CASE REPORT

Apparent prevention of *Mycoplasma hyopneumoniae* infection in growing pigs with a low-cost modified medicated-early-weaning program

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Summary: *A low-cost modified medicated-early-weaning program to eliminate* Mycoplasma hyopneumoniae *was tested in growing pigs from two swine operations over a 12-month period. Pigs received a series of injections of oxytetracycline on days 1, 7, and 14 of age. Pigs were weaned at 14 days of age to off-site nurseries. A thorough diagnostic examination targeted towards detecting* M. hyopneumoniae *was employed, consisting of slaughter checks, histopathologic examination, fluorescent antibody testing of lung tissue, and ELISA serology. Evidence of* Mycoplasma *infection was not detected in any of the tests used. Improvements in growth rate and mortality were seen in post-weaned pigs as well as a reduction in medication and vaccination costs per pig weaned. These results are similar to controlled experimental data previously published and may offer a cost-effective regime for improving the health and performance of growing pigs on commercial operations.*

Mycoplasma hyopneumoniae is a primary pneumonic pathogen in swine.[1,2] When coupled with infections of secondary pathogens such as *Pasteurella multocida,* it can cause significant reductions in postweaning performance.[2-4] Studies have demonstrated that a high proportion of swine in the United States have gross lesions indicative of *M. hyopneumoniae* infection at slaughter.[1,2,4]

Medicated early weaning (MEW) was first developed to eliminate *M. hyopneumoniae* infection from a seedstock source.[5] Although protocols directed at eliminating *M. hyopneumoniae* from offspring of infected breeding herds using MEW or modified medicated early weaning (MMEW) have been successful, they can result in costs of $4.00–$7.00 per pig weaned.[5-7] Such costs are prohibitive to commercial swine producers.

Previous data have indicated the possibility of preventing *M. hyopneumoniae* infection following a series of oxytetracycline injections prior to weaning.[8] Other studies have shown reduced lung lesions and improved growth rates following injection of oxytetracycline at days 1, 7, 14, and 21 of life.[9] In a recent study, *M. hyopneumoniae* infection was not transmitted to early-weaned pigs following either MMEW procedures or isolated weaning techniques.[10] The purpose of the study reported here was to determine whether low-cost MMEW programs could be effective in eliminating *M. hyopneumoniae* in field situations. The procedure used oxytetracycline as the primary injectable antibiotic, did not use mycoplasma vaccine, and was tested in growing pigs from two swine operations.

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Previous farm history

Farm 1

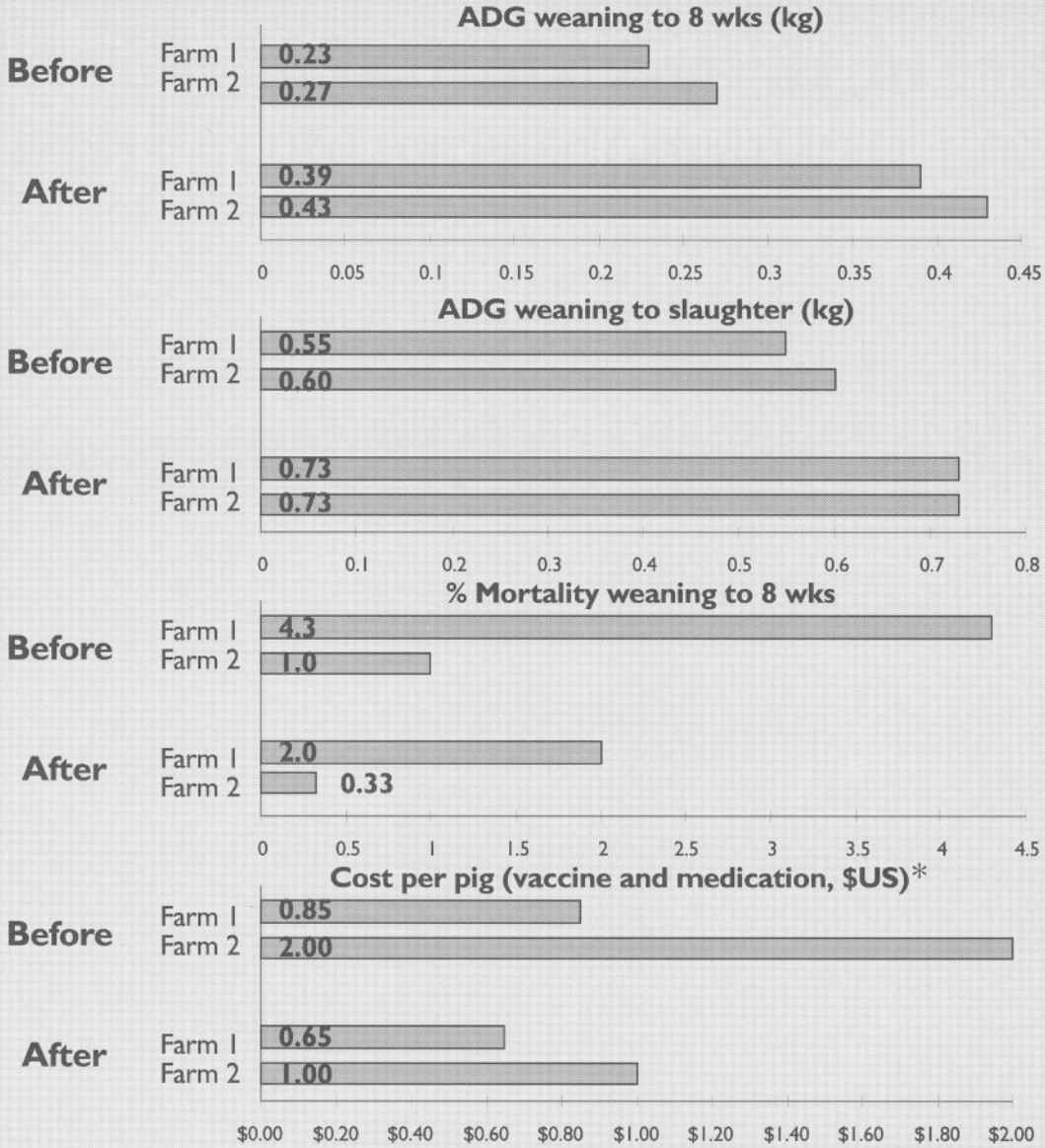
- Facilities: Farm 1 was a 280-sow seedstock herd in Minnesota. Breeding, gestation, farrowing, and nursery facilities were located on one site and finishing facilities were located on another site, 2.5 km (1.5 miles) away. The hot nursery rooms contained double-decked pens and cold nursery rooms contained flat-deck pens.
- Weaning age: 21 days.
- Piglet program: Piglets were administered the following products at the following times:

  Day 1: ¾ mL 200 mg iron, ¼ mL benzathine penicillin

  Days 7–10: 1 mL *Bordetella bronchiseptica/P. multocida* commercial bacterin

  Weaning (day 21): 2 mL *B. bronchiseptica/P. multocida* commercial bacterin
- Sow vaccination: Sows were vaccinated at 5 and 2 weeks prefarrowing against *B. bronchiseptica, P. multocida, Erysipelothrix rhusiopathiae* and *Escherichia coli* using a commercially available bacterin.
- Antibiotic-vaccine cost per pig weaned = $1.00 (Figure 1)
- Average daily gain (weaning–8 weeks) = 0.23 kg per day
- Average daily gain (weaning–slaughter) = 0.55 kg per day
- Percent mortality (weaning–8 weeks) = 4.0%

Figure 1



Growth, mortality, and costs before and after the MMEW protocol was implemented. Vaccine costs of the modified medicated-early-weaning procedure were less expensive than the vaccines used previously on the farms to control mycoplasma pneumonia. Growth performance of both nursery and finishing pigs was improved on Farms 1 and 2 after the MMEW procedure was implemented.

*This cost included all medications, vaccinations, and injectable iron given to piglets preweaning, including the cost of all sow vaccinations. The cost of sow vaccination per pig was based on the average number of pigs born alive per litter over the last 3 years. Example: $1.00 per sow = $.10 per pig based on an average litter size of 10 live pigs. It also included the water medication cost per pig throughout the first 7 days postweaning.

Farm 2

- Facilities: Farm 2 was a 300-sow commercial farrow-to-finish operation in eastern South Dakota. The nursery consisted of two rooms, both with flat-deck pens.
- Weaning age: 18 days of age.
- Piglet Program

  Day 1: ¾ mL 200 mg iron, ¼ ml benzathine penicillin

  Days 7–10: 1 mL *Streptococcus suis* serotypes 1, 2 commercial bacterin, 1 mL *B. bronchiseptica/P. multocida* commercial bacterin, 1 mL *Actinobacillus pleuropneumoniae* serotypes 1, 5, 7 commercial bacterin

  Weaning: 2 mL *S. suis* serotypes 1,2 commercial bacterin, 2 mL *B. bronchiseptica/P. multocida* commercial bacterin, 2 mL *A. pleuropneumoniae* serotypes 1, 5, 7 commercial bacterin.

- Sow vaccination: Sows were vaccinated at 5 and 2 weeks prefarrowing against *B. bronchiseptica/P. multocida, E. rhusiopathiae,* and *S. suis* types 1, 2 using commercially available vaccine.

- Antibiotic-vaccine cost per pig weaned = $2.00 (Figure 1)
- Average daily gain (weaning–8 weeks) = 0.27 kg per day
- Average daily gain (weaning–slaughter) = 0.60kg per day
- Percent mortality (weaning–8 weeks) = 1.0%

Water and feed medications changed frequently on both farms with no regular pattern of usage. Products such as apramycin, gentamycin, tiamulin, and sulfadimethoxane had been used in the drinking water postweaning over the previous 12 months. Feed medication consisted of:

- carbadox (50 g per ton, 0.05 g per kg) or tiamulin (35 g per ton, 0.04 g per kg) from 6 kg to 22 kg (13 to 50 lb);

- tylosin (40 g per ton, 0.044 g per kg) from 22 kg to 54 kg (50 to 120 lb); and

- chlortetracycline (100–400 g per ton, 0.11–0.44 g per kg) from 54 kg (120 lb) to market weight (108 kg, 237 lb)

on both farms.

Methods

Facility modifications

Prior to implementing the MMEW program, weaning facilities were established on a separate site from the breeding herd on both farms. Farm 1 remodeled an existing finishing barn located on a separate site into a one-stage nursery. The remodeled facility consisted of four rooms of flat-deck pens, each room capable of holding 2 weeks of weaned pigs. The cost of remodeling this facility was $60.00 per pig space. Since this project reduced available finishing space, contract finishing barns were rented. Contract cost per pig sold was $8.00. These facilities were located 8.3 km (5 miles) from the breeding herd. Farm 2 built new facilities using a similar pen and room design as Farm 1. The cost of the new facility was $120.00 per pig space. The nursery was built on the same site as the existing finishing facilities.

Detecting *M. hyopneumoniae* infection

To improve the accuracy of detecting *M. hyopneumoniae* infection, a four-part diagnostic profile was used:

- Slaughter check data was compiled prior to initiating the MMEW protocol on all farms, and also twice over a 12-month period on MMEW-derived offspring. Thoracic viscera were manually removed from the slaughter line to allow for an extensive examination of lung tissue. Thirty head from each farm were examined. Lungs were scored grossly for the prevalence of pneumonic lesions and a mean score was calculated. Scoring was based on a previously described procedure (Total respiratory analysis and control [Trac clinics], ELANCO Products Co., Indianapolis, Indiana).

- microscopic examination: For MMEW-derived pigs, cranial and middle lobes were submitted for histopathological exam. To detect whether infection occurred earlier in life, even grossly normal samples were submitted for histopathological exam.

- Fluorescent antibody testing (FAT): If gross observation revealed lesions suggestive of *M. hyopneumoniae* infection, sections of the affected tissue were also submitted for fluorescent antibody testing (FAT). To enhance the accuracy of the FAT, samples were placed on ice and submitted to state diagnostic facilities within 3 hours post collection.[11]

- Serology: The prevalence of antibodies to *M. hyopneumoniae* in the breeding and finishing herds was assessed on both farms prior to the study. Thirty samples from the breeding and finishing area were collected. Serum was analyzed using an ELISA technique previously described.[12] Sample sizes were calculated assuming a disease prevalence of at least 10%. Therefore, 30 samples were collected in all cases to be 95% confident of detecting at least one positive pig. Serum samples were collected from MMEW-derived offspring on a quarterly basis. Thirty samples were taken from pigs at 5–6 months of age and analyzed by ELISA for antibodies to *M. hyopneumoniae.*

Bacteriologic culture for *M. hyopneumoniae* was not included as part of the diagnostic profile. Previous reports indicating a poor sensitivity,[13-15] prolonged growth period,[1] and a high risk of contamination by *Mycoplasma hyorhinis*[1] precluded the use of direct culture in this study.

MMEW protocol

All piglets went through the following MMEW protocol:

- Day 1: ¾ mL 200 mg iron, ½ mL 100mg oxytetracycline (subcutaneous [sc] injection)
- Day 7–10: 1 mL 200 mg oxytetracycline (sc injection)
- Weaning: 1 mL 200 mg oxytetracycline (sc injection)

All other piglet vaccines were eliminated. No antibiotics were given to the sows, orally or via intramuscular injection. No changes were made in the breeding herd vaccination program. Pigs were weaned at a maximum age of 14 days to offsite nurseries. Overall, weaning age averaged 13 days. Pigs were provided trimethoprim (80 mg)-sulfaxamethoxazole (400 mg) in the drinking water at the rate of 30mL per 4.54 L for 7 days postweaning. All feed medications were removed from diets fed to pigs from 54 kg to market weight (108 kg). All pigs were vaccinated against *E. rhusiopathiae* at 8 weeks of age.

Growth performance

Average daily gain data and percent mortality from weaning to 8 weeks and average daily gain from weaning to slaughter was analyzed before and after implementation of the MMEW program. Pigs were routinely weighed by litter at weaning, by

pen group upon leaving the nursery, and by truckload prior to slaughter. Mean weight was calculated per pig in each stage.

Results

Costs

The total antibiotic and vaccination cost per pig weaned during the MMEW program ranged from $0.60—$0.65 (Figure 1).

Growth performance

We observed an improvement in average daily gain and percent mortality from weaning to 8 weeks of age as well as from weaning to slaughter (Figure 1).

Transmission of *M. hyopneumoniae*

Before the MMEW protocol was implemented, both farms demonstrated evidence of *M. hyopneumoniae* infection via serology and gross pathology (Figure 2).

Gross pathology

In the MMEW-derived offspring, six out of sixty lung samples from each farm had lesions suggestive of a pneumonic process. Lesion scores ranged from 0.25%–1.0% of total lung involvement, and were not localized to a specific portion of the lung (Figure 2). Mean lesion scores on lungs of MMEW-derived offspring from Farm 1 were 0.065% (SEM ±0.026) and from Farm 2 were 0.05% (SEM ±0.017). Some of the visual changes in the lungs were due to atelectasis, or electrocution and exsanguination typical of the slaughtering process.

Histopathology and serology

Histologic examination indicated evidence of a bacterial pneumonic process. All samples were negative on FAT and no evidence of lesions suggestive of *M. hyopneumoniae* were detected. All serum samples from MMEW-derived offspring were negative for *M. hyopneumoniae* antibodies (Figure 2). No direct culture attempts were made; however, both farms had a previous history of positive isolation of *B. bronchiseptica*, *P. multocida*, *S. suis*, *Haemophilus parasuis*, and *A. pleuropneumoniae*.

Discussion

The results of these field studies support the conclusions drawn by Clark, et al.,[10] and indicate that it may be possible to eliminate *M. hyopneumoniae* via low-cost MMEW procedures. Clark's study suggested that isolated weaning at an early age may be adequate to eliminate *M. hyopneumoniae* without the use of antibiotics. However, in order to increase the chances of success in field situations, I believe a medication program is an important part of the protocol. Variation in such factors as environmental conditions, season, and management as well as the practice of housing large numbers of pigs in a common airspace make control of respiratory pathogens difficult. Programs using oxytetracycline as the primary antibiotic have been successful in improving postweaning growth performance and are very inexpensive.[9] Our findings and the overall benefit to the health and production of both herds in the present study make early weaning of piglets a viable option if producers are capable of managing pigs of this age.

While it is difficult to determine whether mycoplasma pneumonia was truly eliminated from all pigs in the study farms, no detectable evidence of *M. hyopneumoniae* infection was observed using the diagnostic methodology previously described. While macroscopic exams have been widely used to assess the prevalence of enzootic pneumonia in the past, studies have indicated that gross lesions that suggest such a process may resolve over a 2-month period. Thus, lesions at slaughter may only reflect infection during the late finishing period.[1,13] Microscopic lesions have been reported to persist for up to 4 months following infection.[14] Since the mean slaughter age of MMEW-derived offspring was 5 months, the lack of microscopic lesions suggests that infection may not have occurred after pigs reached 4 weeks of age. Immunofluorescence has been shown to be a highly reliable method for specific diagnosis of *M. hyopneumoniae* infection.[15,16]

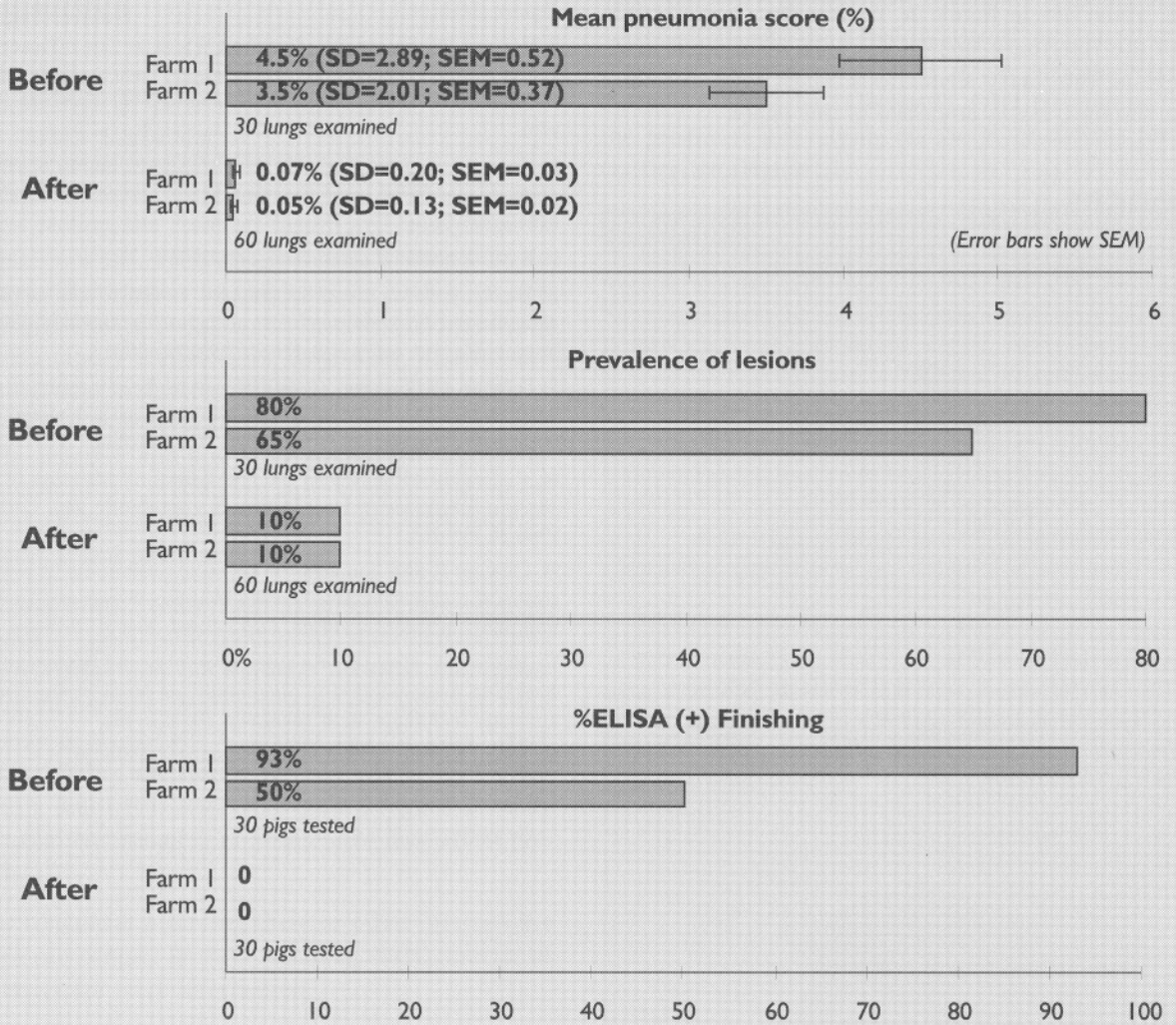
We bled the pigs at 20–24 weeks of age based on evidence that ELISA antibodies to *M. hyopneumoniae* do not develop until later in life, even if infection occurs during the late nursery period.[17] A Tween 20 ELISA test was chosen because it is highly sensitive and specific compared to the complement fixation test.[11]

In the past, MMEW was a technique primarily used by seedstock producers to improve the health status of offspring without depopulating the breeding herd.[5-7] Because of the potential excessive cost per pig weaned, the technology has not been commonly used on commercial farms. Due to the low cost per pig weaned of this program, it could be used by both seedstock producers and commercial producers to improve the performance of their herds if mycoplasma pneumonia is present. The antibiotic and vaccine cost per pig weaned was less during the MMEW protocol than before the program began on both farms. Along with this decrease in cost came an improvement in postweaning performance and a decrease in nursery mortality.

The improvement in performance may have been due to other factors besides the reduction in mycoplasma pneumonia. We observed a decreased incidence of clinical problems due to other diseases, including *A. pleuropneumoniae*, atrophic rhinitis, and *S. suis*. Also, some benefit may have been due to the improved environment postweaning. The new program brought about the use of a one-stage nursery, thereby eliminating the stress of moving at approximately 6–7 weeks of age. The new nursery facilities also had improved ventilation and feeding systems, specifically designed to handle pigs from 2–8 weeks of age.

The difference in cost per pig weaned between the two farms in the study can be attributed to the different levels of breeding-herd productivity. Farm 1 was a seedstock producer with

Figure 2



Slaughter data before the MMEW procedure revealed evidence of infection with *M. hyopneumoniae*, while slaughter data after the procedure showed no definitive evidence of pneumonic lesions due to *M. hyoponeumoniae*. ELISA serology performed before and after the MMEW procedure suggested that *M. hyopneumoniae* was not transmitted to piglets undergoing MMEW.

purebred sow herds. Born live data on these farms ranged from 9.5–10.0 pigs born alive per litter. Farm 2 on the other hand was a commercial producer with an F_1 sow herd. Litter size data on this operation averaged 11.2 born live; thereby, costs were spread over more weaned pigs.

The duration of time that this high level of health can be maintained is unknown. It will depend on factors such as the neighboring hog density, whether or not biosecurity measures are maintained, and the mycoplasma status of incoming breeding stock. Neither of the farms are located in hog-dense areas. Other swine facilities were located 0.83 km (0.5 miles) from the nursery and finishing facilities of Farm 1 and 1.6 km (1 mile) from the offsite facilities of Farm 2. The mycoplasma status of these adjacent operations was not known and testing was not allowed. As of this writing, it appears the number of production sites did not affect the results during the 12-month study period. While Farm 2 used two-site production, Farm 1 used three-site production, with finishing facilities located on a separate site other than the nursery facility. Whether this will have an effect on the long-term maintenance of the health status is unknown. Since both farms will continue to use the protocol on a regular basis, follow-up is possible.

Implications

- MMEW programs need not be expensive to be effective at eradicating *M. hyopneumoniae.*
- A thorough diagnostic program for *M. hyopneumoniae* should involve gross and microscopic evaluation and serology.
- MMEW is a technology that can be used by commercial producers to improve performance without incurring excessive costs.

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