A SCIENTIFIC APPROACH TO INCREASING BIOSECURITY AWARENESS IN SWINE PRODUCTION

Dr. Jason Kelly
Suidae Health & Production; Algona, Iowa, USA

Introduction

Pork production in the United States has changed dramatically over the last 20 years. Today, the largest 1% of all U.S. pork producers represents approximately 60% of all annual production while the smallest 60% represent only 1% of annual production. Intensification of the U.S. swine industry has allowed most producers to raise hogs at a lower cost by placing greater emphasis on facility throughput to spread fixed costs. With the high pig density on most modern hog farms, proper biosecurity is essential to protect swine against the transmission of disease between or among herds.

Biosecurity decisions should be based on facts from practical scientific data rather than relying on speculation. Producers should always be searching for ways where they can minimize their risk of exposure to disease. Establishing a disease surveillance protocol allows for routine monitoring of herd health. An isolation procedure is essential for protecting the existing herd and should include monitoring the health status of incoming replacement stock. Further considerations should include ways to minimize risk of exposure to disease transmission by biological vectors, mechanical vectors, and area spread. Any living organism that can carry a pathogen and allow it to replicate is considered a biological vector. With a mechanical vector, the pathogen is only carried and does not replicate. Defining area spread is less clear. Often whenever a disease outbreak cannot be linked to definite cause, area spread from a neighboring herd is implicated. Area spread could include wind currents as well as unknown biological or mechanical vectors.

On-Farm Biosecurity

The use of boot baths containing disinfectant solution is common to many farms. Recent research has shown that improper use of boot baths are a waste of time and money.[1,2] Bacterial contamination is not reduced by stepping through a pan of disinfectant solution when boots are soiled with manure. Even standing in a pan of disinfectant for 2 minutes did not reduce bacterial numbers on the sole of the boot if they were covered with manure. If boot baths are to be used properly, all manure should be removed manually prior to contact with disinfectant. Manure and other organic material prevent decontamination by encasing and protecting pathogens from disinfectant exposure. Also, organic material inactivates the active ingredients contained in most disinfectants. The amount of contact time required to sanitize the boot varies with the disinfectant. Based on personal experience, a good estimate would be that 99% of all boot baths are used improperly. Based on this research, boot baths containing more manure slurry than disinfectant solution are obviously ineffective.

Nursery problems such as swollen joints and umbilical abscesses have lead some producers to consider increasing hygiene during tail docking and/or teeth clipping. A recent experiment examined the best method to reduce contamination on tail docking pliers.[3] Wiping pliers with a clean cloth was more effective than no treatment and dipping them in a disinfectant solution containing chlorhexidine diacetate for 3 seconds.

Transmission of Infections Agents

Porcine Reproductive and Respiratory Syndrome (PRRS) virus. PRRS virus has plagued the U.S. swine industry for more than 10 years. Most swine genetic companies and some commercial farms have a down time requirement for personnel prior to entering a production facility. The most common requirement is to avoid contact with pigs from other farms for a minimum of 3 nights before entering a production unit. Many trials have been published recently that suggest down time is not necessary to prevent transmission of PRRS. In one such trial,4 people who did not shower after contact with PRRS virus-infected pigs did not transmit the virus after contacting naïve pigs housed in another room. In another trial5, PRRS virus was transmitted from infected pigs to naïve pigs when caretakers did not shower or change boots and coveralls between rooms. In this study, caretakers that washed their hands and changed into clean boots and coveralls did not transmit PRRS. In both of these studies,4,5 down time was not required to prevent transmission of PRRS from infected pigs to naïve pigs.

PRRS virus has been shown to be inactivated quickly on certain fomites.[6] PRRS virus was recovered less than 30 minutes after contamination of stainless steel, plastic, boot rubber, wood shavings, alfalfa, straw, fecal slurry, swine saliva, and swine urine but not when sampled the following day. PRRS virus could not be recovered from denim material, ground corn, or pelleted starter feed contaminated 30 minutes prior to sampling. PRRS virus was recovered from well water daily up to 9 days following contamination and from city water daily for at least 11 days.

Needles, houseflies, and mosquitoes have been documented as potential mechanical vectors for transmitting PRRS virus.[7] Aerosol transmission of PRRS was deemed to be capable of traveling short distances in one review[8] but did not occur under the conditions of one trial.[7] In another study involving a coordinated sequence of events in cold weather, PRRS virus remained viable in 8/10 replicates after being placed into a snowball, compressed beneath a truck fender, subjected to a truck wash, stepped onto by a person's boot, thawed onto the floor, and transferred onto one of several containers by dragging them through the puddle of thawed snow.[9] Using the same protocol except with warm weather and a dirt ball instead of a snowball, PRRS virus remained viable in only 1/10 reps.[10] In these previous two studies,[9,10] some questions remain regarding the practicality of the model compared to actual events that would likely occur on the farm. Further, the use of a swine bioassay where pigs were injected with the PRRS virus-contaminated snow or mud is not representative of an event likely to occur on the farm. If pigs were to be exposed, it would likely be by touching the contaminated object rather than through injection.

Transmissible Gastroenteritis (TGE) virus. One study evaluated the ability of people to act as mechanical vectors to transmit TGE virus from infected pigs to naïve pigs housed in a separate room.[11] TGE virus was transmitted when the caretaker walked directly from infected to naïve pigs. However, TGE virus was not transmitted when the pig caretaker washed hands and changed into clean coveralls and boots. No down time was necessary to prevent transmission of TGE.

Mycoplasma hyopneumoniae. A field-based study concluded that showering and changing into clean boots and coveralls was sufficient to prevent transmission of M. hyopneumoniae from a naturally infected farrow-finish herd to a naïve finishing facility without down time16. Three veterinarians visited the infected farm every week for 20 consecutive weeks and contacted pigs for 3-4 hours per visit to collect nasal swabs and blood samples from nursery and finishing pigs. They wore disposable coveralls and rubber boots during contact with infected pigs but did not wear gloves, facemasks, or hairnets. After contact with the infected pigs, the three veterinarians showered, changed clothing, and drove approximately 60km to the naïve herd where they donned cloth coveralls and rubber boots but did not shower again. At the naïve site they collected nasal swabs and blood samples from four month-old pigs for approximately one hour. Pigs from the infected farm were seropositive to M. hyopneumoniae and positive by nested PCR. Pigs from the naïve were seronegative and negative by nested PCR at the beginning of the study and remained seronegative and negative by nested PCR 154 days later.

Pathogenic Escherichia coli. An evaluation of people as mechanical vectors for transmitting pathogenic E. coli from infected weaned pigs to naïve pigs showed that showering and donning clean outerwear was required to prevent transmission.12 Naïve pigs contacted by a person that did not employ any biosecurity procedures directly after exposure to the infected group developed diarrhea and were culture positive for the same pathogenic strain of E. coli. Pigs contacted after the caretaker washed hands and donned clean outerwear following exposure to the infected group showed less severe signs of diarrhea but were culture positive for the same pathogenic strain of E. coli. No down time was required to prevent transmission of pathogenic E. coli.

Foot and Mouth Disease (FMD) virus. A study[13] was recently conducted to investigate the transmission of FMD virus, one of the most contagious veterinary pathogens known. This study evaluated transmission of FMD virus (the same strain responsible for the 2001 UK outbreak) by people from infected pigs to naïve pigs and sheep. Showering and donning clean outerwear following exposure to FMD virus-infected pigs prevented transfer to naïve pigs and sheep. Further, under the conditions of this study, washing hands and donning clean outerwear following exposure to FMD virus-infected pigs was sufficient to prevent transmission to naïve pigs but not to naïve sheep. No down time was required to prevent transmission of FMD virus.

Other Modes of Disease Transmission

An exhaustive review of published literature outlines the possibility of aerosols, rodents, insects, birds, dogs, and cats to transmit swine pathogens.[8] It was concluded that *Actinobacillus pleuropneumoniae*, hog cholera virus, PRRS virus, and swine vesicular disease virus could likely travel by aerosol over relatively short distances. FMD virus, pseudorabies virus, and *Mycoplasma hyopneumoniae* can likely travel by aerosol over longer distances. In the same literature review, rodents were found to harbor *Bordetella bronchiseptica*, *E. coli*, *Leptospira*, rotavirus, *Salmonella* spp, *Toxoplasma gondii*, and *Brachyspira hyodysenteriae*. Neither pseudorabies virus nor PRRS virus were isolated from rodents on endemically infected farms. Further, it was concluded that under laboratory conditions, insects could transmit African swine fever virus, *Eperythrozoon suis*, hog cholera virus, pseudorabies virus, *Streptococcus suis*, swinepox virus, and TGE virus. Birds on infected farms were found to harbor *B. bronchiseptica* and *Mycobacterium avium*. Experimentally, birds have been shown to transmit hog cholera virus, PRRS virus, and TGE virus. Dogs in contact with infected pigs have been shown to harbor *B. hyodysenteriae* and *Brucella suis*. Cats have been well documented as the definitive host for *Toxoplasma gondii*.

Disinfectant Use

Cleaning and disinfection protocols have been well established as critical components of effective disease control in modern swine production systems. However, cleaning and disinfection efficacy is more commonly based on speculation than on scientific fact. Few research studies have been published that have evaluated disinfectants under typical farm conditions. One study attempted to assess on-farm cleanliness using tests capable of producing feedback within a few minutes[14]. Unfortunately, these tests lacked adequate sensitivity and specificity for on-farm use. For this reason, it is important to determine which disinfection principles can be backed up with scientific evidence and to identify knowledge gaps where additional research is necessary.

A study evaluating transport vehicle sanitation clearly demonstrated the importance of drying time for inactivating PRRS virus[15]. Four different treatment groups with 10 replicates each were used to evaluate cleaning efficacy in scale model trailers where PRRS-infected pigs were kept for 2 hours. Treatment one had bedding material consisting of wood chips removed manually with a scraper. No further cleaning was performed. Treatment two consisted of bedding removal, washing with hot pressurized water, and disinfection using a phenolic disinfectant 1:256 with 10 minutes contact time. Treatment three was cleaned as described in treatment two with the addition of a freeze and subsequent thaw. Treatment four consisted of bedding removal, washing, disinfection, and drying. PRRS virus was detected by PCR in all trailers prior to treatment. All trailers from treatment groups one, two, and three contained PRRS virus detected by PCR. PRRS virus was not detected by PCR from trailers in treatment four where they were thoroughly cleaned, disinfected, and dried.

The presence of residual organic matter along with differences in farm water properties are two major factors affecting disinfectant activity and will vary on every farm. Organic material such as manure, feed, and

secretions can encase and protect infectious organisms as well as inactivate many disinfectant ingredients. Additionally, farm water properties such as hardness and inorganic compounds can alter the activity of many disinfectants.

Two basic *in vitro* procedures exist for evaluating disinfectant efficacy. *In vitro* suspension testing involves the addition of disinfectant solution to a known number of organisms within a test tube. Disinfectants are considered effective if organisms are reduced by a pre-determined amount. Suspension tests simulate on-farm usage conditions very poorly. *In vitro* carrier testing involves the addition of disinfectant solution to a surface containing dried organisms. Disinfectants are considered effective if all organisms on the surface are inactivated. Carrier testing simulates on-farm usage better than suspension testing but some inadequacies remain. *In vitro* testing where organisms are in constant contact with disinfectant solution may not correlate well to on-farm usage where disinfectant dries rapidly on surfaces. Further, the use of horse serum or yeast solutions to simulate the effects of organic matter in many *in vitro* tests represents a very poor simulation of actual organic material present in swine facilities. Many disinfectant testing procedures use sterile, distilled water or synthetic hard water to mix disinfectant solutions, something completely impractical for use in production facilities. On-farm testing provides better information regarding disinfectants than other testing methods. Sampling surfaces in facilities before and after disinfection provide the best results of disinfectant efficacy. Unfortunately, this is very labor-intensive and not practical in many circumstances.

Manufacturers' disinfectant label claims do not necessarily correlate to efficacy under on-farm use conditions because *in vitro* testing cannot perfectly simulate the disinfection process in a swine facility. No disinfectant can be considered efficacious against all swine pathogens under all circumstances.

Conclusions

Modern pork production has become very sophisticated with constant evolution over the years. Large populations of animals located in a relatively small area make effective biosecurity protocols absolutely necessary to safeguard swine herds. A breach in biosecurity can have huge economic implications. Unfortunately, a concept that is so basic and simple can sometimes be overlooked: never underestimate the importance of being clean. When caretakers make a conscious effort to keep themselves clean, recent research reports make it seem quite apparent that evidence is lacking supporting the need for down time to prevent transfer of many swine diseases. Biosecurity considerations should be based on scientific fact rather than speculation. The science behind biosecurity is becoming clearer every day but many questions remained unanswered and further research is necessary.

References

1. Amass SF, Vyverberg BD, Ragland D, et al. Evaluating the efficacy of boot baths in biosecurity protocols. *Swine Health Prod*. 2000;8(4):169-173.
2. Amass SF, Ragland D, Spicer P. Evaluation of the efficacy of a peroxygen compound, Virkon®S, as a boot bath disinfectant. *Swine Health Prod*. 2001;9(3):121-123.
3. Alvarez RM, Kelly JA, Amass SF, et al. Evaluating the efficacy of protocols for decontaminating tail-clipping instruments. *Swine Health Prod*. 2002;10(5):209-211.
4. Amass SF, Stevenson GW, Anderson C, et al. Investigation of people as mechanical vectors for porcine reproductive and respiratory syndrome virus. *Swine Health Prod*. 2000;8(4):161-166.
5. Otake S, Dee SA, Rossow KD, et al. Transmission of porcine reproductive and respiratory syndrome virus by fomites (boots and coveralls). *Swine Health Prod*. 2002;10(2):59-65.
6. Pirtle EC, Beran GW. Stability of porcine reproductive and respiratory syndrome virus in the presence of fomites commonly found on farms. *J Amer Vet Med Assn*. 1996;208(3):390-392.
7. Otake S, Dee S, Rossow K, et al. Transmission of PRRSV by non-porcine vectors: recent research reports. Proc AASV. 2003:517-521.
8. Amass SF, Clark LK. Biosecurity considerations for pork production units. *Swine Health Prod*. 1999;7(5):217-228.
9. Dee S, Deen J, Rossow K, et al. Mechanical transmission of porcine reproductive and respiratory syndrome virus throughout a coordinated sequence of events during cold weather. *Can J Vet Res*. 2002;66:232-239.
10. Dee S, Deen J, Rossow K, et al. Mechanical transmission of porcine reproductive and respiratory syndrome virus throughout a coordinated sequence of events during warm weather. *Can J Vet Res*. 2003;67:12-19.
11. Alvarez RM, Amass SF, Anderson CD, et al. Evaluation of biosecurity protocols to prevent mechanical transmission of transmissible gastroenteritis virus of swine by pork production unit personnel. *The Pig Journal*. 2001; 48:22-23.
12. Amass SF, Halbur PG, Byrne BA, et al. Mechanical transmission of enterotoxigenic Escherichia coli to weaned pigs by people, and biosecurity procedures that prevented such transmission. *Swine Health Prod*. 2003;11(2):61-68.
13. Amass SF, Pacheco JM, Mason PW, et al. Procedures for preventing the transmission of foot-and-mouth disease virus to pigs and sheep by personnel in contact with infected pigs. *Vet record*. 2003;153(5):137-140.
14. Kelly JA, Amass SF, Ragland D, et al. Analysis of Lightning and BioClean tests for assessment of sanitation levels in pork production facilities. *Swine Health Prod*. 2001;9(5):207-213.
15. Dee SA, Deen J, Otake S, Pijoan C. Evaluation of transport vehicles as a source of PRRSV. *Can J Vet Res*. 2004;68(2):128.
16. Batista, L, Pijoan C, Ruiz A, et al. Assessment of transmission of Mycoplasma hyopneumoniae by personnel. *Swine Health Prod*; 2004;12(2):75-77.