Foot and Mouth Disease Vaccine Distribution Exercise and Proof of Concept for Partnership with an Independent Vaccine Distribution Company

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Abstract

To better prepare for a potential foot and mouth disease (FMD) outbreak, the U.S. Department of Agriculture (USDA) and the Iowa Department of Agriculture and Land Stewardship (IDALS) conducted a two-part exercise. Phase 1 was designed to validate end-to-end vaccine logistics processes from FMD confirmation in livestock in Iowa through vaccine receipt from the overseas manufacturer. Phase 2 was a proof of concept, in which IDALS partnered with an independent vaccine distributor to manage the placebo FMD vaccine cold storage, repacking, and distribution process. Independent distributors are already equipped to package, ship, and track the mass distribution of animal health supplies while maintaining the cold chain and chain of custody. In an FMD outbreak, this approach would increase efficiency of the response and reduce time lost by securing cold storage, breaking down pallets, re-packaging vaccine vials, and tracking shipments by federal or state officials who have insufficient personnel and limited or no relevant experience. This would also allow federal and state officials to concentrate their efforts on other vital response activities. Based on the outcomes of this exercise, the authors recommend that the USDA consider an alternative approach to distribution of FMD vaccine during an outbreak. Instead of distributing directly to states, IDALS encourages USDA to consider using one or more independent vaccine distributors and coordinating with the distributor(s) ahead of an outbreak.

Introduction

Foot and mouth disease (FMD) is a highly contagious viral disease that primarily affects cloven-hooved (two-toed) animals. It is considered one of the most important transboundary animal diseases in the world. Almost 3 billion doses of vaccine are produced worldwide each year to

control the disease[1]. There are seven major serotypes of FMD and more than 60 strains[2]. Immunity to one serotype does not cross-protect an animal from infection with other serotypes and not all strains within a serotype cross-protect[2].

The introduction of foot and mouth disease virus (FMDV) into the United States would have devastating impacts on the U.S. economy, including significant impacts from the immediate loss of international trade. In 2021, the U.S. exported an estimated $10.58 billion USD in beef products[3], $7.71 billion USD in pork products[4], and $7.66 billion USD in dairy products[5]. Other costs directly associated with a foreign animal disease (FAD) eradication effort include depopulation, indemnity, disposal, and virus elimination. In addition, there are direct and indirect costs related to lost production, unemployment, and losses in related businesses.

The State of Iowa would be severely impacted by an FMD outbreak as Iowa ranks first in the nation in pork production, in the top 10 states for beef production, and in the top 15 states for dairy production[6]. The very high number and density of FMD-susceptible animals in Iowa make readiness for FMD vaccination a top priority. The importance of livestock to Iowa's state economy creates a much higher risk of economic, social, financial, and environmental consequences from an outbreak than almost any other state. It is important that Iowa livestock sectors prepare multiple strategies for dealing with an FMD outbreak. This includes having the ability to quickly identify and eradicate cases and, if necessary, control disease spread through vaccination.

The April 20, 2021 draft of the Iowa Emergency Foot and Mouth Disease Vaccination Plan[7] states that IDALS is responsible for securely storing vaccine and distributing the correct number of FMD vaccine doses to Authorized and Accredited Veterinarians within the state. Authorized and Accredited Veterinarians then have responsibility for obtaining vaccine from the state distribution point, properly storing and accounting for all vaccine assigned to them, maintaining adequate cold chain storage and chain of custody, overseeing administration of vaccine to animals on designated premises, and ensuring that vaccinated animals are properly identified and tracked. However, many states, including the State of Iowa, are under-resourced to operationalize these efforts in the event of an FMD outbreak.

Partnering with an independent vaccine distributor(s) during an FMD outbreak would help to ensure proper and efficient handling and tracking of this valuable resource and would allow State officials to focus more of their efforts on other vital response activities. Distributors and veterinary clinics handle vaccine in a safe and efficient manner on a daily basis.

To better prepare for vaccination in a potential FMD outbreak, IDALS participated in a U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) exercise to validate end-to-end vaccine logistics processes from FMD confirmation in livestock in Iowa through vaccine receipt from the overseas manufacturer. As a proof of concept, IDALS then partnered with MWI Animal Health (MWI), a part of Amerisource Bergan and an independent vaccine distributor, to manage the placebo FMD vaccine cold storage, repacking, and distribution process. A summary of the exercise, proof of concept, and recommendations based on exercise play and findings from the proof of concept are presented here.

Disclaimer

The events outlined herein describe a fictitious scenario developed for exercise purposes and do not represent an actual outbreak or case of FMD diagnosed in the United States. All vaccine shipped in this exercise was placebo vaccine.

Overview of Exercise

This exercise consisted of two phases. Phase One was organized by the USDA National Veterinary Stockpile (NVS) and Phase Two was organized by IDALS. Phase One took place from August 31 to September 9, 2021, with participants representing USDA-APHIS, the State of Iowa, an overseas vaccine manufacturer, and MWI Animal Health. This phase of the exercise was designed to validate the end-to-end FMDV vaccine logistics processes for the United States from the point of hypothetical FMD confirmation through placebo vaccine delivery to affected states. Phase Two of the exercise took place from September 8 to September 15, 2021, with participants representing USDA-APHIS, the State of Iowa, State Animal Health Officials from four additional states, MWI Animal Health, the Iowa State University Center for Food Security and Public Health, and producers and practicing veterinarians in five states. This phase of the exercise was designed to test distribution of FMD placebo vaccine through normal vaccine distribution channels from an Iowa-designated independent vaccine distributor to veterinary clinics or production companies in the following states: California, Iowa, Kansas, Minnesota, and North Carolina.

Phase One

Phase One of the exercise began with hypothetical suspect FMD cases on hog farms in two Iowa counties. Exercise play began on August 31, 2021, with sample collection by a Foreign Animal Disease Diagnostician (FADD) and samples submitted to the USDA APHIS Foreign Animal Disease Diagnostic Laboratory (FADDL) at Plum Island, New York. For exercise play, an epidemiologic investigation was launched immediately, and a conference call was held with appropriate personnel from USDA-APHIS and the State of Iowa to coordinate efforts and plan the next steps. Exercise samples were designated as presumptive positive based on polymerase chain reaction (PCR) testing and internal notifications were made within USDA-APHIS and the State of Iowa. USDA APHIS's National Veterinary Stockpile (NVS) was notified of the presumptive positive and instructed to prepare for activation of the North American Foot and Mouth Disease Vaccine Bank (NAFMDVB).

Virus isolation and sequencing were assumed to be completed within 36 hours and confirmed that the samples were positive for FMD. The USDA-APHIS Chief Veterinary Officer (CVO) approved the use of placebo vaccine as part of the exercise response efforts and the NAFMDVB was activated. In accordance with the State of Iowa's DRAFT Emergency Foot and Mouth Disease Vaccination Plan[7], IDALS submitted a request to USDA for 231,000 doses of vaccine (two full pallets) and this request was approved by the CVO. The NAFMDVB vaccine manufacturer immediately initiated converting the placebo vaccine antigen concentrate into a finished placebo vaccine for exercise play. Arrangements were made for the placebo vaccine to be exported to the United States.

Two pallets of placebo vaccine were shipped on September 6, arrived in the U.S. on September 7, and were cleared through customs. USDA-APHIS obtained custody of both pallets and confirmed adequate cold chain conditions were maintained (2-8 ℃) throughout the flight via review of temperature logs. USDA-APHIS then transferred the placebo vaccine to the NVS third party logistics company (3PL). On September 8, the 3PL delivered the placebo vaccine in a refrigerated truck to the State of Iowa's designated cold storage site, MWI Animal Health, an independent vaccine distributor located in Edwardsville, Kansas (hereafter referred to as "MWI"). IDALS staff were present to receive the vaccine. Upon arrival, the truck seal was inspected and found to be intact. IDALS staff reviewed the temperature logs and verified that both pallets maintained adequate cold chain conditions throughout transport. IDALS verified the number of vaccine vials in the shipment and added instructional leaflets indicating that this was a placebo vaccine and information from the USDA Center for Veterinary Biologics (CVB) approved vaccine label to each box. Custody of the placebo vaccine was transferred from USDA to IDALS. This completed Phase One of the exercise and initiated Phase Two.

Phase Two

As proof of concept of partnering with a vaccine distributor to handle, track and deliver vaccine to veterinarians, IDALS partnered with MWI during Phase Two of this exercise. After IDALS assumed custody of the placebo vaccine at the designated cold storage facility of MWI, custody was transferred to MWI. The vaccine was securely stored in the MWI cold storage facility which had a temperature-monitoring system connected to the facility's security system. IDALS provided MWI with a list of addresses and number of doses where the placebo vaccine was to be

shipped. MWI utilized routine packaging, shipping, and tracking procedures to distribute specified amounts of the placebo vaccine (two boxes per site, each containing 10 cases of 10 vials per case; 100cc/50 doses per vial for a total of 10,000 doses per site) to the IDALS-designated Authorized Veterinarians at 20 sites in five states on September 14 and 15, 2021. Sites in five states were selected working with the appropriate State Animal Health Official in each state to exercise the concept of a single distributor receiving intact pallets of vaccine and distributing to authorized veterinarians in multiple states. MWI included a temperature indicator in each box shipped to verify if temperature was maintained between 2-8 ℃ during transit. MWI uses a robust inventory and tracking system for chain of custody, and once shipped, IDALS received tracking numbers for each shipment. All cold chain and chain of custody procedures comply with U.S. Food and Drug Administration's Code of Federal Regulations and are regularly audited and enforced. Upon receipt of the shipments, authorized personnel at predetermined veterinary clinics and production companies verified the quantity of placebo vaccine and maintenance of cold chain via the temperature indicator included in each box. Authorized personnel reported this information, along with any issues noted, to IDALS using documentation that IDALS provided prior to the exercise. Photos were also taken at each site to document the receipt and condition of the vaccine and the temperature indicators (shown in Figure 1). Issues noted included one leaking vaccine bottle, one temperature indicator out of range, and inability to locate temperature indicators in one or both boxes at four different sites. In a real-life event, Authorized Veterinarians would be responsible for overseeing the administration of vaccine to animals on premises specified by their state animal health official and ensuring that animals are properly identified and tracked. Once the placebo vaccine was received and receipt and condition were documented, Phase Two of the exercise concluded. For

the purposes of this exercise, authorized personnel returned all placebo vaccine to the IDALS office.

Issues Identified

For the purposes of this exercise, two full pallets of placebo vaccine were shipped by USDA NVS to the IDALS designated storage site (MWI). In an actual outbreak, vaccine availability is likely to be limited. Requests from the state for FMD vaccine must be approved by the U.S. Chief Veterinary Officer. To support the request, the State Veterinarian must provide to the USDA APHIS Veterinary Services FMD Incident Command Group the state's up-to-date FMD Vaccination Plan and the Emergency FMD Vaccine Authorization and Request, found in the USDA Foot-and-Mouth Disease Response Plan, The Red Book, Appendix E, Part I. https://www.aphis.usda.gov/animal_health/emergency_management/downloads/fmd_responseplan.pdf It is likely there will not be enough vaccine to meet all requests and the number of doses allocated to each state will probably not correspond to full pallets of vaccine. The NVS would be responsible for ensuring that pallets are broken down and the vaccine is repackaged into the exact number of doses allocated to each state, all while maintaining the cold chain. In addition, new cold chain monitors would need to be added to each shipment before delivery to the state. Simultaneously, the vaccine need in each state may change as the outbreak develops. If the approved number of doses has already been shipped to a state, it will be difficult to redistribute vaccine to states with greater need. Using a vaccine distributor provides the USDA with the ability to change the number of approved vaccine doses sent from the distributor to various states on short notice to more effectively control the outbreak.

In this exercise, twenty full cases of vaccine (10 vials per case, 100cc/50 doses per vial) were sent to each participating veterinary clinic. In an actual outbreak, it is likely that only the number of doses approved for animals on each premises that the Category 2 accredited veterinarian is approved to vaccinate will be shipped. Animal health distribution companies are much better equipped than state officials to distribute partial boxes of vaccine vials.

Proof of Concept

As demonstrated in Phase Two of this exercise, there are many advantages to using independent distributors to ensure proper vaccine handling and tracking in the event of a FAD. Rapid mass distribution of resources is their area of expertise, and they complete these activities with a high degree of accuracy and success on a daily basis. Advantages include:

- Ability to readily break down intact pallets of vaccine and quickly repackage the authorized amount for shipment to authorized veterinarians;
- Ability to quickly redirect shipments to different locations or states depending on the need determined by the USDA and State Animal Health Officials as the outbreak progresses;
- Access to secure temperature-controlled storage;
- Trained personnel and software for receiving, shipping, and tracking;
- Already-established cold chain, chain of custody, and return policies and procedures; and
- Equipped to easily add extra supplies such as syringes and needles to shipments.

In summary, having arrangements in place with an independent distributor prior to a FAD outbreak, will enable a more efficient and effective distribution of vaccine and more rapid response to FMD.

Lessons Learned

Areas for improvement that were identified in Phase 2 through exercise play included better communication with Authorized veterinarians on where in the packages the internal temperature indicators were located and the importance of finding and reading the indicators. Step-by-step instructions for veterinarians on unpackaging and documenting receipt of the vaccine should be included in each box. An independent distributor could readily add this information to prevent missing or ambiguous cold chain tracking data. Another concern was ensuring that information on USDA CVB approved vaccine labels always accompanied the vaccine vials to the end user. It is recommended that labels be affixed to each vial. If that is not possible because of the emergency need to expedite shipment of vaccine, then an adequate supply of leaflets with the label information should be available to accompany each vial of vaccine to the end user. This repackaging could be accomplished by an independent distributor. In addition, policies and procedures for deviations in cold chain maintenance should also be better defined.

Conclusion

This exercise successfully validated end-to-end vaccine logistics processes from FMD confirmation in livestock in Iowa through vaccine distribution to individual veterinarians in five states. Areas for improvement were identified and noted throughout the exercise. Furthermore, the Iowa Department of Agriculture and Land Stewardship demonstrated multiple advantages to partnering with an independent vaccine distributor to manage the placebo FMD vaccine cold storage, repacking, and distribution process. The need for NVS and state officials to manage cold storage, repackaging of the correct number of doses, and distribution, could be assumed by an

independent distributor rather than the NVS (shipping to states) and state officials (shipping to approved veterinarians). It would also provide greater flexibility for just-in-time determination of the number of doses to ship based on the current outbreak situation. Based on the outcomes of this exercise, IDALS recommended that USDA or states consider working directly with one or multiple independent vaccine distributors in the event of a foreign animal disease outbreak in the U.S. when vaccine is utilized as a tool in response efforts. Independent distributors are readily equipped to package, ship, and track mass distribution of animal health supplies while maintaining cold chain and chain of custody. Utilizing these already established processes would increase efficiency of the response, allow for regulatory officials and veterinarians to focus more of their efforts on other vital response activities, and reduce potential error from the breakdown and re-packaging of materials, ultimately ensuring the most effective use of valuable response resources.

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Figure Legend:

Figure 1. Photo of temperature indicator in range after shipment was received by authorized personnel.