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Review

Biosecurity management practices for the prevention and control of PRRS

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Abstract. Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) has a significant impact on the global productivity of the swine industry. In commercial swine farms, the reduction of economic losses caused by PRRS, using management practices, is a challenge for swine farmers and veterinarian practitioners. Biosecurity Management Practices (BMPs) are considered essential for the prevention and control of PRRSV infection. The aim of the present paper is to briefly review the principles of most common BMPs at farm level. BMPs are a fundamental part of a porcine herd health management programme, aiming to improve the health status and productive performances in swine farms. The purpose of BMPs is either to stop the introduction of PRRSV into negative herds or limit the introduction of new strains into already PRRSV-infected herds. BMPs should be reviewed with regard to both internal and external biosecurity measures. External biosecurity focuses on the risk of introduction of new PRRSV strains or other viral and bacterial co-infections from outside the farm, while internal biosecurity deals with the spread of PRRSV within the farm, after its initial introduction. Implementing BMPs is an essential part of a herd health management programme in order to avoid the introduction of PRRSV strains into swine farms, as well as to stop PRRSV circulation within a herd.
Key Words: PRRS, Biosecurity Management Practices (BMPs), control, prevention, pig

Introduction. Porcine reproductive and respiratory syndrome (PRRS) has been causing tremendous economic losses in swine farms worldwide (Neumann et al 2005). The economic impact of PRRS virus (PRRSV) on the global swine industry is mainly due to reproductive failure in breeding stock or respiratory disease and reduction of growth performances in piglets and growing/finishing pigs, as well as cost of treatments, such as antibiotics for secondary bacterial co-infections (Brockmeier et al 2002; Cho & Dee 2006).

The severity of PRRSV-associated disease may result from a number of factors such as differences in virulence among the PRRSV isolates, probable recombination among the different isolates within the same farm, immune status, host susceptibility and concurrent infections (other viruses and bacteria) and hygiene-monitoring programme (Papatsiros 2012a). To minimize the risk of PRRSV introduction into swine herds, biosecurity protocols are considered to be very important. It is important to understand the epidemiology of PRRS, before trying to reduce the risk of PRRSV entry to farms and PRRS disease control at the farm level. Such valuable information about PRRSV infection at farm level is shown in Table 1. Routes of PRRSV include introduction of infected pigs, contaminated semen, aerosols, non-porcine species (i.e. rodents and birds), insects, feed/water, trucks, fomites (i.e. clothes and boots), and personnel (Table 1). After the initial PRRSV infection of a swine farm, usually PRRSV tends to circulate in the farm, causing subclinical to clinical disease (Zimmerman et al 2006; Papatsiros 2012b). In commercial farrow-to-finish farms, PRRSV is persistent in the infected herd after the initial outbreak due to a cycle of transmission of the virus from the sows to the piglets, and by direct animal contact at later stages (e.g. at weaning), when infected and naïve pigs are mixed (Papatsiros et al 2006; Papatsiros 2012b) or due to virus transmission from pigs with chronic, persistent infection (Allende et al 2000; Benfield et al 2000).

Table 1

Information about PRRSV infection, essential for Biosecurity Management Practices (BMPs)

Direct routes of spread	Direct contact Nasal secretions, saliva, blood, urine, faeces, milk and colostrum, transplacental, contaminated semen Aerosols	Bierk et al 2001 Christianson et al 1993 Mortensen et al 2002 Prieto et al 1997a,b Swenson et al 1994a,b Wagstrom et al 2001 Wills et al 1997a,b; 2002
Indirect routes of spread	Fomites (e.g. boots, coveralls) Equipment (e.g. needles) Insects (e.g. mosquitoes and houseflies) Wild animals (e.g. birds, rodents) Contaminated feed/water, vehicles Human – personnel	Dee et al 2002; 2003 Otake et al 2002a,b,c; 2003a,b Papatsiros 2012a Pitkin et al 2009a Schurrer et al 2004
Shedding period	99 d Pigs carriers until at least 150 d of age (PRRSV persistence)	Allende et al 2000 Benfield et al 2000 Wills et al 1997a,c; 2002
Survival in the environment of the farm	90% of virus infectivity is lost within 1 wk at 4°C (low titers for at least 30 d) Stable at pH 6.5-7.5, but the infectivity is rapidly lost Susceptible to high temperatures (1-6 d at 20-21°C, 3-24 h at 37°C, 6-20 min at 56°C) > 4 months at -70 to -20°C < 24 h at 25°C on solid material 9 to 11 d in water at 25°C/8 d in lagoon water at 4°C Prolonged exposure to UV light as well as chemical inactivation In solution, infectivity for 1-6 d at 20-21°C, 3-24 h at 37°C, and 6-20 min at 56°C	Benfield et al 1992 Bloemraad et al 1994 Dee et al 2002, 2003 Papatsiros 2012a Pirtle & Beran 1996 Zimmerman et al 2006

wk=week, d=day, h=hour, min=minute

Biosecurity Management Practices (BMPs). BMPs are a fundamental part of porcine herd health management programmes for the prevention of PRRSV infection, as well as for the improvement of the health status and productive performances at herd level (Papatsiros 2012a). According to Albina (1997), Le Potier et al (1997) and Weigel et al (2000), the risk of a herd becoming PRRSV-positive increases with:

- density of PRRSV-positive neighbouring herds;
- increasing herd size;
- high number of animal introductions;
- purchase of semen for artificial insemination;
- absence of quarantine for replacement boars and gilts.

The purpose of BMPs is either to stop the introduction of PRRSV into negative herds or limit the introduction of new strains into already PRRSV-infected herds (Dee et al 2001). However, the control of PRRS in a herd, continuously exposed to exogenous infection, is a loss of time and money. Biosecurity measures should be reviewed with regard to both internal and external biosecurity. External biosecurity focuses on the risk of introduction of new PRRS strains or other viral and bacterial co-infections from outside of the farm, while internal biosecurity deals with the spread of PRRSV within the farm, after the initial introduction of PRRSV (Papatsiros 2012a).

The basic elements of BMPs for a commercial farrow-to-finish farm or a sow unit are summarized in Table 2. As infected animals and contaminated semen are the main direct routes of PRRSV transmission, within and between pigs, all replacement animals (boars and gilts) should originate from PRRSV-negative farms (Le Potier et al 1997; Dee 1997). An isolation (quarantine) facility is a critical component of a PRRSV biosecurity programme. Ideally, isolation facilities should be located at distances greater than 120 meters from the breeding herd and ideally offsite, on another farm site. The quarantine period should last a minimum of 30 days, including serological tests and PRRSV vaccinations prior to their introduction into the herd. Blood samples should be collected

24-48 hours after the arrival of replacement animals to the isolation facility as well as 60 days prior to their entry to the breeding herd of the swine farm.

Table 2

Basic elements of Biosecurity Management Practices (BMPs) for commercial swine farms

Transmission routes	**BMPs**	**References**
Replacements animals Gilts source	PRRSV-negative or at least non-shedding Site of gilt production: far away from any other pig facilities Quarantine and testing: minimum of 30 days before the introduction into the herd Separate building for isolation than the main unit	Yoon et al 1993 Dee 1997 Papatsiros 2012a Wills et al 2002
Semen source	PRRSV-negative boar stud Unit under air filtration or far away from other pig facilities	Yoon et al 1993, Christopher-Hennings 2001
Housing facilities	Washing/disinfecting/drying between batches (strictly applied in farrowing rooms, nursery and finisher stage) All-in-all-out (AIAO) pig flow Removal of all organic material (faeces, urine, feed, bedding and body fluids) + power washing of the surfaces Proper sanitation: efficacious disinfectant Adequate downtime or drying time after disinfection Hospital pen/recovery pen for sick pigs	Scheidt et al 1995 Wills et al 2002 Pitkin et al 2011
Equipment/ instruments	One set of processing equipment is disinfected, other in use Changing coveralls and boots – disposable boots and gloves between litters Cleaning of boots, hands and coveralls Bleach boot baths or bag-in-a-box shipping methods Separate equipment (shovels, brooms, scrapers) for the manure passage and the feed alley Changing needles regularly Washing and heating (propane burner) between litters Disinfection after using Disinfection of all incoming supplies – "Double bagging" supplies Specific room for disinfection and drying room of fomites	Otake et al 2002a,b Dee et al 2002; 2003; 2004a Pitkin et al 2011
Personnel/ Visitors	Minimize the numbers of visitors Shower-in/-out: a procedure upon entry to the farm each day One-night down time before entering a farm Washing hands Sanitizers contain iodine and hand washing Fomites belonging to the farm Disposable coveralls and boots or footbaths Changing baths of disinfectant at least every day No entry for equipment, tools or materials, having previous contact with pigs on other farms	Otake et al 2002 Pitkin et al 2009a; 2011 Papatsiros 2012a
Transport	Washing Removal of all organic material (faeces, urine, feed, bedding) Disinfection Drying – adequate drying time after disinfection The use of high volume warm air for drying	Dee et al 2002; 2004b,c
Insects	Insect screen	Otake et al 2002c; 2003a,b Schurrer et al 2004
Aerosols	Air filtration	Otake et al 2002d Pitkin et al 2009b Dee et al 2010; 2011
Hygiene	Disinfectants Washing of boots at the end of the day, using brush and bath of disinfectant (new disinfectant solution every day) Scrape sow's manure each day in the farrowing room with a shovel (1 shovel per room) Carcass disposal: compost or incineration	Shirai et al 2000 Pitkin et al 2011

All incoming animals should be monitored daily for clinical signs by expert personnel, who must visit the isolation facility at the end of the working day. Moreover, semen for artificial insemination should come from PRRSV-negative boar studs because transmission of PRRSV via semen and boars may occur. Shedding of PRRSV in semen may be intermittent and quite variable in duration between boars; viremia is usually absent; and boars may still harbour infectious virus in tissues even after serum (Christopher-Hennings 2001).

Indirect transmission involves transmission by fomites (boots and coveralls), contaminated equipment (e.g. needles), farm personnel and visitors, transport vehicles (contaminated trailers, coolers, containers), substances (e.g. water, food), insects (e.g. houseflies and mosquitoes), or aerosols (Table 1). For this reason, personnel should change needles often in order to avoid moving the PRRS virus from animal to animal via injection (e.g. sows and boars: discard after one injection / piglets: discard after each litter or pen) (Otake et al 2002b). Moreover, equipment that is used in piglet (i.e. instruments for castration, tooth-clipping or tail-docking) should be disinfected. Personnel should have one set of processing equipment in use and the other should be disinfecting.

PRRSV shedding in saliva, urine, and faeces is a high risk factor for the environmental contamination, creating the potential for transmission via fomites, personnel and vehicles (Table 1). All fomites, such as boots, hand gloves and coveralls should be kept clean plus the washing of hands in designated areas prior to entering the animal air space in order to reduce the risk of PRRSV spread by personnel between sites and buildings, tracking contaminated materials (e.g. manure, urine) of infected animals to naïve animals (Otake et al 2002a).

The use of disposable boots, disposable gloves between litters, bleach boot baths or bag-in-a-box shipping methods was highly efficacious in preventing mechanical transmission of PRRSV (Dee et al 2004a). In addition, separate equipment (shovels, brooms, scrapers) should be used for the manure passage and the feed alley at all times in order to reduce the risk of PRRSV spread. Swine farmers should work closely with veterinarians and regularly audit the compliance of personnel movement between facilities and the sanitation of incoming fomites to reduce the risk of PRRSV spread (Pitkin et al 2009a). Moreover, cleaning - disinfection and drying protocols should be applied in all transport vehicles, including external parts (e.g. wheels, trailer) as well as internal parts (e.g. pedals, floor mats, etc). All organic material (e.g. faeces, urine, feed, etc) should be removed and after the sanitation, it is important to be allowed adequate drying time. Drying appeared to be an important component of a sanitation program for ensuring PRRSV biosecurity of transport vehicles. The use of high volume warm air can decrease the amount of time needed for drying (Dee et al 2004b,c).

Moreover, separate shovels, brooms and scrapers should be used for the manure passage and the feed alley at all times in order to reduce the risk of viral spread from behind affected sows to the at-risk sows via the feed alley. In general, biosecurity efforts should focus on all inputs and outputs of the farms, such as pigs, supplies and materials, feed, water, personnel, removal of manure, and reclaims. In addition, the entry of pests such as rodents, insects, and birds from all buildings should be avoided (Zimmerman et al 2006). Finally, all-in-all-out (AIAO) pig flow is effective in controlling a variety of respiratory pathogens in swine farms (Scheidt et al 1995). This method is very effective in reducing the horizontal spread of PRRSV from older, infected pigs to younger, naïve animals. Although, AIAO does not directly control the transmission of PRRSV, it reduces the impact of secondary bacterial co-infections (Papatsiros 2012a). Furthermore, some pens should serve as hospital pens or recovery pens for sick pigs with clinical respiratory signs. The number of hospital and recovery pens required depends on the individual farm and current health status.

The disinfection is a crucial point of BMPs in a PRRSV-infected farm. As shown in Table 1, the survival of PRRSV in the environment is affected by factors, such as substrate, pH, temperature, relative humidity, and exposure to ultraviolet light. Improperly cleaned pens are a source of pathogens for the next group of pigs. Rooms should be washed thoroughly using hot water and a high-pressure sprayer, so that all visible organic matter is removed from floors, walls, feeders and drinkers. PRRSV is inactivated by lipid solvents, such as chloroform and ether (Benfield et al 1992). PRRSV is also relatively labile in the environment and particularly susceptible to heating and drying (Pirtle & Beran 1996). The most important step in the sanitation protocol for complete inactivation of PRRSV is the application of adequate downtime or drying time after disinfection. Cleaned and disinfected pens should be left to dry a minimum of 24 hours before pigs are placed, while barns should be allowed to dry for a minimum of 7-14 days between batches. Since PRRSV persists in cold and wet conditions (Dee et al 2002), all equipment and material used at the farm or for transport of pigs must be cleaned and dried (Dee et al 2004b,c). Finally, PRRSV can survive in lagoon effluent for up to 3 days at 20°C and for 7 days at 4°C. Contact with PRRSV-positive effluent can be a source of infection to naïve pigs. Therefore, producers that utilize recycled lagoon water in their waste management protocols may be at higher risk for external PRRSV introduction than those who use deep pits (Zimmerman et al 2006).

Finally, the filtering of air entering pig housing facilities has been proposed as a means to reduce the risk of airborne transmission of PRRSV from infected herds to at-risk populations (Pitkin et al 2009b). Therefore, air filtration is an effective means to reduce the risk of external PRRSV introduction to large breeding herds located in regions of high pig density (Dee et al 2010). Moreover, increased relative humidity may increase the survival time of respiratory pathogens in the room environment and increased ventilation rates may increase air speed, causing chilling. Chilling, due to the wide daily and rapid small temperature fluctuations, contributes significantly to the increased prevalence of disease by increasing stress levels in affected pigs. For this reason, ventilation and temperature controllers should be adjusted so as to ensure that they are set to control temperature fluctuation and daily variability (Papatsiros 2012a). The use of simple environmental testing equipment, such as humidity monitors, data loggers, air speed and gas testers is very important. PRRSV can also be inactivated through composting or incinerating carcasses.

Conclusions. More than two decades after its emergence, PRRS is still having a major impact on pig health, welfare and production worldwide. Even today, the reduction of economic losses in commercial swine farms is a challenge for farmers and swine veterinarians. The application of BMPs is an essential part of a herd health management programme in order to avoid the introduction of PRRSV strains into swine farms as well as to stop the PRRSV circulation into the herd. The updated knowledge about PRRS disease farm level is considered very important for the best application of BMPs. The implementation and maintaining of BMPs on a regular basis is a beneficial investment for swine farmers.

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