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Cameron S. Schmitt
Iowa State University

Gayle B. Brown
Iowa State University

James A. Roth
Iowa State University

Patrick G. Halbur
Iowa State University

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

Abstract
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 antibacterials 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.

Keywords
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Disciplines
Agriculture | Animal Sciences
Evaluation of Vaccination and Antimicrobial Protocols in Nursery Pigs Coinfected with Porcine Reproductive and Respiratory Syndrome Virus and Streptococcus suis

Cameron S. Schmitt, graduate student; Gayle B. Brown, graduate student; and James A. Roth, professor; Department of Veterinary Microbiology and Preventive Medicine
Patrick G. Halbur, associate professor; Department of Veterinary Diagnostic and Production Animal Medicine

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 antibacterials 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.

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^{3.30} CFU/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).

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^{4.9} 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.

Acknowledgments
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References

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

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

Pigs were intranasally inoculated with PRRSV on day 0 and S. suis on day 7.

IM = Intramuscular, IN = Intranasal.

c Treatments significantly (P<.05) reduced mortality.