Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 1307

2011

A PRRS CAP update on the regional control and elimination of PRRSV (2011)

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A PRRS CAP Update on the Regional Control and Elimination of PRRSV[1]

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Summary

The control and elimination of porcine reproductive and respiratory syndrome virus (PRRSV) represents one of the most challenging tasks facing the swine industry worldwide. Several factors related to the biology of the virus make disease detection and elimination difficult. Efforts are further hampered by a lack of vaccines that can protect naïve herds from infection. With this in mind, elimination efforts that incorporate existing tools and knowledge are being initiated. The principal focus is at the region level. One example of success is the Stevens County project in Minnesota, which has attained a PRRSV-negative status and has been expanded to include all of northern Minnesota.

Key words: PRRSV, PRRSV control and elimination

Introduction

Porcine reproductive and respiratory syndrome (PRRS), initially described in the late 1980s as "Mystery Swine Disease," is associated with reproductive failure in sows, respiratory distress in nursery pigs, and poor growth performance during finishing. Severe outbreaks result in abortion storms accompanied by high sow mortality. The causative agent of PRRS, PRRS virus (PRRSV), was first isolated and identified by investigators in the Netherlands and later in the United States. Viruses of European origin were first identified in U.S herds in 1999, and have further complicated efforts to control the virus.

The entry of PRRSV into a production system can occur through the introduction of infected pigs or the use of PRRSV-contaminated semen. Other avenues for introduction include mechanical vectors. A fourth route is through so-called area spread, which includes aerosols. Transmission by aerosols is still poorly understood; however, a recent report indicates that under the right conditions, PRRSV can travel up to 6 miles (Otake et al., 2010)[3].

After entering a production system, PRRSV is efficiently transmitted both horizontally (pig-to-pig infection) and vertically (transplacental infection). Pigs may become subclinical carriers, further perpetuating the virus. The continued maintenance of the virus as a subclinical continuous infection is termed *endemicity*, which is periodically punctuated by outbreaks that result in high mortality and economic loss.

[1] The work is supported by PRRS CAP, USDA NIFA Award 2008-55620-19132.
[2] PRRS CAP Project Director, Department of Diagnostic Medicine and Pathobiology, Kansas State University, Manhattan, KS 66506.
[3] Otake, S., S. Dee, C. Corzo, S. Oliveira, and J. Deen. 2010. Long-distance airborne transport of infectious PRRSV and Mycoplasma hyopneumoniae from a swine population infected with multiple viral variants. Vet. Microbiol. 145, 198-208.

PRRSV has the capacity to generate a large degree of genetic diversity in both structural and non-structural proteins, which has proved an obstacle for vaccine development (Lunney et al., 2010[4]). An alternative to vaccination is controlled exposure or acclimation, which involves the intentional infection of naïve animals with wild-type live PRRSV, either through contact with infected animals or exposure to infectious material. Controlled exposure is an attempt to induce immunity against farm-specific strains; however, the intentional exposure of young animals to virulent virus presents unintended consequences, such as the risk of introducing other pathogens.

Although PRRSV appears to be a formidable pathogen, the virus is relatively unstable under normal environmental conditions and is especially sensitive to UV radiation (Cutler et al., 2011[5]). The virus has been documented to travel up to 6 miles, but aerial transmission of the virus over long distances appears to be a rare event and dependent on a set of ideal environmental conditions. For example, we found that 10 PRRSV-negative sentinel pigs separated by a distance of less than 30 ft from 190 experimentally infected pigs failed to become infected during continuous exposure over 42 d (see "Is Aerosol Transmission an Important Risk for PRRSV Transmission? An Example of How Simple Biosecurity Procedures can Prevent Virus Spread within a Barn," p. 6).

Virus stability is also affected by temperature. Jacobs et al. (2010[6]) calculated $T^{1/2}$ values of 1.6, 27.4, 84.8 and 155.5 h for temperatures of 86, 68, 50 and 40oF, respectively. The virus is completely inactivated after a short incubation at temperatures greater than 130oF (Bloemrad et al., 1994[7]); therefore, the application of common antimicrobial agents or steam is sufficient to completely inactivate PRRSV on surfaces.

The Control of PRRSV at the Herd Level

Since the discovery of the disease, several approaches have been employed for the control and elimination of PRRSV in single herds (Corzo et al., 2010[8]). Highly effective approaches include depopulation-repopulation and all-in, all-out methods. Both depend on the placement of PRRSV-negative pigs in a facility that is "free" of virus. Herd closure and rollover is the most common method for eliminating virus from sow farms. The technique is based on observations that new PRRSV infections gradually decrease in closed herds. The typical length for herd closure is approximately 220 d, which approximates the maximum period that PRRSV can persist in a pig. All remaining seropositive animals are removed and replaced with negative pigs. The most recent tool for preventing the entry of PRRSV into a virus-negative herd is whole-barn filtration combined with negative pressure ventilation. Filtration is designed to block the

[4] Lunney, J., D. Benfield, and R. Rowland. 2010. Porcine reproductive and respiratory syndrome virus: an update on an emerging and re-emerging viral disease of swine. Virus Res. 154, 1-6.
[5] Cutler, T., C. Wang, Q. Qin, F. Zhou, K. Warren, K. Yoon, S. Hoff, J. Ridpath, and J. Zimmerman. 2011. Kinetics of UV(254) inactivation of selected viral pathogens in a static system. J. Appl. Microbiol. 111, 389-395.
[6] Jacobs, A., J. Hermann, C. Muñoz-Zanzi, J. Prickett, M. Roof, K. Yoon, and J. Zimmerman, 2010. Stability of porcine reproductive and respiratory syndrome virus at ambient temperatures. J. Vet. Diagn. Invest. 22, 257-260.
[7] Bloemraad, M., E. de Kluijver, A. Petersen, G. Burkhardt, and G. Wensvoort. 1994. Porcine reproductive and respiratory syndrome: temperature and pH stability of Lelystad virus and its survival in tissue specimens from viraemic pigs. Vet. Microbiol. 42, 361-371.
[8] Corzo, C., E. Mondaca, S. Wayne, M. Torremorell, S. Dee, P. Davies, and R. Morrison. 2010. Control and elimination of porcine reproductive and respiratory syndrome virus. Virus Res. 154, 185-192.

aerosol entry of PRRSV and other pathogens (Dee et al. 2010[9]). Despite its expense, filtration has proved to be a promising method reducing risk of PRRSV transmission into herds in pig-dense regions.

The Control and Elimination of PRRSV at the Regional Level

Eliminating PRRSV from a single herd by exploiting the virus' biological properties has become relatively easy, but a renewed outbreak is all but inevitable. One strategy for reducing the risk of reintroduction to a single farm is to expand disease and virus control efforts to the region level. This approach is based on the idea that the elimination of PRRSV in a region containing multiple farms will reduce the risk of PRRSV introduction into any single farm. The regional elimination concept has evolved into several regional elimination projects that are supported by private companies and the USDA-funded PRRS Coordinated Agricultural Project (PRRS CAP).

The steps for the initiation and operation of a regional elimination project are summarized below. Detailed descriptions of useful tools and specific biosecurity protocols can be downloaded at the PRRS CAP website (www.prrs.org).

1. Define the boundaries that constitute a region suitable for conducting PRRSV elimination and determine the level of participation. A region is defined by a set of boundaries consisting of natural and/or man-made barriers, such as lakes, cities, mountains, or areas where a cluster of farms is spatially separated from other pig producing sites. The most practical approach is to define a region as a county, but this designation can suffer from serious limitations primarily because viruses do not respect county lines.

The scope and ultimate success of a project is dependent on the level of participation by producers, veterinarians, suppliers, and others, so ongoing communication and producer engagement are critical elements for success. Another important consideration is leadership and the availability of experienced veterinary support.

2. Record premises characteristics and herd density. Location and population size of each site and the overall farm density within a region are mapped and recorded. PRRSV elimination in a region that is dominated by a single type of premises combined with a relatively low density of sites is an ideal situation.

3. Determine PRRSV status at each site. A combination of PRRSV RT-PCR and serology, common diagnostic tests, is used to assess the infection status of individual herds. The amount and frequency of testing needed are determined based on the farm type and level of confidence needed to obtain an accurate result. Holtkamp et al. (2011)[10] describe herd status designations ranging from PRRSV Positive Unstable (Category 1) to PRRSV Negative (Category 4). This common set of terminology is useful for communicating information within a region and for developing standardized reporting methods.

[9] Dee, S., S. Otake, and J. Deen. 2010. Use of a production region model to assess the efficacy of various air filtration systems for preventing airborne transmission of porcine reproductive and respiratory syndrome virus and Mycoplasma hyopneumoniae: results from a 2-year study. Virus Res. 154, 177-184.
[10] Holtkamp, D., D. Polson, M. Torremorell, R. Morrison, D. Augsburger, L. Becton, S. Henry, M. Rodibaugh, R. Rowland, H. Snelson, B. Straw, P. Yeske, and J. Zimmerman. 2011. Terminology for classifying swine herds by porcine reproductive and respiratory syndrome virus status. JSHAP. 19, 44-56.

4. Assess overall herd biosecurity and risk for introduction of PRRSV. The web-based tool, Production Animal Disease Risk Assessment Program (PADRAP), is useful for assessing overall PRRS biosecurity at the herd level and can be a guide for estimating the success of a PRRSV elimination program (www.padrap.org). When reapplied at later time points, the PADRAP can be used to measure improvements in biosecurity over time.

5. Map movement of pigs between farms within the region and entering from sources outside the region. As discussed above, a major biosecurity risk for the entry of PRRSV is through the introduction of PRRSV-infected pigs. A good prospect for PRRSV elimination is a situation where the principal source of pigs and pig transport are confined to sites within the region (intra-regional movement).

6. Implement herd control strategies and report progress. From a menu of herd-based PRRSV elimination methods, summarized above (Corzo et al., 2010), a combination of herd control strategies can be initiated that best fit the type and density of pig farms within the region. Regular status reports are important for updating participants and veterinarians on the progress of the region. Open lines of communication, obtainable goals, and clear criteria related to progress are critical to keeping producers engaged in the process. Reported data include the number of pigs and the PRRSV status for each herd, as well as a general description of progress, including the identification of obstacles to success. Publicized progress provides an incentive for PRRSV-positive farms to make progress toward a negative status.

7. Surveillance. After Category 4 (PRRSV-negative) status is achieved, continued monitoring is important to ensure that farms remain PRRSV-negative. The most common method is to monitor for the presence of PRRSV by standard diagnostic serology. The frequency of sampling is variable, but should be conducted at least twice a year. In addition, herds are monitored for the appearance of PRRS-associated clinical signs.

Current Progress

At this time, the PRRS CAP supports seven regional elimination projects, which enroll approximately 2.5 million pigs. The overall elimination effort within the PRRS CAP is directed by Dr. Robert Morrison, University of Minnesota. A list of ongoing PRRSV regional projects conducted in 6 states is below. Each project is designed to address a specific opportunity or challenge related to PRRSV control and elimination. Detailed information on each project, including progress, can be found at www.prrs.org.

1. Illinois – DeKalb Area, Bethany Swine Health Services, Dr. Noel Garbes
2. Illinois – Western - Tri-County, Carthage Veterinary Service, Ltd., Dr. Dyneah M. Classen
3. Iowa – Iowa County, Iowa State University, Dr. Derald Holtkamp
4. Michigan – Allegan & Ottawa Area, Michigan Pork Producers, Dr. James A. Kober
5. Minnesota – Northern Minnesota Project (above Hwy 212), including Stevens Co., University of Minnesota, Dr. Montse Torremorell
6. Nebraska – Cuming County, Nebraska Veterinary Service, Dr. Alan Snodgrass
7. Pennsylvania – Pennsylvania Project, University of Pennsylvania, Dr. Thomas D. Parsons

An example of success is found in the Stevens County project, which was recently expanded into the Northern Minnesota Project (Corzo, 2010). Stevens County is 1,490 km^2 and contains 87 pig sites (164,000 pigs), including sow farms, boar studs, nurseries, and growing-finishing operations. Only 4 farms declined to participate in the project. As a region, Stevens County is relatively isolated from other pig-associated sites. At the beginning of the project in 2004, 29 sites were PRRSV-positive, 19 sites negative, and the remaining sites of unknown status. As of 2010, all sites were negative for PRRSV, with only sporadic outbreaks in sow farms. In all cases, the outbreaks were linked to the import of PRRSV-positive pigs from outside the region. Recently, the project was expanded to include all of Minnesota north of Hwy 212, a region that includes approximately 1 million pigs.

Recent Advances in Support of PRRSV Elimination

New technologies and methodologies are being employed to improve the effectiveness and lower the costs of PRRSV elimination. For example, oral fluid samples can be used as a substitute for the detection of PRRSV infection (Kittawornrat et al., 2010)[11]. Oral fluid is collected by allowing pigs in a single pen to chew on a rope. Fluid is extracted by squeezing the contents of the rope into a collection container. The oral fluid sample is processed and can be assayed in a manner similar to a routine diagnostic serum sample with only a few modifications. Advantages in the use of oral fluids include the ease of collection, a decrease in pig stress, and the ability to efficiently survey an entire population. Another advancement in support of regional elimination is in the area of risk-based testing and surveillance. Current sampling methods include the application of a standard one-size-fits-all protocol. In a risk-based approach, the historical biosecurity status of a farm and surrounding farms, combined with other information, is incorporated to create a herd-specific sampling regimen that maximize surveillance while minimizing cost.

The application of genomic and genetic approaches to identifying genes associated with PRRS resistance, susceptibility, or tolerance has far-reaching implications in the control and elimination of PRRSV. One goal of a genetic approach is to perform marker-assisted selection to develop pig breeds with improved PRRS-resistance, and to avoid the unintended selection of traits that increase disease susceptibility. Current efforts and progress related to understanding the genetics of disease resistance can be found at www.PRRS.org.

Conclusion

The success of a regional elimination project can be measured on two levels. The first is the installation of a process that fosters communication, education, and improved biosecurity awareness among producers who seek a common goal. The second level is the demonstration that PRRSV has been eliminated, a process that can be expected to require a much longer-term commitment.

[11] Kittawornrat, A., J. Prickett, W. Chittick, C. Wang, M. Engle, J. Johnson, D. Patnayak, T. Schwartz, D. Whitney, C. Olson, K. Schwartz, and J. Zimmerman. 2010. Porcine reproductive and respiratory syndrome virus (PRRSV) in serum and oral fluid samples from individual boars: will oral fluid replace serum for PRRSV surveillance? Virus Res. 154, 170-176.