

Impact of livestock production type vaccination priority order on the control of a foot and mouth disease outbreak in the central United States

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Introduction

The central United States (US) has a large livestock population including cattle, swine, sheep, and goats that are fully susceptible to foot and mouth disease (FMD). Introduction of FMD to the US would have potentially devastating consequences to the livestock industry. Identification of optimal control measures including potential vaccination strategies is essential to minimize the impact of a FMD outbreak. Both dairy and large feedlot operations have frequent indirect contacts, which make them key production types for FMD transmission and thus should be the focus of control strategies. To address this issue, we developed simulation scenarios to assess the impact of livestock production type vaccination priority on FMD outbreaks using the North American Animal Disease Spread Model (NAADSM), a spatially explicit, stochastic infectious disease model.

Materials and Methods

Data obtained from the US Department of Agriculture National Agricultural Statistic Service were used to generate a simulated population of livestock operations. The population included 151,620 herds in the central US defined by latitude and longitude, production type, and herd size. For the simulations, a single 17,000-head feedlot in northeast Colorado was selected as the initial latently infected herd in an otherwise susceptible population.

Direct and indirect contact rates between herds were based on survey data of livestock producers in Kansas and Colorado or estimated from expert opinion. Vaccination strategies varied by herd type priority (large feedlots [$\geq 3,000$ cattle] or dairies), vaccination zone radius (6 miles or 30 miles; 10 km or 50 km), and vaccination capacity (high or low). Low and high vaccine capacities were made on the basis of results from a livestock producer survey and expert opinion. Ring vaccination of herds was triggered around infected herds.

Results

In scenarios with a low-vaccine capacity and a 6-mile (10-km) vaccination zone, the duration of the

outbreak decreased when the dairy herds had the highest vaccine priority, compared with the duration of the outbreak for the scenarios when large feedlots had the highest vaccine priority. However, when the vaccination zone was increased to 31 miles (50 km), the outbreak duration was similar for dairy and large feedlot vaccine priority. The number of herds depopulated was also influenced by the production type with the highest priority for vaccination. In the vaccine strategies that had a low-vaccine capacity and a 31-mile (50-km) vaccination zone, the number of herds depopulated decreased when large feedlots had the highest priority, compared with that for scenarios when dairy herds had the highest vaccine priority. In scenarios with a high-vaccine capacity, the duration of the outbreak and the number of herds depopulated were similar for all vaccine strategies.

Significance

Results indicated that the magnitude of a FMD outbreak varied with the type of livestock production (large feedlot or dairy) that had the highest vaccine priority for scenarios with low-vaccine capacity. Dependent on the vaccination strategy implemented, altering the livestock production type that receives the highest vaccination priority during a FMD outbreak may lead to a decreased duration of the outbreak and limit the number of herds depopulated. These findings highlight the importance of vaccine strategy selection. In these scenarios, the production type with the highest vaccination priority was often the only type of operation vaccinated if the zone was large and the capacity was small. Additional scenarios to further evaluate the effect of vaccination priority, a better understanding of vaccine capacity, and the zone diameter that adequately accounts for the ability to deliver and administer the vaccine during an FMD outbreak is needed.