4. I know how influenza A viruses spread between animals	3.05 ± 1.66	4.55 ± 1.07	−7.58	<.001
5. I know how influenza A viruses spread between animals and people	2.74 ± 1.7	4.52 ± 1.1	−8.4	<.001
6. I know what to do before the fair if my pig seems sick	3.73 ± 1.47	4.71 ± 0.84	−6.67	<.001
7. I know what to do at the fair if my pig seems sick	3.58 ± 1.59	4.63 ± 0.95	−6.33	<.001
8. I know what to do after the fair if my pig comes home with me	3.58 ± 1.7	4.49 ± 1.14	−4.8	<.001
9. I get a flu vaccination each year	3.33 ± 1.8	3.59 ± 1.74	−2.26	<.05
10. My pigs have been vaccinated for influenza A viruses	2.87 ± 1.67	3.39 ± 1.78	−3.04	<.05
11. I have more than one pig at home	3.96 ± 1.74	4.34 ± 1.45	−3.56	<.001
12. I have a veterinarian that I can call if my pig is sick	3.81 ± 1.68	4.27 ± 1.45	−3.25	<.001
13. I have animals other than pigs at home	4.24 ± 1.51	4.51 ± 1.27	−2.06	<.05
14. I know how to take a pigs temperature	2.88 ± 1.76	4.06 ± 1.52	−6.17	<.001
15. I know the clinical signs of influenza in pigs	2.22 ± 1.56	4.29 ± 1.45	−9.17	<.001
16. I am confident in my ability to tell when a pig is sick	3.38 ± 1.54	4.5 ± 1.02	−7.24	<.001
17. I have had influenza infections before (the flu)	3.25 ± 1.88	4.67 ± 0.97	−7.53	<.001
18. I know who to talk to if I think I have influenza	4.05 ± 1.57	4.7 ± 0.88	−4.02	<.001
19. I know what factors make it more risky for humans to visit pig barns	2.97 ± 1.68	4.51 ± 1.12	−8.06	<.001
20. I know what the term biosecurity means	2.75 ± 1.78	4.36 ± 1.32	−7.87	<.001

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CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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