

“Are all farms equal? How farm structure and demography impact disease detection”

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Key points:

- Farms that participate in farrowing need to be especially vigilant in the detection and diagnosis of vesicular diseases
- It is more difficult to diagnose FMD when the strains cause low mortality or no mortality.

Relatively recent outbreaks of vesicular stomatitis, and Seneca Valley virus serve as a reminder to stay vigilant about the detection and diagnosis of vesicular diseases. Prompt diagnosis is critical for containing the spread of such viruses as well as preventing the spread of other undetected vesicular disease, such as foot and mouth disease (FMD), which is one of the most contagious and economically relevant diseases affecting livestock. Here, we model FMD virus spread in farrow to finish, farrow to wean, and nursery/finishing farms for two strains of FMD virus, one high virulence (O/TAW/97) and one of lesser virulence (O/NET/01), and show that strain virulence impacts the time to detection whereas farm structure influences disease dynamics later in the epidemic, which could result in the catastrophic spread of FMD virus between-herds if left undiagnosed and/or uncontrolled on farm.

What did we do?

We developed a disease transmission model to simulate the spread of FMD viruses (O/NET/01 and O/TAW/97) in a farrow-to-finish and farrow-to-wean swine farm and compared those predictions to another model which represents off-site nurseries or finishing farms. The model classified pigs into 5 disease states: susceptible, latently infected, subclinically infected, clinically infected, and recovered; and in the O/TAW/97 model piglets born in infected farrowing rooms experienced mortality¹. The number of pigs in each of the states was calculated and reported at the room and herd-level for 50 days. For the O/TAW/97 farrow to finish and farrow to wean farms, the time to detection was calculated based on the total percentage (15%) of dead piglets on the farm. Whereas the time to detection in all farms of the O/NET/01 model and the O/TAW/97 nursery and finishing farms was calculated based on the percentage (1-50%) of animals displaying clinical signs².

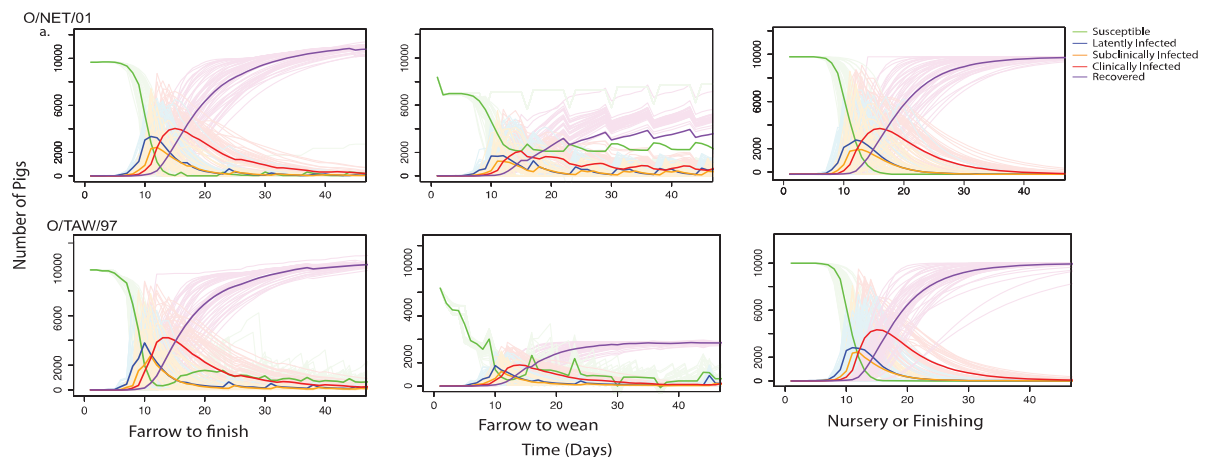
What did we find?

We found that the mean time to detection was about 3 days in the O/TAW/97 farrow to finish and farrow to wean farms and 11 to 11.5 days in all of the farm types of the O/NET/01 model and the nursery and finishing farms of the O/TAW/97 model (Table 1). However, the duration of the epidemic varied between scenarios and the nursery and finishing farms experienced a phenomenon termed “epidemic fadeout”, in which the pathogen became extinct in the population due to the low number of infected individuals and the stochastic nature of the disease. In contrast, sufficient numbers of infected and susceptible pigs remained in the farrow to finish and farrow to wean farms, which allowed for the virus to persist within these populations. These fluctuations can be seen in Figure 1.

Feature	Farrow to finish	Farrow to wean	Homogenously-mixed
Time to detection ONET01 (days)(2.5 th , 97.5 th percentile)	3.36 (2.00, 5.00)	2.89 (2.00, 5.00)	10.78 (9.00, 16.00)
Time to detection OTAW97 (days)(2.5 th , 97.5 th percentile)	11.50 (9.00, 15.00)	11.54 (9.00, 15.00)	11.17 (8.00, 16.00)
Duration of epidemic ONET01 (days)(2.5 th , 97.5 th percentile)	--	--	46.11 (27.00, 50.00)
Duration of epidemic OTAW97 (days)(2.5 th , 97.5 th percentile)	--	--	46.15 (26.98, 50.00)

Table 1: Mean time to detection and duration of the epidemic for the farrow to finish, farrow to wean, and homogenously mixed populations. □

Figure 1: Epidemic curves for the farrow to finish, farrow to wean and nursery or finishing farms for the O/NET/01 strain and the O/TAW/97 strain. Lighter, thinner lines represent the results of 1,000 simulations. Thicker, darker lines represent the mean of the simulations.



What does this mean?

Our findings demonstrate that less virulent strains of FMD virus, which causes very low or no mortality in piglets, may lead to a longer time to detection and that a delay in detection may lead to a greater risk of between farm spread from farms where farrowing occurs.

References:

1. Yang, P.C., Chu R.M., Chung, W.B. & Sung, H.T. (1999a). *The Veterinary Record*. 145(25)