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Abstract

Foot and Mouth disease (FMD) is a highly infectious and contagious viral disease affecting cloven-hoofed livestock that was last detected in the United States (US) in 1929. The prevalence of FMD in other countries, as well as the current potential for this virus to be used as a form of agroterrorism, has made preparations for a potential FMD outbreak a national priority. To assist in the evaluation of national preparedness, all 50 states were surveyed via e-mail, telephone and web search to obtain emergency response plans for FMD or for foreign animal diseases in general. Information from 33 states was obtained and analyzed for estimates of personnel resources needed to respond to an outbreak. These estimates were consolidated and enhanced to create a tool that could be used by individual states to better understand the personnel that would be needed to complete various tasks over time during an outbreak response. The estimates were then coupled, post-processing, to the output from FMD outbreaks simulated in California using the Multiscale Epidemiological/Economic Simulation and Analysis (MESA) model at Lawrence Livermore National Laboratory to estimate the personnel resource demands, by task, over the course of an outbreak response.

Introduction

Foot and Mouth disease (FMD) is an extremely infectious and contagious viral disease that affects cloven-hoofed livestock. While rarely fatal in adult animals, the disease causes significant pain and suffering in infected animals,and has a negative affect on growth and production; meat animals lose weight and in dairy cows milk production drops. The presence of the disease has a negative foreign trade impact and efforts to eradicate the disease during an outbreak also have a negative economic effect on domestic producers and the local economy.

FMD has not been detected in the United States since 1929, but it is prevalent in parts of South America, Asia and the Middle East. The potential for FMD to be introduced into the US from these areas via travelers, smuggling or agroterrorism has made preparations for a potential outbreak a national priority.

Materials and Methods

To assist in the evaluation of national preparedness all 50 US states were surveyed via e-mail, telephone and web search to obtain FMD response plans and documents relating to foreign animal disease response. Responses were received from 44 states and 33 plans and documents were obtained. Information relating to personnel needs was extracted and the personnel estimates were enhanced with input from several state officials to create a more complete understanding of the personnel numbers and types that would be needed to complete various tasks during an outbreak response for various livestock facility types.

The first estimates were limited to the activities during an outbreak response that relate directly to the number of infected premises. This includes activities such as: diagnosis, field epidemiology, tracing direct contacts, tracing high risk indirect contacts, appraisal, euthanasia, disposal, cleaning and disinfection and establishing and maintaining site biosecurity.

The personnel estimates were further sub-divided to account for the different skill levels needed for the various tasks. Each task was analyzed to determine what was needed, and what level of training or education a person involved in the task would require. The responding personnel were divided into four categories: veterinarians (DVM), animal health technicians (AHT), skilled lay personnel (LP) and unskilled lay personnel.

The final variable accounted for was the wide variety of livestock facility types and sizes in the US. The personnel estimates were placed into a spreadsheet and fit to an equation, $Ax + B$, where A is the personnel needed per head, x is the number of head and B is the constant for the particular task on a given facility.

Over the course of the project several assumptions were made with regards to the definitions of personnel type and the tasks in an outbreak response. These definitions and assumptions are included below.

AHT- These individuals may be known as a Livestock Inspector in some states. These individuals are usually State or Federal employees who has skills in livestock handling, examination and sample collection.

LP- In some places we have made the designation between skilled LP and unskilled LP. Skilled LP are assumed to have training in a needed area of outbreak response - operating a backhoe or knowledge regarding disposal, for example. Unskilled LP are intended to fill positions that will require only minimal training on-site. It is assumed that unskilled LP will likely be employees on the infected facility or other labor available through local contractors.

Diagnosis

Diagnosis is defined as the time needed for a veterinarian who is a Foreign Animal Disease Diagnostician (FADD) to travel to the farm, examine the animals, take appropriate samples and complete necessary paperwork. We assumed that this would require one DVM and one AHT per facility, regardless of type or size of the facility. Based on discussions with state officials, we assumed that a large facility, regardless of type, would require approximately 8 hours for diagnosis and a facility of any other size would require 4 hours.

Field Epidemiology

Field epidemiology is considered to be the process of gathering all tracing data from an infected facility. It is assumed that one DVM will be required regardless

of facility type or size. The remainder of the field epidemiology team will consist of a scaled number of AHTs. In all facility types except dairies, this scale results in two AHTs needed for large facilities and one needed for all other sizes. Dairies were assumed to require more personnel and time due to increased contact rates.

Tracing Direct Contacts

A direct contact is animal to animal contact, or in most cases, an animal shipment. Traced direct contacts are assumed to require a visit to the identified facility to evaluate the animals in question. We assumed that this would require one DVM and one AHT per facility, regardless of type or size and that the time required would be similar to the time required for diagnosis.

Tracing Indirect High Risk Contacts

A high-risk indirect contact was assumed to be a person or vehicle that has had contact with animals or infectious animal secretions/excretions on an infected premise and then traveled to a susceptible premises. After discussion with state officials it was assumed that follow up on these contacts could be conducted over the phone by a DVM. Time estimates for these phone calls are assumed to be roughly half of the time needed for a direct contact trace.

Appraisal

Appraisal is the documentation of the number of animals on a facility and their approximate value. We have designated a team of three personnel to conduct appraisal regardless of facility type or size. This team will consist of one AHT, one LP skilled in appraisal and one unskilled LP to assist in record keeping. It is assumed that dairy animals will take longer to appraise due to the presence of valuable genetics.

Euthanasia

Euthanasia is assumed to be the time needed to depopulate all animals on the facility using captive bolt gun. After consultation with state plans and state and industry representatives it was decided to create a team structure that could be increased or decreased based on the number of animals present. For cattle, sheep and goats this team consists of 1 DVM, 5 AHTs and 4 skilled LP. For swine the team has been adjusted to include 1 DVM, 2 AHTs and 7 skilled LP. It was estimated that a team of this size could euthanize 500 cattle or 1000 sheep or goats in 25 hours using captive bolt. Consultation with industry personnel and team members indicated that swine could be depopulated using a combination of CO_2 and captive bolt, and that one team could euthanize 1000 head per 25 hours.

Disposal

Burial was by far the preferred method of disposing of carcasses in the State plans reviewed; all our estimates for disposal are based on burial. Disposal is assumed to be the time needed to prepare a burial site, transport the carcasses

and inter the remains. It is assumed that one LP skilled in disposal is needed to oversee the operation. The rest of the team consists of unskilled LP scaled by facility size.[1]

Cleaning & Disinfection

This section assumes that the procedure for cleaning and disinfection includes an initial spray, removal of all organic material and a second disinfection. It is assumed that one LP skilled in C&D will be needed per 1000 head of cattle, sheep or goats and per 5000 head of swine. Unskilled LP are needed on a scale of 9 per 1000 head of cattle, sheep or goats and 3 per 5000 head of swine.[2]

Biosecurity

We assumed biosecurity to be the task of ensuring compliance with quarantine and disinfecting all vehicles and personnel that enter and leave the infected premise from the start of epidemiologic investigation to the completion of cleaning and disinfection. It is assumed that a team of three personnel consisting of one skilled LP and two unskilled LP will be needed at all times throughout the completion of these tasks.

Results

The personnel estimates were placed into a spreadsheet that took into account the personnel types, facility types and tasks. Each cell was attached to an Ax+B formula, allowing for customization of the output with further data on facility sizes in individual states if desired.

The estimates were then attached to output from FMD outbreaks simulated using the Multiscale Epidemiological/Economic Simulation and Analysis (MESA) model at Lawrence Livermore National Laboratory to estimate the personnel resource demands on a response agency over the course of an outbreak response. The model is spatially explicit, stochastic model and runs on a national scale using facility data from the 2002 NASS census. The model output from three outbreak scenarios in California were paired with the personnel estimates to provide estimates of the personnel resource estimates for an FMD outbreak in California over time. Figure 1 shows visually the results obtained by pairing the MESA model output with the spreadsheet tool.

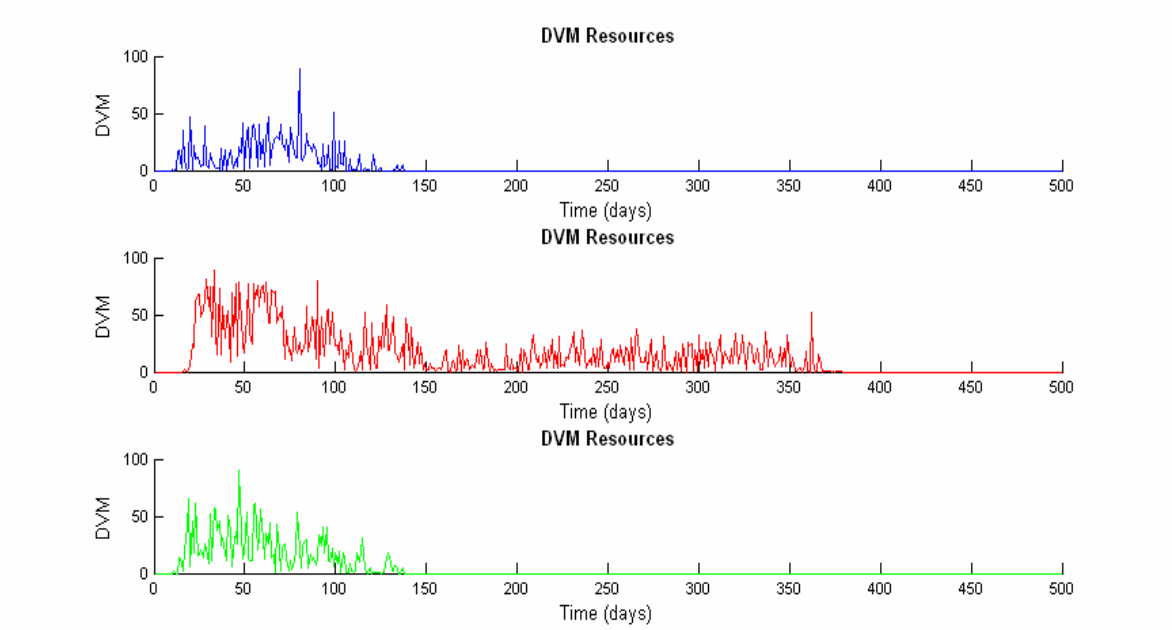

Figure 1: DVMs needed per day for all tasks in three Monte Carlo runs at the 75th percentile, California scenario.

Discussion

Despite the continuing risk of an FMD outbreak in the United States, many states as well as the federal government, do not have FMD response plans that include resource estimates. Even fewer plans have detailed personnel estimates for what it would take to implement their plans. The spreadsheet tool developed as a result of this project was provided to all US states and will hopefully assist states in the estimation of personnel needs for various tasks associated with a FMD outbreak response.

The estimates developed can also be used in conjunction with output from an epidemiological model (eg. MESA) to assess the potential demand on personnel resources over the course of a simulated outbreak. This was tested in modeling runs customized for the state of California. Figure 2 shows the spread during one simulated outbreak.

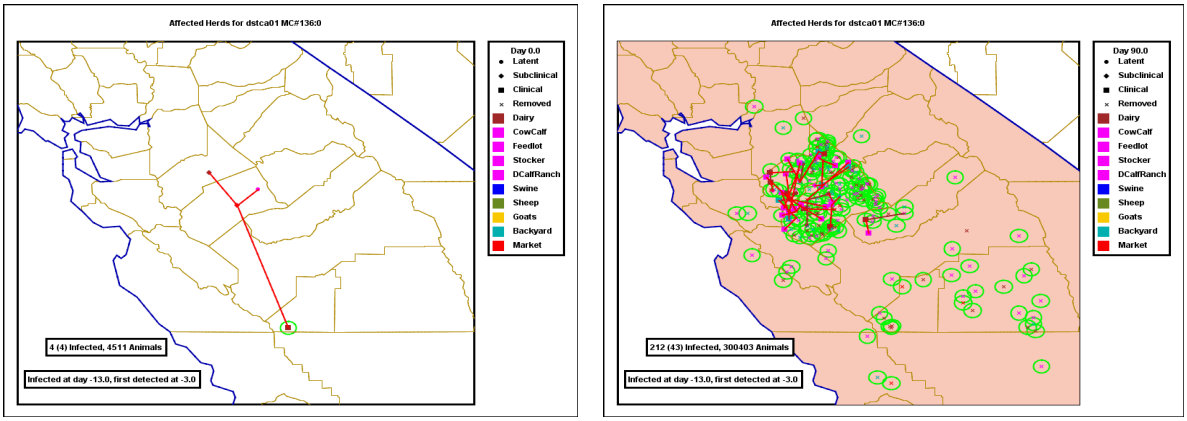

Figure 2: Simulated disease spread during one outbreak in California, day zero and day 90.

In an outbreak, personnel needs in many areas of outbreak response are directly related to the number and type of infected premises and the number of animals on those premises. The personnel categories evaluated here include diagnosis, field epidemiology, direct and high-risk indirect tracing, appraisal, euthanasia, disposal, cleaning and disinfection and on-site biosecurity. Personnel estimates for this area were calculated using the formula Ax+B, where A equaled the personnel per head, x equaled the number of head and B equaled personnel needs independent of facility size. A similar equation can also be used in estimating personnel needs for vaccination or other response activities.

Estimating personnel needs for movement control, surveillance and incident command on a national level will be challenging given all the possible variations in epidemic size and location. Estimates for these personnel resources will be addressed in subsequent work.

Conclusions

Given the potential risk and impact of an FMD outbreak in the United States, it is essential that continued research and policy planning be made a national priority. This project is ongoing and will be evaluating the personnel resources demands for outbreaks in several areas of the country. Additional work needs to focus on estimations for personnel resources needed for movement control, surveillance and incident command. In addition, resource estimates for non-personnel resources should also be estimated.
The personnel estimates developed in this project assumed that there would be an unlimited pool of qualified people available. This is not a realistic assumption. With a better understanding of the actual personnel resources which may be available one could evaluate optimization and prioritization strategies which would lead to optimal disease control. More work is needed to understand the limitations on qualified personnel and the effect of these shortages may have on an outbreak response.

References:

1 - Kansas State, Purdue and Texas A&M. 2004 Aug. Carcass Disposal: A Comprehensive Review. Chapter 1. < http://fss.k-state.edu/index.php?option=com_content&task=view&id=17&Itemid=37> Accessed 2007 15 July.
2 - Bates, et al. Benefit-cost analysis of vaccination and preemptive slaughter as a means for eradicating foot and mouth disease. American Journal of Veterinary Research. 2003 July; 64(7): 805-812. Table 2.

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