Influenza transmission: Creating a seeder pig model using naturally infected pigs

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INTRODUCTION

The objective of this study was to develop a seeder pig model that simulates transmission of influenza A virus in growing pigs, to evaluate strategies to control influenza under field conditions.

MATERIALS AND METHODS

554 weaned pigs from a known influenza A virus (IAV) PCR negative source were placed in a single, tunnel ventilated room of a Pipestone Applied Research (PAR) barn. These pigs served as direct contacts and were distributed in 21 pens (approximately 28 pigs/pen) alternating with empty pens, to prevent nose-nose contact. Seventeen weaned pigs from a known IAV-S positive source served as seeder pigs. These pigs tested IAV-S positive by nasal swabs (NS) using BD Veritor™ System Flu A+B (Becton Dixon; Figure 1a,b) and IAV screening PCR assays. The IAV-S identified was an H3N2 cluster IV virus. On day 0, seeder pigs were placed 1 per pen in 17 of the 21 pens. Four pens (pens 1, 2, 41, 42) were left without a seeder pig for indirect IAV transmission assessment. Six randomly selected IAV-S negative pigs (Figure 2), as well as the seeder pig itself (Figure 3), were systematically sampled in each pen by NS 3 times per week until the IAV PCR results were negative for 3 consecutive sampling events. All pens had oral fluids (OF) collected three times per week until three consecutive samplings tested negative (Figure 4). Oral fluids and nasal swabs were tested for IAV-S PCR targeting the matrix gene.

RESULTS

All direct contact pigs tested IAV-S PCR positive within 2 - 5 days post seeder pig introduction. Pigs in the indirect contact pens became infected within 5 - 7 days (pens 1, 2, 41, 42). Pigs remained positive for 16 - 35 days post introduction of seeder pigs. All sequenced viruses were found to be identical to the H3N2 cluster IV IAV-S. (Figures 2, 3, 4)

DISCUSSION AND CONCLUSION

The seeder pig model developed in this study proved effective in providing a method of mimicking influenza field transmission dynamics. There was strong association between pen-based OF and individual NS detection of IAV-S nucleic acid by PCR, with longer detection of IAV-S in OF. Heat maps used to visualize the spread of IAV-S throughout the barn showed the transmission period lasted over 3 weeks.

Figure 1.
BD Veritor™ System Flu A+B

1a

1b

Figure 2. Number of nasal swab PCR positive results out of 6 direct contact pigs per pen per day of sampling.

	Trial Day																					
Pen.	-1	0	2	5	7	9	12	14	16	19	21	23	26	28	30	33	35	37	40	42	44	
1	0	0	0	0	5	6	6	6	6	2	1	1	1	0	0	0	0					
2	0	0	0	0	5	6	6	6	5	4	2	0	0	0	0	0	0					
5	0	0	0	6	6	6	4	1	0	0	1	0	0	1	1	0	0	0				
7	0	0	0	6	6	6	5	3	1	0	0	0	0	1	0	0	0	0	0			
9	0	0	0	4	6	6	5	3	1	0	0	0	0	0	0	0	0					
11	0	0	6	6	6	6	5	4	5	3	2	2	1	0	0	0	1	0	0	0		
13	0	0	4	6	6	6	3	3	1	0	0	1	0	0	0	0	0	0	0	0		
15	0	0	5	6	6	6	5	3	2	3	0	0	0	0	0	0	0	0	0	0		
17	0	0	0	4	6	6	6	4	5	1	0	0	0	0	0	0	0					
19	0	0	0	6	6	6	6	5	1	1	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	4	6	6	6	4	2	1	1	0	0	0	0	0	0	0					
25	0	0	0	6	6	6	5	3	3	0	0	0	0	0	0	0	0					
27	0	0	3	6	6	6	6	3	2	0	0	0	0	0	0	0	0	0	0	0	0	
29	0	0	0	6	6	6	6	5	4	1	1	1	0	1	0	0	0					
31	0	0	0	5	6	6	6	4	3	2	2	1	0	1	0	0	0	0	0	0		
33	0	0	1	6	6	6	6	2	1	0	0	2	0	0	0	0	0	0	0	0		
35	0	0	0	6	6	6	6	3	5	2	1	2	1	2	0	0	0					
37	0	0	1	6	6	6	5	1	0	0	0	2	0	0	0	0	0	0	0			
39	0	0	0	5	6	6	6	3	1	0	0	1	0	0	0	0	0	0				
41	0	0	0	1	5	6	6	6	2	0	1	1	0	0	0	0	0					
42	0	0	0	0	6	6	6	6	5	2	1	0	0	0	0	0	0					
Total	0	0	24	97	123	126	113	76	54	22	12	14	3	6	1	0	1	0	0	0	0	

Cells shaded in blue indicate no positives detected. Cells shaded progressively darker red indicate higher number of positives. Cells shaded white indicate no samples were collected.

Figure 3. Nasal swab PCR results of each seeder pig after pen placement by day of sampling.

	Trial Day																						
Pen.	-1	0	2	5	7	9	12	14	16	19	21	23	26	28	30	33	35	37	40	42	44		
5		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
7		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0				
9		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
11		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
13		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0						
15		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0						
17		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
19		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
21		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0						
25		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
27		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
29		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
31		1	1	1	1	1	0	1	0	0	0	1	0	0	0	0	0						
33		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
35		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0						
37		1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0						
39		1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0						
Total	0	17	17	17	17	17	11	1	0	1	0	2	0	0	0	0	0	0	0	0	0		

Cells shaded in blue indicate no positives detected. Cells shaded progressively darker red indicate higher number of positives. Cells shaded white indicate no samples were collected.

Figure 4. Pen OF PCR cycle threshold by day of sampling.

	Trial Day																										
Pen.	-1	2	5	7	9	12	14	16	19	21	23	26	28	30	33	35	37	40	42	44	47	50	51	54	55		
1			38	26	24	25	29	29	35	32	33	36	31														
2				28	24	27	29	28	34	33	33		36														
5		36	26	25	27	29	34	32	36	34		36	36														
7			25	25	23	31	34	31	33	34	35	36			37												
9			29	24	24	30	33	34	37	34			35														
11		29	23	25	28	33	36	34	36	35	37	35			37												
13		34	25	23	28	33	34	34	36	35		38															
15		33	27	25	25	32	36	35	36	36	37	36	37														
17			29	24	25	31	33	31	35	33			37														
19		37	30	26	24	29	33	33	33	32	36	37	38			35											
21		36	25		27	34	34	34		31		36	35														
25			22	25	28	34	36	36	36	36		36															
27		30	24	25	25	33	34	32	35	33		34	36	38		35	38										
29			28	24	24	32	34	32	35				36														
31			24	23	25	30	34	33	35	31		35				33											
33		34	25	23	24	26	32	32	38	34		38	34														
35		35	25	24	25	31	31	34	37	36	36	36	36														
37		29	26	24	25	28	34	31	35		32																
39		36	24	25	24	30	37	31	35	32	37	36	36														
41			32	26	24	27	27	31	36	34	37		36														
42			36	24	24	27	32	29	34	34	35		36														
Total	0	369	543	494	527	632	696	676	707	639	388	505	535	38	74	103	38	0	0	0	0	0	0	0	0		

Cells shaded in blue indicate no positives detected. Cells shaded progressively darker red indicate higher number of positives. Cells shaded white indicate no samples were collected.