ORIGINAL RESEARCH

Effect of a mycoplasma vaccine on average daily gain in swine

W. E. Morgan Morrow, BVSc, MS, PhD; Gerardo Iglesias, MVS, PhD; Charles Stanislaw, BS, PhD; Alan Stephenson, MS; and Gene Erickson, DVM, PhD

Summary: *A Mycoplasma hyopneumoniae vaccine (RespiSure®, SmithKline Beecham Animal Health, Exton Pennsylvania) was tested for its effect on pig growth rate in a 150-sow farrow-to-finish unit in North Carolina using all-in–all-out flow in the farrowing and nursery. From October 1991 to December 1991, 625 nursery pigs from five weaned groups were sorted into pens by gender and similar weight, eartagged, and allocated to vaccinate or control groups by pen. Vaccinates received 2 mL of the mycoplasma vaccine on the day they were allocated to treatment and 14 days later. Pigs were weighed individually when moved between buildings at approximately 23 kg (51 lb), and 33 kg (73 lb), and prior to slaughter at 92 kg (202 lb). Average daily gain was not different (P = .24) between vaccinated and control pigs when averaged over all five groups. Barrows grew faster (P = .003) than females when averaged over all three stages of growth. However, vaccine did not affect this difference (P = .37). The weight of pigs entering the nursery was a significant determinant of average daily gain for nursery (P = .0001), growing (P = .0053), and finishing (P = .0001) phases of growth. These data indicate that the mycoplasma vaccine did not improve average daily gain in the trial herd and may not improve average daily gain in similar herds with a low prevalence of infection.*

Pneumonia is a very prevalent and important disease of hogs worldwide.[1] In the United States, a sample of 337 herds from 13 midwestern states revealed that 99% of herds had hogs with lesions of pneumonia.[2] *Mycoplasma hyopneumoniae* has fastidious growth requirements, and overgrowth by secondary bacteria can also be a problem, making it difficult to determine the within-herd prevalence of this pathogen and its contribution to the pneumonia problem. However, Yamamoto and Ogata[3] and Gois[4] isolated *M. hyopneumoniae* from 93% and 25% respectively of pneumonic lungs. Young, et al.,[5] in a serological survey of 597 herds in the United States found 60% of herds to have one or more positive pigs and, in Australia, Mercy and Brennan[6] recorded that 85% of herds had lesions consistent with *M. hyopneumoniae*.

WEMM, CS, AS: North Carolina State University, Department of Animal Science, Box 7621, Raleigh, North Carolina 27695-7621; GI: Lapisa, S.A. de C.V. Km 5.5 Carr, La Piedad, Guadalajara, AP No. 198, Mexico; GE: Rollins Diagnostic Laboratory, North Carolina Department of Agriculture, Raleigh, North Carolina 27605

The economic impact of mycoplasma pneumonia in swine is very dependent on environmental and management factors. Many studies have been conducted investigating the association between mycoplasma pneumonia and performance with inconsistent results.[7,8] More recently, Scheidt, et al.,[9] studied three herds with both bronchopneumonia and atrophic rhinitis and found no correlation between average daily gain (ADG) and severity of pneumonia. However, Sheldrake, et al.,[10] found a significant difference in the slaughter weight of pigs with a pneumonia score[11] greater than 10 compared to pigs on the same farm with scores ranging from 0–10 ($P < 0.001$). Dayalu and Ross[12] reported that *M. hyopneumoniae* vaccination reduced the percentage of lung with pneumonia in experimentally infected pigs. Scheidt, et al.,[13] reported that vaccination with a *M. hyopneumoniae* antigen (RespiSure®, SmithKline Beecham Animal Health, Exton Pennsylvania) increased ADG during the finishing but not growing phase.

The objective of this study was to evaluate the effect of vaccination with *M. hyopneumoniae* antigen on ADG of growing pigs in the Swine Development Center herd at North Carolina State University.

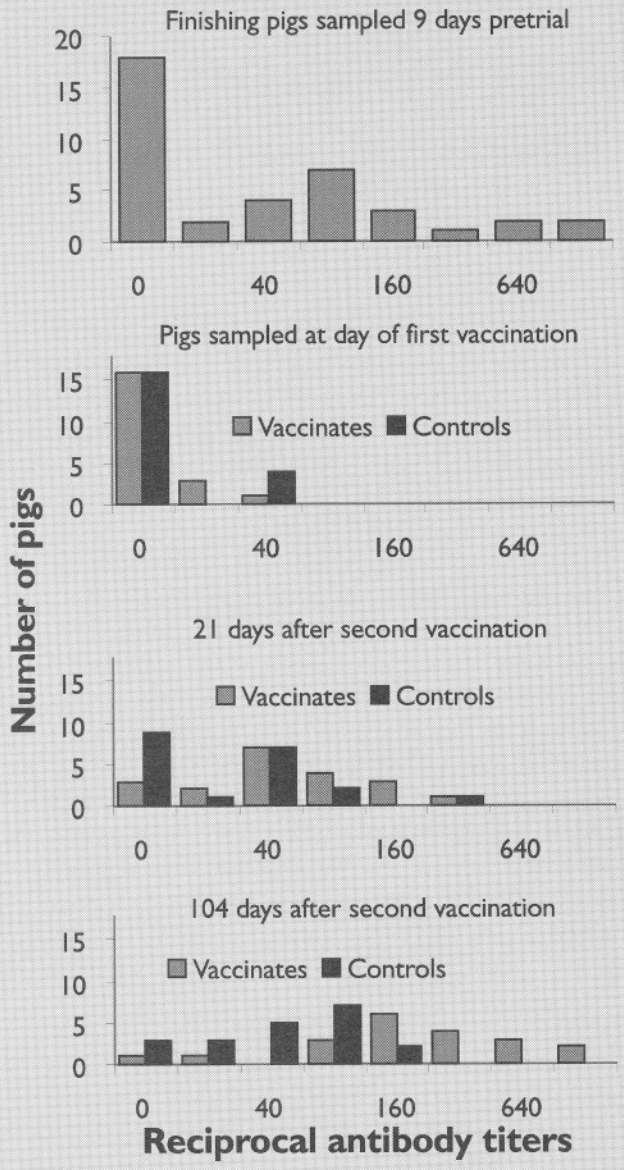
Materials and methods

The Swine Development Center (SDC), located at the Upper Coastal Plain Research Station, Rocky Mount, North Carolina is a 150-sow farrow-to-finish demonstration unit.[14] For years it has had a problem with coughing in pigs from weaning through finishing and sudden death of hogs in the finishing phase of production. Sows and boars were vaccinated for parvovirus and erysipelas but their progeny received no vaccinations.

Disease status and medications

In April 1990, 10 (31%) of 32 hogs slaughtered had lung lesions consistent with mycoplasma pneumonia. Nine days before starting the trial, 15 (38.5%) of 39 pigs sampled from the finishing buildings were seropositive (titers ≥ 1 : 80) for *M. hyopneumoniae* antibodies using Tween 20 ELISA (Figure 1). Hence, the prevalence of *M. hyopneumoniae* organisms circulating in the herd appeared to be low just prior to initiating this study. There was no clinical evidence for atrophic rhinitis in the herd. However, we isolated *Pasteurella multocida* from a hog with pleuritis that died in May 1991 and this pathogen was

Figure 1



Distribution of antibody titers to *M. hyopneumoniae* before and during the trial.

probably contributing to the respiratory disease complex. Neo-Terramycin™ 10/10 (Pfizer Inc., New York, New York) was included in the feed at 10 lb per ton to give 100 g per ton of terramycin in the final nursery pig ration fed from about 8 kg (17.5 lb) through 23 kg (51 lb). We also included CTC 50™ (A.L. Laboratories, Inc. Fort Lee, New Jersey) in the feed at 200 g per ton from 33 kg (73 lb) to 63 kg (143 lb) and decreased to 100 g per ton from 63 kg (143 lb) to slaughter at 100 kg (220 lb).

Nutrition

Rations contained nutrients in concentrations at or above those recommended by the National Research Council.[15]

Facilities

The nursery building has all-in-all-out flow in two side-by-side rooms. Pigs enter at about 4 weeks of age weighing 8 kg (17.6 lb) and leave at about 9 weeks of age weighing 23 kg (51 lb). Each nursery room has sixteen 1.5 × 1.5 m (5 × 5 ft) pens. One has tri-bar flooring and the other has woven wire flooring (Table 1). Ventilation is provided by a plenum under the central aisle with a manually controlled variable-speed exhaust fan. Each room also has additional ventilation provided by a thermostatically controlled exhaust fan in the sidewall. All pigs move from the nursery to a grower, which has eight 3 × 3 m (10 × 10 ft) pens on concrete slats (Table 2). The steel pen dividers permitted nose-to-nose contact. The grower also has all-in-all-out pig flow and is ventilated in the same fashion as the nursery. At about 11.5 weeks of age and weighing 33 kg (73 lb), pigs move to either the female or barrow finishing floor.

The female finishing floor has a row of 4.9 × 3.3 m (16 × 11 ft) pens, and a row of 4.9 × 4.6 m (16 × 15 ft) pens separated by a central aisle. Thirty-two females are housed in each pen and are transferred, by pen, across the aisle to the larger pens at about 63 kg (143 lb) (Table 2). The pens on both sides are fully slatted and the building is open-sided and equipped with roll-up plastic curtains. The steel pen dividers permitted nose-to-nose contact. Pit ventilation is provided by means of a plenum under the center aisle with a variable-speed exhaust fan on one end. Ceiling fans provide additional air movement in conjunction with a thermostatically controlled fogging system for added summer cooling. Waste is removed by weekly draining and recharging.

The barrow finishing floor is similar except it has a row of 3 × 3 m (10 × 10 ft) pens, and a row of 3 × 4.6 m (10 × 15 ft) pens. The steel pen dividers permit nose-to-nose contact. Sixteen barrows are housed in each pen and are moved, by pen, across the aisle to the larger pens at about 63 kg (143 lb) (Table 2). The building has a variable-speed exhaust fan on both ends of the plenum. No additional ventilation is provided. Both sides of the barrow finishing floor are flushed with tanks equipped with water-weighted flush valves. Both finishing buildings are operated using continuous-flow management.

Trial design

From October 1991 to December 1991, we eartagged all nursery pigs from five weaning groups and sorted them into pens by gender (females and barrows) and weight. Eight pens of barrows were on one side of the central passageway, eight pens of females on the other. Then, we allocated the vaccinate or control treatments alternately to the 16 pens in each group. Thus, on the barrow side the first pen was a control, the second a treatment, the third a control and so on. The control treatment was "no vaccine" rather than a placebo to reflect the practical situation for a herd where the decision would be made to either vaccinate or not vaccinate the herd.

Table 1

Stocking density of nursery pigs by treatment of weaning group

Group	Pens per treatment	Controls		Vaccinates	
		Number of pigs	Stocking density m^2/pig (sq ft/pig)	Number of pigs	Stocking density m^2/pig (sq ft/pig)
1	8	71	0.26 (2.82)	67	0.28 (2.98)
2	8	56	0.33 (3.57)	56	0.33 (3.57)
3	8	83	0.22 (2.41)	85	0.22 (2.35)
4	6	44	0.32 (3.41)	43	0.32 (3.49)
5	7	60	0.27 (2.92)	60	0.27 (2.92)
Total	37	314	0.27 (2.95)	311	0.28 (2.97)

Table 2

Stocking density of growing and finishing pigs

Stage of production	Gender	Pen size, m (ft)	Number of pigs/pen	Stocking density m^2/pig (sq ft/pig)
Grower	Female	3 x 3 (10 x 10)	17	0.529 (5.88)
Grower	Barrow	3 x 3 (10 x 10)	17	0.529 (5.88)
Finisher, left side	Female	4.9 x 3.3 (16 x 11)	32	0.505 (5.5)
Finisher, right side	Female	4.9 x 4.6 (16 x 15)	32	0.704 (7.5)
Finisher, left side	Barrow	3 x 3 (10 x 10)	16	0.560 (6.25)
Finisher, right side	Barrow	3 x 4.6 (10 x 15)	16	0.86 (9.375)

Vaccinates received 2 mL of the *M. hyopneumoniae* vaccine RespiSure® when allocated to treatment (at weaning) and 14 days later. This protocol was adopted rather than the recommended 7 and 21 days of age because it is common industry practice and avoids handling 7-day-old pigs. We weighed pigs individually when moving them between buildings at approximately 23 kg (51 lb) and 33 kg (73 lb), and prior to slaughter at 92 kg (202 lb). We did not track the location of pigs after they left the nursery.

Serology

We bled 20 vaccinated and 20 control pigs from the fourth group on the day of the first vaccination and at 21 days and 104 days after the second vaccination. We froze all sera, including the 39 pretrial samples, then had them simultaneously assayed by Tween 20, ELISA test.[16] The sera were serially diluted in two-fold steps, starting at 1 : 20, using test diluent. The highest diluent with an absorbance of ≥ 0.2 was considered to be the end point titer for that pig. We considered titers greater than 1 : 40 to be positive.[17]

Analysis

We tested the hypothesis that there was no difference in ADG between treatments using the repeated measurement option in the GLM procedure of SAS.[18] We used an analysis of covariance model with initial weight as a covariate; group, status (vaccinated or control), gender, and pen (nested within group, status, and gender) as main effects; and tested for the interactions of group and status, and status and gender. The pen was the experimental unit for testing the hypothesis. We included initial pig weight as a covariate to adjust for the variation in initial weights among treatments. We tested for differences between vaccinated and control groups for the prevalence of antibodies using Fisher's Exact test.[19]

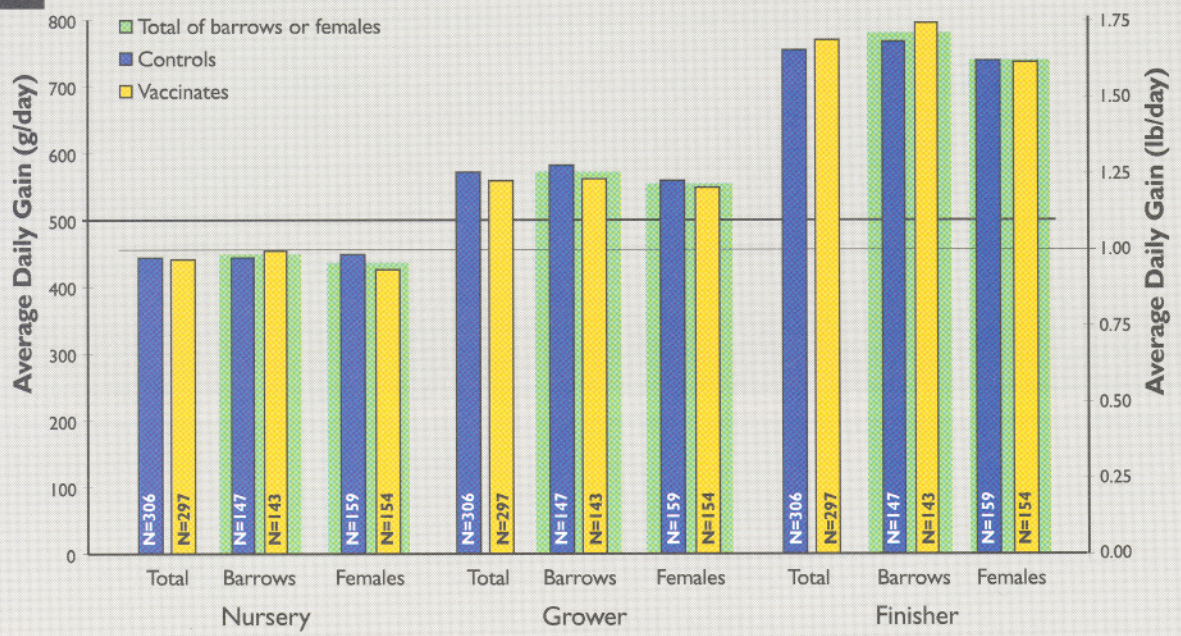
Results and discussion

Of the 625 pigs tested, 11 pigs died (five control, six vaccinate), five were removed (three control, two vaccinate) and six were lost to follow-up. These results are based on the remaining 603. Average daily gain was not different ($P = .24$) between vaccinated and control pigs for all five groups (Figure 2).

Although barrows grew significantly ($P = .0003$) faster than females, particularly in the finishing phase (780 versus 739 g per day, 1.72 versus 1.63 lb per day), vaccine did not affect this difference ($P = .37$) (Figure 2).

The faster ADG of barrows could be partially explained by the greater space they were allowed in both finishing stages

Figure 2



Least-squares means of average daily gain (g/day and lb/day) of vaccinated and control pigs for the nursery, grower, and finisher growth phases, also separated by sex. Least-squares means are the expected value of class means for a balanced design involving the class variables with all covariates at their mean value. Vaccination was with RespiSure® (SmithKline Beecham Animal Health).

(Table 2).[20] The slight and nonsignificant benefit the vaccine seems to have for pigs in the finishing phase was primarily due to a difference of 63.5 g per day (0.14 lb per day) with the fourth group. The difference for the other four groups ranged from +18.1 to -4.5 g per day (+0.04 to -0.01 lb per day). The weight of pigs entering the nursery was a significant determinant of ADG for nursery ($P = .0001$), growing ($P = .0053$), and finishing ($P = .0001$) phases of growth.

Because of the lack of resources, feed consumption was not recorded. We did not examine lungs at slaughter because the objective of the study was to determine the effect on growth rate rather than the intermediary lung lesions, and slaughter lesion scores tend to have only a weak correlation to ADG or feed : gain.[7] We bled the pigs before vaccination to determine baseline antibody titers, at 21 days after the second vaccination to determine the primary response, and at 104 days after the second vaccination to determine a final titer. Twenty samples per treatment was sufficient to detect a difference in proportions of 0.4 (0.4 versus 0.8) at 0.05 level of significance.[21]

All 40 pigs tested on the day of weaning were negative for *M. hyopneumoniae* antibodies, suggesting that their dams had either low or no antibody to the organism. Twenty-one days after the second vaccination, more ($P = .16$, eight of 20 [40%]) of the vaccinated animals were seropositive to *M. hyopneumoniae* compared to the control group where only three of 20 (15%) were seropositive (Figure 1). It is disappointing that so few (40%) vaccinated animals seroconverted at 21 days after the second vaccination; it suggests that the vaccine did not adequately stimulate antibody production in all animals.

Sera collected 104 days after the second vaccination indicated a higher ($P = .001$) proportion of seropositive animals; 18 of 20 vaccinated (90%) compared to nine of 20 control (45%) pigs (Figure 1). However, the proportions of positive sera among vaccinated pigs at all stages are low. Scheidt, et al.,[13] reported five of six pigs (83%) seropositive at 2, 3, and 4 months of age and six of six pigs (100%) at 5 and 6 months of age after vaccinating pigs at 1 and 3 weeks of age. Also, for pigs vaccinated at 6 and 8 weeks of age, Scheidt, et al.,[13] recorded one of six pigs (16.7%) seropositive at 2 months of age, five of six pigs (83%) seropositive at 3, 4, and 6 months of age, and six of six pigs (100%) at 5 months of age. These higher proportions could be due to a higher prevalence of *M. hyopneumoniae* organisms in the herd they studied. The proportion seropositive at 6 months was a good indication whether pigs have been previously infected with *M. hyopneumoniae* because ELISA antibodies develop in susceptible pigs as early as 2 weeks after infection[17] and persist for as long as 52 weeks.[22]

The unvaccinated control pigs, sampled at three stages of growth, could be used to evaluate spread. The presence of seropositive control pigs in the fourth group at 21 and 104 days after the second vaccination indicates that *M. hyopneumoniae* was circulating in the nursery and grower-finisher stages at that time but probably at a low level.

The proportion of seropositive pigs among control pigs at 21 and 104 days after the second vaccination was also low compared to results of Walgren and Schwan,[23] who reported 14 of 14 (100%) pigs seropositive (Tween 20) to *M. hyopneumoniae* 50 days after seronegative pigs were mixed with pigs from a

chronically infected herd. Again, these higher proportions could be due to a greater challenge with *M. hyopneumoniae* organisms in the herd they studied.

The distribution of antibody titers in the sample of pigs from the fourth group at 104 days after the second vaccination illustrates that more vaccinated than control animals were seropositive and that titers were higher. These data suggest that the pigs were challenged after 21 days post second vaccination and, because they were vaccinated, they mounted a strong secondary response.

Because our control and vaccinated pigs shared the same buildings throughout the trial it was possible that they were exposed to fewer mycoplasma. If this was the case, the underexposed controls may have had the opportunity to grow as fast as the vaccinated pigs. However, the percentage of seropositive control pigs in the fourth group, 45% at 104 days after the second vaccination, suggests that *M. hyopneumoniae* exposure was comparable to those in pretrial samples when 38.5% of finishing pigs were seropositive. The prevalence of seropositive pigs in the fourth group was probably representative of the prevalence in all five groups because the fourth group entered the finishing phase buildings when the first three groups were still present and was still there when the fifth group entered.

The lack of effect on ADG in response to the *M. hyopneumoniae* vaccine in our trial was in contrast to some investigators.[11,24-27] However, others[10,28] have demonstrated no increase in ADG. Clearly, the response to vaccination varies by herd and may depend on the prevalence of *M. hyopneumoniae* organisms in the herd or the presence of other pathogens or stresses.

Implications

- Before recommending a *M. hyopneumoniae* vaccine, practitioners should test the sera from a representative sample of finishing pigs for antibodies to *M. hyopneumoniae*. Unless more than 50% of samples are positive to the ELISA, the vaccine may not result in increased ADG.
- To confirm the suitability of a vaccination program, practitioners could conduct a growth rate efficacy trial in their client's herd.

Acknowledgements

The authors thank SmithKline Beecham Animal Health for providing the RespiSure® vaccine and conducting the Tween 20 ELISA assay, M. Gumpertz for statistical advice, and P. Davies for reviewing the manuscript.

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