Evaluation of Vaccination and Antimicrobial Protocols in Nursery Pigs Coinfected with Porcine Reproductive and Respiratory Syndrome Virus and *Streptococcus suis*

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Summary and Implications

We tested the efficacy of nine different intervention strategies to minimize losses associated with experimental coinfection of nursery age pigs with porcine reproductive and respiratory syndrome virus (PRRSV) and *Streptococcus suis*. The antibimicrobials tested included penicillin, ampicillin, tiamulin, and ceftiofur hydrochloride. Vaccines tested included two commercial modified live PRRSV vaccines, an autogenous killed *S. suis* vaccine, and an experimental live autogenous *S. suis* vaccine. We found that the most effective treatment was intramuscular injection of 5 mg/kg ceftiofur hydrochloride on three consecutive days following *S. suis* inoculation. The live autogenous *S. suis* vaccine and treatment with ceftiofur hydrochloride every third day for three treatments also significantly reduced mortality.

Introduction

Mortality associated with PRRSV and *Streptococcus suis* coinfection continues to be one of the major problems in nursery age pigs. It is estimated that 90 – 100% of all pigs are colonized with *S. suis* post partum. Case submissions to the Iowa State University Veterinary Diagnostic Laboratory confirm a 3-fold increase in *S. suis* cases and a 9-fold increase in cases of PRRSV and *S. suis* coinfection during the last 5 years. We have developed an excellent model that mimics PRRSV/*S. suis* coinfection in the field (1). This report summarizes the results from two studies where we tested the efficacy of conventional and experimental intervention strategies for control of PRRSV and *S. suis* coinfection.

Materials and Methods

Study 1 Seventy-six, crossbred, PRRSV-free pigs were weaned at 12 days of age and randomly assigned to seven groups of 10 or 11 pigs each (Table 1). Pigs in group 1 served as unchallenged controls. Pigs in groups 2 – 7 were challenged intranasally with 2 ml of high virulence PRRSV isolate VR-2385 ($10^{4.47}$ $TCID_{50}$/2 ml) on day 0 of the study (30 days of age). Seven days after PRRSV challenge, pigs in groups 2 – 7 were challenged intranasally with 2 ml of *S. suis* serotype 2 ($10^{8.30}$ CFU/2 ml). Group 2 pigs served as untreated positive controls. Antimicrobial treatments included daily intramuscular injection with 66,000 IU/kg procaine penicillin G on days 8 – 10 (group 3), drinking water medication with 23.1 mg/kg tiamulin during days 8--10 (group 4), and daily intramuscular injection of 5.0 mg/kg ceftiofur hydrochloride on days 8 – 10 (group 5). Vaccination regimens included two intramuscular doses of an autogenous killed *S. suis* vaccine (group 6) prior to *S. suis* challenge, or a single 2 ml intramuscular dose of a modified live PRRSV vaccine (group 7) 2 weeks prior to PRRSV challenge.

Study 2 Fifty-six, crossbred, PRRSV-free pigs were weaned at 10 – 12 days of age and randomly placed into five groups (Table 1). All pigs received 2 ml of $10^{6.4}$ $TCID_{50}$/ml high virulence PRRSV isolate VR-2385 intranasally at 29 – 31 days of age on day 0 of the trial and 2 ml of $10^{8.9}$ CFU/ml S. *suis* type 2 isolate ISU VDL #40634/94 intranasally on day 7 of the trial. Pigs in group 1 (n=10) served as untreated positive controls. Pigs in group 2 (n=12) received 5.0 mg/kg ceftiofur hydrochloride (Excenel®, Pharmacia & Upjohn, Kalamazoo, MI) intramuscularly (IM) on days 8, 11, and 14. Pigs in group 3 (n=11) received 11.02 mg/kg ampicillin (Polyflex®, Fort Dodge Laboratories, Fort Dodge, IA) IM on days 8, 9, and 10. Pigs in group 4 (n=12) were vaccinated 14 days prior to PRRSV challenge with a modified live PRRSV vaccine (Suvaxyn® PRRS, Fort Dodge Laboratories). Pigs in group 5 (n=11) were vaccinated with an experimental live autogenous *S. suis* vaccine 19 days prior to *S. suis* challenge.

Results and Discussion

Study 1 Mortality was 0, 63, 45, 54, 9, 40, and 81% in groups 1 – 7, respectively (Table 1). Ceftiofur treatment was the only regimen that significantly ($P < .05$) reduced mortality associated with PRRSV and *S. suis* coinfection. The other treatments and vaccinations were less effective. We conclude that ceftiofur hydrochloride administered by injection for three consecutive days following *S. suis* challenge was the most effective regimen for minimizing disease associated with PRRSV and *S. suis* coinfection.

Study 2 Mortality was 80, 25, 82, 83, and 36% in groups 1 – 5 respectively (Table 1). Treatment with ceftiofur hydrochloride and vaccination with a live autogenous *S. suis* vaccine were the only treatments that significantly reduced mortality (P<.05) associated with PRRSV/*S. suis* coinfection. Pigs treated with ceftiofur hydrochloride showed the least severe gross lung lesions. The live autogenous *S. suis* vaccine had some residual virulence. Pigs that received this vaccine had a higher incidence of adhesions present in the serosal cavities than the ceftiofur hydrochloride treated animals. The PRRSV/*S. suis* coinfection model used represents a severe challenge exposure in which clinical signs and lesions consistent with PRRSV/*S. suis* coinfection were reproduced. The most effective treatment was IM injection of 5 mg/kg ceftiofur hydrochloride on three consecutive days following *S. suis* inoculation. The live autogenous *S. suis* vaccine and treatment with ceftiofur hydrochloride every third day for three treatments also significantly reduced mortality. The other treatments did not significantly reduce mortality.

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References

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Table 1. Mortality associated with PRRSV and *S. suis* coinfection of nursery age pigs following antimicrobial treatment or vaccination.

Group	Treatment	Day of Treatment[a]	Dose and Route[b] of Treatment	Mortality (%)
Study 1				
Group 1	Negative Controls	-	-	0
Group 2	Positive Controls	-	-	63
Group 3	penicillin	8,9,10	66,000 IU/kg IM	45
Group 4	tiamulin	8,9,10	23.1 mg/kg in drinking water	54
Group 5	ceftiofur hydrochloride	8,9,10	5.0 mg/kg IM	9[c]
Group 6	autogenous killed S. suis vaccine	-18, -4	2 ml IM	40
Group 7	modified live PRRSV vaccine #1	-14	2 ml IM	81
Study 2				
Group 1	Positive Controls	-	-	80
Group 2	ceftiofur hydrochloride	8,11,14	5.0 mg/kg IM	25[c]
Group 3	ampicillin	8,9,10	11.02 mg/kg IM	82
Group 4	modified live PRRSV vaccine #2	-14	2 ml IM	83
Group 5	experimental live *S. suis* vaccine	-12	2 ml IN	36[c]

[a]Pigs were intranasally inoculated with PRRSV on day 0 and *S. suis* on day 7.
[b] IM = Intramuscular, IN = Intranasal.
[c] Treatments significantly (P<.05) reduced mortality.