RESEARCH REPORT
SWINE HEALTH

Title: National Swine Health Monitor project: incidence and factors associated with transmission and control of PED virus – **NPB #14-088**

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Industry Summary: The short term objective of this project was to yield better understanding of the epidemiology and field ecology of PEDv and the relative impact of specific management decisions on the risks of infection. The long term objective was to facilitate business continuity by building capacity to enable the industry to quickly detect and have the ability to respond to an emerging pathogen.

With the assistance of this research project, the Swine Health Monitoring Project (SHMP) currently includes approximately 2.5 million sows and 998 sow herds (approximately 50% of the US sow inventory). The power of the project was exemplified recently when participants agreed to also share frequency of detection of Seneca Valley virus.

PRRS and PED clustered in time and space between the fall and winter of 2013 through the spring of 2014. At the farm level, being in swine dense areas within disease clusters increased the risk of becoming infected with either disease and may be, in part, explained by the use of contracted trucking. Conversely, high biosecurity including bio-aerosol filtration reduced the risks. Therefore, efforts could be directed at identifying better ways of implementing strict biosecurity practices that are common among filtered farms, especially if contracted trucking is employed, as a means mitigating the effects of these pathogens in the United States of America.

Of 429 herds with PED virus that achieved the stable state of weaning PEDv PCR negative pigs, the median time was 28 weeks, ranging from 7 – 64 weeks. A median of 2.7 piglets / inventoried sow were not weaned and the average time required to recover to baseline production was 10 weeks in 183 herds. Herd infected in quarters 3 or 4 of the year had approximately twice the negative impact. These data are valuable for veterinarians in advising clients on the anticipated impact and time to re-achieve a stable state with regards to PEDv.

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Scientific Abstract:

A National Swine Health Monitor program would provide a unique opportunity to document risk factors and incidence of several diseases simultaneously, such as PEDv and PRRSv as well as future important pathogens. All pathogens appear to able to spread locally among swine farms despite good biosecurity practices, which presents long term challenges to the US swine industry. An overarching epidemiologic objective is to monitor incidence and prevalence of important pathogens and to understand factors related to control, and potentially elimination of these pathogens. The overall purpose of this project was to create a national Swine Health Monitoring Project (SHMP) accomplish these objectives. In objective 1, the PRRS incidence project and a pilot project to monitor PED virus were joined to create one monitoring project. Today, the SHMP includes approximately 2.5 million sows and 998 sow herds (approximately 50% of the US sow inventory). In objective 2, a subset of the SHMP participants who became infected with PED virus were analyzed for tempero-spatial clustering and associated risk factors. PRRS and PED clustered in time and space between the fall and winter of 2013 through the spring of 2014. At the farm level, being in swine dense areas within disease clusters increased the risk of becoming infected with either disease and may be, in part, explained by the use of contracted trucking. Conversely, high biosecurity including bio-aerosol filtration reduced the risks. In objective 3, impact of PED virus on production and time to eliminate the virus from weaned pigs were determined. Of 429 herds with PED virus that achieved the stable state of weaning PEDv PCR negative pigs, the median time was 28 weeks, ranging from 7 – 64 weeks. A median of 2.7 piglets / inventoried sow were not weaned and the average time required to recover to baseline production was 10 weeks in 183 herds. The Swine Health Monitoring Project continues to expand, evolve and realize it's long term potential.

Introduction:

A National Swine Health Monitor program provides a unique opportunity to document risk factors and incidence of several diseases simultaneously, such as PEDv and PRRSv as well as the future possibility of *Mycoplasma hyopneumoniae* and swine influenza virus. Each of these pathogens appear to able to spread locally among swine farms despite good biosecurity practices, which presents long term challenges to the US swine industry. While enrollment in this project is voluntary, the insights provided by these data yield important and relevant information about these diseases. This research gives a quantitative measure of infection risk that will ultimately influence decision making, prevention and intervention strategies. This project comes at a time when it will help to maintain the US as a world leader in pork production by helping to secure the production of a sustainable, high quality, affordable pork supply. The ever present threat of emerging and foreign health problems also strengthens the case for capturing modern technologies to strengthen regional disease control capacity. This project helps define the state of the art with respect to the potential offered by these types of approaches, and more importantly the barriers that exist to their employment by veterinarians and industry in the USA.

Objectives:

1. To create a National Swine Health Monitoring program.
2. To study the effect of various tools to detect, control and limit the adverse effects of PEDv.
3. Identify farm level risk factors associated with infection with PEDv and/or PRRS virus.

Materials & Methods:

Objective 1 - Before this project was completed, there were two projects underway to record the incidence of important swine diseases; the National PRRSv Incidence Project and the early efforts to determine the impact of PEDv. This project united these two into one; the "Swine Health Monitoring Project (SHMP)." The National PRRSv Incidence Project was more established and participants supported the effort to include PEDv. Therefore, the transition from two projects into one was seamless to the participants.

Objective 2 - We proposed a classification guideline modeled after the PRRS guideline which was adopted in large part. The herds in the study were surveyed for diagnostic reports and production data. Modeling the analysis after that described by Linhares et al. (2014) we described Time to Baseline Production (TTBP) and Time to Stability.

Objective 3 - Each herd in the study was classified into one of the following four categories: 1) PRRSv +/PEDv +; 2) PRRSv +/PEDv –; 3) PRRSv –/PEDv + or 4) PRRSv –/PEDv –. Using a multi-variable Cox Proportional Hazards model we tested for significant associations. Valdes-Do Noso et al. (2013) utilized similar methods to study co-infection of Infectious Salmon Anemia Virus with Sea Lice. Operating under the null hypothesis that the farms negative for both diseases happened to be due to random chance, we tested the alternative hypothesis that specific factors contributed to maintain these farms as free from disease while the others were positive for one or both. By studying each of the four potential combinations disease co-infection we were able to identify potentially unique differences between them. We tested exposure variables commonly regarded as increasing risk of disease such as on-site composting versus rendering pick up, company-owned manure pumping versus contracted, as well as density of neighboring farms and number of semen or gilt sources. Additionally, the use of the Cox Proportional Hazards model allowed us to test for any time dependence in these variables. As in objective 2, we will explore the role of production system and size of sow herd as potential confounders of the associations.

Results:

Objective 1 – The SHMP currently includes approximately 2.5 million sows and 998 sow herds (approximately 50% of the US sow inventory). The power of the project was exemplified recently when participants agreed to also share frequency of detection of Seneca Valley virus.

Objective 2 – Of the 454 herds that were infected with PEDv, 429 achieved stability. The TTS distribution differed significantly from normal ($p<0.001$, figure 1). The average and median TTS were 29.5 and 28.0 weeks, respectively and values ranged from 7 to 64 weeks. The 429 herds had an average inventory of 3,025 sows ranging from 500 to 12,410 sows. Of these sow herds, 80.9% were farrow to wean commercial sow units, 3.5% were farrow to feeder commercial sow units, 12.8% had finishing pigs on site, 2.6% were multiplier sow herds, and 0.2% were genetic nucleus farms. Geographically, 47.1% of the herds are in Southeast region, 38.9% are in the Midwest region, and 14.0% are in the Southern panhandle region.

There was no correlation between TTS and total inventory at the site ($r = 0.04$, $p=0.45$) or sow inventory alone ($r = -0.05$, $p=0.31$). Similarly there was no association between TTS and S-INDEL variant vs Original strain, or PRRS virus status of the sow herd at the time when PEDv infection was detected (table 1). Herds infected in quarters 3 or 4 of the year had approximately 12 weeks longer TTS than herds infected in quarters 1 or 2.

The distribution of values for TTBP was significantly different from normal. For the 195 herds that shared production records, 183 (94%) returned to baseline production as defined by the 99% confidence interval. The median TTBP was 10 weeks and median net loss of piglets was 2.3 / inventoried sow. Only 148 (76%) of the sow herds returned to baseline as defined by getting back to 100% of that achieved before PEDv. In these herds, the median TTBP was 21 weeks and net loss was 2.7 piglets / sow.

There was no association between any measure of production loss and herd inventory. Median net loss of pigs sow in sow herds that were PRRS unstable at the time of PEDv infection was significantly higher compared to herds with other PRRS status. Herds that were infected in 3rd or 4th quarter of the year had almost twice the production impact in TTBP and net loss of piglets compared to herds infected in first 2 quarters of the year.

These data are valuable for veterinarians in advising clients on the anticipated impact and time to re-achieve a stable state with regards to PEDv.

Objective 3 – A subset of 109 breeding herds from the SHMP were selected for this study. Using a temporal spatial, multinomial scan statistic, 5 clusters were identified – most interesting was a PRRSv and PEDv co-infected cluster in SW Minnesota/NW Iowa ($p < 0.001$) (figure 1, cluster labeled 1) (See also, Table 1). There were 4.65 times more cases of PRRSv and PEDv in SW Minnesota and NW Iowa compared to a randomly generated distribution. After adjusting for being within a high risk space-time cluster, the odds of reporting an infection with PRRSv and/or PEDv were 1.03 (95% CI = 1.01 – 1.04, $p = 0.008$) for each additional swine premise in the county and 0.11 (95% CI = 0.03 – 0.47, $p = 0.003$) for high biosecurity (aerosol filtration).

Additionally, contracted trucking increased the odds of being infected within a disease cluster versus outside a disease cluster (OR = 29.99, 95% CI = 3.14 – 286.86, $p = 0.003$). After adjusting for being within a high-risk disease cluster, odds of reporting an infection increased with county level swine density and decreased with high bio-security (filtration). Contracted trucking was 30 times more common among infected farms within a high-risk cluster than infected farms outside a high-risk cluster. All farms should strive for strict biosecurity measures, especially in swine dense regions of SW Minnesota and NW Iowa when contracted trucking is involved.

These data suggest the need for ongoing implementation of high levels of biosecurity in high-risk, swine dense regions, especially if contracted trucking is utilized.

Figure 1: locations of PRRSv and/or PEDv clusters in the upper midwest. A co-infected cluster (labeled 1) is located in SW Minnesota/NW Iowa.

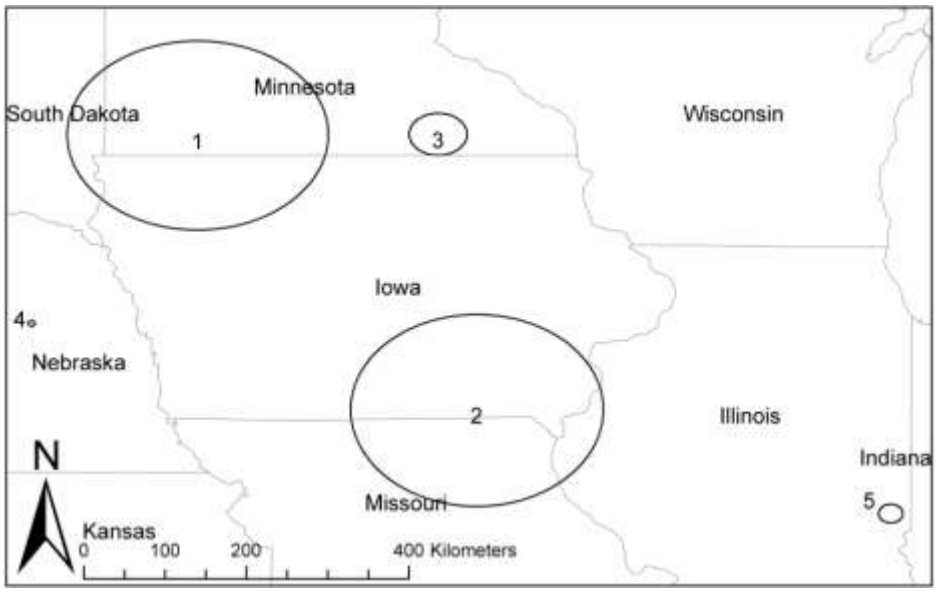

Table 1: Details of each of the 5 clusters detected in this study

Category	Cluster ID	No of herds	Radius (km)	Obs/Exp	P value
PRRSV+/PEDV+	1*	34	116.0	4.65	0.001
PRRSV+/PEDV-	3	2	25.73	20.88	0.001
PRRSV-/PEDV+	2	7	117.76	8.29	0.001
	4	3	3.14	9.67	0.001
PRRSV-/PEDV-	5	10	11.45	1.22	0.001

* indicates most likely cluster

Discussion:

The cooperative data-sharing process developed for this project (SHMP) is beneficial for the control and surveillance of existing pathogens important to the industry. But, it's importance may be even critical if it can better prepare the US swine industry for handling the introduction of potential emergent and foreign animal diseases. To accomplish this, we need a wide and deep reach into the industry and also, a capacity to collect and process health data from all enrolled locations. This will take substantial resources and time to accomplish but the SHMP is a start.

At the farm level, being in areas of high amounts of disease as well as higher swine farm density increased the odds of being infected with either PRRS, PED or both viruses. High levels of biosecurity along with bio-aerosol filtration were associated with decreased odds of disease. Additionally, contracted trucking was more common among diseased farms within high risk clusters, than diseased farms outside high risk clusters. These findings support the need for ongoing biosecurity considerations at the regional and farm level as a means of reducing the effect of these, and potentially other, diseases especially in swine dense regions where there are high amounts of diseases. These data reinforce current recommendations to farmers and it is hoped that these efforts will cumulatively reduce the incidence of not only PRRS and PED within regions.

This study provides a valuable estimate of time required and the variability that seems to exist for a herd to eliminate PED virus from weaned pigs. This is important to know for planning a virus elimination program from the herd that is based on herd closure. Secondly, this study provides estimates of the impact on production and time required for a herd to recover back to levels of production achieved before the virus infected the herd. Such estimates are important for budgeting financial performance of herds. Lastly, lack of correlation between time to stability and production loss suggest that the virus may persist in a herd long after the majority of the clinical impact has been experienced. One consequence of this may be farm managers being tempted to relax their cleaning and disinfection efforts which could in turn perpetuate virus in the farm.