Evaluating the role of vehicle movements to spread African swine fever

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Learn more about our work at https://machado-lab.github.io/

Background: Similar to the movement of live animals known to dominate between-farm pathogen dissemination, transportation of vehicle movements is of great concern as an indirect dissemination route. However, the scarcity of data and the lack of methods capable of combining contact networks, variables associated with pathogens' stability, and uncertainty of cleaning and disinfection limit our ability to understand the contribution of vehicles in African swine fever virus (ASFV) transmission.

Objective: We developed a novel vehicle contact network method that considers environmental variables and vehicle cleaning and disinfection effectiveness. Thus, our goal was to reconstruct a vehicle contact network of U.S. swine companies using ASFV stability profile.

Materials and methods: We collected one year of Global Positioning System data from 823 vehicles transporting feed, pigs, and personnel to farms in two different regions of the U.S., divided into 2,519 farms in region one and 4,619 farms in region two. Farm locations were represented by the Perimeter Buffer Area (PBA), collected from enhanced SPS biosecurity plans available in Rapid Access Biosecurity (RAB) application (RABapp™). In addition, we collected information on 32 clean station and disinfection (C&D) stations available in both regions.
We developed a methodology that identifies when a vehicle contacts a farm based on the distance to the PBA and reconstructed farm indirect contact network by vehicle movements considering the ASFV stability on vehicle surfaces. In addition, we identified when a vehicle contacts a C&D station and simulated between farm contacts considering a C&D effectiveness with all possible values ranging from 0% to 100%.

Results

1. Our results demonstrate that in region one, without effective vehicle cleaning (0%), vehicles connected up to 2,157 farms (88%). Individually, vehicles transporting feed connected 2,151, pigs to farms 2,089, pigs to market 1,507, undefined vehicles 1,760, and personnel three. While region two connected 437 farms (9%) (Figure 1).

2. The simulation results indicated that, when 100% C&D efficacy was achieved, the contact networks were reduced the most for crew transport vehicles with a 66% reduction, followed by vehicles carrying pigs to market and farms, with reductions of 43% and 26%, respectively.

3. Finally, for our simulated pathogen stability scenarios with a C&D effectiveness = 100%, up to 13% and 47% of network's edges in regions one and two, respectively, were highly contaminated (ASFV stability range of 0.8 to 1).

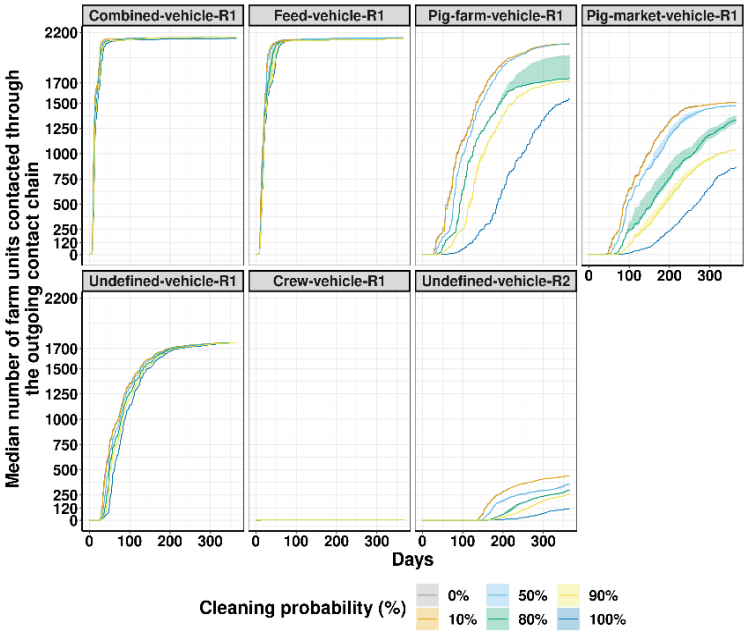

Figure 1. The number of farms contacted through the outgoing contact chain from vehicle movements. Solid lines represent the median, while shadow areas represent the interquartile ranges. (R1) = region 1; (R2) = region 2.

Conclusions and implications: Our results suggest the vehicle network is a potential mechanism for spreading pathogens among farms. Moreover, even with scenarios with high effectiveness of cleaning and disinfection, the risk of vehicles spreading diseases was not eliminated. The new methodology introduced in this study can be used to develop novel disease control strategies, including rerouting vehicles based on their infection status.

For more details, the manuscript is available here https://arxiv.org/abs/2212.07466.