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Evaluation of Vaccination for Control of Respiratory Disease

S. Wongnarkpet, D.U. Pfeiffer and R.S. Morris

Department of Veterinary Clinical Sciences,
Massey University, Palmerston North,
New Zealand

Introduction

Enzootic pneumonia (EP) of pigs caused by *Mycoplasma hyopneumoniae* (MH) is a chronic nonfatal respiratory tract disease of major importance mainly in growing pigs in intensive pig production. It results in substantial economic losses mainly due to reduced growth efficiency (Pointon *et al*., 1985) and increased susceptibility to *Actinobacillus pleuropneumoniae* infection (Yagihashi *et al*.,1984). Porcine pleuropneumonia, caused by *Actinobacillus pleuropneumoniae* (AP) infection, also results in great economic loss in intensive piggeries. In 1989 AP was first diagnosed in New Zealand (Lake, 1990), and now at least five serotypes (1, 5, 6, 7 and 12) are known to be present (Hilbink *et al.* 1992).

There is a wide range of different eradication programmes for *M. hyopneumoniae* available, but the risk of reinfection is high. They are based on the use of antibiotics, environmental improvement and vaccination. A disadvantage of antibiotic treatment for prophylaxis is the increased prevalence of antimicrobial resistant strains of AP (Kim and Jung, 1994; Raemdonck *et al*., 1994). Improvement of the environmental conditions is an important tool in the control of respiratory diseases, but may require major financial investments. Vaccination often represents the only practicable control measure from an economic point of view. AP vaccines have been reported to result in both lower incidence of pleuritis and reduced time required for pigs to reach market weight (Riising, 1980). In many herds pneumonia levels can be significantly reduced through control of *M. hyopneumoniae* infection, even though other respiratory pathogens such as *Pasteurella multocida* may be present and would cause severe disease in the presence of *M. hyopneumoniae*. Simultaneous vaccination against MH and AP has been considered a useful strategy for controlling two economically important diseases, which may potentially provide synergistic benefits in jointly controlling the two diseases.

The objective of this clinical trial was to assess the efficacy of commercial MH and AP vaccines administered simultaneously under field conditions in a typical piggery.

Materials and methods

A farrow-to-finish piggery with 340 sows in the north of the North Island, New Zealand operating a continuous flow system of intensive production was selected on the basis of the presence of MH, AP and *Pasteurella multocida* infection in pigs. A slaughter check investigation with subsequent microbiological confirmation 3 months prior to the clinical trial showed the presence of pleuropneumonia lesions caused by AP serotype 7.

The trial was conducted between August 1993 and March 1994. A total of 190 pigs were randomly allocated to vaccinated and control groups at 2 weeks of age. After weaning, vaccinated and control pigs were kept in separate pens by week groups, but each pair of groups was housed adjacent to each other in comparable pens during each phase of the growth period.

An inactivated and adjuvanted MH vaccine (Suvaxyn® Respifend MH serial 10027) and an adjuvanted AP bacterin containing AP serotypes 1, 5 and 7 (Suvaxyn® Respifend APP serial 17021C) were used in the trial. Pigs were vaccinated intramuscularly with 2 ml of each vaccine at 2 and 4 weeks of age, at separate vaccination sites.

Pigs were individually weighed at 2 weeks, 4 weeks, 11 weeks, 15 weeks of age and one day before slaughter (SL). Mortality of pigs, average daily weight gain (ADG) and days to market were estimated. Feed conversion ratio (FCR) was calculated on a group basis.

Lung and pleurisy lesions were scored using the procedure described by Pointon *et al*. (1992). The apical and cardiac lobes had a maximum score of 10. The diaphragmatic and intermediate lobes were each scored up to 5, giving a total maximum score of 55.

One-way ANOVA was used to compare weights, ADG and FCR among treatment groups. Chi-squared analysis was used to compare treatment status and degree of severity categories of enzootic pneumonia, pleurisy and pleuropneumonia lesions. Average total lung score, degree of severity of lung scores, and days to market were analyzed using the Mann-Whitney U test. Results are expressed using mean ± SD.

Hierarchical log-linear modelling (Fienberg, 1980) was used to test the statistical association between treatment, presence of enzootic pneumonia, pleurisy and pleuropneumonia. A value of 0.5 was added to cells to prevent empty cells.

Results

Average slaughter weight of vaccinated pigs was 2.49 kg higher than in controls (P=0.029). There was no significant difference in overall ADG from weaning to slaughter between the groups. During the period from 15 weeks of age to slaughter the ADG of the vaccinated group was significantly higher than that of controls by 40 g/day (P=0.026).

FCR data was analysed for three consecutive intervals from 4 to 11 wks, 11 to 15 wks and 15 wks to slaughter. It showed a similar trend to ADG with a difference of 0.21kg between groups during the last interval, but it was not statistically significant. There was no difference in the mean number of days to market between the two groups. Two-way repeated measures ANOVA showed that apart from the normal weight increase as pigs aged, treatment alone had no significant effect, but there was a significant time x treatment interaction, reflecting the specific effect of the vaccine on pigs late in the growth period.

Active pneumonia lesions were found in 40% of lungs from the vaccinated group and in 54% from the control group (χ^2=6.77;df=2; P=0.0338). There were no significant differences between the two groups with respect to the prevalence of pleurisy and pleuropneumonia lesions ($\chi^2 = 0.18$, df = 2, $P = 0.91$; $\chi^2 = 0.48$, df = 2, $P = 0.49$).

Vaccinated pigs had significantly lower average total lung scores of enzootic pneumonia lesions (3.46 ± 5.3 vs 7.32 ± 9.02, P=0.0004) and lung scores for individual lobes than control pigs.

The association between the variables treatment status, presence of EP, pleurisy and pleuropneumonia lesions was analyzed using log-linear modelling. The final log-linear model indicated that there were significant first order interactions between EP lesions and treatment and between PP lesions and pleurisy lesions.

Discussion

The combination of two vaccines against MH and AP produced a substantial and significant improvement (2.49 kg) in slaughter weight of pigs, with significantly higher daily gain during the period from 15 weeks to slaughter weight. Although FCR was 0.21 kg better per kg of gain in the vaccinated pigs over the same period, the limited number of replicate measurements possible for this index under group feeding conditions meant that there was insufficient statistical power in the trial design to discriminate whether this was a true or a chance difference. However the results of this trial are consistent with those obtained by other workers using MH vaccines (Weiss and Peterson, 1992; Christensen and Deitemeyer, 1993; Lium *et al*., 1994;Vraa-Andersen *et al*., 1994) and AP vaccines (Heard and Tuck, 1986; Thacker and Mulks, 1988; Beskow *et al*., 1992; Tarasiuk *et al*., 1994).

It is not possible to differentiate the effects on production of the two vaccines, as pigs were immunized using both. The use of the combined vaccines resulted in a reduction of the proportion of pigs with active (acute) EP at slaughter (Bahnson *et al*., 1992) to 40% compared with 54% in control pigs, and increased the proportion with no lesions of EP to 51% in vaccinated pigs compared with 40% in controls. The average total lung score for EP lesions was halved compared with unvaccinated pigs. Interpreting these results, it has to be taken into account that earlier lesions were likely to have resolved by the time of slaughter (Morrison *et al*., 1986). The evidence from this study suggests that MH vaccination is associated with both improved productivity and a reduction in EP lesions, each of which is measurable in slaughter animals.

As shown using log-linear analysis the use of the combined vaccines is associated with lower prevalence of enzootic pneumonia lesions, but no association with vaccination was detected for pleurisy or pleuropneumonia. This suggests that while the EP vaccine had an effect on EP lesions, the killed whole cell AP bacterin as used here did not have an equivalent effect on AP lesions. Experience elsewhere suggests that this vaccine protects mainly against mortality (which the trial had insufficient power to evaluate). A fully effective AP vaccine should ideally contain both bacterial whole cell antigens and secreted toxins (capsular polysaccharide, lipopolysaccharide, outer membrane proteins, cytotoxin and haemolysin) as has been demonstrated in mice by Bhatia *et al*. (1990).

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