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Outbreak investigation in a production system

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Introduction

In swine medicine, we frequently deal with individual herd disease outbreaks, the most common being sow farm PRRS breaks, but due to the hierarchy, consolidation and interconnectedness of our industry today we can commonly experience disease outbreaks that affect multiple farms within or across a region or system. Examples would include PRRS infected boar studs, Leptospirosis in gilt development finishers or contamination of a truck wash facility with TGE where a point source is directly connected to multiple downstream facilities.

This paper focuses on the investigation of disease outbreaks in a system involving multiple sites and assumes a basic knowledge of disease investigation with individual herds. A good review of disease outbreak investigation in a single herd has been covered by Waldner and Campbell.[1] While many of the same principles apply to system outbreaks (consider farms as individual cases), there are additional dynamics that must be considered; infrastructure of system, number of samples, total diagnostic expenses, organization and logistics of data and communication amongst many personnel.

Principles

The basic principles of epidemiology and disease investigation apply and must occur at two levels; farm and system. These involve collecting as much information as you can concerning: who, what, when, where, why, how. When dealing with system outbreaks "who" can be the individual types of animals on affected farms (e.g. gilts, gestational age) or the type of farm by some characteristic (e.g. farms without isolation, or a particular gilt/semen source). The "what" can be specific clinical sign, symptom or production parameter. "When" is an important question to ask to generate a potential exposure period and generate temporal data across affected farms which may indicate the exposure event (e.g. gilt delivery, loading crews). The "where" can indicate area spread within a geographical region, maybe related to weather patterns or central loci (watershed, feed mill). "Where" may also demonstrate a non-regional factor which could indicate another common source like pig flow or service routes that are not necessarily region specific. The "why" and "how" are the questions that require the most investigation and are ultimately what we need to understand for mmediate control and future preventative measures (e.g. vaccination, biosecurity).

Index case

One of the most difficult parts of an outbreak investigation in a system is determining when it is an outbreak beyond the index case. In large dynamic systems, there is the "constant fires" dilemma that can mask a true outbreak and the general "lumping" of disease into categories and assigning a etiologic diagnosis ("Strepy pigs," "PRRSy pigs," scours). Disease may be subclinical and not as noticeable amongst other issues but still represents an outbreak. Outbreaks (or destabilization) of disease can occur within one farm and requires its own investigation, but that is not the intent of this paper, although the basic concepts are very similar. What is the challenge is when a second or third farm, related or not, experience an outbreak of the same disease(s). It is important to clarify here that when discussing a disease in an outbreak situation, we must specify the agent, with detail, and ensure it is the same originating agent. A common example is when there are sequential PRRS breaks that appear related, however when sequencing of the isolates are completed, it is apparent the isolates are not of the same lineage. This does not totally mean that the outbreak is not related as there may be a centralized source with multiple pathogens (eg, rendering vehicle or truck wash). For simplicity in this paper, we will consider system outbreaks with a single pathogen variant.

By definition the index case is the first recognized, however this is usually not discernible until several farms are affected. In the development of an outbreak, many it may be necessary to return to previous steps to re-evaluate the situation on several occasions once more data is available. It is important however to raise awareness of the situation to other farms in the immediate area or system. This may be easier to do with diseases that are not endemic to the farm or system (TGE, swine dysentery, PRRS) or are uncharacteristic in presentation. Some systems have the ability to identify significant changes in real-time performance data, such as statistical process control charts, that might signal outbreaks of endemic diseases or less clinically apparent disease. These are very helpful when a system outbreak is identified and some quick method of triage is required to prioritize additional investigations. Care must be taken to add clinical evaluation to these sets of data as there are other non-disease related influences to data capture.

Establish a case definition

Once the problem is confirmed to be an outbreak, the next step is to evaluate the extent of the problem. This allows a better understanding of the severity of the event as well as helps to identify common linkages between the cases.

If the inciting pathogen is known, a concise description of the clinical signs can be broadcast to key parts of the system. A quick review of the literature (historical and recent) or phone call can help to provide alternative presentations of the disease, because not all diseases will present with similar clinical signs depending on herd immunity, stage of life, concurrent infections, management or other factors.

It is important when establishing a case definition that you include enough details to encompass the range of potential clinical presentations, however not to be exhaustive to exclude cases. Also, the case definition should not be as vague as to include every farm with a health challenge. We are all aware that during the height of the pandemic H1N1 outbreak, anyone that presented to their doctor with a fever and respiratory issue it was diagnosed (ironically with no diagnostics) as pH1N1. Like today when everything is "PRRS" or when everything was "Circo."

It is important to create a sense of heightened awareness when outbreaks are suspected, but this must be tempered or a response that results in overwhelming of the production, veterinary and diagnostic staff. In our system, if we suspect or confirm a case of TGE a communication goes out to our sow farms and production service staff and we ask to communicate any significant scour event. This is usually in the format of a daily evaluation and communication to a central location (fax, email, phone call). Farms that do not call-in will be actively contacted. This heightened awareness is important but usually leads to excessive reporting of scours (that are not above the normal prevalence) and can quickly lead to chaos and misuse of resources. Remember information moves fast and out of control in the Swine-Vine-meets-the-Grapevine-Game scenario.

Identification of risk factors

Another important investigation step is to identify factors that are shared by the case farms. This can also help to identify or triage other farms in the system in which to investigate the current health status. In many large systems, several key factors are already known or are easily obtainable and the data can be evaluated by Chi-Square, Odds Ratios or other quick and basic statistical methods.[2,3] Due to the high level of biosecurity in systems, many aspects of potential disease transmission are already mapped out: service routes, semen sources, gilt sources, pig flow, utilities routes, mortality management routes, sign-in sheets for non-farm personnel, livehaul or market haul schedules, feed schedules, etc. This aspect makes is easier to evaluate common linkages between farms, where otherwise time and resources would be needed to put these pieces together.

Diagnostics

Once the disease is identified, a review and understanding of the available diagnostic methods should be consulted. This allows you to consider the abilities and limitations to widespread investigation, confirmation and ruling-in or ruling-out disease on farms within the system. In addition to the actual tests available, it should be decided what level of testing and potential cost would be incurred with large processing and testing of samples. Sample size is important when evaluating the extent of disease and a level of confidence and detection has to be decided to ensure proper evaluation of sites. Several sampling attempts or routine monitoring may be required during and post outbreak and a good understanding of the level of detection and/or test capability needs to be understood. There are established epidemiological methods for this and many are available on-line as calculators,[4] which makes using them easier. When tests are selected, supportive laboratories should be identified. Contact with the laboratory should be made to discuss the situation and give detail to the type, number and distribution of the samples. In some cases, due to volume, it may be necessary to submit samples over a period of time or to multiple laboratories. Doing so requires a system to organize sample submissions and eventual results in a common location and format. The volume that a lab or set of labs can process my dictate the level at which you can test or the time it will take to realistically assess all of the sites in question.

In addition, contacting the lab and discussing the testing options may lead to improved processing by discussing how samples should be submitted or processed prior to arrival. One example would be to use serum separator tubes and spin down samples in-house prior to shipping or pouring off serum into sample tubes. While this may increase work on the system's part, it can streamline the process at the lab, and frankly improve laboratory relations. Continuing the example, it may be helpful to have sticker labels pre-made for the farms that are consistent with some scheme and keep it consistent for all samples associated with the outbreak investigation. Practically this prevents illegible writing on the farm staff's part, makes it easy to read at the laboratory and makes compiling and analyzing the data easier. For example, we might use a label "8501-G-01" with 8501 representing the farm identifier in our data system, G representing gilt (N nursery, S sow, W wean pig, etc) if different life stages are to be sampled simultaneously and 01 representing the sample number. Dates, lot numbers or other identifiers can be added. Once samples are processed in-house, shipping of samples should be consistent as well. Load serum tubes in serum boxes in the same logical manner for the lab technician and have system to separate cases or groups of samples. When sending samples, communicate with the laboratory as to what you are sending and when it should arrive. Careful discussion with the lab prior to starting the investigation can identify the best lead-time for submission based on lab requirements, such as day of the week particular test are run or development of required substrates prior to processing (culture media, reagents, antigen, cell cultures, etc). In some cases, the lab may be able to allocate resources or labor to this particular event, run tests on "off" days or only run portions of test panels. One example may be to run only *L pomona* antisera on samples instead of the other 5 serovars, saving resources, equipment and time, or allowing for more samples to be processed at a time.

Communication with the laboratory has another benefit when investigating outbreaks … experience and expertise. The main diagnostic labs that will likely process your samples usually have some experience with similar situations and can help determine the most effective ways to approach the situation. They may be aware of other systems that have experienced similar situations and can help to put you in contact with key personnel; however this must be done so that confidentiality is not compromised.

Once you have determined the type of data that will be generated a system of data capture, management, analysis and summary should be considered for easy use. This may be in the form of spreadsheets, pivot-table friendly data or some database system. While not essential, digitized data is easier to manipulate. If data is not available in that format, paper reports can be hand entered into a data system by most anyone, but care should be taken to include all pertinent information, prevent entry errors and the need for continued re-entry of data.

Control

When the disease agent is identified and farms begin to be evaluated, common control measures can begin to be implemented, such as preventative or treatment medications, vaccinations (mass or routine), increased biosecurity and disinfection. It must be determined how extensive within a system the control measures should be. For example, should all sow farms get a booster vaccination or just those in an affected region or gilt pyramid? In some diseases, mass vaccination can mask the ability to detect natural infection (PRRS, SIV, FMD), and may limit your ability to identify new farms in the outbreak. This may not be an issue if control of endemic disease is the goal, but if eradication of the agent is the goal this can result in excessive animals to be removed from the system or overall confusion in result interpretation.

When implementing control measures on multiple facilities, system constraints need to be fully understood. Mass treatments and vaccinations can lead to uncommon withdrawl issues in a system. In some situations a preemptive culling of sows may be required before a product with a 21 or 28 day withdrawl is used to prevent production or welfare issues. In one case in our system, the application of widespread feed medication to many of the sow farms resulted in a shortage of available cull sows for the market. After getting over that issue, subsequent treatments on this scale had to be staggered which led to strains on the feed mill's ability to produce the medicated diet plus the normal rations, reduced their efficiency in runs and required extensive organization and coordination of those involved in the sow cull schedule to ensure implementation. Communication during the next event was essential and appreciated. Consider the logistic coordination challenges with attempting this on one farm … now multiply this by 40 sow farms.

When arranging for mass treatment or vaccination of farms, procurement of product, distribution of product, ensuring compliance of the program and validation are all important factors. In large systems, an immediate need for large volumes of product can put a strain on other parts of the system, the warehouse or other markets (consider the early days of PCV2 vaccine or the recent issues with iron). The total volume of product may not be available at a single shipment and require additional time to arrive and thus be implemented. Once you have product available, distribution to the sites needs to be coordinated with the event, especially if there is minimal storage available on the farm relative to the amount of product required. There needs to be some way to ensure implementation and completion of the program. This allows for accountability and improves compliance, which validates the response (or lack of) of the program. We have accomplished this by using marking syringes, supervisor participation and specific memos that require a supervisor (farm manager, production manager) to read, communicate to team and fill out completion date/time with signature, which is then returned to a central collection point and filed. For some vaccinations, post-event serology workup can help confirm effective exposure and lack of non-exposed groups (e.g. PRRS ELISA).

Resolution

Once farms are identified, control measures are put in place and time has lapsed for effective response, the next step is to define success. This may be as simple as a return to normal pre-outbreak production levels or as complex as demonstrating negative status on affected farms with monitoring and/or sentinel programs. The same issues discussed in the "Control" section can apply here, when post-measure serology or sentinel diagnostics are collected. The coordination of the farms to collect the samples and the diagnostic lab to receive and process the samples in an efficient and timely manner is important.

It is important to clearly define what will define a successful resolution to the situation and what will define a failure and require additional efforts. Stabilization of disease is much different than eradication, especially when it comes to confirmation with diagnostics. The monitoring levels and the efforts required are significantly different.

Another challenge with resolution of outbreaks in large systems, especially if the agent is already endemic or not high profile, is finalizing resolution. It is easy to move on to the next thing when the clinical signs and number of affected farms start to diminish below a noticeable level. Effective control and treatment measures in the face of an outbreak may lead to a false sense of security and laxity in implementation (consider the final phase of PRV eradication). This is considered "System Compliance" to a health program and can lead to recrudescence of the outbreak at a system level. We see this commonly on individual farms going through a PRRS stabilization or eradication event. We shut the doors, expose herd, minimize piglet movement and wait …. But things start to get better, abortions stop, born alive returns to normal and wean pigs look better. So we start to routinely move pigs in the farrowing house and open the door to gilts … and we break back or start weaning increased viremic pigs. This is all because we failed to stick to the plan and follow it through to completion. This is non-compliance! We stopped taking the pills because we felt better.

Communication

Communication is always an important component of any health protocol. In individual herd outbreaks communication is usually between the owner, the stockperson(s), the veterinarian and maybe a nearby farm or regulatory veterinarian. This is relatively a small group when compared to those involved in a system outbreak; farm managers, production personnel, veterinarians, support services, third parties, etc. In addition, when dealing with a single herd, most people involved have a working knowledge of the situation while in larger systems people are often specialized/compartmentalized and do not fully grasp the full picture. Correct, clear, concise and professional communication during an outbreak to all involved parties is essential for rapid resolution of the problem. In addition, making key individuals aware of the aspects of the situation allows for delegation of tasks to those that are more suited for that type of task or understand that part of the system better than you might. Key personnel within the transportation department can help to provide trucking routes, schedules, the exact time and locations visited by vehicles (usually through embedded GPS units) and can provide much quicker than production personnel. The same applies to other aspects within the system; human relations, land and nutrient management, maintenance, feed delivery, crews (loading, vaccination, placement) and contractors (mail, construction, utilities). Systems that have multiple veterinarians can communicate across flows, pyramids or pods. Systems that have separate production/business divisions need effective communication to investigate larger outbreaks and spreading of disease. Areas where multiple systems are intimately associated, communication across "party" lines needs to be professional and respect each other's business confidentiality, while still providing pertinent information about the clinical signs, extent and risk of disease to surrounding facilities (e.g. TGE, Swine Dysentery or PRRS in regional eradication efforts).

Discussion

Outbreaks will occur on individual farms. In today's consolidated swine industry, these outbreaks have the potential to expand beyond the walls of a single farm or flow, and create chaos in a system, region or across systems. The principles of epidemiology, outbreak investigation and diagnostic medicine apply to these situations very similarly as when evaluating disease on a single unit. The extent, scope and non-farm infrastructure in today's large animal systems requires that the principles are manipulated to fit and address these differences. Extrapolation of the basic concepts of single farm investigation requires an organized, timely and systematic approach and requires clear and concise communication among all involved. It also requires teamwork, delegation of responsibilities and thinking at a system level. While each outbreak will be different, the basic concepts remain the same, the only issue is how your team will apply those concepts to the situation.

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