Managing Infectious Disease Outbreaks at Events and Farms; Challenges and the Resources for Success

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Managing infectious disease outbreaks can be a daunting task, but the challenge is much easier to meet when you are well prepared. It is critical to understand what resources are available to you, how to find them, and how to put them to use. You also need to understand the enemy; know how different diseases spread and how to contain them. This article reviews a series of real-life case scenarios featuring common infectious disease threats, highlighting important lessons about disease control. Authors’ address: Department of Clinical Sciences, James L. Voss Veterinary Teaching Hospital, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, 300 West Drake Road, Fort Collins, CO 80523-1620; e-mail: lunnp@mail.colostate.edu (Lunn). © 2007 AAEP.

1. Introduction

These proceedings discuss strategies for managing infectious disease outbreaks on farms and equine gatherings and events. The ideal strategy for management is clearly prevention, but the reality is that we are more frequently called on for a response to an outbreak. The organization of these proceedings is designed to support the accompanying presentations rather than to provide a comprehensive reference source for this subject. Nevertheless, when taken together with the excellent guidelines and other publications referenced herein, the proceedings should be valuable in planning and responding to many of the highly contagious infectious diseases that we face today. We will begin with an explanation of the problems confronting equine veterinarians today in managing these disease outbreaks and review the resources available to help us prepare and respond to such disease outbreaks. The next section outlines strategies for outbreak management, emphasizing critical steps that can lead to success. A series of case scenarios are provided that illustrate strategies used in responding to these outbreaks. These cases will be used in the presentations to highlight critical strategies for success, but also to show the dilemma’s facing veterinarians in management of infectious disease outbreaks. In another presentation and proceedings in this session, Dr. Richard Newton of the Animal Health Trust, UK, will provide a trans-Atlantic perspective and highlight some specific strategies and experiences from Europe that give a different perspective and perhaps some lessons for how we manage these problems.

2. Problem

There seems to have been an increasing number of outbreaks of infectious disease affecting horses in
recent years in North America, particularly affecting high-profile race meetings and competitive events. These outbreaks have caused suffering and death in horses, anxiety and uncertainty among horse owners and the general public, and enormous economic losses to the equine industry and communities dependent on the equine industry.

Recognized recent outbreaks have been associated with both viral and bacterial agents. Disease outbreaks caused by viral causes include influenza, equine herpesvirus-1, equine viral arteritis, vesicular stomatitis, and equine infectious anemia. Disease outbreaks caused by bacterial causes included Streptococcus equi var equi, Salmonella spp., and methicillin-resistant Staphylococcus aureus (MRSA). A summary of the number of recent stories in The Horse magazine featuring equine infectious diseases prepared by Dr. Paul Morley of Colorado State University (Fig. 1) shows that the occurrence and interest in the various causes of infectious contagious disease peak and fall over the 10-yr period summarized in this figure. The largest number of stories featuring West Nile virus (WNV), followed by equine herpesvirus-1 (EHV-1), with the largest number of stories in 2006 featuring EHV-1.

The origins of modern veterinary medicine are rooted in society’s need to control infectious disease in animals. The same challenges face equine veterinarians today, because we are expected to play a pivotal role in the prevention, investigation, and mitigation of outbreaks of contagious infectious disease. These challenges are sophisticated, and often daunting, and are accompanied by high expectations and intense scrutiny from owners and the public. To play our role effectively, preparation and planning are critical, together with a good understanding of modern resources and strategies. Even so equipped, we are also dependent on having both the trust and financial support of owners, farm managers, and event organizers if we are going to be successful in these missions.

The financial impact of outbreaks includes the lost revenue because of the resulting stoppage of horse movement, the cost associated with the diagnostic work-up and monitoring of ill and in contact (exposed) horses, the cost of treatment of ill horses, the cost associated with mitigation including prevention strategies (vaccination and biosecurity protocols), enhanced monitoring, the loss of use of the horses that are ill and exposed during the outbreak, and the loss associated with horses that may die because of the illness. There are very few existing detailed estimates of the financial cost of such outbreaks, but those that do exist indicate the impact can be substantial. During an EHV-1 outbreak in early 2007 in Wellington, FL, an article posted on the Sun Sentinel newspaper website estimated daily losses to the local economy in Wellington to have exceeded $750,000 per day. Without question, it would be preferable to prevent a disease outbreak rather than to try to contain it. However, it is not easy to put a value on a disease outbreak that was prevented. Thus, it can be challenging to get adequate support to put outbreak pre-planning into place.

In recognition and response to the growing importance of infectious disease control in equine veterinary practice, the AAEP developed guidelines for control of infectious diseases at equine events (available at www.aaeep.org). These guidelines provide an action plan when the veterinarian is faced with an equine infectious disease outbreak and provide details regarding the clinical and laboratory diagnostic aspects of selected equine infectious contagious diseases. The guidelines also address pre-event planning to be prepared to deal with an infectious disease occurrence. In addition to these guidelines, the executive board of the AAEP established a standing committee for infectious diseases in 2006 based on the recognition that the AAEP play a key role in assisting the equine industry in the control of such diseases. Both authors of these proceedings served on the panel that developed these guidelines, which was led by Dr. Mary Scollay.

<table>
<thead>
<tr>
<th>Year</th>
<th>EHV Count</th>
<th>EHV Pct</th>
<th>WNV Count</th>
<th>WNV Pct</th>
<th>Salmonella Count</th>
<th>Salmonella Pct</th>
<th>Influenza Count</th>
<th>Influenza Pct</th>
<th>S. equi Count</th>
<th>S. equi Pct</th>
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<tr>
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<td>8%</td>
<td>3</td>
<td>12%</td>
<td>11</td>
<td>29%</td>
<td>15</td>
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<td>1</td>
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<td>1</td>
<td>3%</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

Total: 194 438 25 38 46

Fig. 1. Compilation of the number of stories in TheHorse.com by type of infectious contagious disease and year. Each story is not necessarily reflecting an outbreak or separate outbreak but would be an approximation of interest in the topic for that year, and interest is often prompted by occurrence of the disease. Summary courtesy of Dr. Paul Morley of Colorado State University College of Veterinary Medicine and Biomedical Sciences.
These proceedings are meant to complement those guidelines and refer to them frequently.

Is the equine industry at a point where they are interested in investing more time and money in developing a comprehensive plan to address some of the controllable equine infectious diseases? Perhaps the recent outbreaks of equine infectious diseases that have occurred create the teachable moment in the equine industry. Armed with some key messages, the equine veterinarian can serve as a source of information to horse owners, farm managers, and equine event organizers so that they can make informed decisions regarding pre-planning for control of equine infectious diseases.

3. What Resources Are Available?

What resources do we have to help us prepare for and deal with contagious infectious disease outbreaks? In an era when contagious disease seems to be not only a constant concern, but also a real threat, where do you turn for help? This question is just as relevant when you are trying to prevent an outbreak (such as during event planning or consulting on farm management) or when you are responding to an outbreak situation. We can consider this issue by trying to answer a series of questions:

Where Can I Find Information?

In addition to the ever-expanding library of equine texts, there are some sources of information designed specifically to help meet this challenge. Most recently the AAEP published guidelines on its website in the member’s section for managing infectious disease outbreaks, and it is intended that these will be updated continuously. It’s the first version, but it already provides a central source for information about where to find some of the resources described below, an outline of the most important principles, and key steps in responding to different types of disease outbreaks—it is a great place to start. One limitation, however, is that the guidelines focus mainly on managing outbreaks rather than on detailed planning to prevent one. Although textbooks and frequent attendance at continuing education meetings can help you in that kind of planning, another great resource is the Vet Clinics of North America: Equine Practice, December, 2004 edition entitled “Infection Control.” In addition, the recent publication of “Equine Infectious Diseases” has two particularly valuable chapters on this subject.\(^1\)\(^2\)

Although there is a lot of good information out there if you know where to look, there is also a good amount of disinformation, albeit well intentioned. Unfortunately, some of this material is highly accessible to your clients, and it can be like climbing a mountain to persuade someone that what they heard from a guy they met yesterday in the feed store is not the gospel truth, even if you are standing in front of them with 20 yr of education and just as much experience (plus having come to our talk)! In these and similar circumstances, your best plan is to be patient, delivering a consistent clear and firm message and referring to solid sources of information. One critical source of information that we all rely on is our experience, but it is worth reflecting on the fact that experiences with the same infectious disease in different circumstances can vary enormously. Even though we may think we have seen enough neurological equine herpesvirus outbreaks to predict that a relatively small proportion of the at-risk horses will be affected, remember the experiences of the veterinarians in the 2003 outbreak at the University of Findlay, where 46 of 135, or 34%, of resident horses developed the disease.\(^3\) The lesson for all of us is to not “guarantee” how severe the outbreak is going to get based on what we saw last time. Instead, it is often better to plan for something worse until we have firm evidence that the outbreak is under control and is going to stay that way.

Where Can I Find Materials to Implement Biosecurity Measures?

You can find many resources on the AAEP website to answer this question. The key issue, however, is to have these resources ready before you need them whenever you can. One of the most important resources is the availability of facilities that can be used for isolation, whether for prevention of introduction of contagious disease or for limiting its spread when it is detected. In some of the most important and high-risk situations you will encounter, there will often be no provision whatsoever for this type of facility. Disinfectants, gloves, foot baths, signs, etc., can be obtained quickly and sometimes improvised, but often the hardest things to produce in the face of a problem are the protocols you need to put in place to control spread and introduction of infection. These protocols guide everything from your actions, to authorization for movement of animals, to how the stall cleaners go about their work. These need time and careful thought to develop for specific situations—above all, try and develop both specific and generic protocols that you can use to prevent or respond to outbreaks. Although it may seem overwhelming to develop plans to reduce exposure to all important infectious disease agents, several criteria can be used to decide which agents will be considered. For example, what will be the impact of the disease if it occurs and the cost of prevention? Another concept that can help to simplify planning is that control methods for one agent may be similar to another if the route of exposure and spread are shared. If you are charged with disease prevention for a facility, and given significant authority to make management decisions for this purpose, it can be a major responsibility. There may be advantages to seeking guidance from colleagues or consultants to validate your plans.

Although the AAEP website offers a lot of advice on materials for use in infectious disease outbreaks,
there is one resource that is so valuable that we will give it some extra space here—that is a “biosecurity kit” that you carry in your truck to help you and a handler examine a horse while minimizing the chances that you’ll carry contamination on to another horse. A biosecurity kit could contain examination gloves (one pair per horse examined), pairs of coveralls dedicated to a given animal’s examination or that of a group of animals of equal status, a covering for the upper body that would be impervious to secretions such as nasal discharge, plastic shoe covers, and ideally some type of head covering. The practitioner when arriving at the premises could use such a kit. A spray container of disinfectant for the soles of shoes or boots and hand sanitizer or hand soap with water source would be needed once the barrier precautions were removed. A list of potential sources for some of these items is in Table 1.

Table 1. Examples of Products That Can Be Used to Make a Basic Biosecurity Kit for a Mobile Veterinary Practitioner

<table>
<thead>
<tr>
<th>Product Name/Type</th>
<th>Source</th>
<th>Contact Info</th>
<th>Approximate Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic aprons</td>
<td>Poly Conversions, Rantoul, IL 61866</td>
<td>(888)-893-3330</td>
<td>$75.75 per case of 75 gowns</td>
</tr>
<tr>
<td>Tyvek coverall with attached hood, elastic wrists and ankles</td>
<td>Enviro Safety Products, Visalia, CA 93291</td>
<td>Phone: 559-651-0976, Fax: 559-651-1320, <a href="http://www.envirosafetyproducts.com">www.envirosafetyproducts.com</a></td>
<td>$4.50 each</td>
</tr>
<tr>
<td>White disposable gowns</td>
<td>McKesson Medical Surgical, Denver, CO 80239</td>
<td>800-525-3000 (info), 800-933-4633 ext 8884</td>
<td>$86.80 case (30 gowns)</td>
</tr>
<tr>
<td>Disposable plastic boots</td>
<td>Continental Plastic Corp., Delavan, WI 53115</td>
<td>(414)-728-4800</td>
<td>$56.00 per case of 500 boots</td>
</tr>
<tr>
<td>“Knot-a-boot”</td>
<td>Colorado Animal Health, Longmont, CO 80501</td>
<td>(303)-772-2636</td>
<td>$55/10 lb</td>
</tr>
<tr>
<td>Alcohol hand sanitizer-use product with at least 61% ethyl alcohol</td>
<td>Multiple potential products</td>
<td>Purell available over the counter in convenience stores</td>
<td>$1.75 Purell 2 fl oz. Flip cap: $4.39 each 3 oz bottle 3M Avagard D ethyl alcohol hand sanitizer</td>
</tr>
<tr>
<td>Examples include Purell and 3M Avagard D ethyl alcohol hand sanitizer</td>
<td>3M Health Care, St. Paul, MN 800-228-3957</td>
<td>800-228-3957</td>
<td>$274.95 per case (2000 thermometers)</td>
</tr>
</tbody>
</table>

How Fast and How Easily Can I Get a Diagnosis Using a Test and How Do I Interpret It?

This could be the longest section of this entire paper, but let us keep it short and focus on the principles and realities of testing for infectious disease. There is a substantial amount of information about this topic in the AAEP infectious disease outbreak guidelines, and we will not repeat it all here. Whatever test you choose, it is likely to be a bad choice unless the horse has some increased chance of having that disease. Unless we are running screening tests—we will get to those—we decide to use tests when we think there is an increased likelihood that the horse has the disease we are testing for. Therefore, our history and physical examination findings are critical. Consider two different circumstances and responses when you encounter a horse with a fever. If this is the first case you have seen in the barn and you immediately test for salmonella, you are not going to be any further ahead if the cause is influenza virus infection, so you need more information from your physical exam before you can choose the test or even decide whether you are going to test. However, if this febrile horse were in the same aisle of stalls as three cases of severe diarrhea, your test selection would seem well justified. Clearly to make good decisions, we all need to have good criteria for initiating testing. Risk aversion and/or “what is at stake” are important factors in deciding to start running tests. Nevertheless, do not forget that you do not want to run a test unless you know how you are going to interpret the result and what actions you are going to take because of that result! Remember, even for many tests for infectious disease agents, you can get false positives, so our goal is to use tests when we think there is an increased risk of presence of the disease. In those circumstances, a positive result is more likely to predict disease. For a great discussion of this issue, and an understanding of the concepts of positive and negative predictive values of tests, see Dr. Paul Morley and Dr. Bill Savilles’s AAEP proceedings from 1997.4 The article is written about equine protozoal myelitis, but it
explains principles you can and will use every day in the clinic. It is also important to remember that, for many infectious diseases, the detection test is just one part of the formula leading to a diagnosis. The test only tells us the disease causing agent is present, but there can be more to diagnosis than just detecting the presence of an infectious agent.

Now that you have decided you want to run a test, what is available? For stand-side testing, the answer is very little indeed. Currently, you can use influenza virus diagnostic kits on any benchtop, or theoretically truck hood, if you have 20 min and some familiarity with the directions. In reality, the test is too expensive and has too short a shelf-life for anyone to carry it around in the truck routinely. You might, on the other hand, be able to run some bacteriology tests back at your clinic, if you are lucky enough to have a microbiology laboratory set-up, but chances are you do not. Therefore, you are going to be sending out samples by mail or courier to the laboratory of your choice (see the AAEP site for suggestions on how to make those choices because laboratory quality varies). If we assume that you have decided on the diseases for which you want to test (e.g., respiratory versus enteric pathogens), and you know which laboratory you are going to send your samples to, you still have to decide on the specific type of test and how to take and preserve your samples. If you are not familiar with these issues, one of the best ways to make these decisions is to call the laboratory and ask—this is particularly valuable with regard to what type of sample to collect.

When we culture and isolate viruses or bacteria in a laboratory, we typically confirm their identity with further molecular or immunohistochemical tests, making this type of test the “gold standard” for identifying infectious agents. However, these classical tests are slow and typically less sensitive than polymerase chain reaction (PCR). Generally speaking, we make increasing use of PCR-based testing technologies for most of the pathogens we are concerned about. The advantages of speed and sensitivity make this a good choice in many instances, and in an increasing number of cases, the new real-time PCR tests can increase speed, sensitivity, and specificity in the right hands. It is possible for laboratories to report results the day they get the samples, although 48 h may be more realistic. The disadvantages of PCR are that, because we often set up these tests to maximize sensitivity, the risk of a false positive can be higher than it would be with conventional virus isolation. Another disadvantage is that if the laboratory does not also isolate the pathogen in culture, an opportunity will be lost for future use in forensic investigation of the outbreak through studying where that strain came from (typically using more advanced molecular sequencing techniques) or for incorporating that strain in a future vaccine. Although the microbiologists will want an isolate, and the absolute confidence in diagnosis that goes with it, the clinician will settle for PCR results in the short term. The best solution is to ask the laboratory to run PCR tests and to attempt conventional isolation if the PCR is positive—just remember, PCR is more sensitive, so if the culture does not confirm the PCR, the PCR result may still be right.

A frequent problem is having appropriate sampling materials available when you need them. The AAEP guidelines have specific information on this topic. In all likelihood, you do have swabs and containers suitable for bacteriological sampling, but it is typically less likely that you are carrying or stocking viral isolation supplies. You can submit suboptimal samples using bacteriological swabs and conventional transport media for viral isolation, but you are limiting your chances of success. The best plan is to buy some virus isolation kits containing swabs and viral transport vials and watch the shelf life because they do expire. One important point: viral transport media must not be used for bacterial samples, the antibiotics in the media being the reason. It is generally better for samples to sit in your refrigerator over the weekend than on a loading dock at 90°F. Therefore, unless the laboratory receives samples on Saturday, ship overnight on Monday through Thursday or drive them to the laboratory directly. Generally refrigeration can preserve samples for several days, and cold packs are very helpful in mailers. Freezing is acceptable for viruses but a bad idea for bacterial samples.

Finally, what to do with the result? In many instances, the answer is straightforward enough, and if not, call the laboratory to discuss it. However, there are some tests available that report results that are very difficult to interpret. At the time of writing, the most obvious example is the new molecular PCR tests for EHV-1 that can distinguish between strains carrying a genetic mutation (more accurately called a single nucleotide polymorphism [SNP]) in the DNA polymerase gene (DNApol) that is more commonly found in EHV-1 strains isolated from cases of neurological disease. If you use such a strain-specific PCR test, instead of just getting an EHV-1 positive or negative result, the positive result will come back with the additional piece of information that the strain is of the “neuro” or “non-neuro” pathogenic type. At the time of writing, the value and advantages of having this information are not as clear as they may seem! In the first instance, we do not know that this distinction is absolute, and in fact, it currently seems unlikely that it is—this means that the genetic mutation is more common in strains causing neurological disease, but strains without the mutation can also cause neurological cases.

Nevertheless, it is useful information to know that this EHV-1 strain carries a marker for increased pathogenicity—it might be wise to further increase the stringency of your responses until you see which
way the outbreak is going to progress. The problems could come when the outbreak is over. We know that infection with EHV-1 typically leads to life-long latent infection. Therefore, are horses that have been infected with the “neurological” EHV-1 strains a risk to all others for the rest of their lives? This is possible, because that same strain that infected them can be preserved in a latent state, but the real risk is just not known. In a number of outbreaks in 2006, we saw cases of the neurological form of EHV-1 spread from horse to horse and from facility to facility with the transport of infected horses. Nevertheless, the pattern of spread was one of direct transmission of infectious virus. Once active cases ended, the pattern of transmission ended with it. We are not aware of a documented case of a horse exposed during an outbreak of neurological EHV-1 recovering and months or years later being the source of infection in a new outbreak. That is not to say it could not and has not happened, but in reality, there is probably some proportion of horses that are latently infected with the so-called “neurological” EHV-1 strains that carry the genetic mutation, and not all of these horses are likely to cause outbreaks of this disease. At this time, we just do not know the implications of the recent discovery of this marker, and until researchers like Dr. George Allen at the University of Kentucky complete a great deal of research on the molecular epidemiological implications of the marker, it will be important to be conservative in how we interpret this information.

How Useful Are Screening Tests in Preventing Entry or Movement of Infection?

A great deal could be written here, and for a more detailed discussion, the reader is referred to one of the many excellent texts on clinical epidemiology. The heart of the issue is that you are almost certain to have to make compromises if you want a screening test. Now, if you are lucky enough to have a test that is 100% sensitive and 100% specific, compromise will be unnecessary! Given the limitations of almost all testing technologies, it is almost certain, however, that you will have to choose a test that is either very sensitive, but not as specific as you’d like, or vice versa. How would you choose? Well, if you cannot stand the prospect of missing a case of the disease (this might be true for colon cancer in humans), you may be willing to accept some significant number of false positives—you can always rule them out with more tests later. Applying these arguments to testing horses for infectious disease on entry to a show, you might set different priorities, because false-positive diagnoses may cause all kinds of headaches. You might therefore choose a test that is highly specific (few false positives) and have to accept reduced sensitivity. Now you have a test that means what it says when it diagnoses a disease, but will miss some cases—a good example would be the bench-top ELISA kit used for diagnosing equine influenza. As a screening test, it has some value, but if it is used alone it will not keep the disease out. For this reason, the veterinary authorities in Dubai use the test for all horses entering, but also subject the horse to a lengthy quarantine period—their risk aversion is very high for obvious reasons, and the screening test is just not good enough. In most situations and for most infectious diseases we are concerned about, we might reach a similar conclusion about available screening tests. Many tests are too slow or have limitations in terms of their sensitivity or specificity. This means that using these tests as the sole method of controlling movement of infection is inadequate. The bottom line is that screening tests do not have a lot of value when used alone, and it would be preferable to use them in combination with a quarantine period to control entry of many infectious diseases, if you use them at all. The same is true for using these tests to release animals from a quarantine or farm, after an outbreak of neurological EHV-1 for example. A PCR test here may seem valuable, but it may provide a false sense of security and should not be used as the sole criteria for movement of that horse.

How Useful Is Vaccination for Prevention and Intervention?

Vaccination is generally a good thing, even though protection is almost always <100%. Articles and protocols for vaccination abound, and the recently updated AAEP vaccination guidelines provide detailed information on vaccination strategies. For prevention of outbreaks of contagious disease, we need good vaccines. We have them now in North America for influenza virus, but we do not for salmonella. For several other important infectious diseases, such as EHV-1 and S. equi, we have vaccines with some proven value, but which do not and cannot prevent spread of infectious disease completely in an outbreak. Nevertheless, we believe these vaccines can and do help reduce the severity of disease.

An ideally timed vaccination will maximize immunity at the time of maximal risk. Therefore, booster vaccinations 2–3 wk before trips to sale barns or shows are an attractive strategy. What use should we make of vaccines in the face of an outbreak? The answer is a lot of use in the majority of circumstances. If horses are properly vaccinated to begin with, a booster vaccination can be expected to generate a powerful memory response within a couple of days. This is just as true for conventional killed boosters as it is for modified live vaccines (MLVs). If vaccination history is missing or there has been no prior vaccination, options are much more limited. Nevertheless, there are a number of MLVs for both influenza and WNV, with proven protection as early as 7 days after primary vaccination.

One vexing issue concerning EHV-1 neurological disease is the concern that the occurrence of the
disease may be made more likely by host immunity or vaccination. This remains a theory, but there are reasons to consider it seriously. Opinions will vary on this question; some will argue that EHV-1 booster vaccinations for horses at risk of exposure in outbreaks of neurological EHV-1 may prevent infection and spread of the virus through the equine population. Others express concern about possibly increasing risk of development of the neurologic form of the disease by vaccination in the face of the outbreak. There is currently no evidence to suggest that boosting EHV-1 immunity by vaccination in the face of an outbreak carries increased risk of development of the neurologic form of the disease, and in fact, many authorities recommend this approach to control of the outbreak. This remains an area where we need more information.

What Is the Role of the Veterinarian in Responding to Infectious Disease Outbreaks?

This is an important question for all of us to ask ourselves, to measure both our responsibilities and our options. On the one hand, if you have no authority to direct the control or prevention of an outbreak or if your opinions are not sought or heard, what you certainly do not want is responsibility for the blame if and when things go wrong! However, as veterinarians, we feel the natural and appropriate desire to take responsibility for the health and well being of animals, particularly in the face of a clear risk. If you are charged with disease prevention at an equine facility, and if your ambitions extend beyond routine vaccinations, you will need to negotiate with facility management as to what measures can be put in place without restricting business in an unacceptable way. One obvious example is the use of an isolation facility or process for all horses entering a facility. This strategy can be very powerful and has successfully kept influenza virus out of Australia and New Zealand, despite quite extensive horse movements. Nevertheless, an isolation period that is too short or protocols that are not designed for control of specific diseases can provide a false sense of security. Managers of farms and events need to understand and accept the risks that result from how they manage facilities, and veterinarians need to clearly identify these risks so that the managers take responsibility for the consequences of their decisions.

Even though managerial decisions can make control of entry and spread of contagious diseases difficult, even in the most challenging circumstances, there are still likely to be some measures that can be taken. If isolation procedures cannot be followed for animals entering a sale barn or showground, increased surveillance and health checks at entry could be used. Even if a facility fills to capacity, the risk of spread of infection might be reduced if owners and horses are restricted within the natural boundaries of a building and exercise area. Feeding utensils, manure removal equipment, stall cleaners, and grooms can sometimes be restricted to working only in a certain barn and barns. In this way, the equine population at an event can be partitioned, which could be a huge advantage if contagious disease breaks out.

In responding to a suspected infectious contagious disease outbreak, the same issues arise: do you have the authority to make decisions and are you being listened to? If the answer is yes, you will need a good plan in which you have enough confidence so that a day or a week later when everyone has developed an “expert” opinion, you can stay on message as the situation develops. The plan still needs to be flexible, as new information becomes available (diagnostic tests for example) and circumstances change in the facility. The time to develop the plan is before you need to use it. If you are going to be responsible for responding to a disease outbreak, the first step to take is develop a response plan and know where the resources are that you will need.

One of the most important strategies for maintaining both control of outbreak response and the confidence of managers, owners, and the public is good communication. This can vary from talking to the owner/manager daily to posting news releases around a major showground and talking to the media. Media training is advisable! The important thing is to determine your message and how to get it across in an unambiguous way. Do not volunteer opinions without some basis for them and be polite, gracious, but firm when others differ with you (unless they happen to be right, in which case you might consider contrition).

Veterinarians have additional and specific responsibilities if they are concerned that they are dealing with a disease agent not normally found in the country, i.e., a foreign animal disease or an emerging disease agent. In this circumstance, you should promptly contact regional health officials. If a veterinary practitioner is concerned that the clinical signs in an animal or population of animals is consistent with those of a foreign animal disease or emerging disease, the practitioner should contact one of three health officials in their area. These include (1) a foreign animal disease diagnostician if the practitioner knows who they are, (2) state veterinarian, or (3) the APHIS-VS Area Veterinarian in Charge (AVIC). The decision to initiate this type of investigation is often difficult for the veterinary practitioner, even though the investigation and laboratory testing is at no charge to the animal owner. The first call by the practitioner to one of the three health officials listed above may only be to discuss the situation before formally reporting a disease occurrence for investigation. These early discussions are encouraged to avoid crisis situations.

Managing infectious disease risk is something all equine veterinarians do on a daily basis, although when faced with the risk of a major outbreak, many of us can feel ill-prepared. Take heart! As the regular veterinarian for an equine operation or event,
you will likely have more knowledge regarding the horses and their health care and movement than anyone else, and thus you can play a critical part in outbreak investigation. However, depending on the scope and type of outbreak, you may need to involve a team of people with expertise in various areas such as diagnostic laboratory testing, epidemiology, hygiene, and pathology.

4. Strategies for Outbreak Management

The point of departure for this section will be the moment that you first seriously consider that an outbreak of infectious disease is occurring in a group of horses. You could be the first person to suspect this and be about to set off the alarm, or you could have been called in to a situation where there is no doubt about the existence of an outbreak, but with no understanding of what it is or how to stop it. You have two missions in outbreak management, and you are going to take them both on at once: investigation (finding out what is happening) and control (stopping it).

Outbreak investigation revolves around answering some basic questions including what, when, where, who, and ultimately why. These questions may not always be easy to answer, but answering them is fundamental to outbreak investigation. One excellent article identifies a series of logical steps to outbreak investigation, and if you follow them, your chances of being able to fully report the outbreak and explain its cause will be high. However, unless you have just been called in solely to do an investigation, it is likely that you may need to focus your outbreak investigation on three questions:

1. What is the diagnosis of the disease and its etiology?
2. How far has the disease spread already?
3. How far could it spread and what populations are at risk?

Keep these questions in mind, as they are the parts of outbreak investigation that are the most valuable in helping you to control the outbreak.

Let's imagine you are standing outside one of several barns at a large event center that is hosting a competitive event over the course of 2 wk, with horses moving on and off the property throughout the period. You have been called in to examine a series of horses in this barn that have developed fevers in the last 72 h. Let's not rush into that barn, you already might have some reason to suspect that there may be respiratory disease, with a possibly infectious etiology. Your diagnosis is likely to require going stall to stall and handling each horse. This might be a good time to decide how to accomplish that without personally spreading an infectious agent through the barn, and then on to the other barns on the site you are going to visit later that day. As you prepare suitable clothing, foot-wear, and gloves for you and the handler you will also want to plan for samples you could want to take—the fewer trips in and out of those stalls you need to make the better. Now let us imagine you have examined the horses and determined that a few are exhibiting mild mucopurulent nasal discharge and sporadic coughing. You have a tentative diagnosis of respiratory disease, and your concern that it is infectious is strengthened. Given the circumstances, the implications are potentially severe, with many horses at risk at the site, and excellent opportunities for the outbreak to spread beyond as horses leave. You have enough information to be very concerned, but do you have enough to require action beyond getting those nasal swab samples you took to the laboratory?

Let us look at how the AAEP infectious disease guidelines recommend we proceed; here is an adapted version of how the guidelines suggest you should respond to the hypothetical scenario just described and our scorecard:

1. Do No Harm! Do not rush into the stall until you have a plan.
   - So far so good, we recognized the risks and took appropriate biosecurity precautions to avoid worsening the situation.

2. Attempt a diagnosis of the disease and its etiology and initial assessment
   - We have a tentative diagnosis of respiratory disease, with signs consistent with several infectious/contagious etiologies.
   - Nasal swabs have been submitted to the state diagnostic laboratory for appropriate viral identification by PCR and bacterial culture. The earliest we expect results is tomorrow afternoon.

3. Communicate your findings to the horse owners and event organizers and implement your plan for restricting spread of a possible disease outbreak.
   - Good news, you get a good reception, your concerns are taken seriously, and as the designated veterinarian for the event center you are asked to provide a plan of action.
   - You decide to implement biosecurity measures aimed at controlling a possible outbreak of infectious respiratory disease. You work on the basis that the agent could be something highly infectious that spreads easily, like influenza virus (you are effectively responding to the worse case scenario). To help implement these biosecurity measures you use a series of protocols you have previously designed and typed out for the event center, complemented
by signage you print off using templates from the AAEP website.

- No isolation facility is available as every barn is occupied for the competition, but you decide that all horses in the affected barn are at a very high risk of exposure because a virus-like influenza can travel easily and quickly through shared air space in such a barn. Your decision is to quarantine the barn, stopping all horse movement, and strictly regulating movement of owners, grooms, stall cleaners, and all equipment both within the barn, and in and out of the barn. Disease surveillance in the horses in the barn is increased, with temperatures now taken twice daily. You make a mental note that you will designate your assistant to check the record of temperatures twice a day. You effectively establish a primary biosecurity perimeter around the barn.

- You establish a secondary perimeter covering the entire event center. Steps are taken to increase disease surveillance, but no other restrictions are implemented. This response could be regarded as your first major compromise. Should you have closed the gates to horse traffic in and out of the event center given the chances that if this is influenza it may have spread beyond the first barn before you were called? Should horse movement be limited within the secondary perimeter in an attempt to segregate the population in case of further disease spread? There is no single correct answer here; many factors will play into your decision, including the authority you enjoy to make rules.

4. The laboratory diagnosis is returned in 24 hours—influenza virus is detected in nasal samples taken from three of the five horses you sampled in the barn.

- This is a bad news/good news outcome. It is bad news that you have an influenza outbreak, but just great news that you have a specific diagnosis this early in the outbreak. You were already under pressure from many owners of apparently healthy horses in the barn to let them leave.

5. Implement the disease-specific recommendations from the AAEP website.

- Maintain full quarantine for the affected barn within the primary perimeter and tell owners this will be in place for at least 14 days.
- You fulfill your obligation to contact the State Veterinarian and inform him of the diagnosis. You are offered assistance, which you graciously accept.
- It is decided to increase biosecurity for horses in the secondary perimeter, i.e., all horses at the site. No movement on or off the site is allowed for a period of one week, pending no development of further cases of influenza virus infection. Steps are taken to reduce commingling of horses by regulating movement, and the use of exercise facilities. Heightened disease surveillance is maintained.

6. No further cases are detected within the secondary perimeter during the following week.

- During this time you communicate to the owners of these horses how they should be handled on leaving the event center. You recommend that they be taken home or to another location where they can be housed in isolation from other horses for a further 2 wk. In no circumstances are they to travel to another equine gathering.
- Horses are released from the secondary perimeter after a week from the initial diagnosis and after 2 wk from the primary perimeter.

This hypothetical outbreak description enjoyed many of the advantages of fictional writing, you got an early and accurate diagnosis, everyone did what you said, and you were lucky enough to have intervened before the outbreak had moved out into the larger population! Nevertheless, it captures the sequence of actions that we should take in responding to an outbreak.

Finally, here are two additional strategies that you should use during an outbreak; they are very simple, but can have a major effect on how effective your efforts are.

- Personally observe how people are following biosecurity recommendations and physically show them exactly how to follow isolation and similar protocols. Do not assume that your instructions are obvious!
- Set the standards by your own behavior; never short-cut a biosecurity step. People will take their lead from your example.

5. Case Scenarios

This section outlines some specific examples of real-world outbreaks. These cases and others will be reviewed in the presentations, focusing on the key messages and questions raised by these real world challenges.

Outbreak of Neurological EHV-1 Infection in a Large Veterinary Hospital

In the fall of 2006, an aged mare presented to the Veterinary Teaching Hospital, Colorado State University, with a history of the rapid onset of ataxia, progressing to recumbency. The mare was normally a resident of a farm housing a large population of competitive show horses and had recently
returned from a show. A diagnosis of EHV-1 myelitis was considered as a likely differential from the outset, and barrier precaution protocols were used from the time of arrival of the patient. The mare was moved to a stall at the extreme end of the equine barn that was equipped with an overhead hoist for managing recumbent horses. Barrier isolation procedures were followed, and a veterinarian with extensive experience of EHV-1 managed the case. Nasal swabs and blood samples tested negative for EHV-1, but the mare was euthanized 7 days after admission when her condition deteriorated. Five days after the mare’s admission, undifferentiated fevers were detected in horses in the orthopedic ward at the opposite end of the barn, >150 ft away from the mare. Barrier precautions were introduced, and nasal swabs were submitted for PCR testing for EHV-1. With the intervention of the weekend, results were not available until 7 days after admission of the suspect case, and these tests confirmed the presence of EHV-1. At this point, the hospital was closed and quarantined, and measures were taken to contact owners and veterinarians of all horses that had been discharged during the at-risk period. Within a day, a report was received of cases of pyrexia and one case of ataxia at a barn that had received horses discharged from the clinic during the period. The hospital re-opened.

Take home messages

- EHV-1 can cause mild to fatal disease in the same outbreak, and is highly contagious.
- Outbreaks are lengthy, this one lasted a month from the time of occurrence of the index case to the hospital re-opened.
- Communication was critical both within the hospital in managing the outbreak, and with external groups to maintain client confidence.

Questions

- You can read on the web that this virus can’t spread beyond 35 feet by aerosol, so how did it get past experienced and prepared infection control procedures and biosecurity experts?
- What do you think about our criteria for ending the quarantine, they are substantially different from what is on the AAEP website? Could you afford to run that many PCR’s?

Outbreak of Influenza Virus in a Large Teaching Hospital

In the spring of 2003, a mare and neonatal foal were admitted to the Veterinary Teaching Hospital, University of Wisconsin-Madison. The foal was suffering from neonatal maladjustment syndrome and initially responded well to treatment. The mare was observed to be febrile and coughing shortly after admission, and the foal developed the same signs within 72 h of admission. Throughout this period, no attempt was made to diagnose the cause of the respiratory disease in the mare, and both mare and foal were kept in the neonatal care ward with the main hospital barn. Diagnostic testing was performed 5 days after admission, and nasal swabs tested positive for equine influenza virus, a diagnosis that was subsequently confirmed by viral isolation. The hospital was closed and quarantined, and all horses were immediately tested for influenza virus shedding. Two of the total of 17 residents were positive, both of which had been admitted for routine surgery, and only one of which showed any signs of disease (limited to a day of fever). The foal’s condition deteriorated, and it died of viral interstitial pneumonia. During the period after admission of the mare and foal, and before the diagnosis of influenza virus infection, two horses from the School of Veterinary Medicine’s teaching herd spent an afternoon in the hospital to allow for teaching procedures, before being returned to the barn they shared with six other aged horses. These horses were subject to annual influenza vaccinations and had received a booster 1 mo previously. Forty-eight hours after returning to the barn, one of the two teaching horses became febrile for 24 h. Testing of nasal swabs by PCR showed influenza infection in the febrile horse, and one other horse that had not left the barn. The hospital remained closed for 14 days, the teaching herd was quarantined for the same period, and all horses were discharged without further event.

Take home messages

- Influenza virus can cause subclinical to fatal disease in the same outbreak, and is highly contagious to all horses sharing an airspace.
- Once opportunities for viral spread are removed, the outbreak is generally self-limiting within 7-10 days.
- Vaccination did not prevent infection, but is likely to have severely limited spread and disease.
Question

- Why didn’t we run diagnostic tests when clinical signs in the mare were first detected?

Strangles Case Scenarios

Scenario 1

A farm that was developing an embryo transfer program was to have 10 potential recipient mares delivered by a horse trader. On arrival at the farm, the manager noticed that two horses on the trailer had purulent nasal discharge and refused delivery of these mares. They accepted the other eight mares and put them in the farm’s quarantine pen. This pen was at least 35 ft from any of the facilities used for resident horses. The personnel were instructed to have minimal contact with these mares and to provide these animals care after caring for resident horses on the farm. Subsequently, several of these new mares developed clinical disease consistent with strangles, but no diagnostic tests were performed at that time. Subsequently, several resident mares and juvenile horses developed purulent nasal discharge and fever, and some developed abscesses in the head and neck region. One yearling subsequently developed colic and was diagnosed with metastatic abscess and eventually was euthanized because of complications of strangles.

Take home messages

- Strangles can result in costly outbreaks for breeding farms. Horses with complications due to strangles can die.
- Horses that appear healthy but are exposed to S. equi can go on to develop disease and pose a risk to resident horses.

Question

- The owner of the farm wants to know how this problem could have been avoided?

Scenario 2

An owner of a small breeding facility that has broodmares and foals, as well as embryo transfer recipient mares and horses in training, reports an outbreak of strangles. This farm has a total of 32 horses. Age distribution of horses on the operation at the time of the outbreak was as follows: 4 horses <1 yr of age (weanlings), 7 horses 1.5–2 yr of age (yearlings), 2 horses 2–3 yr of age, 4 horses 3–4 yr of age, and 15 horses >4 yr of age. Only one horse in the >4-yr age group, a broodmare, developed signs of strangles (a ruptured abscess). Of the four weanlings, all got ill and one died (possibly from asphyxia). Of the seven yearlings, six got ill; of the 2–3 yr olds, both became ill; and of the 3–4 yr olds, three of four showed signs and one died. Therefore, a total of 15 horses got clinical disease consistent with strangles, and 2 died: 1 weanling and 1 3-yr-old. Apparently several of the clinically ill horses had abscesses break around the ears and eyes, as well as in the submandibular area. Only one horse, a 3 yr old in training, was vaccinated against strangles before the outbreak, and it did not develop clinical signs of strangles. No cases of purpura were recognized as part of this outbreak per the owner of the operation. The owner reports no new strangles cases until the next spring when several foals still at the mare’s side developed strangles. Several of these foals developed very severe disease.

Take home messages

- Possible that horses in training or newly arrived mares that were housed on the same facility with resident broodmares and foals were shedding S. equi.
- The recurrence of disease in weanlings nearly a year after the initial outbreak with no obvious disease in older horses would suggest a chronic shedder(s) in this herd.

Question

- The owner wants to know what he can do to avoid this problem in the future?

Scenario 3

A training operation had ~30 horses, 1.5–2 yr of age, that came in from multiple farms throughout the western United States at about the same time in late summer or early fall of 2005. Vaccination history before arrival was unclear. These horses were not vaccinated at the training center. Several of these horses experienced a flu-like infection a few months after arrival. At least one of the horses was positive for influenza on Directogen test of a nasal swab. Then, within 1–2 wk, these horses experienced a more serious respiratory infection that clinically was consistent with strangles. These horses were housed in outdoor pens in groups of six to eight per pen, with shared water bowls between adjacent pens. A total of 18 of these horses reportedly showed signs of illness consistent with strangles. Several had multiple abscesses rupturing not only under the jaw but also around the ears, eyes, and in retropharyngeal areas. Of the 18 affected horses, 3 died: 2 were euthanized because of abdominal abscesses and 1 died of complications and was found to have had a chest abscess. At least four of the surviving horses were treated with long-term antibiotics because of elevated peripheral white blood cell counts; some horses also had elevated white blood cell counts in abdominal fluid. No purpura cases occurred. This operation had 10 older show horses on the premises with limited exposure to these juvenile horses (same handlers but older horses wore
kept in stalls away from pens), none of which developed disease.

**Take home messages**

- Prior influenza infection may have increased the severity of illness due to subsequent strangles.
- The shared water source and nose to nose contact through the fence line likely resulted in spread of disease from pen to pen.
- Screening for shedding with subsequent treatment could reduce the risk that any persistent shedders pose to other horses.

**Question**

- What would be the initial plan for investigation?

We thank the working group led by Dr. Mary Scollay, who wrote the AAE0 guidelines for Managing Infectious Disease Outbreaks, which were extensively referenced in writing these proceedings. We also thank Drs. Paul Morley and Lutz Goehring of Colorado State University for details of one of the case scenarios.

**References and Footnote**


"Directigen, Becton Dickinson, Franklin Lakes, NJ 07417."