BIOSECURITY: REASONING AND LACK OF REASONS

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ABSTRACT

Biosecurity is a discipline that is difficult to evaluate based on experimental or historic data. Research is used to identify potential mechanisms for transferal and less for prevention. The use of this information needs to be based on a good mechanistic understanding of the management of risk. Mathematically, this risk needs to be understood in a nonlinear fashion. In management, this risk needs to be understood in terms of policy and compliance.

INTRODUCTION

Biosecurity is one of the most important production strategies we need to address. We agree that disease introduction is one of the most important contingencies to address. Yet there are very few aspects of the biosecurity that can be quantified. We have little idea as to the true risk of exposure to its various aspects. Thus we have a ready audience to suggest and purport a long number of different biosecurity procedures. Unfortunately, most biosecurity procedures are untested as to their importance, and even fewer have been tested for farm-level determinants. Some have been tested as to their mechanism and have been shown to be feasible methods of transferal of pathogens.

It has to be emphasized that most biosecurity measures have only been tested as to their plausibility. Furthermore, we have to understand that we mostly speak about intentions of biosecurity and rarely speak about the likelihood of compliance and the relative costs of high compliance levels. Finally, most of the putative biosecurity effects are not linear. Doubling the distance, doubling the down time or doubling the disinfectant dose will never half the risk of introduction. A reasoned approach to biosecurity needs to involve an understanding of mechanisms of risk along with the costs of failure to address biosecurity risks.

THE COSTS OF DISEASE ENTRY

There have been various estimates of the cost of disease entry onto a single farm, into a region or network of farms, or into a country. Devastating is the adjective often used; it is very costly, it is ugly, it is depressing. The costs can be divided into three areas:

- The introduction of a pathogen onto a naïve farm is one of the highest potential costs identified by most farmers. Many of these pathogens result in catastrophic financial losses and compromised welfare for pigs. Some of these welfare concerns can be difficult

to address as pig flows are compromised and systems can become quite crowded. We see farm laborer satisfaction declining significantly when there are increased challenges of infectious disease. We see increased antibiotic use, and, overall, we see the cost of production increase and value of output decreased, especially in the short run.

- The introduction of pathogens into a herd also increases the risk for other herds. This can be through various networks, whether it be by delivery, common transport methods or common employees. It can also be by simple geographic proximity, especially with pathogens that are transmitted by air or insects.
- The introduction of pathogens may also result in regulatory effects that will decrease the value of pork within a country or region. This aspect of biosecurity is often underplayed and yet it is a valuable part of any biosecurity system, in that it reduces the likelihood of entry of pathogens into a country, as well as a farm.

THE RISK OF DISEASE ENTRY

Disease introduction continues to be a common event. At the University of Minnesota Disease Eradication Center we are studying in detail the likelihood of transferal of PRRS virus. The risk is significant and appears to be in excess of 10% per year for many sow herds. This agent comes from infected pigs, usually in the first month of infection. Thus the major source of virus comes from nurseries or grow finish groups that go through an outbreak episode. This source of virus is unlikely to be chronically infected pigs, especially sows. We must recognize that the source of pathogens is different than the target of pathogens in swine production. For multiple site production our main concern of entry is the sow herd. Yet the relative number of animals is small in sow herds, and for most pathogens there is a level of immunity that limits pathogen shedding. Thus the source of pathogens is most likely to be nurseries and grow finish sites. If we assume that shedding is a linear function of the weight of animals, grow finish sites far outweigh nurseries as sources of pathogens.

Can we reduce the amount of pathogen shedding? One of the secrets of pseudorabies eradication is that PRV vaccine was used to reduce the likelihood of outbreaks and shedding in infected growing pig herds. Currently, this same effect has been investigated for PRRS virus. Another possibility is the use of filtering to reduce the amount of shedding from the herd. This has not really been studied but should be considered, especially in conjunction with odor control methodologies.

Graphical information systems (GIS) have been used to study proximity and its effect upon likelihood of transmission. GIS is especially useful when it is combined with network analysis, which examines relationships between farms, whether it is the transfer of animals, technicians or trucks. There have been more and more cases where molecular techniques have identified transport as a major biosecurity challenge. A wide range of disinfecting procedures have been examined, with drying appearing to be an essential aspect. The safer alternative is to restrict the size of the network by dedicating trailers to farms.

The previous paragraphs illustrate that there are various mechanisms available for further study of disease transferal mechanisms. How these are integrated into farm policy is

important. The general rules of good biosecurity management are to create a comprehensive policy that addresses all concerns in a comprehensive manner. Secondly allow for compliance that is easy and reliable. Thus three major assumptions should be challenged within the swine industry. The first is the question of compliance, that everyone is as interested as herd owners. The second is the mathematical problem of linear thinking. We think that doing something twice as good will result in being twice as safe. The third is that we are able to recognize all major risks.

Linear Thinking

It is evident that there will be no simple answer to biosecurity questions. Yet we need a reasoned approach to the different research aspects that we see in current biosecurity discussions. I think that the biggest lack of reasoning is in the understanding of how to manage exponential risks. Exponential risks are best described in terms of a half-life. Linear thinking suggests that reducing a factor by half also reduces the exposure to risk by half. For almost all of the risk factors that we examine, the effects are not linear and have an exponential relationship. Unfortunately, there are very few of us that can think in exponential terms.

The classic illustration of exponential effects is in paper folding. A normal sheet of paper folded in half and refolded and refolded again is approximately the thickness of your fingernail. If you could fold the paper in half 10 times, it would be the thickness of the width of your hand. At a total of 17 folds it would be as tall as a two-story house; five more folds would make it as high as the Sears Tower. 10 more folds puts it beyond the atmosphere. 20 more folds would bring it to the sun.

If we can take the idea of exponential risk to the discussions we are currently having, many of the discussions will change. Three points need to be emphasized:

- There is no such thing as a zero risk if the mechanism is present. We cannot speak in absolutes, as we are simply reducing the risk by manipulating factors such as distance, cleaning, and disinfection. Questions such as whether aerosol transfer is possible is an inane question if it is shown to travel one meter.
- Doing all steps half decently is much more effective than doing only half of the steps extremely well. We must always be worried about missing a major mechanism of transferal of pathogens, as an uncontrolled mechanism may be the most important.
- We must always be looking for new mechanisms of risk reduction. For instance washing trucks more thoroughly appears to only have a small effect in comparison to a new technology with that separate mechanism. Such an example is drying of the trailers.
- More research has to be done in estimating half-lives of pathogens under different transfer mechanisms. Some of these can be estimated theoretically - dispersion calculations are readily available for aerosol transfer. Survival half-lives under different conditions can also be estimated for many pathogens. Even simple dispersion and turbulence models places that half-life of pathogen concentration at less than 50 meters.

In many ways, the management of exponential risk really follows the adage of working

smarter, not harder. Overextending certain effects, such as showering, may have little effect as most of the effect is seen within a short time. Adding time to an already controlled mechanism may do more for the manager than disease transferal. To work smarter does involve further information to model potential intervention effects.

Compliance

It is hard to identify a security system in other types of enterprises that does not have a method to measure and assure compliance. Many businesses with much less inventory at risk use a variety of compliance assurance methods including video cameras, spot inspections, and security officers. Many swine farm owners find such security measures distasteful. It is assumed that the purpose of security compliance measures is to police employees. In fact, in our experience, the real failures in compliance almost inevitably lead to the identification of management faults instead.

If we agree that there is a real cost to biosecurity measures and that there is also a real complexity to its management, it has often been an unfair expectation of employees to understand and comply with all measures. Even more egregious mistakes have been made once and the costs of compliance are borne by the employees. A simple example of compliance management is the placement of time cards. In many farms the time cards are placed after the shower. This places the cost of showering on the employee, and, if the employee is late, showers are curtailed, and biosecurity is assumably compromised.

Cameras, along with time lapse video recorders, are an excellent tool. Such security systems are relatively inexpensive and four cameras along with a time lapse VCR can often be purchased for less than $1000. The major purpose is not to act as a deterrent, as cameras' efficacies are relatively low. Instead, the review of activities illustrates failures and factors leading to its failures. In review of videotapes we have found three major concerns in compliance:

- Foot traffic. Traffic in foyers, through showers and through secondary entryways is higher than expected. Protocols are followed at initial entry, but if secondary entries and exits are allowed, protocols fail. Likewise, weekend compliance is lower.
- Unscheduled and unwelcome visitors. Whether it is livestock trucks, neighbors or even salespersons, traffic will be higher than expected unless gates at the entry to the farm are locked. It is also apparent that locking and unlocking gates is a laborious task for many employees and keys are distributed beyond the original intended audience. Theft is also a problem in many regions, and there have been reports of thieves that collect pigs from numerous farms.
- Supply introduction. Inventories and equipment are kept too low on many farms, so that introduction of supplies and equipment is compromised to allow employees to do their tasks. Whether it be disinfection, special deliveries, or packaging protocols, employees will compromise biosecurity to get their work done.

Identification of biosecurity failures allows for discussion, not punishment. Systematic changes, such as increases in supply inventory, restrictions on entry and exit, and simply

adequate time for employees to get their work done. Weekend work is especially problematic as there are often secondary activities for the employee, along with a limited workforce. Unexpected problems, such as disease outbreaks or mechanical difficulties, will result in a choice between neglecting family or biosecurity. It is a position many of us do not appreciate.

CONCLUSIONS

Biosecurity cannot be reviewed in all aspects in a short time. It is a discipline that needs further description and explanation. We will continue to identify potential mechanisms for pathogen movement and control. However, farm level decisions have to be made with the knowledge that the mechanisms do not have a linear effect, and moreover, farm management must take compliance into account. These two aspects are the major challenges in the future.