

ANNUAL REPORT PROJECT NC-229

PERIOD COVERED: June 2008 to November 2009

INSTITUTION OR STATION: University of Minnesota

A. NC-229 REPRESENTATIVE:

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Other PRINCIPAL LEADERS associated with the projects

Davies, Peter; UMN
Dee, Scott; UMN
Deen, John; UMN
Joo, Han Soo; UMN
Molitor, Tom; UMN
Morrison, Robert; UMN
Rossow, Kurt; UMN
Rovira, Albert; UMN

B. PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Objective 1. Elucidate the mechanisms of host-pathogen(s) interactions.

Indicate progress in the following areas.

1. Research related to pathogenesis/persistence

Pig age influences the pathogenesis of PRRSV infection. Clinical signs were markedly more severe and prolonged in young piglets than in finishers or sows. Viremia was prolonged in weaned pigs for both attenuated and virulent PRRSV. Viremia was reduced in magnitude and duration in finisher pigs and sows. Many sows did not show evidence of viremia following infection with attenuated PRRSV.

2. Research related to virus evolution

Whole genome sequencing was continued on field isolates. Data indicate that recombination occurs in the field.

3. Research related to mechanisms of transmission

4. Research related to viral Immunity and cross-protection.

Antibody responses were observed in all pigs irrespective of age, with older pigs tending to seroconvert sooner and achieve higher antibody levels than 3-week-old animals. Interferon γ (IFN γ) secreting peripheral blood mononuclear cells were more abundant in sows but not specifically increased by PRRSV infection in any age group, and interleukin-10 (IL-10) levels in blood were not correlated with PRRSV infection status. These findings show that animal age, perhaps due to increased innate immune resistance, strongly influences the outcome of acute PRRSV infection, whereas an antibody response is triggered at a low threshold of infection that is independent of age. Prolonged infection was not due to IL-10-mediated immunosuppression, and PRRSV did not elicit a specific IFN γ response, especially in non-adult animals. Equivalent

antibody responses were elicited in response to virulent and attenuated viruses, indicating that the antigenic mass necessary for an immune response is produced at a low level of infection, and is not predicted by viremic status. Thus, viral replication was occurring in lung or lymphoid tissues even though viremia was not always observed.

Research was continued to examine efficacy of homologous immune protection in reproductive disease. Inoculation pre-breeding, followed by late gestation challenge with a virus more than 98% similar genetically, resulted in fever in 13 of 15 sows and abortions in 3 of 15 sows. Litters in the remaining 12 sows were normal, but about 18% of piglets were viremic at 1 day of age. At weaning, about 38% of piglets were viremic.

5. Research related to epidemiology.

Objective 2. Understand the ecology and epidemiology of PRRSV and emerging viral diseases of swine.

Indicate progress in the following areas.

1. Research related to pathogenesis/persistence

2. Research related to virus evolution.

3. *Research related to mechanisms of transmission*

Evidence of airborne transport of PRRSV out to 4.7 km was documented along with associated meteorological conditions.

4. Research related to viral Immunity and cross-protection

5. *Research related to epidemiology*

Diagnostic tests for PCV2 and differential PCR for subtypes 2a and 2b were refined, and ultrastructural studies were conducted to detect coinfecting agents in clinical samples. The tools were applied to epidemiologic studies of PCV2, including the ecology of PCV2 in boar studs, and associations of PCV2 subtypes with clinical disease.

Objective 3. Develop effective and efficient approaches for detection, prevention and control of PRRSV and emerging viral diseases of swine.

Indicate progress in the following areas.

1. Research related to pathogenesis/persistence

2. Research related to virus evolution

3. *Research related to mechanisms of transmission*

Year 3 of the evaluation of air filtration as a means to reduce the risk of aerosol transmission of PRRSV was completed at the SDEC production region model.

A standardized means to validate the efficacy of biosecurity interventions to reduce the risk of airborne spread of PRRSV was developed.

Year 1 of the assessment of air filtration to reduce the risk of airborne spread of PRRSV in large sow units in swine dense regions was initiated.

Efficacy of regional control of PRRS was evaluated in Stevens County, Minnesota. Communication and implementation of best practices has reduced PRRS incidence to one infected herd in 89 existing sites.

4. Research related to viral Immunity and cross-protection

5. Research related to epidemiology

C. IMPACT AND VALUE OF RESEARCH TO STAKEHOLDERS:

The value of airborne transmission research results to stakeholders includes a comprehensive understanding of the airborne routes and significance for the spread of PRRSV between farms. The continued ability to demonstrate the efficacy of air filtration to reduce this risk, initially via the production region model and then under controlled field conditions provides producers and veterinarians with a tool to reduce this important risk factor.

Regional elimination of PRRS demonstrates to stakeholders that the disease can be eliminated from a region and provides tools and methods that can be implemented in other regions.

Immunity research informed stakeholders of significant age-dependent differences in the ability of pigs to resist PRRSV infection, providing important information on proper application of live vaccines in the field, and efficacy of serum inoculation in the control of PRRS disease in gestating sows and vertical transmission of PRRSV.

These results have produced the following funds:

Dee SA. An assessment of air filtration for reducing the risk of airborne spread of PRRSV to in large commercial sow herds in swine dense regions. Minnesota Pork Board, \$30,000, June 1, 2008-May 31, 2009.

Zimmerman JJ, Dee SA, Davies PD, Holtkamp D, O'Connor A, Pohl S. Identifying ecological and epidemiological factors in the control of PRRS: A field-based approach. USDA NRI PRRS CAP 2. \$180,000, December, 2008-November, 2009.

Dee SA. An evaluation of aerosol biosecurity measures for hot weather. Boehringer-Ingelheim PRRS Research Initiative. \$25,000 April 1, 2008-March 31, 2009.

Dee SA. Use of a production region model to evaluate biosecurity protocol efficacy for reducing the risk of PRRS virus and *Mycoplasma hyopneumoniae* spread between farms. National Pork Board, \$250,392 August 1, 2007-July 31, 2009.

Dvorak CMT, Dee SA, Murtaugh MP. Dissemination of PCV2 viral particles from sow to piglets. National Pork Board, \$84,466 Sept 1, 2009-Aug 31, 2010.

D. PRRS PUBLICATIONS ISSUED OR “IN PRESS”

1) Refereed publications

Cano JP, Dee SA Murtaugh MM, and Morrison RB. Infection dynamics and clinical manifestations following experimental inoculation of gilts at 90 days of gestation with porcine reproductive and respiratory syndrome virus. . *Can J Vet Res* (Accepted for publication).

Cano, J.P., S.A. Dee, M.P. Murtaugh, A. Rovira, and R.B. Morrison. 2008. Infection dynamics and clinical manifestations following experimental inoculation of gilts at 90 days of gestation with a low dose of porcine reproductive and respiratory syndrome virus. *Can. J. Vet. Res.* 73:303-307.

de Abin, M.F, G. Spronk, M. Wagner, M. Fitzsimmons, J. Abrahante, and M.P. Murtaugh. 2009. Comparative infection efficiency of porcine reproductive and respiratory syndrome virus field isolates on MA104 cells and porcine alveolar macrophages. *Can. J. Vet. Res.* 73:200-204.

Dee SA, Otake S, Oliviera S and Deen J. Evidence of long distance airborne spread of porcine reproductive and respiratory syndrome virus and *Mycoplasma hyopneumoniae*. *Vet Res* 2009, 40(4)39.

Dee SA, Pitkin AN and Deen J. Evaluation of alternative strategies to MERV 16-based air filtration systems for reduction of the risk of airborne spread of porcine reproductive and respiratory syndrome virus. *Vet Microbiol* doi:10.1016/j.vetmic.2009.03.019.

Klinge, K.L., E.M. Vaughn, M.B. Roof, E.M. Bautista, and M.P. Murtaugh. 2009. Age-dependent resistance to Porcine reproductive and respiratory syndrome virus replication in swine. *Viol. J.* 6:177-187.

Murtaugh, M.P., C.R. Johnson, Z. Xiao, R.W. Scamurra, and Y. Zhou. 2009. Species specialization in cytokine biology: is interleukin-4 central to the TH1-TH2 paradigm in swine. *Develop. Comp. Immunol.* 33:344-352.

Pieters M, Dee SA, Fano E and Pijoan C. An assessment of the duration of *Mycoplasma hyopneumoniae* infection in an experimentally infected population of pigs. *Vet Microbiol* 2009;143:261-264.

Pitkin AN, Deen J and Dee SA. Further assessment of fomites and personnel as vehicles for the mechanical transport and transmission of porcine reproductive and respiratory syndrome virus. *Can J Vet Res* (Accepted for publication).

Pitkin AN, Deen J and Dee SA. Use of a production region model to assess the airborne spread of porcine reproductive and respiratory syndrome virus. *Vet Microbiol* 2009;136:1-7.

Pitkin AN, Otake S, Deen J, Moon RD, Dee SA. Further assessment of houseflies (*Musca domestica*) as vectors for the mechanical transport and transmission of porcine reproductive and respiratory syndrome virus under field conditions. *Can J Vet Res* 2009;73:91-96.

2) Abstracts or Proceedings

Dee SA and Otake S. Investigation of alternative strategies for aerosol biosecurity for PRRSV. CRWAD, Chicago, IL, December 2008.

Dee SA and Otake S. Use of a production region model to evaluate issues regarding the aerobiology of PRRSV and *Mycoplasma hyopneumoniae*. CRWAD, Chicago, IL, December 2008.

Dee SA, AN Pitkin, Deen J. Alternative strategies for aerosol biosecurity for PRRSV. 2008 Pijoan Intl Symp on Swine Dis Erad St. Paul, September, 2008.

Dee SA, Otake S, Deen J. Use of a production region model to evaluate the transmission and biosecurity of PRRS and *Mycoplasma hyopneumoniae*. AASV, Dallas, Tx, March 2009.

Dee SA, Pitkin AN, Otake S and Deen J. Transmission of EP and PRRS. PIC Veterinary Conference, Stratford-upon-Avon, England, February 2009.

Haley CA, Wagner B, Murtaugh MP. 2009. Estimating the sensitivity and specificity of a new ELISA test for porcine circovirus 2 exposure using a study pseudo gold standard and latent-class analysis. Proc Amer Assoc Swine Vet. pp 255-261.

Morrison RB, Davies PD and Dee SA. Regional and national eradication of PRRS. PIC Veterinary Conference, Stratford-upon-Avon, England, February 2009.

Morrison, RB. Update on PRRS elimination in Stevens County, MN. Allen D Leman Swine Conference, preconference workshop. Pp. 67-74.

Murtaugh M. 2009. Update on PRRSV immunology and viral genetics: from hopeless to hopeful. Proc Amer Assoc Swine Vet. pp 459-462.

Otake S, Deen J, Dee SA. New information aerosol transmission and biosecurity for *Mycoplasma hyopneumoniae*. Leman Swine Conference St. Paul, MN September 2008.

Otake S, Deen J, Dee SA. Preliminary information from recent research on PRRSV and *Mycoplasma hyopneumoniae* transmission and biosecurity: Field application of air filters. Leman Swine Conference St. Paul, MN September 2008.

Prickett JR, Opriessnig T, Johnson J, Murtaugh MP, Stone S, Zimmerman JJ. 2009. Detection of PCV2 and anti-PCV2 antibodies in porcine oral fluid samples. Conf Res Workers Anim Dis.

Prickett JR, Opriessnig T, Johnson J, Murtaugh MP, Stone S, Zimmerman JJ. 2009. Detection of PCV2 and anti-PCV2 antibodies in porcine oral fluid samples. Proc Amer Assoc Swine Vet.

Prickett J, Opriessnig T, Johnson J, Murtaugh M, Stone S, Zimmerman J. 2009. Detection of PCV2 and anti-PCV2 antibodies in porcine oral fluid samples. 52st Annu Conf, Amer Assoc Vet Lab Diagn. San Diego, California, p. 135.

Rovira A, Abrahante J, Murtaugh M. 2009. Detection of porcine reproductive and respiratory syndrome virus (PRRSV) by reverse transcriptase loop mediated isothermal amplification (RT-LAMP). Proc Amer Assoc Swine Vet. pp 109-110.

3) Book chapters or monographs

E. FUNDING SOURCES FOR PRRSV RESEARCH

1) Current

PRRS CAP 2, Minnesota Pork Board, National Pork Board, USDA, University of Minnesota Swine Disease Eradication Center, Minnesota Rapid Agricultural Response Fund

F. WORK PLANNED FOR NEXT YEAR

Analyze the data from years 2 and 3 of the production region model project which was completed in November, 2009. Modification of the filtration interventions in the model and conducting additional assessments during January-June 2010. Continued evaluation of air filtration to reduce the risk of airborne spread of PRRSV in large sow herds in swine dense

regions (year 2). Further assessment of airborne transport of PRRSV over longer distances (2-10 km). Further characterization of efficacy of immune protection and prevention of PRRS in late gestation pregnant sows using the identical virus for inoculation and challenge. Characterization of PCV2 exposure and infection status of sows and piglets in the farrowing room. Further characterization of PRRSV evolution.