

Comparison of techniques for controlling the spread of PRRSV in a large swine herd

Gonzalo Bruna, DVM,MS; Salvador Cabeza de Vaca,[†] DVM,MS; HanSoo Joo, DVM,PhD; Carlos Pijoan, DVM,PhD

Summary

Objective: To evaluate medicated offsite weaning (MOW), partial depopulation (PD), and the use of a modified live virus vaccine (MLV) as possible techniques to control porcine reproductive and respiratory syndrome virus (PRRSV).

Methods: Four groups of 30 pigs from a PRRSV-infected farm were included in the study. Serum antibody responses to PRRSV (IFA), Mycoplasma hyopneumoniae (Tween-ELISA), and Actinobacillus pleuropneumoniae (BAHIA) were examined and bacteriology was performed at days 21, 35, 60, 90, 120, and 150 in all groups. We also measured average daily gain (ADG), mortality, and incidence of cough from 10 days of age to slaughter. PigMON[®] data were collected at slaughter.

Results: MOW was the only technique able to maintain PRRSV-negative animals. PD and MLV resulted in a decrease in PRRSV seroprevalence. Even though PD was unable to eradicate PRRSV, performance was improved after this procedure was initiated. Differences in performance were not seen between the PD and MLV groups.

Implications: Medicated offsite weaning may be able to stop the spread of PRRSV. Partial depopulation will reduce the decreased growth performance associated with PRRSV. Modified-live virus vaccine did not improve performance compared to partial depopulation in herds infected with PRRSV.

Keywords: swine, PRRSV, MEW, depopulation, vaccine

Received: Nov 3, 1995

Accepted: Nov 29, 1996

Herds infected with porcine reproductive and respiratory syndrome virus (PRRSV) experience reproductive losses followed by an increased intensity of pneumonia and poor growth in the nursery and finishing stages. The reproductive phase of the disease can last 2-3 months, but postweaning problems tend to become endemic. Some herds do not experience the clinical reproductive phase,¹⁻⁵ but exhibit nursery and grow-finishing problems associ-

ated with secondary infections.⁶ After the onset of disease, the sow herd usually becomes serologically stable, with low indirect fluorescent antibody (IFA) titers. Depending on the health status of incoming seedstock and on management practices in the herd, the virus can stop spreading.³

Several approaches to control PRRSV have been suggested, including depopulation-repopulation, test and removal, multisite production, segregated early weaning (SEW), and partial depopulation (PD).² Partial depopulation (PD) has proven very successful in eradicating disease while not dramatically affecting production, pig flow, or net profit of the operation. The following study was conducted in an effort to compare PD with SEW and use of modified-live virus (MLV) vaccine as means of eradicating PRRSV, controlling secondary infections, and improving production.

Materials and methods

Farm history

The trial was conducted in a 1400-sow farrow-to-finish seedstock herd that became infected with PRRSV in 1992 (Figure 1). Endemic respiratory problems, diarrhea, and *Streptococcus suis* meningitis increased in the nursery pigs, despite the use of antibiotics. The farm used all-in-all-out (AIAO) animal flow in the eight farrowing and seven nursery rooms. The mean weaning age was 21 days.

At the start of the control program (February 1993), incoming seedstock were quarantined before being placed in an on-farm gilt pool. Paired serum samples were tested for PRRSV antibody by IFA to confirm negative or decreasing titers in the gilts during the quarantine. Serological monitoring for PRRSV antibodies in the breeding herd was also started in February 1993.

The herd was closed to incoming animals during the entire summer of 1994, which resulted in a low prevalence (<10%) of seropositive breeding animals in September. At that time, the virus seemed to be present only in the nursery and grow/finish pigs. A PD protocol was implemented during September 1994. The nursery rooms, grower, and finisher (gilt development) were washed, disinfected, and emptied for 2 weeks. However, 3 weeks later the procedure had to be repeated, as the first attempt had failed to eliminate the virus from the nurseries.

After the second depopulation attempt, the farm started using a PRRS modified-live virus vaccine (MLV-RespPRRS[®], NOBL Laboratories, Iowa) in all animals. Piglets received their first intramuscular vaccine

College of Veterinary Medicine, Department of Clinical and Population Sciences, University of Minnesota, St. Paul, Minnesota, 55108.

[†]deceased February 1997

This article is available on the AASP Web site at:

<http://www.aasp.org/shap/issues/v5n2/index.html>

dose at 14 days of age and a second dose at 28 days of age; all breeding stock were also vaccinated. The piglet vaccination protocol was continued for 2 more months (November and December 1994), and then the breeding herd was vaccinated every 6 months.

Experimental design

Four groups of 30 pigs were monitored from 10 days of age to slaughter. Piglets in all groups were weaned at 21 days of age:

- control group -- These pigs followed the normal farm flow.
- medicated offsite weaning (MOW) group - 150 pigs weaned at 21 days in September 1994 were placed in a mechanically ventilated offsite nursery unit with six pigs per pen (University of Minnesota Experimental Station at Waseca). Thirty of the 150 pigs were randomly selected, ear tagged, and monitored. On arrival, all pigs were injected once subcutaneously with 300 µg per kg ivermectin (Ivomec[®], Merck) and intramuscularly with 50 mg ceftiofur per pig (Naxcel[®], UpJohn). Tiamulin (Denagard[®], Fermenta) was given at 180 ppm in drinking water for 2 weeks.
- partial depopulation (PD) group--Thirty pigs entering the nursery (of a total of 325 pigs) after the second PD protocol⁷ were randomly selected, ear tagged, and monitored. Because of the use of MLV vaccine, these animals were all seropositive at 60 days of age. For this reason, this PD group was only monitored until the last day before vaccination. Therefore, only nursery data will be presented for this group.
- piglets born from vaccinated sows (MLV) group--Thirty pigs from a group of 325 were monitored beginning at weaning in January 1995; these were not vaccinated, but were farrowed by sows that had been vaccinated with MLV vaccine (MLV-RespPRRS[®]) 4 weeks prior to farrowing.

Serological analysis

Blood samples were taken at 21 (weaning), 35, 60, 90, 120, and 150 days of age for the PRRSV IFA test.⁸ The breeding herd was also monitored serologically during the experiment to detect virus circulation in these animals. Tween-ELISA for *Mycoplasma hyopneumoniae*,⁹ and blood agar hemolysis inhibition assay (BAHIA) for *Actinobacillus pleuropneumoniae* APX-III and APX-II were also performed on all the pigs' sera.

Bacteriological analysis

All experimental pigs were swabbed in the oropharynx-tonsillar area on days 10, 21, 28, 35, 60, and 120 of age for bacterial isolation. Bacteriological cultures included direct plating on blood agar and on McConkey 1% glucose agar. In addition, swabs were resuspended in a brain heart infusion (BHI) broth, supplemented with 16 mg per 100 mL nicotine adenine dinucleotide (NAD), 3.5 µg per mL bacitracin,

Figure 1

1992		• 1400-sow herd became infected with PRRSV
1993	February	• incoming seedstock quarantined • paired serum samples to test for PRRSV by IFA • serological monitoring for PRRSV antibodies
1994	September	• herd closed to incoming animals • control group established • first PD protocol implemented • <10% seropositive breeding animals • MOW group weaned
	October	• second PD protocol implemented • MLV vaccine program initiated
	November	• piglet vaccination
	December	• piglet vaccination
1995	January	• MLV piglets weaned

Study timeline

and 2 µg per mL neomycin. This suspension was diluted tenfold to 10:4 and incubated overnight. The broth was then plated on blood agar with a *Staphylococcus aureus* nurse streak or on 5% CO₂ from the highest dilution showing turbidity. Bacterial colonies growing on the different media were identified using conventional microbiological techniques.

Performance monitoring

Average daily gain (ADG), weight at 60 days, and mortality rates were measured in all groups in the different stages of production.

PigMON[®] scoring system

Lesions at slaughter were scored with the PigMON[®] system¹⁰ in all groups.

Cough index

Frequency of cough was measured using methods previously described⁸ at 21, 28, 35, 60, 90, 120, and 150 days of age. Individual coughs were counted for periods of 3 minutes as well as 15 minutes per group. One coughing animal represented one unit in the cough index.

Statistical analysis

Differences in ADG and weight at 60 days were analyzed by a general linear models procedure (SAS).¹¹ Mortality rate was evaluated using analysis of variance (SAS). No statistical analysis was performed on the serological data.

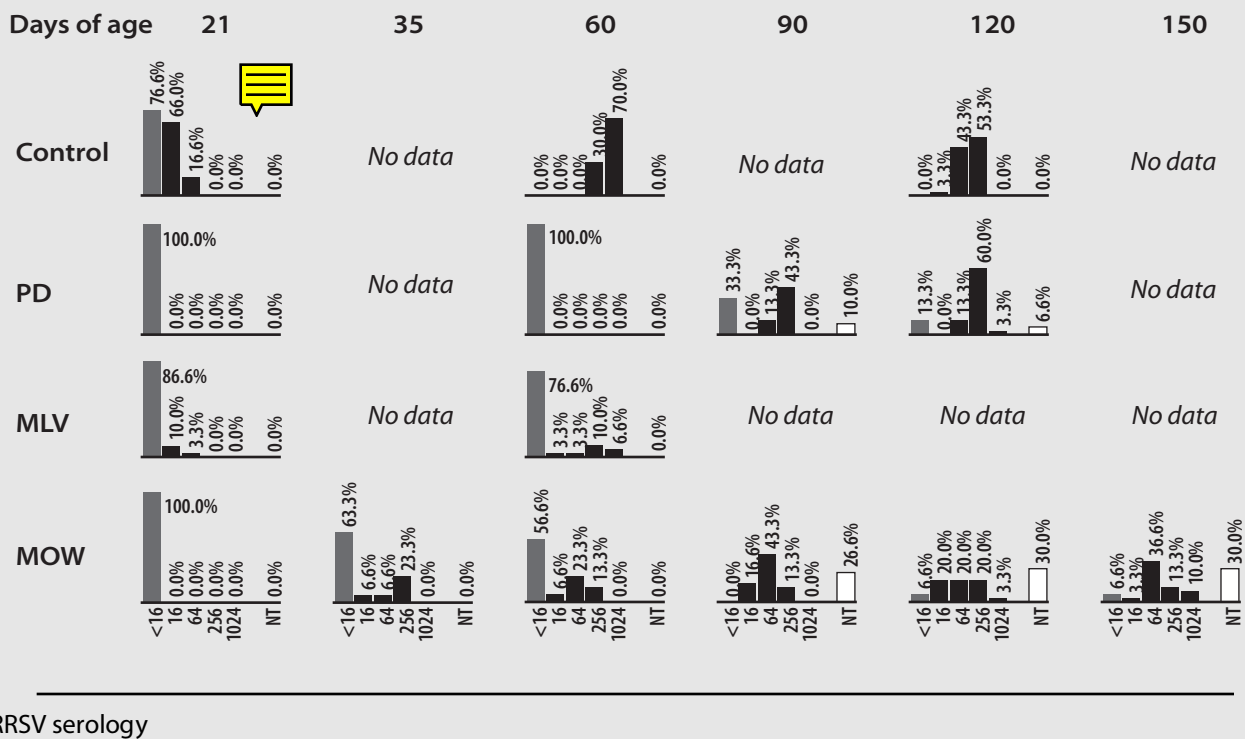
Results

Serological analysis

PRRSV-IFA

Pigs in the control group at 21 days of age were seronegative or had low positive titers of a maximum of 1:64 (16.6%) (Figure 2). However, at 60 days of age, 100% of the pigs had titers 1:256. Pigs in the MOW group were seronegative at both 21 and 60 days of age. This group was

Figure 2



then commingled in a grow-finish unit with pigs infected with PRRSV, and became seropositive. The pigs in the PD group were seronegative at weaning, except one pig that had a 1:64 titer. However, at 60 days of age (prior to vaccination), seroconversion was observed in 20% of the group. The MLV group pigs also had an intermediate seroconversion with 44% positive animals at 60 days of age.

Mycoplasma ELISA

Control group pigs had seroconverted at 60 days of age. Medicated offsite weaning and MLV group pigs were seronegative at 60 days of age, seroconverting by 120 days of age (Figure 3). The PD group had not seroconverted at 60 days of age, which was the last time they were monitored.

A. pleuropneumoniae BAHIA

In all groups passive antibodies were detected until 35 days of age. Seroconversion was not observed in the grow-finish stage (Figure 4).

Bacteriological analysis

Streptococcus suis, *Bordetella bronchiseptica*, and *Actinobacillus suis* were isolated in all groups with differences among age and frequency of isolation (Table 1). *Actinobacillus pleuropneumoniae* serotype 1 and *Salmonella choleraesuis* were isolated at day 100, but only in necropsied animals belonging to the control group. In the PD group, *Haemophilus parasuis* was isolated in a 50-day-old necropsied animal.

Performance monitoring

Mortality rates during the nursery stage did not differ significantly among the four treatment groups (Figure 5). In grow-finishing pigs, mortality was significantly higher in the control group than in the MOW or MLV groups ($P < .005$).

In the nursery stage, ADG was significantly lower in the control group than all other groups ($P < .02$) (Figure 5). MOW pigs in the nursery stage had significantly better ADG than all other groups ($P < .02$).

Weight of the animals at 60 days of age also differed significantly among all the treatment groups, with control pigs having the lowest weights ($P < .02$). The pigs in the MOW group had the highest weight at 60 days of age ($P < .0002$) (Figure 5).

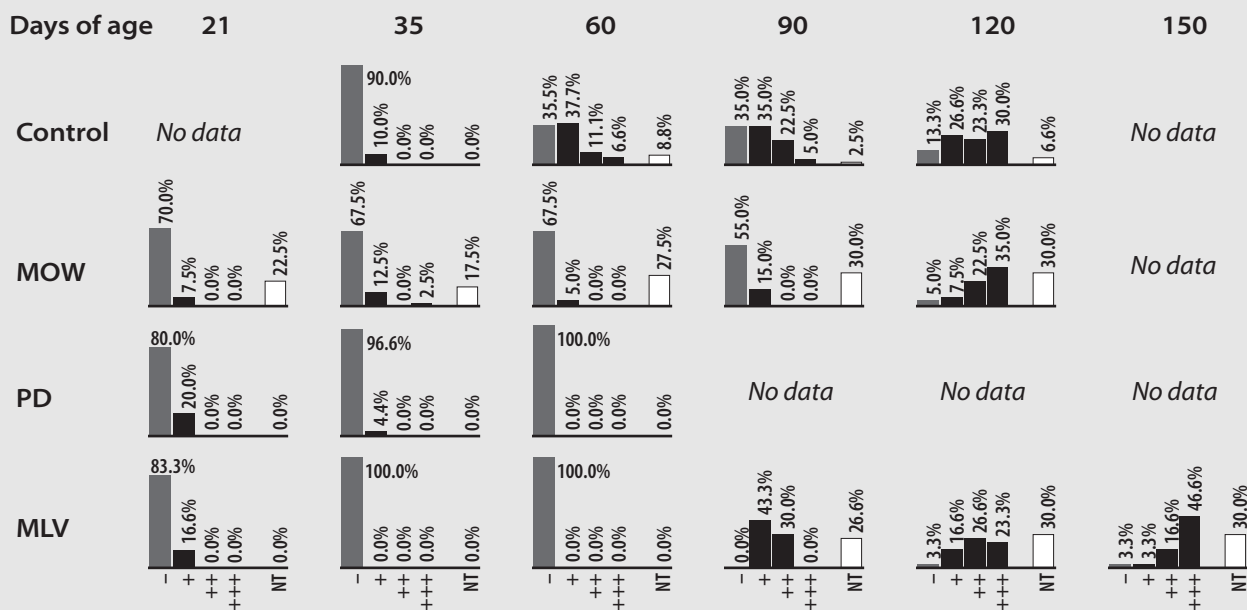
PigMON® scoring system

Prevalence of enzootic pneumonia (EP) was highest in the control group pigs at slaughter (Table 2), and lowest in MOW pigs. Lung lesions were less severe in pigs in the MLV treatment group, and most severe in the control pigs.

Cough index

Pigs in all groups showed an increase in the cough index during the grow-finish stage (Figure 6). Control and MOW animals had the highest indexes. However, the cough index per animal was low in all groups, suggesting that pneumonia was not an important clinical problem in this herd..

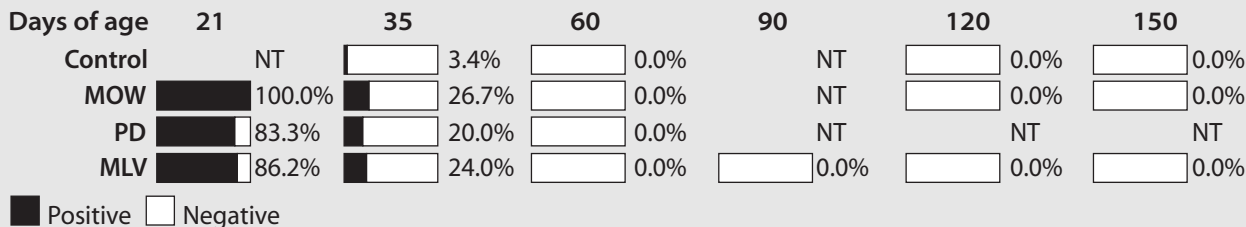
Figure 3



Mycoplasma hyopneumoniae serology. ELISA optical density ranges:

- <400
- + 400-700
- ++ 700-1000
- +++ >1000

Figure 4



Actinobacillus pleuropneumoniae BAHIA serology results

Discussion

PRRSV

The clinical history and diagnostic results indicate that PRRSV was spreading within the herd after the PD procedure. In the first PD attempt, the nursery rooms were washed and disinfected only once. However, the exhaust fans had not been turned off during the disinfection process. Post-disinfection inspection revealed that the pits had not been properly washed and flushed. Fecal debris was found in the pits and on the wood boards that had been placed on the floor for creep feed. Fecal samples from these sites were taken to the University of Minnesota Diagnostic Laboratory, which failed to isolate virus. Second and third washing and disinfections were then completed in nursery rooms 4, 5, 6, and 7 with the wood boards kept in the rooms.

However, pigs that later entered these rooms slowly seroconverted to PRRSV. Fecal debris could have protected the virus from the disinfectants, and the wood boards might have been virus reservoirs between groups, although viral isolation attempts from these materials were negative.

Another possible cause of the recirculation of PRRSV in the herd was building design. There is a common hallway among all buildings of the farm. Pregnant gilts go from the gilt pool to the gestation barn through this hallway, which is next to the nursery rooms. The virus could also have been carried on fomites by personnel from nursery rooms 1, 2, 3, which housed infected animals, to the rest of the nursery rooms 4, 5, 6, and 7. The distance between the gilt barn and the nursery rooms was approximately 15 meters. The exhaust fans of the gilt barn were

Table 1

Bacteriological isolation							
	Age in days						
	10	15	21	28	35	60	120
Control	<i>S. suis</i> 3 <i>A. suis</i>	<i>S. suis</i> 3 <i>A. suis</i>	<i>S. suis</i> 3 <i>A. suis</i>	<i>S. suis</i>	<i>S. suis</i>	<i>S. suis</i> 1, 5, 6 <i>A. suis</i> <i>B. bronchiseptica</i>	<i>S. suis</i> 5, 6, 7 <i>A. suis</i> <i>A. pleuropneumoniae</i> 1* <i>S. cholerasuis</i> *
MOW	NT	NT	NT	<i>S. suis</i> 5 <i>A. suis</i> <i>B. bronchiseptica</i>	<i>S. suis</i> 3, 4, 6 <i>A. suis</i> <i>B. bronchiseptica</i>	<i>S. suis</i> 4, 9 <i>A. suis</i> <i>B. bronchiseptica</i>	<i>S. suis</i> <i>A. suis</i> <i>B. bronchiseptica</i>
PD	NT	NT	<i>S. suis</i> 1/2, 1, 2, 3 <i>A. suis</i>	<i>S. suis</i>	<i>S. suis</i> <i>A. suis</i>	NT <i>H. parasuis</i> *	NT
MLV	NT	NT	<i>S. suis</i> 1/2, 1, 2, 3 <i>A. suis</i>	<i>S. suis</i> 1/2, <i>A. suis</i>	<i>S. suis</i> 1/2, <i>B. bronchiseptica</i>	<i>S. suis</i> 1, 5	<i>S. suis</i> 1, 2, 5 <i>B. bronchiseptica</i>
*	Isolated at necropsy						
NT	Not tested						
MOW	Medicated offsite weaning						
PD	Partial depopulation						
MLV	Piglets born from sows vaccinated with modified-live vaccine (MLV-RespPRRS®)						

set from East to West, and the ventilation in the nursery rooms was from North to South, which makes airborne transmission improbable.

The normal flow of labor was always from younger to older animals. Furthermore, footbaths were used among rooms during and after the PD protocol and labor traffic was restricted. These procedures would tend to minimize transmission, but only if they were strictly followed by the farm personnel. On the other hand, there were no facilities to allow personnel to wash their hands between rooms, which could also have been a means of transmission.

The presence of incoming seedstock may be the most likely explanation for the failure to eliminate virus in this farm. Gilts taken off the farm at the beginning of the depopulation period were brought back to the breeding barn 4 weeks later. Titers to PRRSV of 1:256 were found in seven of 13 of these animals. When IFA titers are trending upward and reach >1:256, it strongly suggests viremia, indicating that these gilts could have been the source of reinfection of susceptible animals in the breeding herd.

Sows with high constant serum titers (>1:256) were found in the gestation barn. These animals could have been carriers and shed the virus, even though they were negative to virus isolation from serum. Some experiments have demonstrated that virus can be isolated from the palatine tonsils for periods of up to 157 days post-infection, 134 days after the last isolation of virus from serum.⁶ Also, transmission of PRRSV by pigs infected as long as 15 weeks earlier has been reported.¹² Alternatively, these high titers in multiparous sows could be caused by reinfection of immunodeficient adult animals or of animals whose immunity had decayed sufficiently to leave them vulnerable to

reinfection; however, this explanation is only likely if we accept PRRSV immunity as temporary.

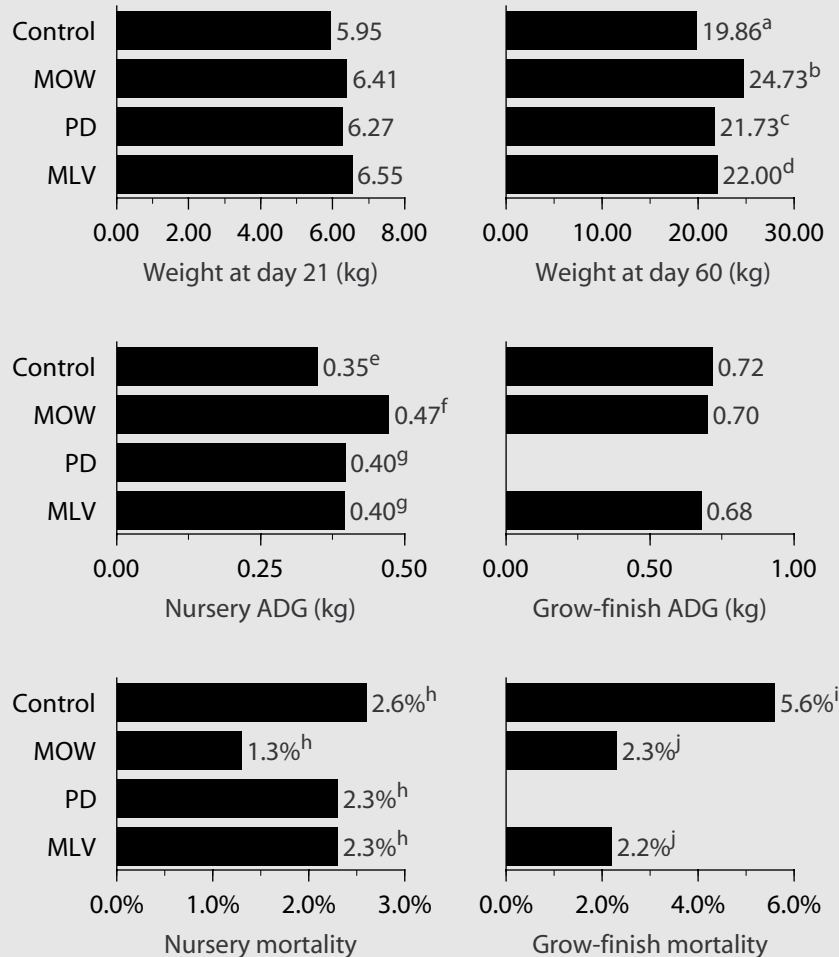
The existence of different field and virulent strains could be the reason for the re-appearance of clinical episodes in previously infected herds.

Herd size can be a determining factor in the success of a PD. Large herds (>1000 sows) have higher possibilities of maintaining an endemic PRRSV infection. If some animals in the gestation barn had escaped original exposure to the virus, it could result in the presence of small pockets of infected subpopulations in the gestation barns. In these large endemic herds with low virus circulation, it is possible that some gilts could have reached reproductive age without having been infected.

The MLV group of weaned pigs had a slow seroconversion, even though they were farrowed by vaccinated sows. Pigs were negative to an IFA-IgG test at 21 days of age. At 35 days of age some animals seroconverted, suggesting that these pigs were infected with PRRSV. In this specific herd, sow vaccination did not appear to protect the piglets in the nursery stage or delay the age at infection, as the prevalence of PRRSV infected animals was similar between both PD and MLV groups following the PD protocol. These results suggest that the production benefits obtained can be attributed solely to the PD protocol, and not to vaccination.

Growth performance

Even though the PRRSV infection persisted, the PD protocol appeared to result in improved ADG at least while the pigs were in the nursery stage and not commingled with pigs from infected sources.

Figure 5**Growth performance data**

abcd	$P < .02$	h	$P > .36$
b,acd	$P < .0002$	ij	$P < .005$
efg	$P < .02$	j	$P > .98$
g	$P > .73$		

the farrowing rooms, with a consequent dissemination into the nursery rooms.

Although the mean weaning age was 21 days, *M. hyopneumoniae* appeared to be eliminated from the MOW, PD, and MLV groups. A lower prevalence of microorganisms resulted in a lower number of colonized pigs. This lower colonization would presumably not produce clinical signs and seroconversion. Clark, et al.,¹³ also found that pigs housed separately have low levels of *Mycoplasma* infection. *Mycoplasma* control by segregation of PD is variable, however, since many outbreaks of delayed mycoplasma pneumonia have recently been reported in SEW herds.

Coughing

Bahnson, et al.,¹⁴ reported a positive correlation between enzootic pneumonia lesions and cough. In this experiment, the cough episodes were not very common on clinical inspections, suggesting a low level of disease.

Pigs in the MOW group remained seronegative throughout the nursery stage, perhaps because fewer animals (150) were used in this group, thereby reducing the possibility of having infected pigs coming from a farm in which the vast majority of sows were negative. These MOW pigs were probably derived from noninfected sows, a fact which, in addition to the benefits of segregated weaning, led to the best performance among the three groups. These production improvements were lost when this group was commingled with conventional animals.

Bacteriology

Fewer bacteria were isolated in pigs after the PD protocol and during the segregation of the MOW group. However, these differences in isolation frequency could also be attributed to swabbing and to the low sensitivity of these bacteriological techniques.

Actinobacillus suis was isolated in all groups at early ages, which indicates the importance of this emerging pathogen in high-health farms.

Meningitis, apparently associated with *S.suis*, diminished after the PD protocol. A reduction in both the use of antibiotics and in the number of poor-doing pigs was also observed.

Mycoplasma hyopneumoniae appeared to be eradicated from the nursery in the MOW, PD, and MLV groups, as suggested by seroconversion age. Seroconversion to this microorganism usually takes place 4 to 7 weeks after infection. The control group seroconverted at the end of the nursery stage, suggesting infection of some animals in

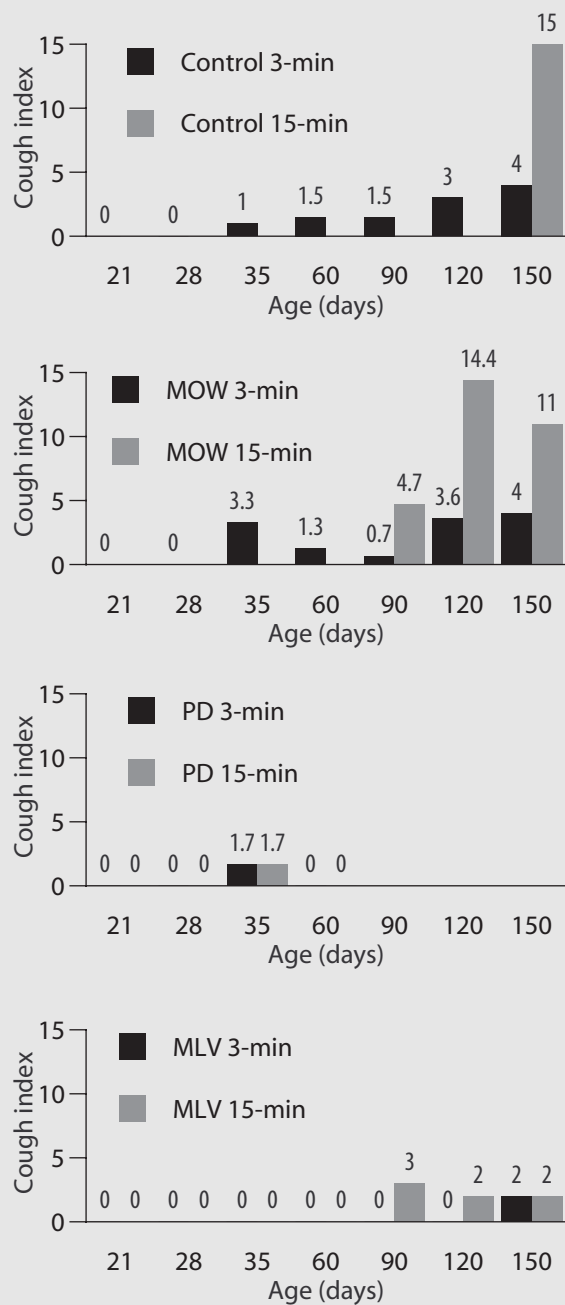
Implications

- It appears that to maintain the benefits of MOW, segregation should be maintained all the way to market.
- Only MOW was able to maintain animals free of PRRSV.
- Even though the PD protocol in this farm did not eradicate PRRSV, the reduced need for antibiotics in this group suggests that it may be a useful strategy.
- The group farrowed by vaccinated sows with the MLV-vaccine did not have any additional benefits compared with the PD group, suggesting that MLV-vaccination of sows does not result in improved productivity of their litters.

References

1. Christianson WT, Joo HS. Porcine reproductive and respiratory syndrome: A review. *SHAP*. 1994; 2(2):10-28.
2. Dee SA, Joo HS. PRRS-clinical management and control: Eradication and health. *Allen D Leman Conf*. 1993; St. Paul, Minnesota.

Figure 6



Cough index results

Table 2

Necropsy results

Group	Enzootic pneumonia	Lung lesions	Pleuritis	Atrophic rhinitis	Papular dermatitis
Control	85%	10.8%	3%	0.6%	0.6%
MOW	62%	6.1%	7%	0.6%	0.6%
PD	NT	NT	NT	NT	NT
MLV	87%	5.5%	0%	1.6%	0%

- Dee S, Joo HS, Pijoan C. Control of porcine reproductive and respiratory syndrome virus transmission: Handling infected seedstock. 1994. *Continuing Ed. Article #6*. 1994;16(7):927-933.
- Wills WR, Zimmerman JJ, Yoon K, Swenson SL, McGinley MJ, Hill HT, Platt KB. Porcine reproductive and respiratory syndrome virus: Isolation from chronically infected swine. *AASP Annual Meeting*. 1995; Omaha, Nebraska. 387-389.
- Stevenson GW, Van Alstine WG, Kanitz CL, Keffaber KK. Endemic porcine reproductive and respiratory syndrome virus infection of nursery pigs in two swine herds without current reproductive failure. *J Vet Diagn Invest*. 1993;5:432-434.
- Molitor T. Secondary infections associated with porcine reproductive and respiratory syndrome. 1993. *Allen D Leman Conference*. 1993; St. Paul, Minnesota. 236-237.
- Dee SA, Joo HS. Prevention of the spread of porcine reproductive and respiratory syndrome virus in endemically infected pig herds by nursery depopulation. *Vet Rec*. 1994;135:6-9.
- Yoon IJ, Joo HS, Christianson WT, et al. An indirect fluorescent antibody test for the detection of antibody to swine infertility and respiratory syndrome virus in swine sera. *J Vet Diagn Invest*. 1992;4:144-147.
- Bereiter M, Young TF, Joo HS, Ross RF. Evaluation of the ELISA and comparison to the complement fixation test and radial immunodiffusion enzyme assay for detection of antibodies against *Mycoplasma hyopneumoniae* in swine serum. *Vet Microb*. 1990;25:177-192.
- PigMON® slaughter inspection procedures manual. Developed through collaboration of the USDA National Animal Health Monitoring System and the University of Minnesota Swine Group. June 1992.
- SAS User's Guide*, version 6, 4th ed. Cary, North Carolina: SAS Institute Inc., 1994.
- Albina E, Madec F, Cariolet R, Torrison J. Immune response and persistence of the porcine reproductive and respiratory syndrome virus in infected pigs and farm units. *Vet Rec*. 1994;134: 567-573.
- Clark LK, Scheidt AB, Armstrong CH, et al. The effect of all-in/all-out management on pigs from a herd with enzootic pneumonia. *Vet Med*. 1991;86(9):946-951.
- Bahnsen PD. Enzootic pneumonia of swine: Epidemiology and effect on the rate of gain. PhD Degree Thesis. 1994. College Vet Med. University of Minnesota.

