

Title: Use of animal movement data and epidemiological modeling to identify premises at high risk of infection in the event of a foot-and-mouth disease epidemic, **NPB #14-030**

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Revised

Scientific Abstract:

Foot-and-mouth disease (FMD) is a highly contagious viral pathogen that affects cloven-hoofed animals including pigs, cattle, sheep, and goats. Affected animals display blisters on the mouth, teats, and toes, which may lead to the inability to feed, drink or walk. Most animals do not die as a result of infection, but recovered animals usually have decreased performance. Due to astonishing financial losses as a result of international trade bans on infected countries, traditional responses to FMD outbreaks have included mass slaughter, vaccination, and animal movement bans. However, these control strategies may have a relative effectiveness in detecting latent and undetected infected animals to prevent FMD spread beyond the control zones through animal movements that occurred prior to the movement ban. In this study, we use swine movement data collected from producers to construct within- and between-herd transmission models to simulate the hypothetical spread of FMD. Here we show that, swine-specific parameter values and models are necessary to capture transmission dynamics necessary to understand FMD persistence within a population that may influence between-farm transmission. Our results indicate that the latent period and incubation period of FMD infection varies by strain, FMD persistence within a population is critically dependent on farm structure and availability of susceptible individuals into the population, and that the size and duration of an FMD outbreak in swine is dependent on the size of the control zones, frequency of veterinary visits, and efficacy of movement restrictions. More specifically, we found that farrow-to-finish and farrow-to-wean herds experience ongoing infection due to the weekly birthing of susceptible piglets therefore, the assumption of homogenous-mixing for modeling within-herd transmission of FMD may be sufficient when average outputs are modeled but that farm structure and demography needs to be considered to accurately model deviations from the outputs. When using the simplifying assumption of homogenous-mixing within swine herds, we found that increasing the control zones by 20% and 50% results in a significant reduction of the predicted mean number of infected farms by 50% and 76%, respectively and reduces the mean duration of the epidemic by 39% and 80%, respectively. Decreasing the frequency of veterinary visits by 20% and 50% increases the predicted mean number of farms to 13% and 43%, respectively, and the mean duration of the epidemic by 6.2% and 20%, respectively. Lastly, we found that decreasing the efficacy of the movement restrictions by 20% increased the predicted mean number of infected farms by 62% and the mean duration of the epidemic by 20%. These data can support FMD emergency preparedness and planning in the US, although follow-up studies are required to evaluate the impact that farm structure may impose on the variability of results. The output of this project will significantly contribute to the development of tools that support food security through prevention and containment of FMD. Furthermore, these models will serve as a framework for the development of quantitative tools relevant to respond to introduction of other foreign animal diseases.

These research results were submitted in fulfillment of checkoff-funded research projects. This report is published directly as submitted by the project's principal investigator. This report has not been peer-reviewed.

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