CASE REPORT

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Using vaccination and unidirectional pig flow to control PRRSV transmission

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Summary

Objective: To assess the effectiveness of a new protocol for the control of PRRSV spread in an infected finishing pig population.

Methods: PRRS vaccine was administered and unidirectional pig flow was used in a finishing pig unit to establish a noninfected population. After the protocol was completed, seronegative nursery pigs were introduced to the facility on a monthly basis, and their serostatus was monitored over a 4-month period. Previously infected and/or vaccinated pigs co-existed in the same airspace throughout the study.

Results: A seronegative finishing pig population was established over time after we marketed infected pigs and then introduced seronegative stock. One hundred percent (120 of120) of the samples collected after the study was completed were seronegative according to the indirect-fluorescent antibody test.

Implications: This control protocol may provide an option to control and potentially eliminate PRRSV from segregated finishing populations and does not require complete depopulation of the facility.

Keywords: swine, PRRSV, vaccine, pig flow

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Porcine reproductive and respiratory syndrome virus (PRRSV) was first identified in 1991.[1] Veterinarians have since developed numerous strategies, such as partial depopulation (PD),[2–6] to control the spread of the virus and prevent the clinical disease. Depopulating the nursery or the finisher has prevented viral spread within infected populations, resulting in improved productivity and profitability within PRRSV-positive herds. The PD strategy calls for completely emptying an infected facility and thoroughly cleaning and disinfecting it. The facility is then allowed to sit empty for 7 days and is filled over time. While PD has been shown to be effective,[2–5] it is difficult to implement during periods of cold weather or when there are large inventories (> 1000 pigs) to depopulate.

Commercial PRRSV vaccines have been available since June 1994 (RespPRRS®, Boehringer Ingelheim Animal Health/NOBL Laboratories, St. Joseph, Missouri). Such products are modified-live virus preparations. The transmission of vaccine virus has been reported to occur between vaccinated pigs and nonvaccinated contact controls.[7] The spread of field PRRSV is also enhanced when carrier pigs shed virus to subpopulations of naïve swine that coexist within the same population.[8] Published reports have also demonstrated that regularly introducing seronegative, naïve pigs into infected populations enhances the spread of virus and maintains the infection.[9]

Vaccination has been suggested as a potential means to eliminate naïve subpopulations and to control the spread of field virus within infected herds. Although vaccination generates a detectable humoral immune response, it is the cellular immune response that is thought to be responsible for inducing protection.[10] At this time, little is known of the characteristics of the cellular immune response that is generated after a naïve pig is infected. A recently published paper[11] has observed in-vitro evidence that the cellular immune system is capable of generating an anamnestic response following re-exposure to field virus. Whether a similar response could be detected after repeated exposure to vaccine virus was not assessed; however, administering multiple vaccinations (hyperimmunization) has been reported to prevent the spread of vaccine and field virus from lactating sows to piglets.[12]

The purpose of this paper is to describe a new protocol for controlling the spread of PRRSV through the use of mass vaccination and unidirectional pig flow. The protocol was based on the following four hypotheses:

- Eliminating seronegative subpopulations through the process of mass vaccination will prevent the spread of field virus within the population.
- Hyperimmunization of the entire population will prevent the spread of vaccine virus.
- Establishing a unidirectional pig flow by preventing naïve pigs from being introduced into the hyperimmunized population for a controlled period will produce a noninfectious population.
- Once established, the noninfectious population will be incapable of transmitting field or vaccine virus, allowing both strains to be eliminated as vaccinated, infected pigs are marketed and naïve replacements are introduced over time.

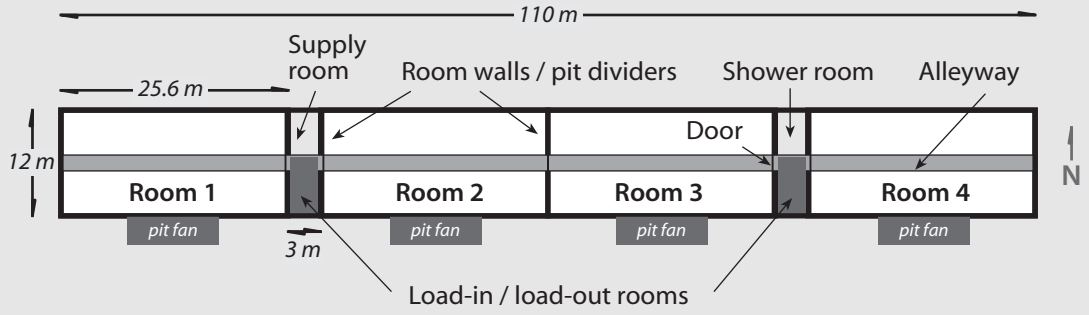
Materials and methods

Herd history

The study herd consisted of 800 sows. Multisite production techniques were used. The breeding, gestating, and farrowing (site 1) facilities were located 0.3 km (0.5 miles) from the nursery (site 2). The

SAD: Swine Health Center, Morris, Minnesota 56267; RP: NOBL Laboratories

Figure 1



Site 3 finishing facility

finishing facility (site 3) was located 15 km (25 miles) from site 2. The herd was a shareholder in a PRRSV-negative seedstock company, and had been determined to be negative to PRRSV through a regular program of serologic monitoring over a 3-year period.

The initial PRRSV infection was detected in the site-3 finishing facility during September 1996. The source of the virus was not determined; however, it was not due to the introduction of infected pigs. The nursery that served as the source of the pigs in this trial had been determined to be negative through a regular monthly testing program in which 30 pigs had been serosampled every quarter over the previous 5 years. In conjunction with regulatory testing for Aujezsky's disease virus (pseudorabies virus), random serologic samples had been collected from sites 1 and 3. Sites 1 and 3 were tested every 30 days, and the site 2 population was sampled on a quarterly basis and analyzed using the indirect-fluorescent antibody (IFA) test. During the month of September 1996, all three sites had been sampled. Antibodies to PRRSV were detected in 16 of 30 samples collected from site 3. Positive samples were detected in pigs from only one of the four rooms within the site-3 facility, and antibodies were not detected in serologic samples from sites 1 and 2.

Clinical signs detected in the finishing population included elevated mortality (0.5%–1.5%) and an increased incidence of respiratory disease. Approximately 50% of the pigs in the building were affected. In order to assess the spread of the infection, 10 random samples were collected from the remaining three rooms later in the month. Because the producer wished to sell PRRSV-negative seedstock, the ability to eliminate the virus was assessed. Complete depopulation of the finishing facility was considered; however, due to the impending winter weather it was not feasible for the building to remain empty for an extended period. Therefore, the protocol of mass vaccination and unidirectional pig flow was devised as an alternative means of eliminating the virus.

Building design

The facility consisted of four rooms (rooms 1 through 4), each 25.6 m × 12 m (84 × 40 ft), which was adequate capacity to house 400 pigs from 25–110 kg (55–242 lb). Thus, the facility totaled 110 m × 12 m (360 × 40 ft). Designated "load out" rooms (6.7 m × 3m, 22 × 10 ft) were included to allow pigs to enter and exit (Figure 1). Rooms were filled over a 4-week period, with 100 pigs entering the building each week. When pigs reached 110 kg (242 lb), the entire room was emptied, washed, and disinfected; however, due to the schedule of pig flow, only one room was emptied each month. Each room contained 20 pens, and pigs remained in the same pen throughout the finishing period. Twenty pigs were placed in each pen, with 0.68 m^2 (7.5 sq ft) of space allowed per pig. Open gating was provided between all pens, and the flooring throughout the entire building was total slatted concrete. An alleyway extended down the length of each room throughout the entire facility. A plywood wall separated each room. Concrete partitions were used to establish individual pit compartments; each pit compartment was 2.5m (8 ft) deep.

The building was a curtain-sided, naturally ventilated facility. During the winter months, the curtains remained closed and air was drawn through ceiling inlets. Each pit compartment was ventilated mechanically and these fans ran continuously throughout the year. All people working in the building were required to shower in and out of the building at all times, and movement of employees between sites occurred only under emergency conditions.

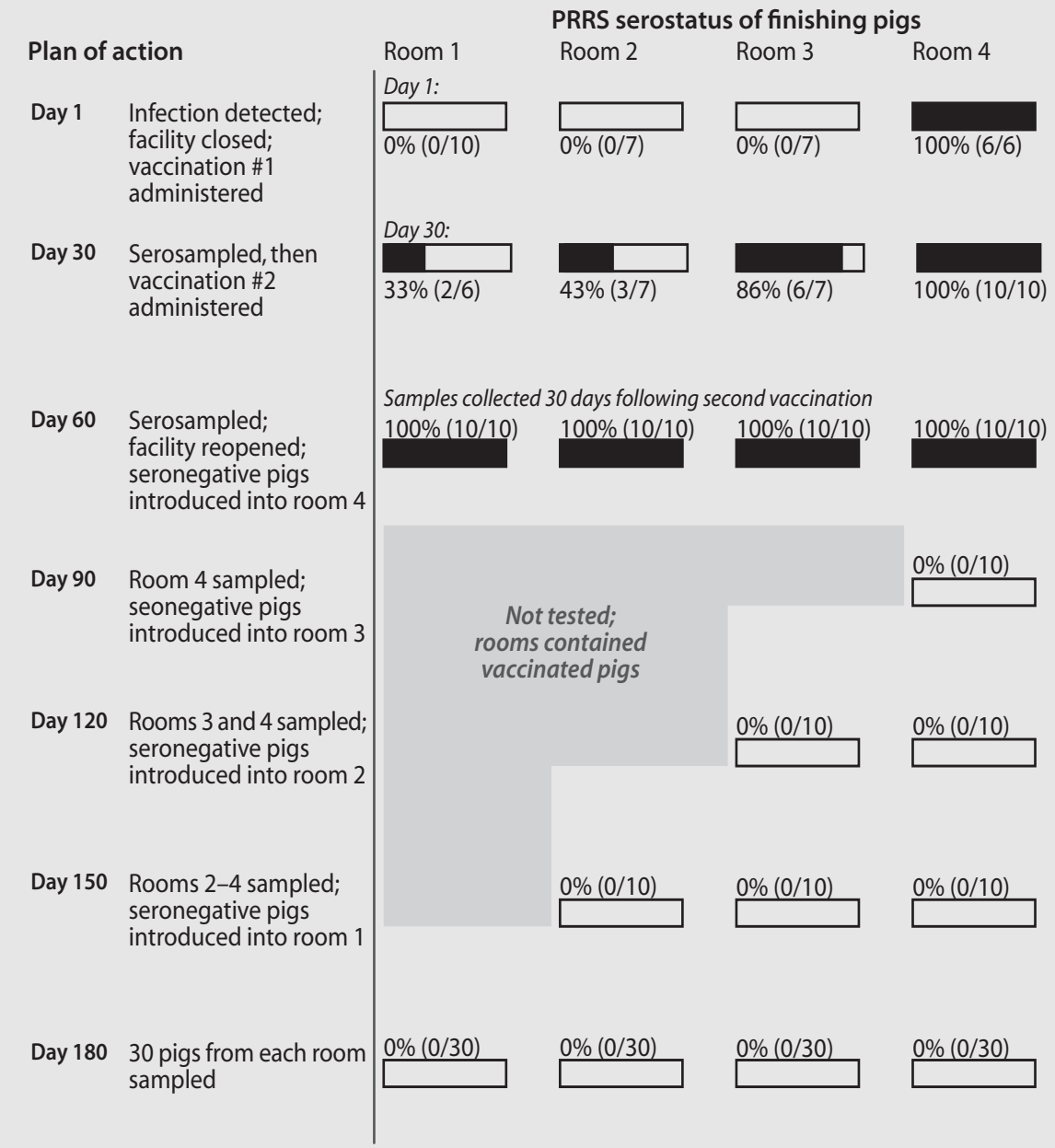
Unidirectional pig flow protocol

Immediately after the infection was detected, alternative finishing facilities were rented to establish a unidirectional pig flow and prevent naïve nursery pigs from being introduced into the facility (Figure 2). Based on the capacity of the rented buildings, it was calculated that the finishing building could remain closed to new pigs for a maximum of 60 days. During this period, pigs that had attained 110 kg (242 lb) continued to be sold to slaughter, maintaining the unidirectional flow. As each room was emptied, it was washed using 90°C (194°F) water, disinfected with a phenol-based compound, and allowed to dry for a period of 2–3 days. Over the 4-month study, one room was emptied each month, and pit compartments were not emptied. Finally, the traffic pattern of personnel was not altered at any time during the study, except that a change of footwear was required between infected and cleaned rooms.

Protocol of mass vaccination and hyperimmunization

The vaccination protocol was carried out for a 60-day period (Figure 2). On a designated date (day 1), all pigs within the facility were

Figure 2



Plan of action and PRRS serostatus of finishing pigs immediately postinfection and throughout the course of the study

intramuscularly vaccinated with 2.0 mL of RespPRRS®. Thirty days later, the vaccination was repeated. No further use of vaccine was employed at any time during the study.

Monitoring protocol

At the end of the 60-day period, the first group of nonvaccinated, naïve nursery pigs was allowed to enter the site-3 facility (Figure 2). Once a room was completely repopulated with nonvaccinated pigs, a serological sample was obtained from 10 pigs, each randomly selected from 10 pens, also randomly selected from that room. Sample sizes were calculated to be 95% confident of detecting at least one positive pig if the prevalence of the infected population was ≥ 30% and samples were analyzed by IFA test.[13]

Over the course of the 4-month finishing period, each room was filled with seronegative pigs, and sampling was repeated in the most recently repopulated rooms and all previously repopulated rooms. After the fourth and final room was repopulated, 30 random serologic samples were collected from pigs in all rooms. This sample size was calculated to be 95% confident of detecting at least one positive pig if the prevalence of infection within the population was ≥ 10%.

Statistical analysis

Frequency of IFA-positive results by week were analyzed with the Cochran-Mantel-Haenszel test using SAS (SAS version 6.10, Cary North Carolina).

Results

According to the data collected during the first month post infection, field virus spread rapidly throughout the building; however, not every pig became infected. Repeatedly administering the vaccine did not result in any visible side effects. After the seronegative, nonvaccinated pigs from the site-2 nursery were introduced into the facility, seroconversion was not detected at any time during the 4-month repopulation process (Figure 2). At the end of the study, all 120 samples from pigs in all four rooms were negative for antibodies to PRRSV. This prevalence was significantly reduced from the prevalence at the initiation of the study ($P = .01$). We observed no clinical signs of PRRS-related respiratory disease similar to those described after the initial infection at any time during the repopulation process.

Discussion

The true source of infection in this herd was never determined. Based on the testing of nursery pigs, it was determined that the nursery was not infected. Other finishing facilities, managed by the same personnel, remained seronegative at all times. The facility was well isolated (3 km, 2 miles) from other swine.

The diagnostic data indicate that transmission of PRRSV field virus and vaccine virus did not occur throughout the study. During the 4-month period required to market the infected/vaccinated pigs, seroconversion was not detected in any of the nonvaccinates tested. Before the study was initiated, serological monitoring indicated that field virus was capable of spreading through the facility, but that not all pigs were infected (Figure 2). Therefore, one would speculate that if field virus or vaccine virus was actively spreading throughout the population, naïve pigs should have seroconverted. The inability to detect seroconversion suggests that a noninfected population was maintained with the vaccination and unidirectional pigflow protocol. This strategy has been applied to control and eliminate other swine pathogens.[14]

At no time during the present study were all four rooms simultaneously depopulated. Only one room was emptied each month over the 4-month study period. This is in contrast to previous descriptions of nursery depopulation in which all nursery rooms were simultaneously depopulated.[2–4] Each month, before nonvaccinated pigs were introduced from the site-2 nursery, the finishing room was emptied and cleaned. Therefore, it was important to create a noninfectious population, because rooms of infected and/or vaccinated pigs were housed within the same airspace as the nonvaccinated, naïve subjects throughout the 4-month repopulation period.

While the diagnostic data indicate that both vaccine and field virus have been eliminated from the population, whether this is true will depend on further testing over time. Seromonitoring of this herd has continued on a monthly basis. Ten samples per room have been collected each month and seropositive pigs have not yet been detected in any section of the building over the 10-month period since the study has been completed. One could argue that sample sizes should be increased to improve the sensitivity of the sampling methods; however, based on the high seroprevalence detected postinfection, the sampling methods employed should be capable of detecting infection quite accurately.

Our results were based on data collected on only one farm; to determine whether the protocol described could be effectively applied in other herds, it is necessary to replicate the study in other segregated finishing populations. Follow-up studies are currently in progress and preliminary results appear promising. As of this writing, the protocol has been repeated in an unrelated finishing facility with identical results over an 8-month period since the protocol was completed. It is still unclear whether this protocol would be effective in one-site production systems. This study is currently underway. If virus circulation is limited to the finishing population, it may be effective. However, if active virus infection is present in the breeding herd, its success may be limited.

One of the original hypotheses stated that multiple doses of vaccine (hyperimmunization) will reduce the spread of vaccine virus; however, we could not test this hypothesis. This study did not determine whether two doses of vaccine were more effective than a single dose. To do so would require us to repeat the protocol, yet only administer a single dose of vaccine. If successful, the protocol would not only be more cost-effective, it would also reduce the stress on the labor force and the pigs. Administering two vaccinations, however, reduces the risk of improperly vaccinated or nonvaccinated pigs existing in the population.

If the results of this study can be reproduced over a large number of herd systems, it may provide the ability to control and/or eliminate PRRSV within infected finishing populations without requiring complete depopulation of the facility.

Implications

- Partial depopulation cannot be applied to control PRRSV transmission in all cases; therefore, new protocols are needed.
- The spread of PRRSV is maintained in a herd through the presence of naïve subpopulations.
- We created a noninfectious population in a finishing herd using vaccination and unidirectional pig flow.

References

1. Wensvoort G, Terpstra C, Pol JMA, et al. Mystery swine disease in the Netherlands: The isolation of Lelystad virus. *Vet Q*. 1991; 13:121–130.

2. Dee SA, Joo HS. Prevention of PRRSV spread in endemically infected swine herds by nursery depopulation. *Vet Rec.* 1994; 135:6–9.

3. Dee SA, Joo HS, Polson DD, et al. Evaluation of the effects of nursery depopulation on the persistence of porcine reproduction and respiratory syndrome virus and the productivity of 34 farms. *Vet Rec*. 1997; 140:247–248.

4. Dee SA, Joo HS, Polson DD, Marsh, WE. Evaluation of nursery depopulation on the profitability of 34 pig farms. *Vet Rec*. 1997; 140:498–500.

5. Dee SA, Joo HS, Pijoan C. Controlling the spread of PRRSV in the breeding herd through management of the gilt pool. *SHAP*. 1994; 3:64–69.

6. Dee SA, Morrison RB, Joo HS: Eradication of PRRSV using multi-site production and nursery depopulation. *SHAP*. 1993; 1:20–23.

7. Torrison JL, Knoll M, Wiseman B. Evidence of pig-to-pig transmission of a modified live PRRSV vaccine. *Proc AASP Annual Meeting*. 1996: 89–91.

8. Dee SA, Joo HS, Henry S, et al. Detecting subpopulations after PRRSV infection in large breeding herds using multiple serologic tests. *SHAP*. 1996; 4:181–184.

9. Dee SA, Joo HS. Clinical investigation of recurrent reproductive failure associated with PRRSV infection in a sow herd. *JAVMA*. 1994; 205:1017–1018.

10. Gorcyca DE, Schlesinger KJ, Geeding PW, et al. Protection against reproductive disease caused by PRRSV by vaccinating with a MLV PRRS vaccine prior to breeding. *Proc 14 IPVS Congress*. 1996;66.

11. Bautista EM, Meulenberg JM, Choi S, et al. PRRSV-specific T cell responses in infected and vaccinated pigs. *Proc 14 IPVS Congress*. 1996;63.

12. Dee SA, Joo HS, Park BK, et al. Attempted elimination of PRRSV from a seedstock herd using breeding herd and nursery depopulation. *Vet Rec* (accepted for publication).

13. Yoon IJ, Joo HS, Christianson WT. An indirect-fluorescent antibody test for the detection of antibody to PRRSV in swine sera. *J Vet Diagn Invest*. 1992: 4:144–147.

14. Wiseman BS, Harris DL, Curran BJ. Elimination of TGE virus from a herd affected with enzootic form of the disease. *Proc AASP Ann Meet*. 1988: 145–149.