The effects of vaccinating pigs for mycoplasmal pneumonia in a swine herd affected by enzootic pneumonia

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Summary: *We compared weight gain, feed disappearance, coughing prevalence, and lung lesion scores among pigs vaccinated against* Mycoplasma hyopneumoniae *(treatments 1 and 2) and nonvaccinated controls. Pigs in both vaccinated treatment groups gained significantly more weight (0.14 lb per day, P < .05) during the finishing phase when grow-finish data were pooled and compared to the control group. Pigs in both vaccinated treatments consumed significantly more feed (0.49 and 0.41 lb, respectively) versus the control (P < .05) during the finishing phase. We recorded significantly fewer coughs by treatment 2 (vaccinated at 6 and 8 weeks of age) pigs than by treatment 1 (vaccinated at 2 and 3 weeks of age) and control pigs (P < .05). Coughing frequency was highest when pigs were 4-5½ months of age. Severity of lung lesions detected at slaughter in both groups 1 and 2 were reduced significantly (6% and 4% respectively) compared to the control group (12%, P < .05). All other feed and growth parameters during the growing, finishing, and combined phases between both treatment groups and the controls were not significant (P > .05). The prevalence of lung lesions was similar for all three groups. These results indicate that an* M. hyopneumoniae *vaccine can significantly reduce the severity of lung lesions of enzootic pneumonia detected at slaughter, significantly increase feed disappearance during the finishing phase, and significantly increases average daily gain during the finishing phase. It did not improve feed efficiency in this trial, however.*

Enzootic pneumonia (EP) is the most economically important respiratory disease of swine worldwide.[1] *Mycoplasma hyopneumoniae* and *Pasteurella multocida*, the major primary and secondary agents that cause EP,[1] contribute to these monetary costs by interfering with growth. Enzootic pneumonia lowers feed consumption and adversely affects feed conversion during the acute phase of illness, resulting in reduced pig growth. Occasionally, pigs die when serious and unusual secondary complications occur.[1]

Pigs with EP are often treated with parenteral, water-soluble or feed-additive antimicrobial therapy, and the disease can be controlled with all-in/all-out growing-finishing production and vaccination with an *M. hyopneumoniae* antigen. Producers are entitled to know with reasonable assurance, however, that disease control and growth improvement measures (use of antimicrobial vaccines, medicated early weaning (MEW), all-in/all-out grow-finish, new facilities, etc.) will generate a net positive income.

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Materials and Methods

Herd history

In this study, we tested the effect of an *M. hyopneumoniae* vaccine on growth, feed disappearance, coughing prevalence, and lung lesions. We included two distinct groups for age at vaccination to study the optimum age at which to vaccinate pigs. The experiment was carried out in the Department of Animal Sciences swine herd at Purdue University. This herd is affected by EP, which has been diagnosed within the past 8 years. Slaughter checks indicate 80%-90% prevalence of gross lung lesions consistent with EP. Indirect-immunofluorescence assay (IFA) and culture have demonstrated the presence of *M. hyopneumoniae*, *P. multocida*, and antibodies to *M. hyopneumoniae* are detectable through serology in this herd.

Treatments

One hundred and fifty individually identified 7-day-old pigs were assigned using a stratified random allocation to one of three groups by litter, sex, and birth weight. Each group included 48 principals and two sentinel pigs:

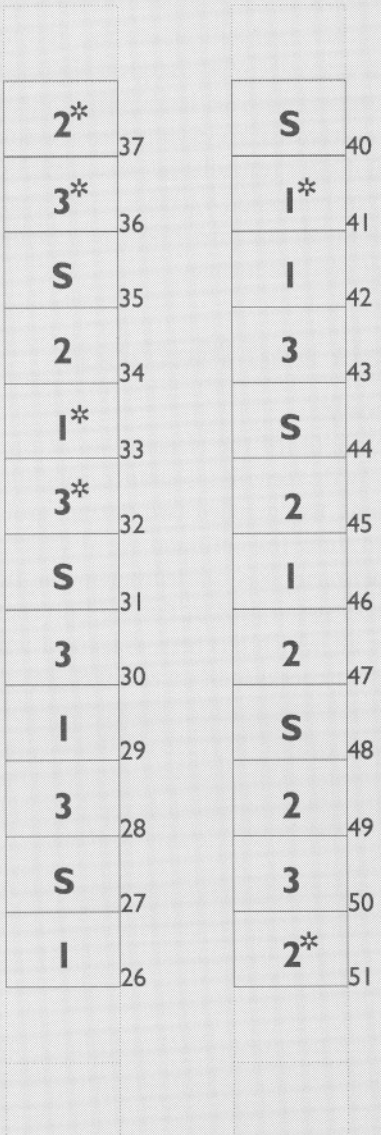
- Treatment 1 pigs were intramuscularly injected in the neck with 2 mL of an *M. hyopneumoniae* vaccine (Respisure®, SmithKline Beecham Animal Health, Exton, Pennsylvania) at 1 and at 3 weeks of age;
- Treatment 2 pigs were intramuscularly injected in the neck with 2 mL of the same vaccine at 6 and at 8 weeks of age (we determined this timing to be after the decline of maternally acquired immunity and before the onset of clinical EP during the grow/finish phases of production at this herd);[2]
- Control pigs were not vaccinated for *M. hyopneumoniae*.

All treatment and control pigs received an erysipelas vaccine at 8 weeks of age. This vaccine contained no *Mycoplasma* spp.

Timeline/Procedures

Pigs were farrowed naturally within the Animal Sciences Swine Research Unit at Purdue University. Approximately 36 sows were farrowed per group with a 2- to 3-week farrowing interval.

Figure 1



Stratified random allocation of treatments from 2-6 months of age (growing/finishing unit 1, Animal Sciences Swine Center, Purdue University).
S = Seeder pigs (older pigs already infected with *Mycoplasma hyopneumoniae* and *Pasteurella multocida*.
1, 2, 3 = Treatments 1, 2, and 3.
* = This pen included one sentinel pig during the 2-4 months of age period.

- Birth to 1 month old (weaning): pigs were housed in the farrowing facility;
- 1 month old - 2 months old: pigs were moved into a nursery room;
- 2 months old - 4 months old (i.e., growing phase): pigs were moved into a continuous-flow grow/finish facility (Figure 1). This facility was made up of 6 x 12 foot pens, each with a two-hole self feeder and one nipple watering device. The floors were concrete slats with gates and pen dividers made of fiberglass rods. The building had a mechanical ventilation system;
- 4 months old: The sentinel pigs were slaughtered and submitted for necropsy. Each lung was examined for gross and microscopic lesions consistent with EP, tested by IFA to detect the presence of *M. hyopneumoniae*, and cultured for the presence of *P. multocida*; and
- 4 months old - 6 months old: (i.e.: finishing phase.) At 5 months of age, two pigs in treatment 1 became lame and were removed from the study.

We performed six concurrent replicates. Each replicate consisted of a block of four pens in the grow/finish facility that included each of the three groups plus one pen of older, coughing (seeder) pigs from the infected Animal Science herd (Figure 1). These seeder pigs naturally transmitted *M. hyopneumoniae* and *P. multocida* to the principals. We collected serum from one principal pig per pen (i.e., six principal pigs per treatment) once each month between 2 and 6 months and tested sera with an enzyme-linked immunosorbent assay (ELISA) to detect antibodies to *M. hyopneumoniae*.

Weight gain

Individual pigs were weighed at birth and once a month thereafter. We computed average daily weight gain (ADG) and days-to-230-lb on an individual pig basis (n = 50 from 2–4 months old, n = 48 from 4-6 months old).[3]

Feed disappearance

We measured feed disappearance on a pen basis once each month during the period that the pigs were 2–6 months old:

- From 2–4 months old, the pigs (n = 50 per treatment) received a 16% crude protein, vitamin/mineral-fortified, corn, and soybean grower ration; and
- from 4-6 months old, the pigs (n = 48 per treatment) received a 14% crude protein, vitamin/mineral-fortified, corn, and soybean finishing ration.

Both rations were ground and offered as meal and neither ration contained any antimicrobials. We calculated feed disappearance by subtracting the feed weighed back at the end of the month from the total lb of feed placed in the feeder. Using formulas listed in the Pork Industry Handbook,[3] we computed average daily feed intake (ADFI) and feed con-

version (F:G) on a pen basis (n = 6 pens) by dividing lb of feed that disappeared by the number of pigs in the pen during each day (i.e., the number of pig days). When the two sentinel pigs were removed at 4 months of age (and when the two lame treatment-1 pigs were removed at 5 months old), the remaining feed was weighed and we again calculated feed disappearance based on the number of pig days.

Coughing

Each week we examined the pigs, and recorded the number of pigs we heard coughing during the 3-minute examination period. We also noted other clinical signs of disease.

Lung lesions

At slaughter, all lungs were retrieved and examined for gross lesions consistent with EP. For each individual lung, we sketched all lesions onto a diagram of a lung and used a digitizer to compute the affected area of that lung. We performed routine bacterial culture on those lungs.

Statistical analysis

We used the Student Newman-Keuls (using the General Linear Model procedures of the Statistical Analysis System [SAS])[4] test to compare treatment groups with nonvaccinated controls for the following parameters:

- the mean weight gain among pigs (on an individual-pig basis);
- feed conversion (f:g) and the mean lb of feed dissappearance (on a pig days basis); and
- the prevalence and severity of lung lesions.

Because pigs were weighed each month and because the ration was changed at 4 months of age, we performed the statistical analysis for feed disappearance and weight gain for growing, finishing and a combined phase (i.e., 2-6 months of age). Because of the limited sample size and the high variation in growth in this study, we pooled the data for the vaccinated groupsduring the growing, finishing, and combined phase analysis to form a combined group.

We used the maximum likelihood ratio to analyze the log-linear model of the catmod procedure (SAS) to compare the number of pigs coughing among the treatment and control groups (using n = 50 per treatment for the 2-4 month period and n = 48 per treatment for the 4-6 month period).

Results

Growth

Average daily gain during the finishing phase was significantly improved ($P < .05$) when both vaccinated groups 1 and 2 were pooled and compared to the controls (Table 1). The mean days-to-230-lb for both vaccinated groups was 177 days compared to 186 days for the control, but the differences were not significant ($P > .05$).

Feed disappearance

Average daily feed disappearance during the finishing phase was significantly ($P < .05$) improved (7.9% better) in both vaccinated groups 1 and 2 versus the control (Figure 2). Feed conversion, however, did not significantly differ ($P > .05$) during any phase of production.

Table 1

Growth data by treatment

Parameter	Treatment 1 (vaccinated 1 & 3 weeks)	Treatment 2 (vaccinated 6 & 8 weeks)	Treatment 3 (control)
Days to 230 lb (104 kg)	177	177	186
ADG growing lb (kg)	1.58 (0.717)	1.55 (0.703)	1.50 (0.680)
ADG finishing lb (kg)	1.82 (0.826)*[a]	1.82 (0.826)*[a]	1.69 (0.766)[b]
ADG combined lb (kg)	1.70 (0.771)	1.68 (0.762)	1.59 (0.721)

Values with unlike superscripts ([a,b]) are significantly different ($P<.05$).
*Treatments 1 and 2 are combined in the finishing analysis.

Coughing

On our first weekly clinical examination of the pigs (1 week after placing them in the grow/finish facility), none of the principal pigs were coughing, but many of the older, seeder pigs were exhibiting a dry, nonproductive cough (Figure 3). We noticed principal pigs in groups 1 and 2 coughing about 6 weeks after being moved into the finishing unit (at about 3.5 months of age). We observed 21 individual control pigs, 13 treatment-1 pigs, and five treatment-2 pigs coughing during the study. The observed frequency for coughing was highest 10 weeks after the pigs were moved into the grow/finish unit (at about 4.5 months of age). Coughing was not detected after 5 months of age. Other conditions that we noted in pigs during this study included lameness, septic arthritis, umbilical hernia, posterior paresis, subcutaneous abscess, dermatitis, sneezing, roughened hair coat, and diarrhea; however, other than coughing, we did not attribute any of these clinical signs to EP.

Lung lesions

The prevalence of lung lesions consistent with EP were:

- 84% for treatment 1;

- 84% for treatment 2; and
- 90% for the controls.

Pigs in both treatment groups had significantly ($P < .05$) reduced lesion scores, (6% in treatment 1 and 4% in treatment 2) compared to nonvaccinated control pigs (12%).

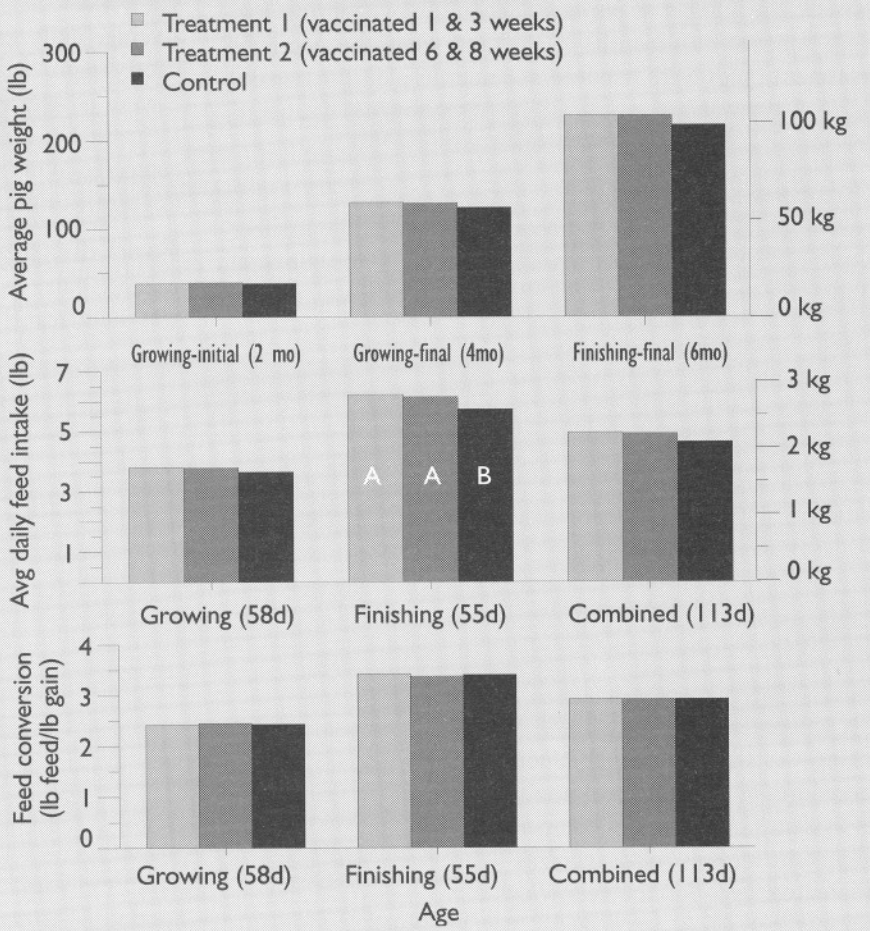
Necropsy and microbiology results of lungs from the six sentinel pigs included the following:

- all six lungs had gross lesions consistent with EP;
- all six lungs had microscopic lesions consistent with mycoplasmal pneumonia and suggestive of a secondary bacterial pneumonia;
- all six lungs were positive for *M. hyopneumoniae* by IFA; and
- bacterial cultures from three lungs were positive for *P. multocida*, and bacterial cultures from one lung were positive for *Bordetella bronchiseptica*.

We obtained the following serologic results with an ELISA (Figure 4):

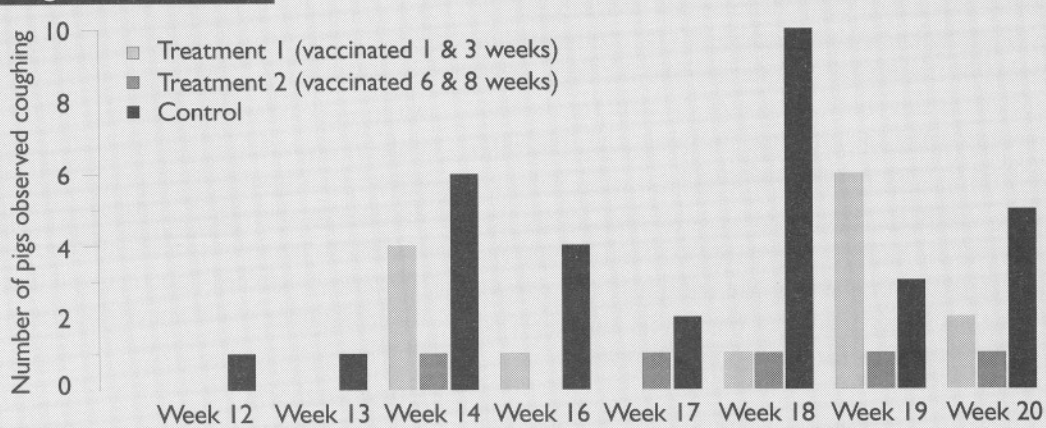
- at 2 months of age, 7 sera were positive for *M. hyopneumoniae*, 3 were suspect, and 8 were negative;
- by 5 months of age, all 18 sera were positive for *M. hyopneumoniae*; and

Figure 2

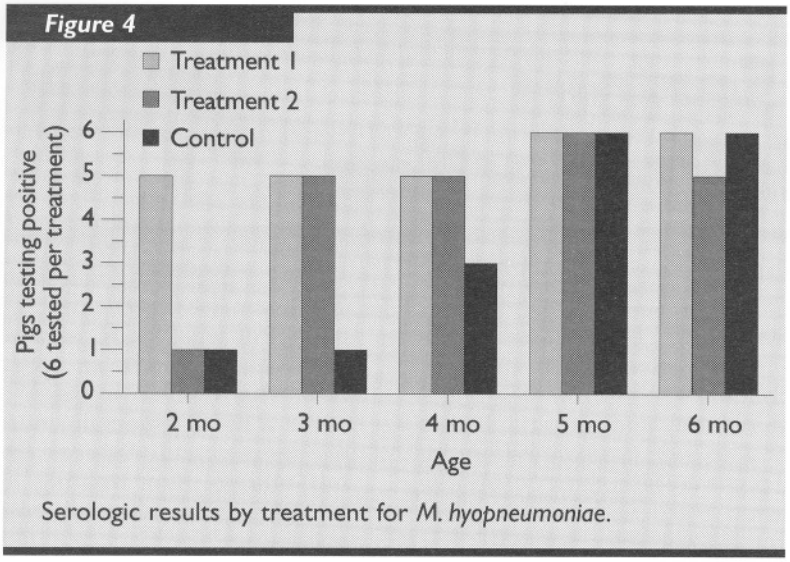


Feed consumption and conversion parameters by treatment. Different letters (A,B) indicate significant difference.

Figure 3



Number of pigs observed coughing by treatment.



Serologic results by treatment for *M. hyopneumoniae*.

- at 6 months of age, 17 sera were positive and one was suspect.

Discussion

The use of an *M. hyopneumoniae* vaccine in this swine herd significantly reduced the severity of lung lesions detected at slaughter and improved growth performance and feed disappearance during the finishing phase of production. The improvements observed in the vaccinated treatment groups were most noticeable during the time of highest coughing frequency. Coughing is a clinical sign associated with EP, but can also be a sign of other diseases.[5]

Feed conversion was not affected by vaccination in this study. This finding conflicts with that of other reports and is perhaps due to the absence of concurrent infections with PRRS virus, pseudorabies virus, or clinical signs of *Actinobacillus pleuropneumoniae*. A 9-day numerical reduction in days-to-230-lb was observed in both treatment groups versus the control pigs, but the difference might not have been significant because the growth of the pigs was so variable. In retrospect, considering the growth variation of pigs in this study, each treatment would have required a minimum of 108 pigs to detect a significant difference in days-to-230-lb, everything else being equal.

The prevalence of gross lesions typical of EP was similar in all three groups, indicating that vaccinating piglets does not prevent them from becoming infected by *M. hyopneumoniae* or *P. multocida*. The pigs had been in the continuous-flow unit for 2 months, which is sufficient time for these microorganisms to transmit from older pigs to the younger pigs, and for pneumonia to develop.

Historically, pigs reared in this facility start coughing either 1 month after they arrive in the continuous-flow, grow/finish unit or, if born in the facility, at 3 months of age. Examining lungs at slaughter during the past 8 years has consistently revealed an 80%–90% prevalence of gross lesions, typical of EP. Gross lesions detected in this study were within the expected range for this herd.

Because vaccinating for *M. hyopneumoniae* did not improve feed efficiency, producers may want to compensate for the cost of vaccinating pigs by increasing the number of pigs they produce in their herd during the finishing phase.

Acknowledgments

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