Impact of uncertainty in foot and mouth disease indirect transmission probability on outbreak duration and number of herds depopulated

S.W. McReynolds, *DVM, MPH*; **M.W. Sanderson**, *DVM, MS, DACVPM*
Department of Diagnostic Medicine and Pathobiology, Kansas State University, Manhattan, KS 66506

Introduction

The central United States (US) has a large livestock population including cattle, swine, sheep, and goats that are susceptible to foot and mouth disease (FMD). Because FMD is a highly infective foreign animal disease, the only method to assess the impact of an introduction and the effectiveness of control programs is via modeling. We developed simulation scenarios to assess the impact of the introduction of FMD in the central US and the effect of vaccination strategies and variation in biosecurity on FMD outbreaks using the North American Animal Disease Spread Model (NAADSM), a spatially explicit, stochastic infectious disease model.

Materials and Methods

Data 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 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. Scenarios were simulated for different vaccination protocols compared to depopulation only. Ring vaccination of herds was triggered around infected herds. Large feedlots ($\geq$ 3,000 head) had the highest vaccination priority. Simulated vaccination protocols included low- and high-vaccine capacity on the basis of results from a livestock producer survey and expert opinion, vaccination zones of 6 miles vs 31 miles (10 km vs 50 km), and vaccination trigger of 10 or 100 infected herds. The effect of biosecurity methods was modeled by varying the probability of indirect transmission following an indirect contact between an infected and susceptible herd as 15%, 20%, and 25%.

Results

Increasing probability of transmission following an indirect contact between an infected and susceptible herd increased the number of herds depopulated and the outbreak duration. In scenarios with a probability of transmission following indirect contact between an infected and susceptible herd of 15%, no vaccination strategy altered the median number of herds depopulated or outbreak duration, compared with that for the baseline scenario (no vaccination), but the 90th percentile for each of those scenarios was decreased, particularly when the vaccination zone was set at 31 miles (50 km). When the probability of transmission following indirect contact was set at 20%, all vaccination scenarios decreased the median and 90th percentile number of herds depopulated, compared with those for the baseline scenario, but outbreak duration was only decreased when the vaccination zone was 31 miles (50 km). When the probability of transmission following indirect contact was set at 25%, only the vaccination scenario with high capacity and a 31-mile (50-km) zone were effective at decreasing the number of herds depopulated, compared with that for the baseline scenario.

Significance

The probability of transmission following indirect contact between an infected and susceptible herd is a measure of the biosecurity practices applied to traffic and people on and off the farm. Important aspects include truck washing, boot washing, and control of visitor contact with animals. The level of biosecurity required to achieve a given probability of transmission is not known. The results of these scenarios were compared to assess the impact of the probability of transmission following an indirect contact (an indicator of biosecurity controls) on the number of herds depopulated and the duration of the FMD outbreak. Outbreak size and number of herds depopulated were sensitive to transmission probability (i.e., biosecurity). Increased size of the vaccination zone during an outbreak may lead to decreased length of the outbreak and reduce the number of herds destroyed, even in an outbreak with high probability of indirect transmission. A better understanding of the biosecurity practices necessary to control transmission probability would allow more focused planning of optimal control efforts.