May and June 2016 • Volume 24, Number 3

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The Journal of the American Association of Swine Veterinarians

Journal of Swine Health and Production

(**ISSN 1537-209X**) Volume 24, Number 3; May and June 2016

The *Journal of Swine Health and Production* is published by the American Association of Swine Veterinarians.

The *Journal of Swine Health and Production* is a refereed publication and is a benefit of membership in the American Association of Swine Veterinarians. Subscriptions ($US) are available to nonmembers at $145.00 per year (six issues) for United States, Canada, and Mexico. The cost is $180.00 for all countries outside North America. For inquiries regarding membership or subscriptions, please contact

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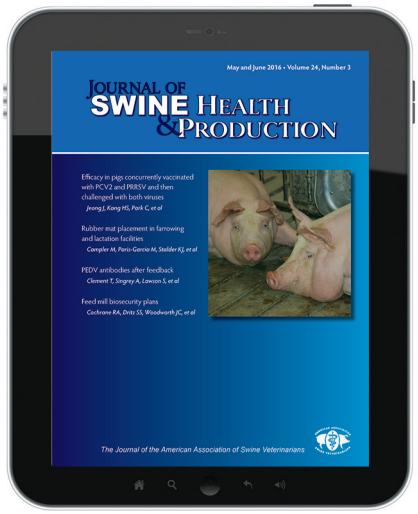

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Quoted from the Executive Editor's message, page 129

Introducing Kavault (avilamycin)

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Houston, we've had a problem!

On April 14, 1970, Apollo 13 crew members Jack Swigert and Jim Lovell calmly reported a problem aboard their spacecraft as it was on its way to the moon. "Okay Houston, we've had a problem here." This now famous statement set in motion the transformation of this routine mission into a problem-solving event that would capture the attention of the entire globe. The crew suddenly found themselves short of power, heat, and water, and the new focus became not a successful landing on the moon but the safe return of the crew. Improvisation quickly became the order of the day.

Flight Director Gene Kranz was faced with the monumental task of leading a team effort that would focus on bringing the astronauts safely home. In order to solve these problems, Kranz needed to pull together people with the necessary skills, experience, and knowledge and then provide them with clear goals and timelines. "Failure is not an option." The goal was to work the problem as it lay before them. For Kranz, the tragic Apollo 1 fire had already led to the conclusion that guessing and intuition were unacceptable substitutes for logic and reason in any problem-solving process. Getting the right people on the bus for each individual problem was the order of the day. And there were lots of individual problems.

"...every solution creates a new set of problems."

The problem-solving process starts with clearly defining the problem and identifying the desired outcomes. After analyzing the available information, an array of possible solutions is generated, possible consequences evaluated, and a course of action decided. A great team then focuses on planning and implementing that particular course of action no matter what their previous preferences might have been. They also recognize that every solution creates a new set of problems. They anticipate that unintended consequences will happen and then get on with monitoring the progress and preparing to adapt as necessary. "Stuff happens." Eisenhower was quoted as saying "In preparing for battle I have always found that plans are useless but planning is indispensable."[1]

As an association, we have many issues that we face together with our pork supply-chain partners. Some of these issues are long-term challenges. Others may arise very quickly and just as quickly are resolved. As an organization, it is clear that we rely heavily on our AASV staff. In the face of an emerging problem, our staff will often set aside the day-to-day work of managing our organization and step into the fray of issues management. We can't thank them enough for the excellent job that they do. The reality, however, is that at the end of the day, all of that management work still needs to done and we should ask ourselves how we might help.

One of the other great assets of our organization is the skills and knowledge of our membership. We struggle at times in finding effective ways of tapping into that great resource. This happens in part because we all empathize with just how busy our colleagues are in their day-to-day work, family, and community responsibilities. The formation of a committee without clear goals and timelines can therefore become a monumental commitment. Members voluntarily committing to a standing committee can start to feel like there is no light at the end of the tunnel. Who needs that?

It is helpful to recognize that our members go through periods in their lives where their abilities to give of their time can change. That having been said, most members can provide input on problem solving on a short-term basis. This is especially true where there is a sunrise and sunset to the problem solution and where there is flexibility on scheduling the timing of their input. One of the major life-threatening issues of the Apollo 13 mission was the issue of the CO_2 filters. As the CO_2 levels reached dangerous levels, a team was formed to figure out how to use the resources at hand to "pound a round peg into a square hole." This resulted in a wonderful outcome. Rest assured, however, that there was no standing CO_2 scrubber committee left in place. Put the team together. Provide a working solution. Dissolve the team. Wonderful.

As we move forward, we need to connect the people with expertise and passion to a problem so that they are capable of inputting in whatever way that they can. This may be as simple as volunteering to review a draft document or providing some information or feedback to a committee. A very helpful process. Apollo 13 went down in history as being one of the most "successful failures" in space exploration, and an inspiration to future generations.

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George Charbonneau, DVM
AASV President

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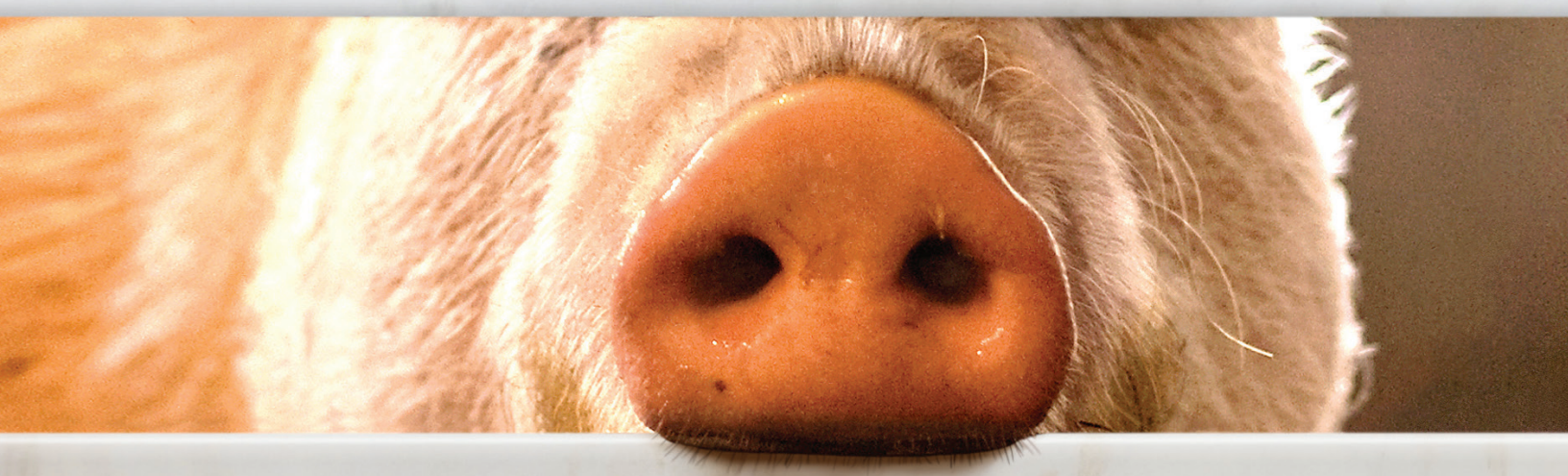

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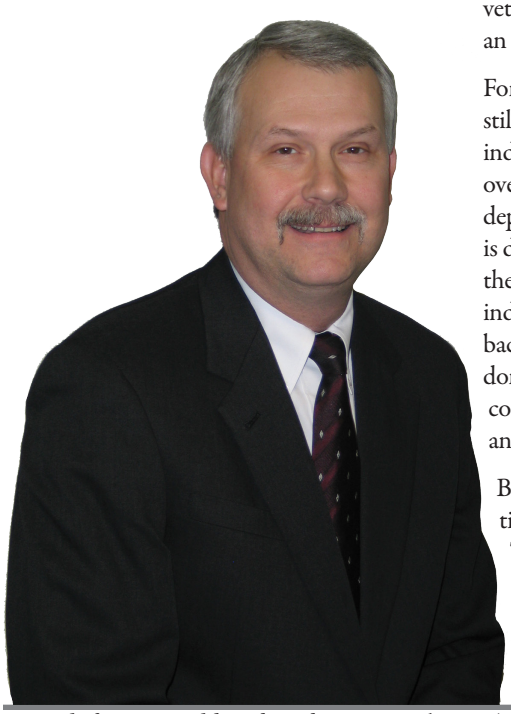
Don't forget to turn back around

I have always been a fan of country music, even before it was cool. One of my favorite artists, Tim McGraw, recently released a new song entitled "Humble and Kind." It's the type of song that reflects on the important things in life while also delivering some advice. Part of the song goes like this: *When you get where you're going, Don't forget – turn back around, And help the next one in line* (Tim McGraw, album *Humble and Kind*, 2015).

This is great advice for all of us in the profession of swine veterinary medicine. We each have points in our careers where we help someone advance his or her career. We can do that individually through professional, personal, and business relationships. We can also do that in a shared manner through an organization like the AASV Foundation (AASVF). The AASVF is based on the premise of capitalizing the contributions of its members to accomplish the AASVF mission "to empower swine veterinarians to achieve a higher level of personal and professional effectiveness."

In recent years, the AASVF has mounted significant efforts to attract the best and brightest veterinary students to begin and sustain careers in swine veterinary medicine. This is being done through funding for travel to the annual meeting, internships, externships, and an expanding program of scholarships. If you were at the 2016 AASV Annual Meeting, then you had the opportunity to see 150 veterinary students from 24 different colleges of veterinary medicine. You also had the opportunity to see some of the fruits of the foundation's efforts displayed in the young leaders who are active as committee members and chairs, as well as presenters during the sessions.



"We each have points in our careers where we help someone advance his or her career."

Another area of growth for the foundation is in the funding of research with direct application to our profession. In 2016, over $60,000 will be spent on projects selected through a competitive process. With decreasing federal and university budgets for swine research, this is an area of growing need. The foundation also funds the annual Dunne and Hogg lectures at the AASV Annual Meeting, as well as the Hogg Scholarship that is given to a swine veterinarian wishing to return to college for an advanced degree.

For all that the foundation has done, there is still so much to do. Members of AASV and industry partners have been very generous over the years. The work of the foundation is dependent on two flows of funds. The first is derived from fund-raising events such as the auction, raffle, and golf outing. Many individuals and companies provide extensive backing for these events. The second is from donations. The foundation gladly accepts contributions of any size. Every dollar counts and will be put to use.

Beyond general contributions, the foundation has three structured giving programs. The first, the entry-level Leman Fellow program, requires a commitment to contribute $1000 either as a single donation or spread out in payments. The intent is to provide an attainable pathway for anyone wishing to support the foundation.

The next level, the Heritage Fellow program, entails a donation of at least $5000, which may be made directly or through a bequest or life insurance policy as part of estate planning. The response to this program has been significant, with more than 50 Heritage Fellow donors participating since the program's inception in 2001. Members of all ages have come forward from various points in their careers to participate.

The newest giving program, the Legacy Fund, is based on a gift of $50,000 or more to the foundation. We recently announced our first Legacy donor, Dr Nathan Winkelman. This gift is a substantial amount and one that signifies the giver's commitment to "Ensuring our Future....Creating a Legacy."

The funds donated through all three giving programs are restricted so that only the income is spent on foundation programming, thus preserving the initial principal of the donation under market conditions. The funds are invested in a mix of stocks and bonds selected by professional financial advisors.

The foundation recognizes that our members are all at different points in their careers. By creating giving programs that are attainable, members can participate where and when they are comfortable. All three of the giving programs are linked so that donations are cumulative through a lifetime of giving. This allows a contributor to start as a Leman Fellow with $1000, then progress to the Heritage Fellow, and on to the Legacy Fund.

Are you at a point in your career where it is time to start giving back? If you are and you like what the foundation is doing, then please consider supporting it financially. There is no better time to "turn back around, And help the next one in line!"

Tom Burkgren, DVM
Executive Director

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Shout-out!

I am writing this editorial on the way home from the AASV Annual Meeting in New Orleans. As I mentioned in my March-April 2016 editorial, I always find the annual meeting highly motivational.[1] And this year I thought the meeting delivered once again. I just wanted to give a shout-out to the organizers for another great meeting – thank you!

I have discussed the topic of journal impact factors in a previous editorial, and in that editorial I explained how impact factors are calculated.[2] I also discussed that journal impact factors do not necessarily reflect the impact or quality of individual manuscripts on a particular subject area, but that impact factors are an important consideration when some authors choose the journal to which they submit their publications. To remind you, the reporting of impact factors is always a few years behind, as the calculation involves counting citations from the two most previous full calendar years. So what that means is that JSHAP's most current impact factor is for 2014 and it was based on the number of citations from items published in 2012 and 2013 divided by the total number of items published in 2012 and 2013. I am re-visiting the topic of impact factors because I wanted to share with you that JSHAP's impact factor for 2014 is 1.205! This represents a dramatic increase, as our next highest impact factor was in 2013 at 0.771. What I am very happy about is the positive trend in improvement each year in JSHAP's impact factor, as well as the size of the increase for 2014. And, as I have said previously, JSHAP's impact factor is considered by some authors when choosing a journal to submit to, so this increase is very positive for the journal. This has put JSHAP's rating in the veterinary sciences category of journals at 47 of 133 and also represents the journal's highest ranking ever. Of course, many individuals contribute to all the hard work behind the research, writing, peer-review, and publication of the manuscripts published in JSHAP. A shout-out to all of you who contribute to the success of JSHAP!

"…I wanted to share with you that JSHAP's impact factor for 2014 is 1.205…. a dramatic increase, as our next highest impact factor was in 2013 at 0.771."

Once again, I really enjoyed reading this issue of JSHAP and I am certain that the contributions to this issue will continue to affect the journal's impact factor down the road – a shout-out to the authors! This issue contains a very interesting peer-reviewed commentary on feed mill biosecurity plans by Cochrane et al[3] and is a commentary on the systematic approach towards preventing biological pathogens in swine feed. Additionally, the original research article by Jeong et al[4] makes a valuable contribution to the peer-reviewed literature on important vaccine comparisons. The journal does not receive very many manuscripts in the "Production Tool" genre, so I was very interested in the information in the manuscript by Campler et al[5] that presents tips and techniques for rubber-mat placement. And this issue also contains a case study by Clement et al[6] focused on the humoral responses elicited by feedback exposure to porcine epidemic diarrhea virus, another very timely topic.

I will leave you to enjoy this issue of JSHAP, I know I did.

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Terri O'Sullivan, DVM, PhD
Executive Editor

Comparative efficacy of concurrent administration of a porcine circovirus type 2 (PCV2) vaccine plus a porcine reproductive and respiratory syndrome virus (PRRSV) vaccine from two commercial sources in pigs challenged with both viruses

Jiwoon Jeong, DVM; Hei Suk Kang, MS; Changhoon Park, DVM, PhD; Hwi Won Seo, DVM, PhD; Ikjae Kang, DVM, PhD; Kyuhyung Choi, DVM; Chanhee Chae, DVM, PhD

Summary

Objective: To compare clinical, virologic, immunologic, and pathologic parameters in pigs each concurrently administered a porcine circovirus type 2 (PCV2) and a porcine reproductive and respiratory syndrome virus (PRRSV) vaccine from one of two commercial sources and challenged with field strains of both viruses.

Materials and methods: One group of pigs administered concurrently Fostera PCV and Fostera PRRS (Zoetis, Florham Park, New Jersey) and another group administered concurrently Ingelvac CircoFLEX and Ingelvac PRRS MLV (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) at study day -28 (21 days of age) were challenged with both viruses at study day 0 (49 days of age). Serum samples were tested for viremia by real-time polymerase chain reaction (PCR), and for antibodies by a commercial enzyme-linked immunosorbent assay and a virus neutralization test. Peripheral blood mononuclear cells were tested for interferon-γ secreting cells (IFN-γ-SC) by enzyme-linked immunospot assay. Lung and lymphoid tissues were tested for lesions and viral antigen by histopathology and immunohistochemistry.

Results: Significant differences were observed between vaccinated, challenged and unvaccinated, challenged groups in clinical (average weight gain and clinical signs), virologic (PCR testing), immunologic (antibodies, IFN-γ-SC, and interleukin-10), pathologic (lesions and viral antigen) outcomes. No significant differences were observed between the two vaccinated, challenged groups in clinical, virologic (except PCV2 viremia at day 14), immunologic, and pathologic outcomes.

Implications: Under the conditions of this study, it makes no difference to protection whether PCV2 and PRRSV vaccines are administered concurrently. Concurrent vaccination is efficacious for controlling co-infection with PCV2 and PRRSV.

Keywords: swine, porcine circovirus-associated diseases, porcine circovirus type 2, porcine reproductive and respiratory syndrome virus, vaccine

Received: August 26, 2015
Accepted: December 29, 2015

Resumen - Eficacia comparativa de la administración simultánea de una vacuna de circovirus porcino tipo 2 (PCV2) más una vacuna del virus del síndrome reproductivo y respiratorio porcino (PRRSV) de dos casas comerciales en cerdos retados con ambos virus

Objetivo: Comparar los parámetros clínicos, virológicos, inmunológicos, y patológicos en cerdos a los que se les administró simultáneamente una vacuna una de circovirus porcino tipo 2 (PCV2 por sus siglas en inglés) y del virus del síndrome reproductivo y respiratorio porcino (PRRSV por sus siglas en inglés) de una de las dos casas comerciales y fueron retados con cepas de campo de ambos virus.

Materiales y métodos: Los dos grupos de cerdos, uno al que se le administró simultáneamente Fostera PCV y Fostera PRRS (Zoetis, Florham Park, New Jersey) y otro, al que se le administró Ingelvac CircoFLEX e Ingelvac PRRS MLV (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) en el día -28 del estudio (21 días de edad) fueron retados con ambos virus en el día 0 del estudio (49 días de edad). Las muestras de suero se analizaron para medir viremia por medio de la reacción en cadena de polimerasa en tiempo real (PCR), y en busca de anticuerpos por medio de ensayo por inmunoabsorción ligado a enzimas comercial y una prueba de neutralización de virus. Se probaron las células mononucleares de sangre periférica en busca de células que secretan interferón γ (IFN-γ-SC, por sus siglas en inglés) por medio del ensayo inmunospot ligado a enzimas. Se probaron los tejidos linfoides y de pulmón en busca de antígenos virales, y lesiones por medio de histopatología e inmunohistoquímica.

Resultados: Se observaron diferencias significativas entre los grupos retados sin vacunar y los retados vacunados en evaluación clínica (ganancia de peso promedio y signos

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This article is available online at http://www.aasv.org/shap.html.

Jeong J, Kang HS, Park C, et al. Comparative efficacy of concurrent administration of a porcine circovirus type 2 (PCV2) vaccine plus a porcine reproductive and respiratory syndrome virus (PRRSV) vaccine from two commercial sources in pigs challenged with both viruses. *J Swine Health Prod.* 2016;24(3):130–141.

clínicos), virológicos (pruebas de PCR), inmunológicos (anticuerpos, IFN-γ-SC, e interleukina-10), patológicos (lesiones y antígeno viral). No se observaron diferencias significativas entre los dos grupos retados y vacunados en la evaluación de resultados clínicos, virológicos (excepto viremia contra PCV2 en el día 14), inmunológicos, y patológicos.

Implicaciones: Bajo las condiciones de este estudio, no hay diferencia en la protección si las vacunas de PCV2 y PRRSV se administran simultáneamente. La vacunación simultánea es eficaz para controlar la coinfección con PCV2 y PRRSV.

Résumé - Comparaison de l'efficacité de l'administration simultanée d'un vaccin circovirus porcin de type 2 (CVP2) et d'un vaccin du virus du syndrome reproducteur et respiratoire porcin (VSRRP) de deux sources commerciales chez des porcs soumis à une infection défi avec les deux virus

Objectif: Comparer les paramètres cliniques, virologiques, immunologiques, et pathologiques chez des porcs ayant été simultanément vacciné avec un vaccin contre le circovirus porcin de type 2 (CVP2) et le virus du syndrome reproducteur et respiratoire porcin (VSRRP) d'une de deux sources commerciales et soumis à une infection défi avec des souches de champs des deux virus.

Matériels et méthodes: Un groupe de porcs a reçu simultanément Fostera PCV et Fostera PRRS (Zoetis, Florham Park, New Jersey) et un autre a reçu simultanément Ingelvac CircoFLEX et Ingelvac PRRS MLV (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) au jour -28 de l'étude (21 jours d'âge) et les animaux infectés avec les deux virus au jour 0 de l'étude (49 jours d'âge). Des échantillons de sérum ont été testés par réaction d'amplification en chaine par la polymérase (ACP) pour détecter une virémie, et par une épreuve immunoenzymatique commerciale ainsi qu'un test de neutralisation virale pour détecter des anticorps. Les cellules mononucléaires du sang périphérique ont été testées pour la présence de cellules productrices d'interféron-γ (IFN-γ-SC) au moyen d'une épreuve immunoenzymatique par tache. Les tissus lymphoïde et pulmonaire ont été examinés pour la présence de lésions et d'antigène viral par histopathologie et immunohistochimie.

Résultats: Des différences significatives ont été observées entre les groupes d'animaux vaccinés et infectés et les animaux non-vaccinés et infectés du point de vue clinique (gain moyen quotidien et signes cliniques), virologique (épreuve ACP), immunologique (anticorps, IFN-γ-SC, et interleukine-10), et pathologique (lésions et antigène viral). Aucune différence significative ne fut notée entre les deux groupes d'animaux vaccinés et infectés pour ce qui est des aspects clinique, virologique (sauf la virémie CVP2 au jour 14), immunologique et pathologique.

Implications: Dans les conditions expérimentales de la présente étude, aucune différence dans la protection ne fut causée par l'administration simultanée des vaccins CVP2 et VSRRP. La vaccination simultanée est efficace pour limiter la co-infection par CVP2 et VSRRP.

Porcine respiratory disease complex (PRDC) is a serious health problem in growing and finishing pigs, typically approximately 16 to 22 weeks of age, and is characterized by slow growth, poor feed efficiency, lethargy, anorexia, fever, cough, and dyspnea.[1] Pathogens involved in PRDC can be viral, bacterial, or both. Among them, a co-infection with porcine circovirus type 2 (PCV2) and porcine reproductive and respiratory syndrome virus (PRRSV) is the most common etiology of PRDC.[2] Therefore, controlling both PCV2 and PRRSV infection is a high priority for the swine industry globally. Since vaccination is one of the major tools to control PCV2 and PRRSV infection, vaccination of pigs with both PCV2 and PRRSV is necessary to control PRDC efficiently.

Recently, a new commercial modified-live PRRSV vaccine (Fostera PRRS; Zoetis, Florham Park, New Jersey) was introduced into the international market to control respiratory disease in growing pigs. In the field, swine producers usually administer both single-dose PCV2 and PRRSV vaccines concurrently to control PRDC. Hence, comparing use of single-dose PCV2 and PRRSV vaccines administered concurrently mirrors field conditions. However, to the knowledge of the authors, no one has reported comparing clinical, virologic, immunologic, and pathologic parameters when commercial single-dose PCV2 and PRRSV vaccines are administered concurrently. The objective of this study was to compare growth performance and virologic, immunologic, and pathologic parameters in wean-to-finish pigs concurrently vaccinated with a PCV2 vaccine plus a PRRSV vaccine, respectively, from two commercial sources.

Materials and methods

All animal protocols were approved by the Seoul National University Institutional Animal Care and Use Committee.

Experimental study

Sixty colostrum-fed, crossbred, conventional piglets were purchased at 5 days of age from a commercial Korean farm. Upon arrival at a research facility, all piglets in this study tested negative for PCV2 and PRRSV by serological testing (PCV2 Ab Mono Blocking ELISA; Synbiotics, Lyon, France, and PRRS X3 Ab test; Idexx Laboratories Inc, Westbrook, Maine). All piglets also tested negative for PCV2 and PRRSV viremia by real-time polymerase chain reaction (PCR).[3,4]

A total of 60 pigs were randomly divided into four groups using the random number generation function in Excel (Microsoft Corporation, Redmond, Washington) (Table 1). Sample size was calculated assuming a 90% power ($1 - \beta = .90$) of detecting a difference at the 5% level of significance ($\alpha = .05$), which was based on expected results of ELISA antibody titers (PCV2 and PRRSV), virus load (PCV2 and PRRSV) determined by real-time PCR, and lung and lymphoid lesions represented by scores.[5] The treatment timeline is shown in Table 1. Pigs in Group 1 were administered one 2.0 mL dose of Fostera PCV (Zoetis) and one 2.0 mL dose of Fostera PRRS (Zoetis) intramuscularly in the right and left sides of the neck, respectively, at study day -28 (21 days of age) according to the manufacturer's label instructions. Pigs in Group 2 were administered one 1.0-mL dose of Ingelvac CircoFLEX (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) and one 2.0-mL dose of Ingelvac PRRS MLV (Boehringer Ingelheim Vetmedica Inc) intramuscularly in the right and left sides of the neck, respectively, at study day -28 according to the manufacturer's label instructions. At study day 0 (49 days of age), each pig in groups 1, 2, and 3 was inoculated intranasally with 2 mL of PCV2b (strain SNUVR000463; 5th passage; 1.2×10^5 median tissue culture infective doses ($TCID_{50}$) per mL). In the afternoon of the same day, the same pigs were inoculated intranasally with 2 mL of PRRSV (strain SNUVR090851; 5th passage; 1.2×10^5 $TCID_{50}$ per mL). Co-infection with these PCV2b and PRRSV strains induced severe interstitial pneumonia and lymphoid depletion of lymph nodes in infected pigs.[6] Group 3 pigs served as the positive-control

Table 1: Means (with standard deviations) of lymphoid and pulmonary lesion scores and numbers of cells positive for lymphoid porcine circovirus type 2 (PCV2) antigen and pulmonary porcine reproductive and respiratory syndrome virus (PRRSV) antigen in pigs vaccinated concurrently with PCV2 and PRRSV vaccines and challenged with PCV2 and PRRSV*

Group	Vaccination (21 days of age)	Challenge (49 days of age)	Lymph node		Lung		
			Lesion score†	No. of $PCV2^+$ cells‡	Lesion score†	No. of $PRRSV^+$ cells‡	No. of $PCV2^+$ cells‡
1	Fostera PCV and Fostera PRRSV	PCV2 and PRRSV	0.43 (0.53)[a]	3.15(3.52)[a]	1.15 (0.23)[a]	1.76 (3.87)[a]	1.65 (2.19)[a]
2	Ingelvac CircoFLEX and Ingelvac PRRS MLV	PCV2 and PRRSV	0.71 (0.59)[a]	7.05(5.45)[a]	1.23 (0.38)[a]	1.54 (3.43)[a]	2.09 (2.60)[a]
3	None	PCV2 and PRRSV	2.11 (0.73)[b]	20.70(8.17)[b]	2.23 (0.44)[b]	2.95 (3.31)[b]	6.78 (5.21)[b]
4	None	None	0.28 (0.41)[a]	0	0.11 (0.54)[c]	0	0

* Group 1 pigs were concurrently administered Fostera PCV and Fostera PRRS vaccines (Zoetis, Florham Park, New Jersey) and Group 2 pigs were concurrently administered Ingelvac CircoFlex and Ingelvac PRRS MLV vaccines (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri), and both groups were challenged with both viruses. The body weight of each pig was measured at study days -28 (21days of age), 0, 21 (70 days of age), 63, and 126 (175 days of age). Blood samples with EDTA were collected from pigs for interferon-γ secreting cells and without anticoagulant for serologic testing at study days -42, -28, 0, 14, 28, 63, 91, and 126. Nasal swabs were also collected on these study days.

† Pigs in all groups were euthanized at 175 days of age. Superficial inguinal lymph node and lung were collected for histopathologic examination and immunohistochemical testing. Lymphoid lesion scores: 0 = no lymphoid depletion or granulomatous replacement; 1 = mild lymphoid depletion; 2 = moderate lymphoid depletion; and 3 = severe lymphoid depletion and histiocytic replacement. Lung lesion scores: 0 = no microscopic lesions; 1 = mild interstitial pneumonia; 2 = moderate multifocal interstitial pneumonia; 3 = moderate diffuse interstitial pneumonia; and 4 = severe interstitial pneumonia. Scores were compared among groups using Fisher's exact test.

‡ Numbers of lymphoid and pulmonary cells positive for PCV2 antigen, and of pulmonary cells positive for PRRSV antigen, per unit area (0.25 mm^2) of lung were counted using an NIH Image J 1.45s program (`http://imagej.nih.gov/ij/download.html`). Numbers of positive cells were compared among groups using Tukey's test.

[abc] Within a column, values with different superscript letters are significantly different ($P < .05$).

group (challenged but not vaccinated), and Group 4 pigs served as the negative-control group (unchallenged and unvaccinated). Groups were housed in separate rooms (five pigs per room) within the same facility. Blood samples were collected at study days -42, -28, 0 (49 days of age), 14, 28, 63, 91, and 126 (175 days of age). Each pig was sedated with an intravenous injection of azaperon (Stresnil; Janssen Pharmaceutica, Beerse, Belgium) and then euthanized for necropsy at study day 126. Lung and lymph nodes were collected for histopathologic and immunohistochemistry examination.

Clinical evaluation

Beginning on the day when groups 1, 2, and 3 were inoculated (day 0), all pigs were monitored daily for physical condition and scored weekly for clinical respiratory disease severity using scores ranging from 0 (normal) to 6 (severe dyspnea, abdominal breathing, and death).[7] Observers were blinded to vaccination status. Rectal body temperature was recorded daily from day 0 through 21.

Assessment of growth performance

Body weight of each pig in groups 1, 2, 3, and 4 was measured at study days -28, 0, 21, 63, and 126. Average daily gain (ADG; grams per pig) was analyzed over four time periods: between day -28 and 0; 0 and 21; 21 and 63; and 63 and 126, respectively. The ADG during these various production stages was calculated as the difference between the starting and final weights divided by the duration of the stage. Data from dead pigs were included in the calculation.

PCV2 serological testing

Serum samples were tested using a commercial PCV2 ELISA (Synbiotics) and serum virus neutralization using the heterologous challenging PCV2b (strain SNUVR000463).[8] Serum samples were considered positive for anti-PCV2 antibody if the reciprocal ELISA titer was > 350, according to the manufacturer's instructions. Neutralizing antibody (NAb) data were converted to base 2 logarithms for analysis.

PRRSV serological testing

Serum samples were tested using a commercial PRRSV ELISA (Idexx Laboratories Inc) and serum virus neutralization using the heterologous challenging PRRSV (strain SNUVR090851).[9] Serum samples were considered positive for anti-PRRSV antibody if the sample-to-positive (S:P) ratio was > 0.4, according to the manufacturer's instructions. The NAb data were converted to base 2 logarithms for analysis.

Quantification of PCV2 DNA

QIAamp DNA Mini Kit (Qiagen Inc, Valencia, California) was used to extract DNA from serum samples. The DNA extracts were used to quantify numbers of PCV2 genomic DNA copies by real-time PCR as previously described.[3] The numbers of genomic copies of PCV2 DNA per mL of serum were converted to base 10 logarithms for analysis.

Quantification of PRRSV RNA

A QIAamp RNA Mini Kit (Qiagen Inc) was

used to extract RNA from serum samples. The RNA extracts were used to quantify numbers of PRRSV genomic RNA copies by real-time PCR as previously described.[4] The numbers of genomic copies of PRRSV RNA per mL of serum were converted to base 10 logarithms for analysis.

Enzyme-linked immunospot assay

The numbers of PCV2- and PRRSV-specific interferon-γ secreting cells (IFN-γ-SC) were determined in peripheral blood mononuclear cells (PBMC) by the enzyme-linked immunospot (ELISPOT) method as previously described.[6,10] Whole PCV2b and PRRSV (the strains used for challenge), each at a multiplicity of infection of 0.01, were used to stimulate PBMC. Phytohemagglutinin (10 μg per mL; Roche Diagnostics GmbH, Mannheim, Germany) and phosphate buffered saline were used as positive and negative controls, respectively. The results were expressed as the numbers of IFN-γ-SC per million PBMC.

Interleukin-10

The protein concentrations of interleukin-10 (IL-10) were quantified in the supernatants of PBMC cultures (2×10^6 cells per well; 250 μL) in vitro for 20 hours with the challenging PRRSV (multiplicity of infection of 0.01) or phytohemagglutinin (10 μg per mL) using commercial ELISA kits (Pig Interleukin-10 ELISA kit; Cusabio Biotech, Wuhan, China) according to the manufacturer's instructions. The detection limit for IL-10 was 1.5 pg per mL.

Histopathologic examination

For morphometric analysis of histopathologic lesion scores in lymph nodes, the superficial inguinal lymph node was collected from each pig, and three sections of that lymph node were examined blindly as previously described.[11,12] Lymphoid lesions were scored on a scale from 0 to 3: 0, no lymphoid depletion or granulomatous replacement; 1 = mild lymphoid depletion; 2 = moderate lymphoid depletion; and 3 = severe lymphoid depletion and histiocytic replacement.[11]

For morphometric analysis of histopathologic lesion scores in lung, eight samples of lung tissue (two from the right cranial lobe, two from the right middle lobe, one from the ventromedial part of the right caudal lobe, one from the dorsomedial part of the right caudal lobe, one from the mid-lateral part of the right caudal lobe, and one from the accessory lobe) were collected from each pig and three sections of that lung tissue were examined histologically by one of the authors (JJ), blinded to the animal IDs, as previously described.[7] Lung lesions were scored on a scale from 0 to 4: 0 = no microscopic lesions; 1 = mild interstitial pneumonia; 2 = moderate multifocal interstitial pneumonia; 3 = moderate diffuse interstitial pneumonia; and 4 = severe interstitial pneumonia.[7]

Immunohistochemical examination for PCV2 antigen was performed using PCV2 polyclonal antibody (Iowa State University, Ames, Iowa).[13] Immunohistochemical examination for PRRSV antigen was performed using SR30 monoclonal antibody (Rural Technologies Inc, Brookings, South Dakota).[14] Numbers of lymphoid cells positive for PCV2 antigen in lymph node[12] and of pulmonary cells positive for PRRSV and PCV2 antigen in lung per unit area (0.25 mm^2)[15] were counted using an NIH Image J 1.45s program (`http://imagej.nih.gov/ij/download.html`).

Statistical analysis

Continuous data (rectal body temperature; body weight; PCV2 DNA (log_{10} PCV2 genomic copies per mL) determined by real-time PCR; PPRSV RNA (log_{10} PRRSV genomic copies per mL) determined by real-time PCR; PCV2 and PRRSV serum titer; number of IFN-γ-SC per 10^6 PBMC determined by ELISPOT assay; numbers of lung sections positive for PRRSV antigen and PCV2 antigen; and lymph-node sections positive for PCV2 antigen per unit area (0.25 mm^2; determined by immunohistochemistry) were analyzed using repeated measures ANOVA for each time point. If the ANOVA showed a significant effect, Tukey's test for multiple comparisons was performed at each time point. Fisher's exact test was used for discrete data (clinical respiratory score and lung and lymphoid lesion scores). A chi-square test was used for mortality rate. A value of $P < .05$ was considered significant.

Results

Clinical evaluation

Mean respiratory scores were significantly higher ($P < .05$) in unvaccinated, challenged pigs (Group 3) than in vaccinated, challenged pigs (Group 1 and Group 2) from day 7 to 42 and from day 84 to 98 (Figure 1A). Mean rectal temperature (ranging from 39.7°C to 40.2°C) was significantly higher ($P < .05$) in unvaccinated, challenged pigs (Group 3) than in vaccinated, challenged pigs (Group 1 and Group 2) from day 4 to 7 (Figure 1B). Overall mortality rates were 5% (one of 20 pigs) in Group 1, 10% (two of 20 pigs) in Group 2, 30% (three of 10 pigs) in Group 3, and 0% (0 of 10 pigs) in Group 4. There was no significant difference in mortality rate between vaccinated, challenged pigs (Group 1 and Group 2) and unvaccinated, challenged pigs (Group 3). Diagnostic results indicated that pig deaths were primarily related to severe pneumonia.

Growth performance

Mean ADGs were significantly higher ($P < .05$) in vaccinated, challenged pigs (Group 1 and Group 2) and unvaccinated, unchallenged pigs (Group 4) than in unvaccinated challenged pigs (Group 3) throughout the experiment. However, mean ADG did not differ between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) (Table 2).

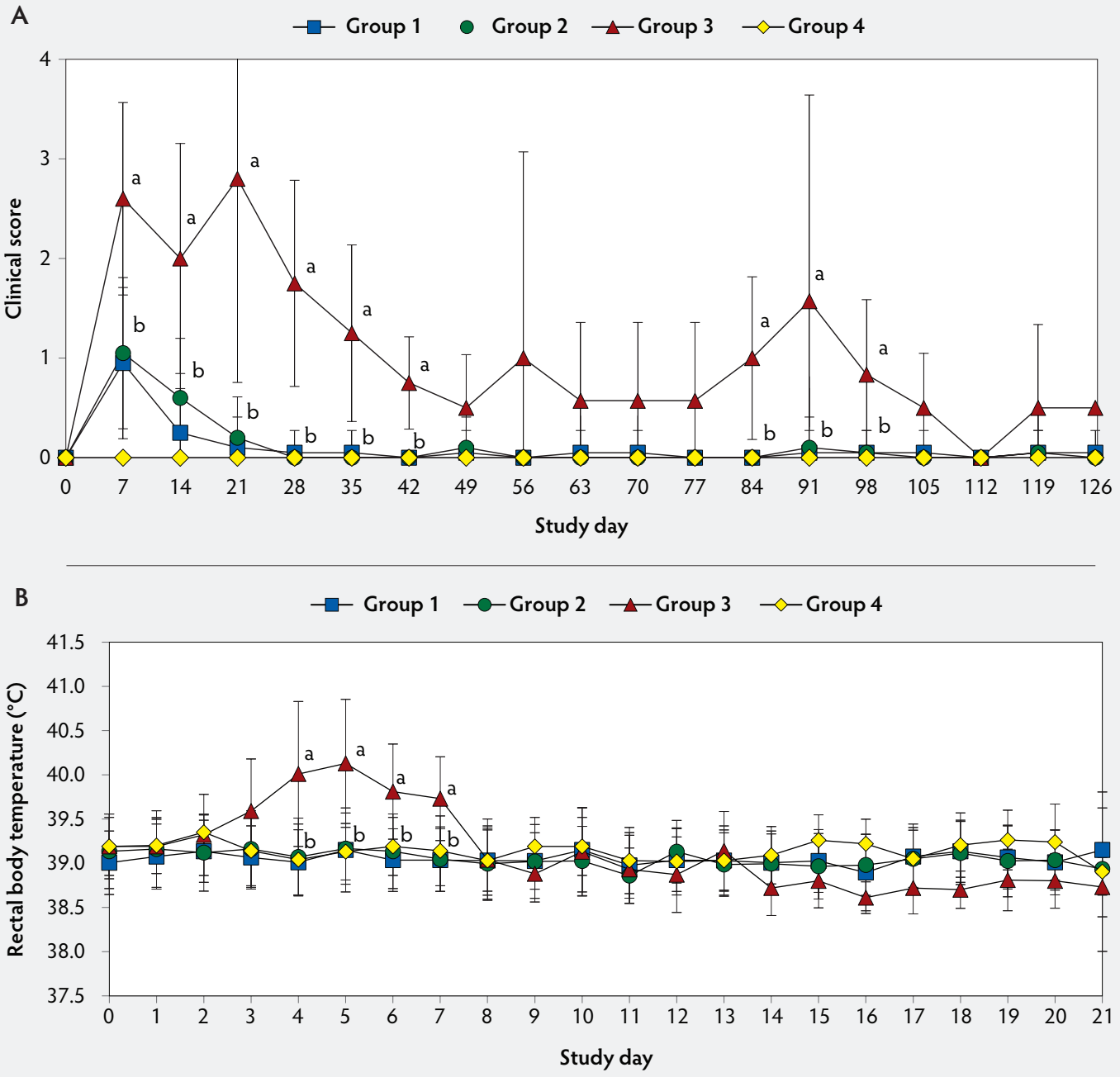
Quantification of PCV2 DNA in serum samples

No PCV2 DNA was detected in the serum samples of pigs tested at days -42, -28, and 0. On days 14 through 126, the numbers of genomic copies of PCV2 in serum were significantly lower ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). Numbers of genomic copies of PCV2 in serum differed between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) at day 14 (Figure 2A). No PCV2 DNA was detected in serum samples of Group 4 pigs (unvaccinated, unchallenged pigs) throughout the experiment.

Quantification of PRRSV RNA in sera

No PRRSV RNA was detected in the serum samples of pigs tested at days -42, -28, and 0. On days 14 and 28, the numbers of genomic copies of PRRSV in serum were significantly lower ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). Numbers of genomic copies of PRRSV in serum did not differ between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) (Figure 2B). No PRRSV RNA was detected in serum of Group 4 pigs (unvaccinated, unchallenged pigs) throughout the experiment.

Figure 1: Means (with standard deviations) of the scores for clinical signs (Panel A) and rectal body temperature (Panel B) in pigs in the study described in Table 1. Different letters (a,b) indicate significant differences among groups (Panel A, $P < .05$; Fisher's exact test and Panel B, $P < .05$; one-way ANOVA).



Immunological responses to PCV2

On days 0 through 28, anti-PCV2 antibody titers were significantly higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). Anti-PCV2 antibody titers differed between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) at day 0 (Figure 3A). On days 0 through 91, mean NAb titers were significantly higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). Mean NAb titers differed between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) at day 14 (Figure 3B). On days 0 through 28, numbers of PCV2-specific IFN-γ-SC were significantly higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). Numbers of PCV2-specific IFN-γ-SC differed between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) at days 0 and 14 (Figure 3C). No anti-PCV2 antibodies or PCV2-specific NAb or IFN-γ-SC were detected in Group 4 (unvaccinated, unchallenged pigs).

Immunologic responses to PRRSV

On days 0 thorugh 63, anti-PRRSV antibody titers were significantly higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs) (Figure 4A). On days 91 and 126, mean NAb titers were significantly

Table 2: Means (with standard deviation) of average daily gain (ADG) in pigs in the study described in Table 1

Period between study days*	Age (days)	ADG (g/day)			
		Group 1	Group 2	Group 3	Group 4
-28 to 0	21-49	329 (31)	330 (28)	326 (25)	340 (27)
0 to 21	49-70	629 (33)[a]	612 (35)[a]	519 (24)[b]	626 (43)[a]
21 to 63	70-112	792 (44)[a]	785 (47)[a]	672 (45)[b]	804 (39)[a]
63 to 126	112-175	734 (43)[a]	718 (39)[a]	650 (33)[b]	728 (42)[a]
-28 to 126	21-175	662 (33)[a]	651 (34)[a]	579 (39)[b]	664 (43)[a]

* The body weight of each pig in each group was measured at study days -28 (21days of age), 0, 21 (70 days of age), 63, and 126 (175 days of age) and ADGs were compared among groups using Tukey's test.
[ab] Within a row, values with different superscript letters are significantly different ($P < .05$).

higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs) (Figure 4B). On days 0 through 28, numbers of PRRSV-specific IFN-γ-SC were significantly higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs) (Figure 4C). No anti-PRRSV antibodies or PRRSV-specific NAb or IFN-γ-SC were detected in Group 4 (unvaccinated, unchallenged pigs).

PRRSV-specific IL-10

On day 0, IL-10 levels were significantly higher ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). Concentrations of IL-10 differed between the two groups of vaccinated, challenged pigs (Group 1 and Group 2) at day 0. On day 28, IL-10 concentrations were significantly higher ($P < .05$) in Group 3 (unvaccinated, challenged pigs) than in Group 1 and Group 2 (vaccinated, challenged pigs) (Figure 5). No IL-10 was detected in Group 4 (unvaccinated, unchallenged pigs).

Pathologic testing

Lymphoid and pulmonary lesion scores were significantly lower ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs). The numbers of lymphoid cells positive for PCV2 antigen (Figure 6), and pulmonary cells positive for PRRSV antigen (Figure 7) and PCV2 antigen (Figure 8) were significantly lower ($P < .05$) in Group 1 and Group 2 (vaccinated, challenged pigs) than in Group 3 (unvaccinated, challenged pigs) (Table 1).

Discussion

This study demonstrated that the single-dose vaccination regimen for PCV2 and PRRSV vaccine is efficacious for controlling co-infection with PCV2 and PRRSV. Regardless of types of vaccines, ADG was higher and mortality rate was lower in the vaccinated, challenged animals than in the unvaccinated, challenged animals.

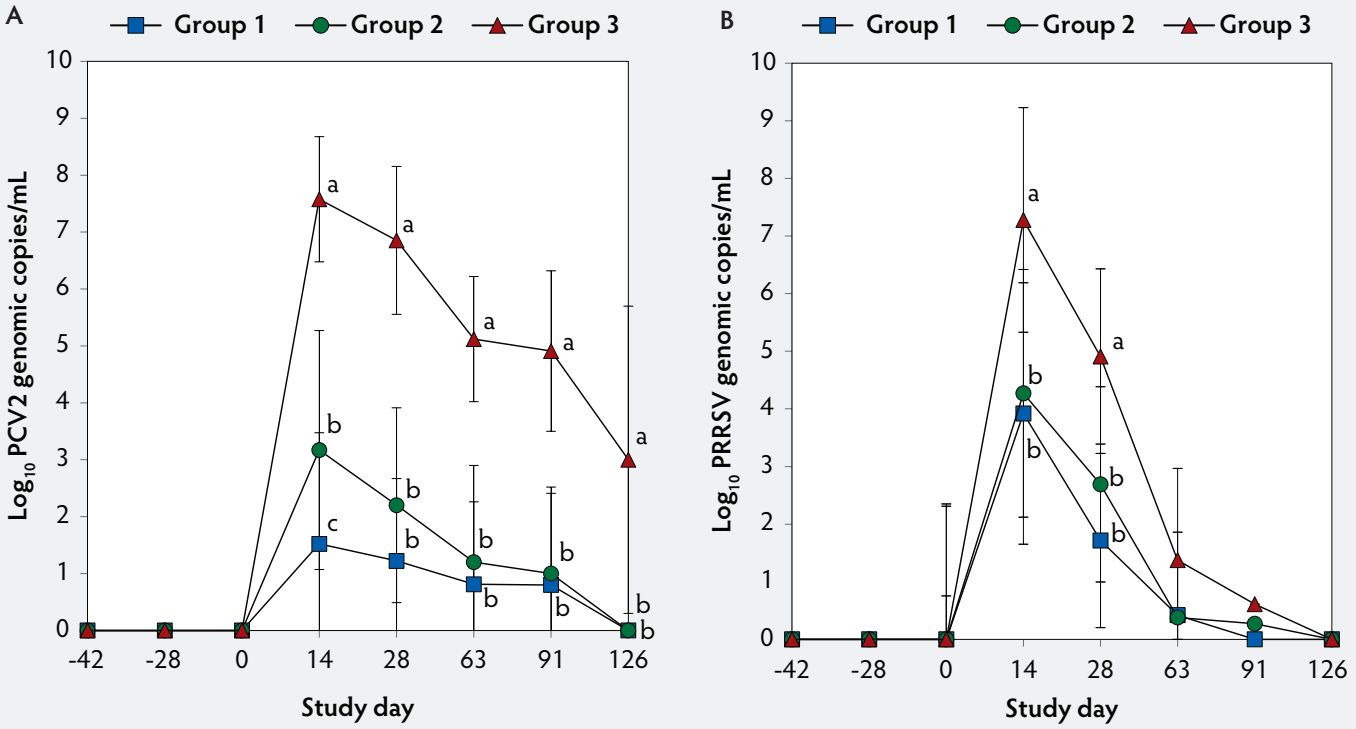
Porcine circovirus type 2 viremia is correlated with the severity of PCV2-induced lymphoid lesions.[16,17] Therefore, PCV2 viremia is an appropriate parameter to evaluate a PCV2 vaccine. A lower number of genomic copies of PCV2 DNA correlates with induction of PCV2-specific NAb and IFN-γ-SC.[16-20] In the current study, only vaccinated animals exhibited PCV2-specific NAb and IFN-γ-SC. Pigs immunized with the Fostera PCV and Fostera PRRSV vaccine (Group 1) had higher titers of PCV2-specific NAb and higher numbers of IFN-γ-SC than did pigs immunized with the Ingelvac CircoFLEX and Ingelvac PRRS MLV vaccines (Group 2). These differences likely influenced the lower numbers of genomic copies of PCV2 DNA in Group 2. These results agree with previous findings that the Fostera PCV vaccine results in significantly lower numbers of genomic copies of PCV2 DNA and greater protective immunity (higher titers of PCV2-specific NAb and higher numbers of IFN-γ-SC) when compared to the Ingelvac CircoFLEX vaccine.[21]

The number of genomic PRRSV RNA copies in serum samples is a critical parameter to evaluate the efficacy of vaccines in control of PRRSV infection.[22] In the present study, PRRSV viremia had resolved before neutralizing antibodies were developed. Therefore, neutralizing antibodies are not essential for the lower number of genomic PRRSV RNA copies as reported in previous studies.[23,24] In addition, there is no evidence that PRRSV antibodies detected by ELISA play a role in protection against infection with PRRSV.[25] In contrast, a lower number of PRRSV genomic RNA copies coincided with the appearance of PRRSV-specific IFN-γ-SC in vaccinated, challenged animals. Therefore, PRRSV-specific IFN-γ-SC are responsible for PRRSV clearance, although the role of IFN-γ-SC in a lower number of PRRSV RNA copies is still conflicting.[23,26] In the present study, no significant differences were observed in the ability of the two tested PRRSV vaccines to induce PRRSV-specific IFN-γ-SC and reduce PRRSV viremia, as a previous study showed.[10]

Pathologic evaluation is another critical parameter to determine the efficacy of the PCV2 and PRRSV vaccines under experimental conditions. The characteristic microscopic lesions caused by co-infection with PCV2 and PRRSV were severe interstitial pneumonia and lymphoid depletion in the unvaccinated, challenged animals in the present and previous studies.[2,27] Single-dose vaccination with PCV2 and PRRSV at 21 days of age was effective in lowering scores for lung and lymphoid lesions in the vaccinated, challenged animals, compared to the unvaccinated, challenged animals, without significant differences between Fostera PCV-PRRS and Ingelvac CircoFLEX-PRRS MLV.

There is interest in the possible interference with the efficacy of one vaccine by another, because animals received both PCV2 and PRRSV vaccines at the same time in this study. Especially, induction of IL-10 by PRRSV vaccine raised concerns that vaccination with PRRSV may interfere with the

Figure 2: Means (with standard deviations) of the number of genomic copies of PCV2 DNA (transformed to base 10 logarithms; Panel A) and PRRSV RNA (transformed to base 10 logarithms; Panel B) in serum samples from pigs in the study described in Table 1. Different letters (a,b) indicate significant differences among groups ($P < .05$; repeated measures ANOVA).



efficacy of a PCV2 vaccine.[28] Interleukin-10 is a well-known cytokine synthesis inhibiting factor and inhibits cell-mediated immune responses.[29] Both PRRSV vaccines used in this study induced maximal levels of IL-10 at study day 0 (28 days post vaccination) that thereafter decreased rapidly. Nevertheless, PCV2- and PRRSV-specific IFN-γ-SC increased gradually, beginning at study day 0 and reaching a peak at study day 14, even in the presence of IL-10. These results suggest that induction of IL-10 by PRRSV vaccines may not interfere with cell-mediated immunity induced by PCV2 vaccines. This information is clinically meaningful, as swine producers prefer to administer both vaccines at the same time, saving labor and resulting in less stress to the animals.

Vaccination is still considered the most effective tool for controlling PRDC caused by co-infection with PCV2 and PRRSV, although co-infection can still be controlled by other practices, such as improved management, pig flow, biosecurity measures, and housing conditions. The results of this study may provide swine practitioners and producers with another option in controlling PRDC, through concurrent administration of single-dose PRRSV and PCV2 vaccines.

Implications

- Under the conditions of this study, it makes no difference to protection whether single-dose PCV2 and PRRSV vaccines are administered concurrently.
- Under the conditions of this study, concurrent vaccination of pigs with PCV2 and PRRSV is efficacious for controlling co-infection with PCV2 and PRRSV.

Acknowledgements

This research was supported by Zoetis Ltd; contract research funds from the Research Institute for Veterinary Science (RIVS) of the College of Veterinary Medicine, Seoul National University; and Brain Korea 21 Plus Program for Creative Veterinary Science Research in the Republic of Korea. The first two authors contributed equally to this work.

Conflict of interest

None reported.

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Figure 3: Mean (with standard deviation) for anti-PCV2 reciprocal ELISA antibody titers (Panel A); group means transformed to base 2 logarithms (with standard deviation) for neutralizing antibody (NAb) reciprocal titers (Panel B); and mean (with standard deviation) of PCV2-specific interferon-γ secreting cells (IFN-γ-SC) in peripheral blood mononuclear cells (PBMC) (Panel C) in the study described in Table 1. Different letters (a,b) indicate significant differences among groups ($P < .05$; repeated measures ANOVA).

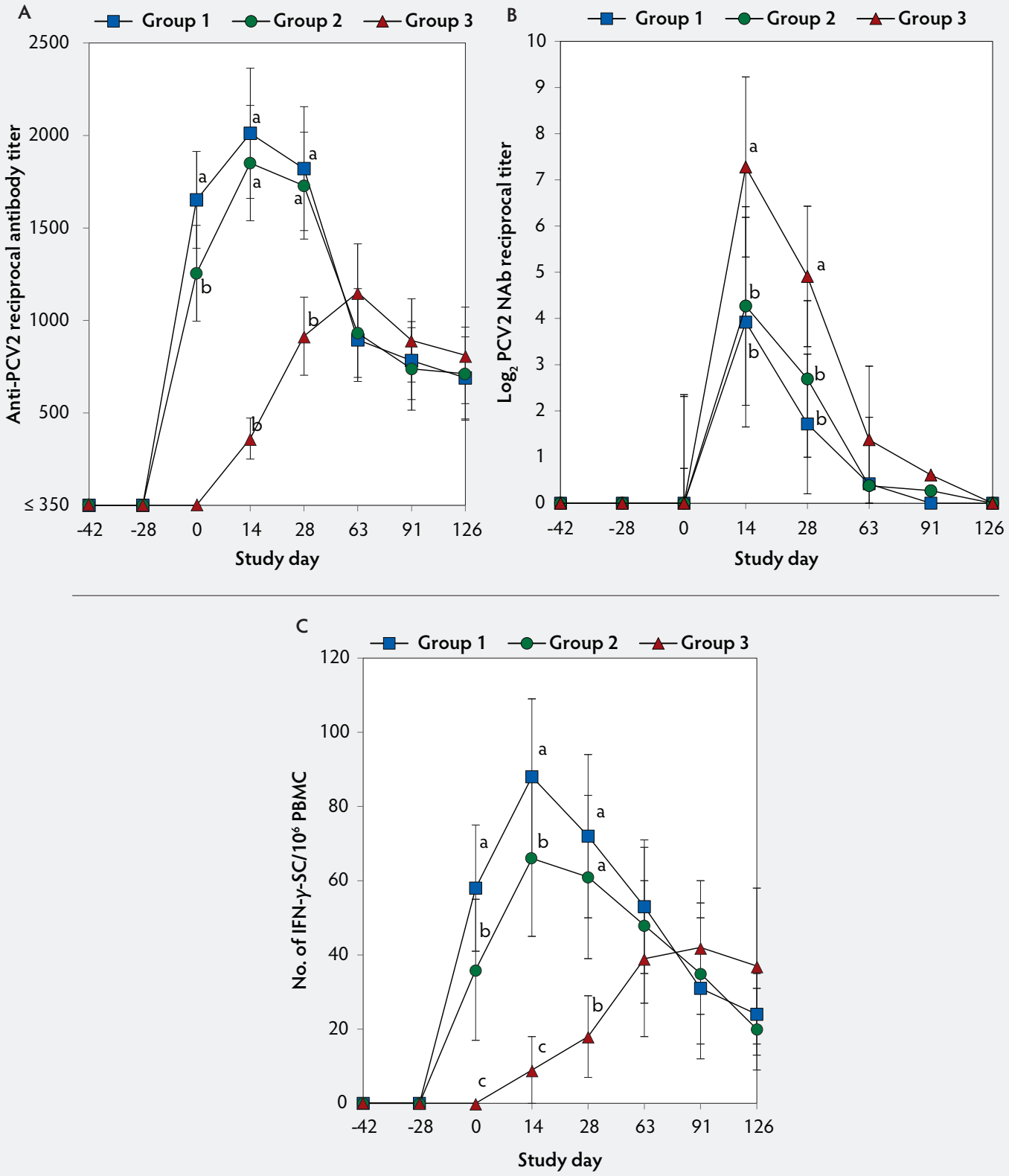

Figure 4: Means (with standard deviation) of commercial PRRSV ELISA sample-to-positive (S:P) ratio (Panel A); group means transformed to base 2 logarithms (with standard deviation) for neutralizing antibody (NAb) reciprocal titers (Panel B); and mean (with standard deviation) of PRRSV-specific interferon-γ secreting cells (IFN-γ-SC) in peripheral blood mononuclear cells (PBMC) (Panel C) in the study described in Table 1. Different letters (a,b) indicate significant differences among groups ($P < .05$; repeated measures ANOVA).

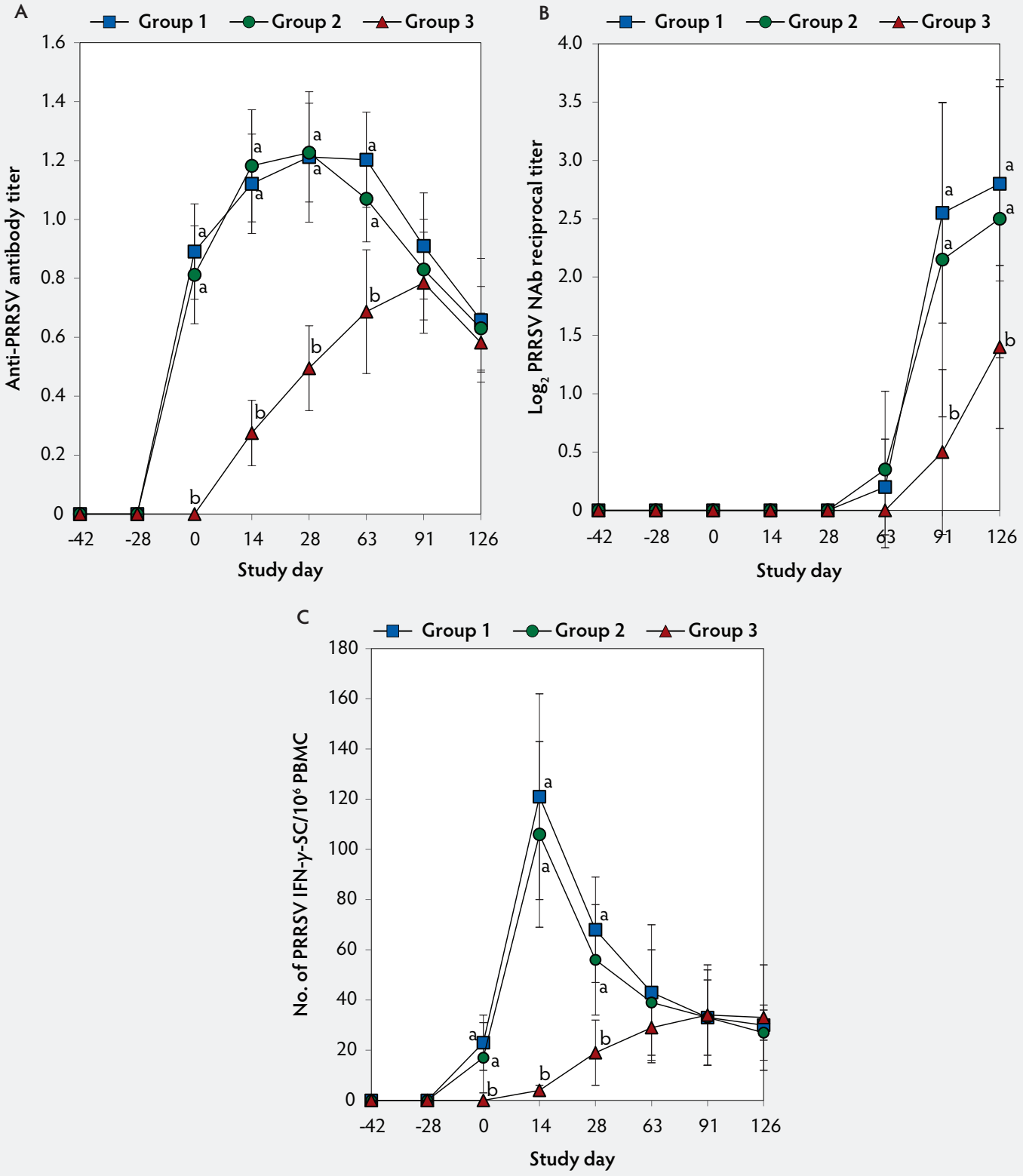

Figure 5: Mean (with standard deviation) for PRRSV-specific IL-10 concentrations in serum samples from pigs in the study described in Table 1. Different letters (a,b) indicate significant differences among groups ($P < .05$; repeated measures ANOVA).

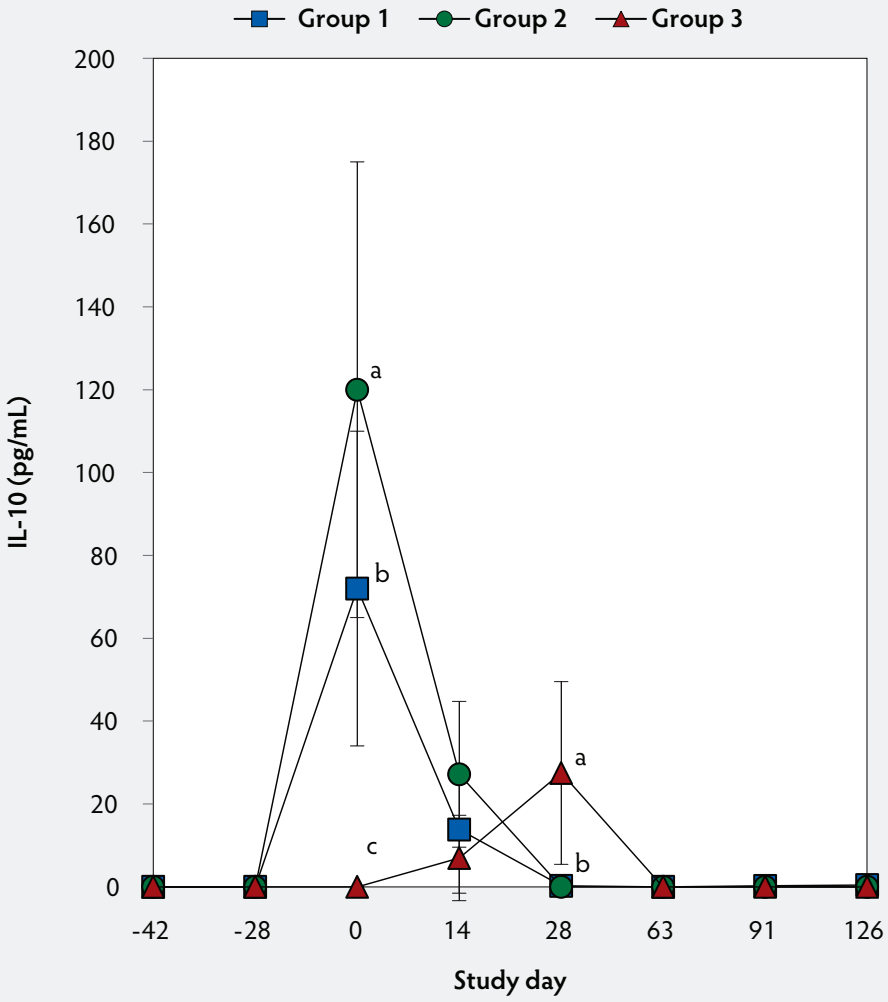

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Figure 6: Immunohistochemical testing to detect porcine circovirus type 2 (PCV2) antigen in lymph nodes of pigs in the study described in Table 1 was performed using PCV2 polyclonal antibody (Iowa State University, Ames, Iowa). Few PCV2 antigen-positive cells (arrowheads) were detected in macrophages in Group 1 pigs (Panel A). Numerous PCV2 antigen-positive cells were detected in macrophages in Group 3 pigs (Panel B) (magnification × 400).

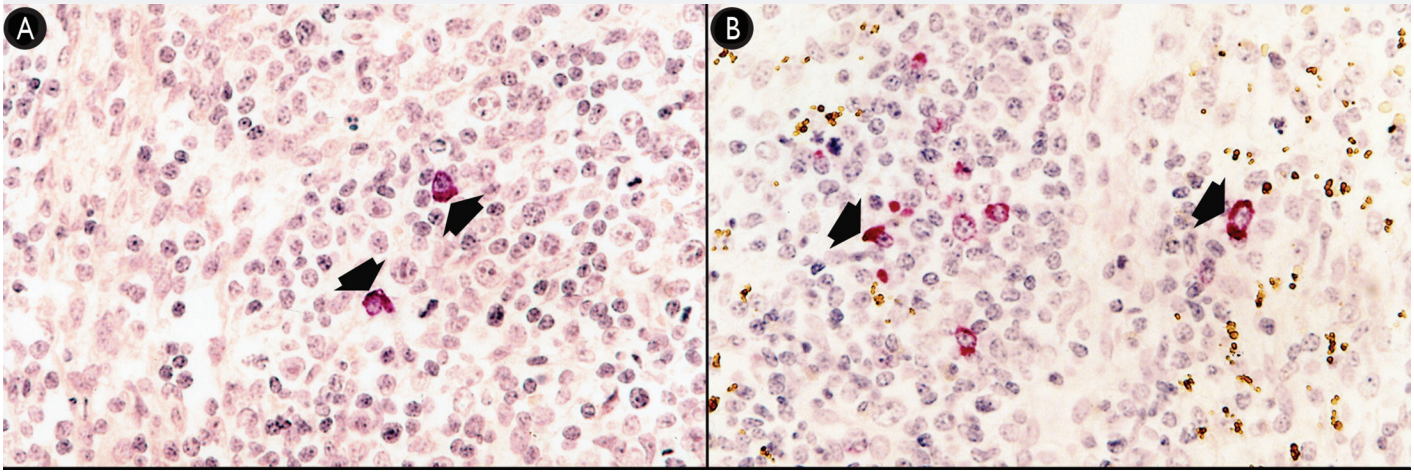

Figure 7: Immunohistochemical testing to detect porcine reproductive and respiratory syndrome virus (PRRSV) antigen in lungs of pigs in the study described in Table 1 was performed using SR30 monoclonal antibody (Rural Technologies Inc, Brookings, South Dakota). Few PRRSV antigen-positive cells (arrowheads) were detected in macrophages in pigs from Group 1 (Panel A). Numerous PRRSV antigen-positive cells were detected in macrophages in pigs from Group 3 (Panel B) (magnification × 200).

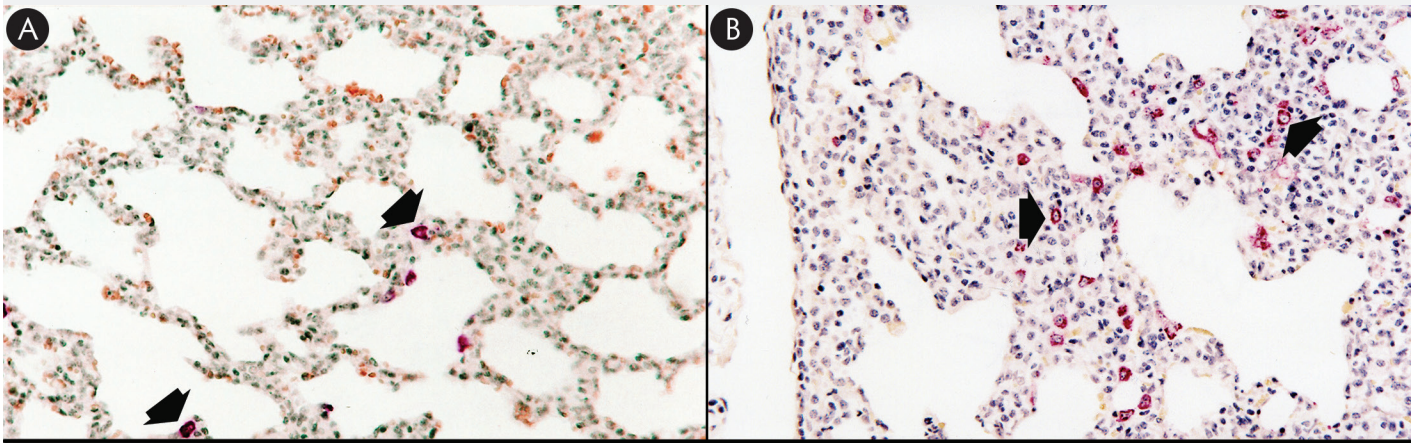

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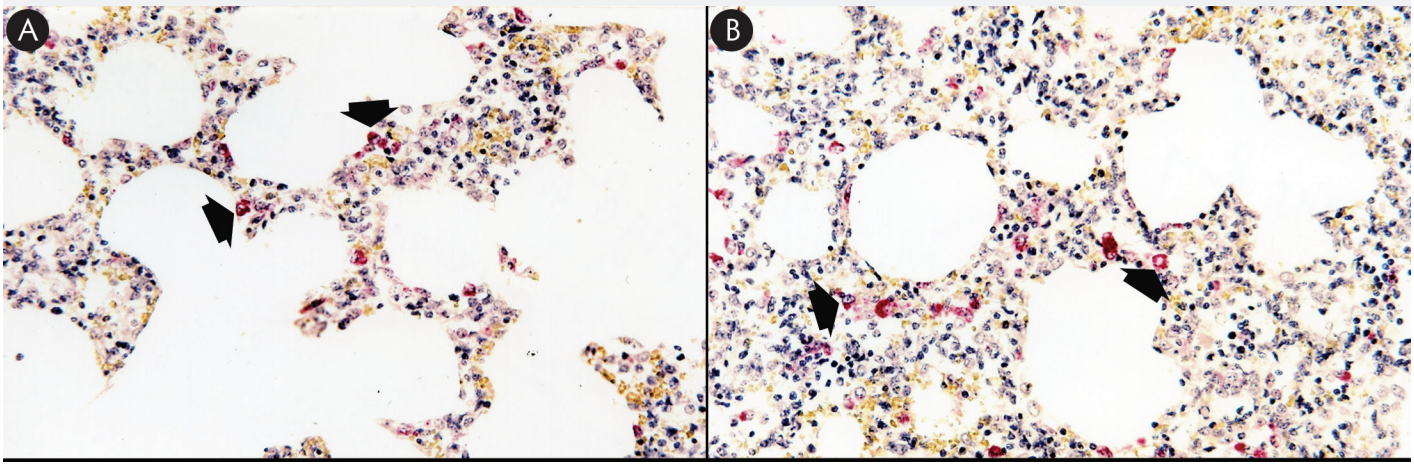
Figure 8: Immunohistochemical testing to detect porcine circovirus type 2 (PCV2) antigen in lungs of pigs in the study described in Table 1 was performed using PCV2 polyclonal antibody (Iowa State University, Ames, Iowa). Few PCV2 antigen-positive cells (arrowheads) were detected in macrophages in pigs from Group 1 (Panel A). Numerous PCV2 antigen-positive cells were detected in macrophages in pigs from Group 3 (Panel B) (magnification × 200).



Rubber mat placement in a farrowing and lactation facility: Tips and techniques

Magnus Campler, PhD; Monique Pairis-Garcia, DVM, PhD; Kenneth J. Stalder, PhD; Anna K. Johnson, PhD

Summary

Sow lameness may result in severe economic consequences to the producer, as lameness has been associated with increases in involuntary culling, poor reproductive performance, and suboptimal sow longevity. Lameness prevalence and severity are impacted by facility design, with a particular focus on hard concrete surfaces. Use of rubber mats has been previously investigated for its ability to increase sow comfort, prevent lameness development, and mitigate lameness severity. However, limited recommendations or guidelines are available to producers and veterinarians to successfully implement on-farm mat use. This production tool provides guidelines and techniques for selecting, installing, and maintaining rubber mats in farrowing stalls for multiparous sows.

Keywords: swine, lameness, rubber mats, on-farm, stall

Received: August 25, 2015
Accepted: January 5, 2016

Resumen - Colocación de tapete de hule en instalaciones de parto y lactancia: Consejos y técnicas

La cojera de las hembras puede resultar en consecuencias económicas importantes para el productor, ya que la cojera se ha relacionado con el incremento de sacrificios involuntarios, pobre desempeño reproductivo, y longevidad subóptima de la hembra. La prevalencia y severidad de la cojera son influidos por el diseño de las instalaciones, con un enfoque particular en superficies de concreto duras. El uso de tapetes de hule ha sido previamente investigado por su capacidad de incrementar la comodidad de las hembras, prevenir el desarrollo de cojera y mitigar la severidad de la cojera. Sin embargo, hay limitadas recomendaciones o normas disponibles para que los productores y veterinarios implementen exitosamente el uso de tapetes en granjas. Esta herramienta de producción provee normas y técnicas para seleccionar, instalar, y mantener tapetes de hule en jaulas de maternidad para hembras multíparas.

Résumé - Installation de tapis en caoutchouc dans des unités de mise-bas et de lactation: Trucs et techniques

Les boiteries chez la truie peuvent avoir de graves conséquences économiques pour le producteur, étant donné que la boiterie a été associée avec une augmentation des réformes involontaires, de mauvaises performances de reproduction, et une longévité sous-optimale des truies. La prévalence et la sévérité des boiteries sont influencées par le design des installations, avec une emphase particulière sur les surfaces dures en béton. L'utilisation de tapis en caoutchouc a été étudiée antérieurement pour sa capacité à augmenter le confort des truies, à prévenir l'apparition de boiterie, et à diminuer la sévérité de la boiterie. Toutefois, des recommandations ou directives limitées sont disponibles aux producteurs et vétérinaires pour implémenter de manière efficace l'utilisation des tapis à la ferme. Le présent outil fournit des directives et des techniques pour sélectionner, installer, et assurer la maintenance de tapis de caoutchouc dans des cages de mise-bas pour les truies multipares.

After reproductive failure, sow lameness is the second most common reason for involuntary sow culling in the United States.[1] Feet and leg problems have been associated with several factors that result in premature culling, including poor reproductive performance, poor farrowing performance, and suboptimal sow longevity.[2] With an estimated 15% sow culling rate due to lameness, annual industry gilt replacement costs have been estimated at $23 million per year, emphasizing that the economic impact must not be underestimated. Although lameness is considered a sow welfare concern and has economic impacts for the industry, few practical on-farm solutions have been developed.

Sow lameness is often a multifactorial problem that can be difficult to prevent and, in turn, to manage. Environmental conditions may play a critical role in lameness severity and prevalence, as both concrete flooring and slats increase the risk of sow lameness.[3,4] These facility conditions may also increase injury risk due to slick flooring, thus resulting in additional lameness. Several other conditions can result in a sow becoming lame, including neurological deficits, trauma, osteochondrosis, arthritis, metabolic disorders, and infectious disease.[5-7] Managing pain as a byproduct of lameness can be conducted either through pharmaceutical intervention (ie, administration of a nonsteroidal anti-inflammatory drug [NSAID]) or a facility adaptation that provides a more comfortable and accommodating environment. The use of rubber mats may provide a solution that reduces lameness occurrence or severity by providing a softer resting area. Rubber mats have several advantages for on-farm use; for example, they are re-useable and easy to clean and can be utilized in pit-system barns with minimal manure buildup.[8,9]

Limited research has been conducted on utilizing rubber mats during either gestation

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This article is available online at http://www.aasv.org/shap.html.

Campler M, Pairis-Garcia M, Stalder KJ, et al. Rubber mat placement in a farrowing and lactation facility: Tips and techniques. *J Swine Health Prod.* 2016;24(3):142–146.

or lactation to reduce lameness and injuries. Only a few studies have demonstrated the benefits of rubber-mat use, which include decreased lameness and lesions[8-10] and decreased development and healing time of shoulder ulcers.[11-13] However, negative effects of rubber mats have also been demonstrated, for example, a higher incidence of piglet lesions[14,15] and decreased sow comfort if hard rubber mats are used.[16] To date, no study has yet identified the optimal rubber mat or provided any consensus on guidelines for successful use and management of rubber mats in a sow facility.

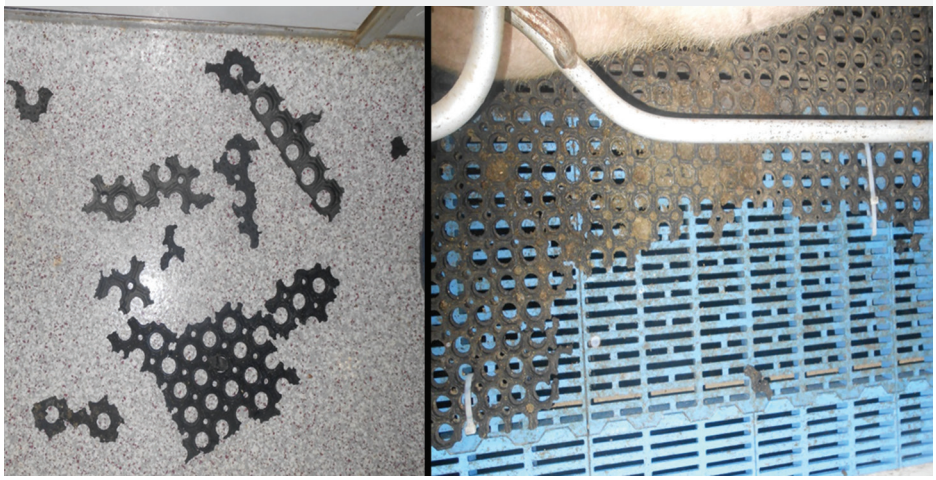
Therefore, the objective of this production tool was to provide additional information, guidelines, and techniques for selecting, installing, and maintaining rubber mats in unidirectional farrowing stalls for multiparous sows.

Choosing the right mat

The variation in rubber mats available for purchase can make selecting an appropriate mat for use in a stalled system difficult. However, when introducing mats into a sow facility, a few key mat variables must be considered. Primarily, the rubber mat has to be thick enough to provide sow comfort without causing injury and be able to withstand sow and piglet manipulation over an extended period of time. This is especially important when placing mats in farrowing stalls, as sows are highly motivated to root and manipulate objects just prior to farrowing.[17,18] Damage to the rubber mat may result in reduced sow comfort, and rubber mat fragments may clog and damage a pit system (Figure 1). Secondly, mats should allow for fecal matter and urine to pass through into the pit system without excessive manure build-up or additional manure-scraping requirements. In addition, the rubber mat should be strong enough and have the integrity to be reused multiple times. For this production tool, 25 perforated boar mats by FarmerBoy Ag (Meyerstown, Pennsylvania) were placed in a commercial sow facility (price: $78.08 per mat [all values provided in US dollars]; width × length × thickness, 99 × 150 × 1.9 cm respectively; perforation size, 1.4 cm). Mats were placed in farrowing stalls and were used through four lactation cycles over a 4-month period. During this time period, mats were exposed to sow and piglet manipulation, staff handling, and power washing and disinfection, with minimal to no signs of damage. This mat was selected after previous experience (unpublished data) with a perforated rubber mat (heavy-duty rubber mat, Farmtek, Dyersville, Iowa; price $47.95; width × length × thickness, 99 × 150 × 1.4 cm respectively; perforation size, 2.2 cm) that showed excessive tearing and fragmenting during one lactation cycle. By 10 to 14 days post placement of the 30 Farmtek rubber mats, at least 30% to 50% of each mat was torn or severely damaged (ie, fragmented; Figure 1) due to normal wear and oral manipulation by the sow and piglets. Thus, all mats were consequently removed from the stalls. The difference in durability between these two mats suggests that the rubber-mat thickness of choice should be at least 1.9 cm to withstand the daily postural adjustments and manipulations of the sow. It should be noted that use of rubber mats should take into consideration environmental conditions, as mats may prevent sows from cooling down during hot and humid summer months.[8]

Different rubber mats and thicknesses have been tested out in various other studies[8,11-13,15] (ie, 1.27 cm, 0.5 cm, 3.8 cm, 1.8 cm, and 3.0 cm, respectively), but no conclusions on either optimal thickness or material composition for rubber mats in farrowing stalls have been presented. As this production tool was based solely on mat performance and application of two mats in a production setting, further research evaluating additional mats and mat composition is needed.

Figure 1: A 99 × 150 × 1.4-cm heavy-duty rubber mat damaged by the sow during the day prior to farrowing. Note the different sizes of fragments (7.5 to 25 cm) as well as the damaged area in the rubber mat on the right (approximately 25 × 75 cm).



Cost and management

The rubber mat should be cost efficient, based on the farm's input and output costs, and require little additional labor. Inputs to be used include the cost of the rubber mat, the zip ties, and the labor needed for installation. One output could be monitoring pre-weaning mortality during lactation. Work published by Grandjot[19] reported that lame sows had a 14.6% greater pre-weaning piglet mortality rate than non-lame sows. Hence, if the average litter size is 13, this translates into a loss of 1.9 piglets per litter. Assuming that rubber mats would have a positive effect on reducing pre-weaning piglet mortality, an increase of 1.9 weaned piglets per litter could theoretically be considered increased output. Furthermore, assuming a market value of $40 per weaned pig, two extra weaned pigs per litter would not only cover the initial purchase cost of the FarmerBoy rubber mat ($78.08), but would also provide a rubber mat for up to five or six new litters before replacement is needed. A mat can successfully be placed and zip-tied down in less than 5 minutes prior to moving the sow into the farrowing stall and can be pre-cut to accommodate farrowing-stall dimensions (Figure 2). Pre-cut mats can easily be stored on a pallet close to the farrowing room and be moved and put in place by one person without excessive effort or time. After each lactation cycle, rubber mats can be removed by simply cutting the zip-ties and lifting the mat out of the stall. It is highly recommended that mats be cleaned after each use utilizing both a pressure washer and disinfectant. If mats deteriorate or become damaged, proper disposal

of the mat is important, and disposal fees may need to be taken into account.

Mat placement and installation

Mat placement is crucial. An incorrectly placed mat may result in an uneven resting surface and increased manure build up (Figure 3). The placement or pre-cutting of the mat may need to be adjusted depending on the specific stall measurements, but the key is to ensure that the mat is wide enough to accommodate the sow's entire body in recumbency and is positioned in a way to minimize manure build-up at the posterior end of the stall.

It has been shown that when rubber mats are placed only under the hind quarters of the sow, occurrence of shoulder ulcers is much lower than when sows lie on bare concrete (Figure 3).[11] However, little evidence exists that placing the rubber mat under the shoulder increases the risk of shoulder ulcer development, compared to having the sow lie on bare concrete. It is therefore arguable that placing the mat at shoulder level is better, as all four legs of the sow have access to the mat simultaneously. As lameness can result from either front or hind limb injury, support should be provided for all legs. The assumption that it is best to place mats at shoulder level is strengthened by the evidence that lame sows are approximately 16 times as likely as non-lame sows to develop shoulder ulcers,[20] and the fact that existing shoulder ulcers heal faster in sows housed on rubber mats[12] further strengthens this assumption. Mats that accommodate only the hindquarters also create a surface ridge that may be less comfortable than either full-mat placement or no mat at all. This ridge might cause lesions in sows provided with rubber mats or may be abrasive to the skin when the recumbent sow is shifting position, especially between nursing bouts. Perforated rubber mats do reduce manure build-up, but manure build-up may still occur, as sow length and defecation patterns play a critical role.

Maintaining a consistent rubber-mat placement requires that the four corners of the mat be fastened to the stall floor. This may be achieved by threading extra-heavy-duty zip ties (61-cm, 79-kg tensile strength; Cable Ties Plus Inc, Duxbury, Massachusetts) through the perforations in the rubber mat and through the slatted floor. Zip-tie threading can be achieved by using a pair of 19-cm long blunt-nose pliers or any gripping tool

Figure 2: Cutting a perforated rubber boar mat to the dimensions 99 × 150 × 1.9 cm for placement in a farrowing-lactation stall. The mat should be placed so that the short side faces the back of the farrowing-lactation stall, starting just below the cross bar, and extending forward to include the shoulder of the sow.

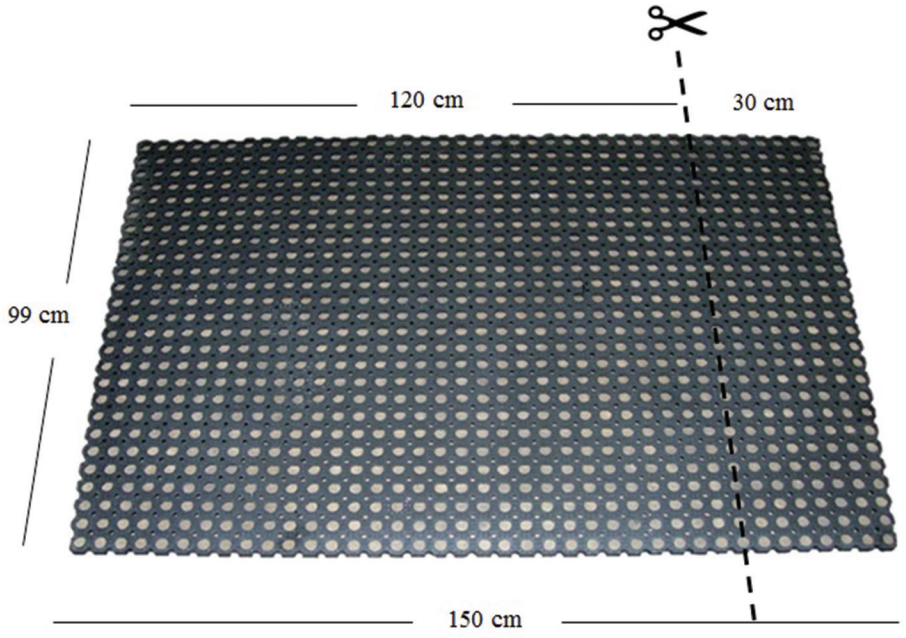
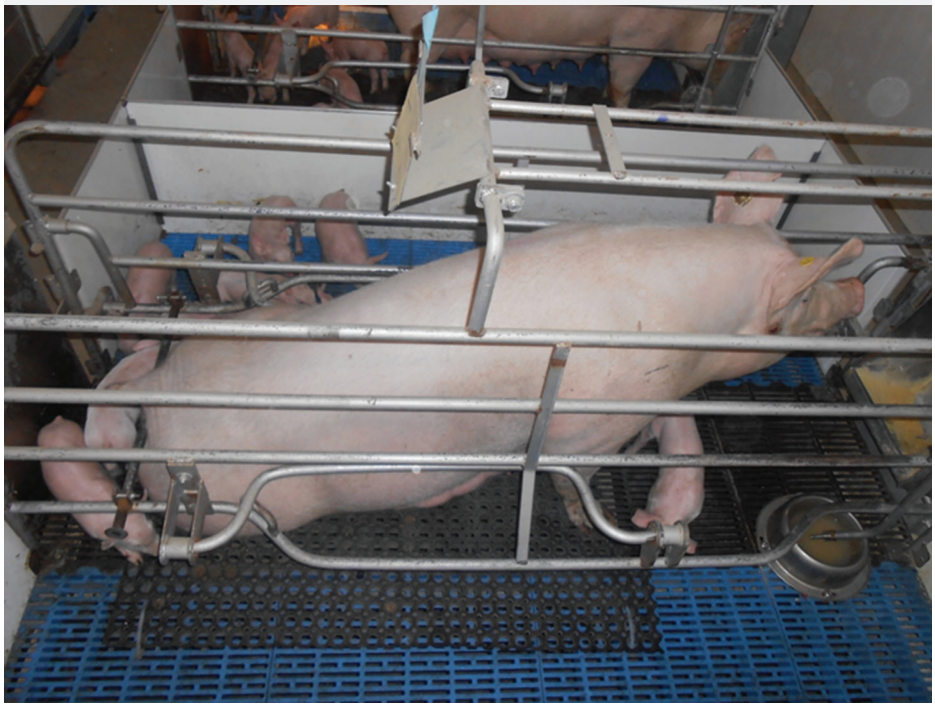


Figure 3: Proper placement of rubber mat in a farrowing-lactation stall. Note how the mat ends at the cross bar to allow manure to drop onto the slatted flooring rather than onto the rubber mat.



that can fit through the floor slats. Detailed suggestions for equipment are provided in Table 1. Placing the zip tie at least 7.5 cm (three perforations) away from the edge of the rubber mat is important to prevent excessive tension and consequent tearing of the mat (Figure 4).

The balance between selecting a mat with perforations that prevent manure accumulation and still providing a comfortable resting surface may be hard to determine. For this production tool, the 1.4-cm perforation size worked sufficiently in allowing accumulated manure to pass through the mat. However, manure build-up may still be a concern for farrowing-lactation stalls where sows can turn 180° and control over placement of the manure deposit is lost.

Implications

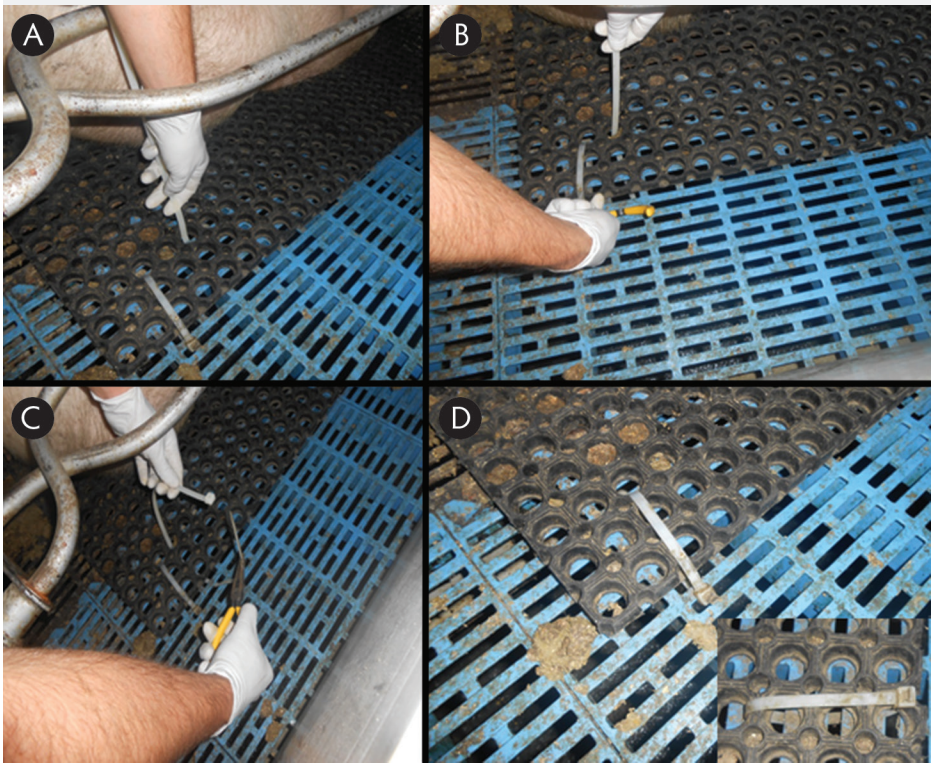
- Perforated rubber mats may provide an easy and inexpensive way to improve sow comfort in farrowing stalls.
- Mat size, cleanliness, cost, durability, and management are important factors to consider.
- Rubber mats need to be placed properly under the sow and fastened securely to ensure maximum sow benefit.

Table 1: Examples of materials required to install a perforated rubber mat in a commercial farrowing stall

Item description	Vendor	Part no.
Boar mat*	FarmerBoy Ag, Meyerstown, Pennsylvania	SKU: 13040001
Heavy-duty, 79-kg tensile zip-ties†	Cable Ties Plus Inc, Duxbury, Massachusetts	SKUCP-24-175-N
Long-nose pliers‡	The Home Depot	SKU: 339858
Utility knife	The Home Depot	Model # 46119

* Dimensions: width × length × thickness, 99 × 150 × 1.9 cm, respectively.
† Length, 61.0 cm; width, 0.9 cm; bundle diameter, 0.5-19.2 cm.
‡ 19-cm pliers or longer.

Figure 4: Step-by-step visualization of zip-tie fastening the rubber mat to the slatted flooring in a farrowing-lactation stall. Panels A-C: Threading the zip-tie 7.5 cm from the mat edge through the slatted flooring with help of blunt-nose pliers. Panel D: Fastened mat with optimal zip-tie position, with the lock close to the slatted flooring.



Conflict of interest

None reported.

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Conversion tables

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28.4
1 lb (16 oz)	453.59 g	lb to kg	0.45
2.2 lb	1 kg	kg to lb	2.2
1 in	2.54 cm	in to cm	2.54
0.39 in	1 cm	cm to in	0.39
1 ft (12 in)	0.31 m	ft to m	0.3
3.28 ft	1 m	m to ft	3.28
1 mi	1.6 km	mi to km	1.6
0.62 mi	1 km	km to mi	0.62
1 in^2	6.45 cm^2	in^2 to cm^2	6.45
0.16 in^2	1 cm^2	cm^2 to in^2	0.16
1 ft^2	0.09 m^2	ft^2 to m^2	0.09
10.76 ft^2	1 m^2	m^2 to ft^2	10.8
1 ft^3	0.03 m^3	ft^3 to m^3	0.03
35.3 ft^3	1 m^3	m^3 to ft^3	35
1 gal (128 fl oz)	3.8 L	gal to L	3.8
0.264 gal	1 L	L to gal	0.26
1 qt (32 fl oz)	946.36 mL	qt to L	0.95
33.815 fl oz	1 L	L to qt	1.1

Temperature equivalents (approx)

°F	°C
32	0
50	10
60	15.5
61	16
65	18.3
70	21.1
75	23.8
80	26.6
82	28
85	29.4
90	32.2
102	38.8
103	39.4
104	40.0
105	40.5
106	41.1
212	100

°F = (°C × 9/5) + 32
°C = (°F - 32) × 5/9

Conversion chart, kg to lb (approx)

Pig size	Lb	Kg
Birth	3.3-4.4	1.5-2.0
Weaning	7.7	3.5
	11	5
	22	10
Nursery	33	15
	44	20
	55	25
	66	30
Grower	99	45
	110	50
	132	60
Finisher	198	90
	220	100
	231	105
	242	110
	253	115
Sow	300	135
	661	300
Boar	794	360
	800	363

1 tonne = 1000 kg
1 ppm = 0.0001% = 1 mg/kg = 1 g/tonne
1 ppm = 1 mg/L

Peer reviewed

Case study

Measurement of neutralizing antibodies against porcine epidemic diarrhea virus in sow serum, colostrum, and milk samples and in piglet serum samples after feedback

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Summary

The introduction of porcine epidemic diarrhea virus (PEDV) into the naive US swine population in April 2013 resulted in significant mortality. The high mortality rates observed indicated the need to boost herd immunity to PEDV. To optimize feedback protocols or other future control measures used to increase immunity, a fluorescent focus neutralization (FFN) assay was developed and used to determine the titers of neutralizing antibodies in sow serum, milk, and colostrum samples and in piglet serum samples. Sow serum samples from two farm sites within different production systems (A, B) were tested. At least 24 sows per site were screened for neutralizing antibodies at 0, 3, 6, 7, and 24 weeks post feedback (PF). These functional antibodies were detected in sow serum samples at both sites 3, 6, 7, and 24 weeks PF and in milk and colostrum samples by 7 weeks PF. At 6 weeks PF, neutralizing antibodies were detected in 27 of 30 Site A piglets (90%), compared to 15 of 29 Site B piglets (52%). Piglets at both sites had detectable neutralizing antibodies, and sentinel pigs were successfully introduced into both systems without re-infection with PEDV by 24 weeks PF.

Keywords: swine, porcine epidemic diarrhea virus, neutralizing antibody, feedback, fluorescent focus neutralization

Received: August 28, 2015
Accepted: December 2, 2015

Resumen - Medición de anticuerpos neutralizantes contra el virus de la diarrea epidémica porcina en muestras de suero de la hembra, calostro y leche, y de suero de lechones después de la retroalimentación

La introducción del virus de la diarrea epidémica porcina (PEDV por sus siglas en inglés) en la población porcina libre del virus en EUA en Abril del 2013 resultó en mortalidad significativa. Los altos índices de mortalidad observados señalaron la necesidad de aumentar la inmunidad del hato contra PEDV. Para optimizar los protocolos de retroalimentación u otras medidas futuras de control utilizadas para incrementar la inmunidad, se desarrolló un ensayo de neutralización de focos fluorescentes (FFN por sus siglas en inglés) y se utilizó para determinar los títulos de anticuerpos neutralizantes en muestras de suero de hembra, leche, calostro y suero de lechones. Se analizaron muestras de suero de hembras de dos sitios porcinos en de dos sistemas (A, B). Se muestrearon por lo menos 24 hembras por sitio en busca de anticuerpos neutralizantes a las 0, 3, 6, 7, y 24 semanas post retroalimentación (PF por sus siglas en inglés). Estos anticuerpos funcionales se detectaron en muestras de suero de hembras en ambos sitios a las 3, 6, 7, y 24 semanas PF y en muestras de leche y calostro a las 7 semanas PF. A las 6 semanas PF, se detectaron anticuerpos neutralizantes en 27 de 30 lechones del Sitio A (90%), comparado con 15 de 29 lechones del Sitio B (52%). Los lechones en ambos sitios tuvieron anticuerpos neutralizantes detectables, y se introdujeron cerdos centinelas exitosamente en ambos sistemas sin reinfección con PEDV a las 24 semanas PF.

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This article is available online at http://www.aasv.org/shap.html.

Clement T, Singrey A, Lawson S, et al. Measurement of neutralizing antibodies against porcine epidemic diarrhea virus in sow serum, colostrum, and milk samples and in piglet serum samples after feedback. *J Swine Health Prod.* 2016;24(3):147–153.

Résumé - Quantification des anticorps neutralisants contre le virus de la diarrhée épidémique porcine dans des échantillons de sérum, de colostrum, et de lait de truies et des échantillons de sérum de porcelets après rétroaction

L'introduction du virus de la diarrhée épidémique porcine (VDEP) dans la population porcine naive des États-Unis en avril 2013 a entrainé de nombreuses mortalités. Les taux de mortalité élevés observés indiquaient le besoin de stimuler l'immunité des troupeaux envers le VDEP. Afin d'optimiser les protocoles de rétroaction ou autres mesures de contrôle utilisées pour augmenter l'immunité, une épreuve de neutralisation de fluorescence a été développée et utilisée pour déterminer les titres d'anticorps neutralisants dans des échantillons de sérum, de lait, et de colostrum de truies et dans des échantillons de sérum de porcelets. Des échantillons de sérum de truie de deux sites de ferme différents de deux systèmes de production différents (A, B) ont été testés. Au moins 24 truies par site ont été testées pour des anticorps neutralisants à 0, 3, 6, 7, et 24 semaines post-rétroaction (PR). Des

anticorps fonctionnels ont été détectés dans les échantillons de sérum des truies aux deux sites à 3, 6, 7, et 24 semaines PR et dans les échantillons de lait et de colostrum à la 7e semaine PR. À 6 semaines PR, des anticorps neutralisants ont été détectés chez 27 des 30 porcelets du Site A (90%), comparativement à 15 des 29 porcelets du Site B (52%). Aux deux sites, les porcelets avaient des anticorps neutralisants détectables, et des porcs sentinelles ont été introduits de manière réussie dans les deux systèmes sans ré-infection avec le VDEP à 24 semaines PR.

Porcine epidemic diarrhea virus (PEDV) is a highly contagious, enveloped, single-stranded positive-sense RNA virus belonging to the *Coronaviridae* family. The virus was first identified in Europe in 1971 and later in the United States in April 2013.[1] Porcine epidemic diarrhea virus had also been reported in Korea, China, Japan, the Philippines, and Thailand prior to 2013.[2] Infection with PEDV results in severe diarrhea and dehydration, which is followed by high mortality in suckling piglets.[3] In addition to high mortality rates in young piglets, PEDV infection also contributes to significant production losses in older animals.[4]

The lack of effective PEDV vaccines capable of eliciting lactogenic protective immunity led multiple production systems in the United States to adopt feedback exposure protocols. Experimental infection using feedback of PEDV-infected intestinal material given to pigs by oral dosing was previously demonstrated in England.[5] Feedback of intestines infected with transmissible gastroenteritis virus (TGEV), another coronavirus, had been used previously to protect piglets from TGEV-induced mortality.[6,7] The protective mechanism underlying the immunity provided by feedback exposure to infected intestinal material has not been fully established, but is likely a result of virus replication in the mucosal epithelium and subsequent development of mucosal effectors of protective immunity (antibodies or cell-mediated responses) that are transferred from the exposed sow to the piglet through milk or colostrum. Neutralizing antibodies may help prevent binding of virus to receptors, block uptake into cells, prevent uncoating of the viral genomes in endosomes, or cause aggregation of virus particles, or the enveloped virus may be lysed by antiviral antibodies and complement.[8]

The overall goal of this study was to evaluate humoral immune responses, mainly focusing on neutralizing antibody responses, elicited by feedback exposure to PEDV-infected intestinal material. Additionally, we assessed the titers and duration of PEDV neutralizing antibodies in the serum of exposed sows and newborn piglets, and in the milk and colostrum of exposed sows. This was an observational case study conducted in two distinct farm sites within different production systems (A, B) that were naturally infected with PEDV in 2014. We compared titers of neutralizing antibodies after initial PEDV infection and feedback exposure in both study sites.

All samples used in this study were derived from routine diagnostic submissions to the South Dakota Animal Disease Research and Diagnostic Laboratory (SD ADRDL). Therefore, institutional animal care and use committee approval was not required for the specific purposes of this study.

Farm sites (A and B) and feedback protocols

Two commercial units performed whole-herd feedback protocols. Site A was a 4000-sow farrow-to-wean farm and Site B was a 4300-sow breed-to-wean site. After first detection of PEDV by polymerase chain reaction (PCR) testing, both sites stopped all traffic to and from the units and performed herd closure. Each site humanely euthanized PEDV-infected piglets according to standard farm practices. The intestines and intestinal contents were collected and homogenized with water using a blender. Site A fed 4 fluid ounces (approximately 118 mL) of the intestinal homogenate to all sows and gilts in the herd, while site B provided 4 to 8 fluid ounces (approximately 118 to 236 mL) of the feedback preparation per animal. The frequency and duration of the feedback exposure protocol adopted by sites A and B were different. Site A used higher frequency and duration of feedback than did Site B. During the first 2 weeks, Site A administered feedback three times a week to all pigs, while Site B administered feedback only once a week during this time period. After 2 weeks, Site B discontinued feedback, whereas Site A continued feedback during weeks 3 to 6, administering feedback twice a week to the gilts and once a week to the open sows.

Serum, milk, and colostrum sample collection

Sow serum samples were collected at 0, 3, 6, 7, and 24 weeks post feedback (PF) exposure. Milk samples (Site A, n = 7) (Site B, n = 29) were collected after farrowing from the same group of sows. Colostrum samples from Site B (n = 34) were also collected from the same group of sows. Limited milk and no colostrum samples were obtained from Site A due to the difficulty of obtaining these samples after farrowing. Serum samples from piglets farrowed from these sows were collected and evaluated for neutralizing antibodies at 9 weeks PF (Site A, 12 to 14 days of age) and 10 weeks PF (Site B, 18 days of age).

Fluorescent focus neutralization assay

Anti-PEDV neutralizing antibody titers were determined by fluorescent focus neutralization (FFN) assays as previously described.[9] Endpoints were interpreted as the highest serum dilution resulting in 90% fewer fluorescent foci than in negative controls. Titers of < 1:20 were considered negative and ≥ 1:20 were indicative of the presence of neutralizing antibodies.

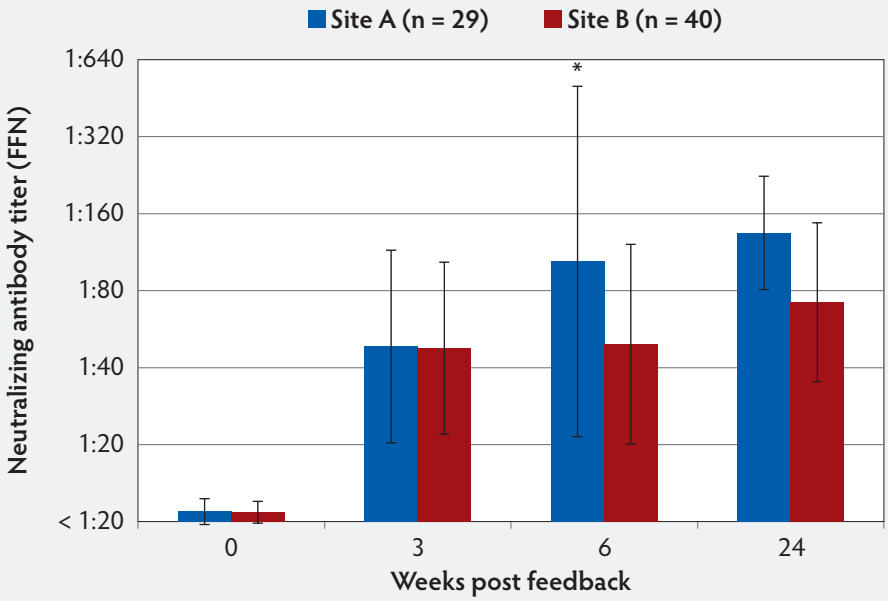
Statistical analysis

Statistical analysis was performed using GraphPad InStat version 3.06 (GraphPad Software, Inc, La Jolla, California). Intracomparison and intercomparison of means were calculated between sites and at different collection times post inoculation using one-way analysis of variance with Tukey's HSD multiple comparisons test to determine mean significance.[10] Differences between groups were considered statistically significant at $P < .05$ for all analyses.

Neutralizing antibodies in sow serum samples

The FFN assay detected neutralizing antibodies in sow serum samples at both sites by the third week after initiation of the feedback protocol (Figure 1). The majority of the samples collected when the feedback protocol was initiated had FFN titers of < 1:20, indicating the whole herd had just been introduced to PEDV and had not developed PEDV neutralizing antibody previously. Six weeks after feedback exposure, Site A sow serum titers were significantly higher than those from Site B ($P < .01$) (Figure 1).

Figure 1: Following feedback exposure, this longitudinal case study measured PEDV neutralizing antibodies in serum samples from sows in two separate production systems. Both sites (A and B) housed at least 4000 breeding animals given a top dressing on feed of at least 4 ounces (approximately 118 mL) of homogenized intestinal contents from PEDV-infected piglets. The frequency and duration of feedback were greater in Site A than in Site B. This figure shows the mean PEDV FFN assay titers with standard deviation in sow serum samples from sites A and B at 0, 3, 6, and 24 weeks PF exposure. A significant difference (*) was observed by pairwise analysis between site A (n = 29) and B (n = 40) at week 6 ($P < .01$; one-way analysis of variance with Tukey's HSD multiple comparisons test). When significance is not indicated, values are to be interpreted as not significantly different. Animals in both sites had detectable PEDV-neutralizing antibody, and sentinel pigs were successfully introduced into their systems without re-infection of PEDV by 24 weeks PF. PEDV = porcine epidemic diarrhea virus; FFN = fluorescent focus neutralization; PF = post feedback.



Indirect fluorescent antibody assay and comparison with FFN

At the time of the study, a commercial ELISA was not available, so an "in-house" indirect fluorescent antibody assay (IFA) was performed on sow serum samples at 6 weeks and 24 weeks PF (Figure 2). This assay has been previously described.[9] A positive sample was indicated if a PEDV-specific fluorescent signal was observed at a serum dilution of 1:40 or greater.

By 6 weeks PF, a greater percentage of sows were seropositive via FFN testing than via IFA testing. In Site A, 100% of sows were seropositive by FFN at 6 weeks PF, and in Site B, 95% of sows were seropositive by FFN. By 24 weeks PF, 100% of sows in both sites were seropositive by FFN (Figure 2).

PCR and sequencing

Intestinal homogenates used for feedback exposure were sent to the SD ADRDL and real-time multiplex PCR for PEDV, porcine deltacoronavirus (PDCoV), and TGEV (EZ-PED/TGE/PDCoV MPX 1.0; Tetracore Inc, Rockville, Maryland) was performed to obtain the semi-quantitative cycle threshold (Ct) values for the presence of PEDV nucleic acid. The feedback material had low Ct values, indicating a large amount of PEDV nucleic acid. For Site A, the feedback material Ct = 16.57, and for Site B, the feedback material Ct = 17.97. Deoxyribonucleic acid sequencing of the S1 region of the spike gene was performed on the intestinal homogenate for reference.

Clinical signs

Piglet loss during the initial outbreaks at both sites was reported as 100% for 2 to 3 weeks. Approximately 6 weeks after initial infection, clinical signs at Site A were reported as "clinically insignificant," but clinical signs at Site B were reported as "clinically significant," with the request to perform additional PCR and DNA sequencing to rule out a variant PEDV as the cause of continued clinical signs. Polymerase chain reaction testing indicated that shedding of the PEDV at Site B was continuing, and S1 PEDV sequencing confirmed that the virus was the same PEDV strain that was originally introduced into the herd prior to initiation of the feedback exposure protocol. Polymerase chain reaction was also performed to rule out introduction of other enteric coronaviruses, such as PDCoV and TGEV, which were not detected.

Neutralizing antibodies in serum, milk, and colostrum samples

Neutralizing antibodies were detected in milk and serum samples collected on Site A from individual sows at the time of farrowing. Interestingly, neutralizing antibody titers in milk were similar to those detected in serum, with titers ranging from 1:160 to 1:640 in serum samples and 1:160 to 1:1280 in milk samples (Figure 3). Neutralizing antibody titers in colostrum samples collected on Site B were higher than titers in milk and serum samples collected at this site (Figure 4, Figure 5). Additionally on Site B, mean antibody titers detected in milk samples were higher than titers detected in serum samples.

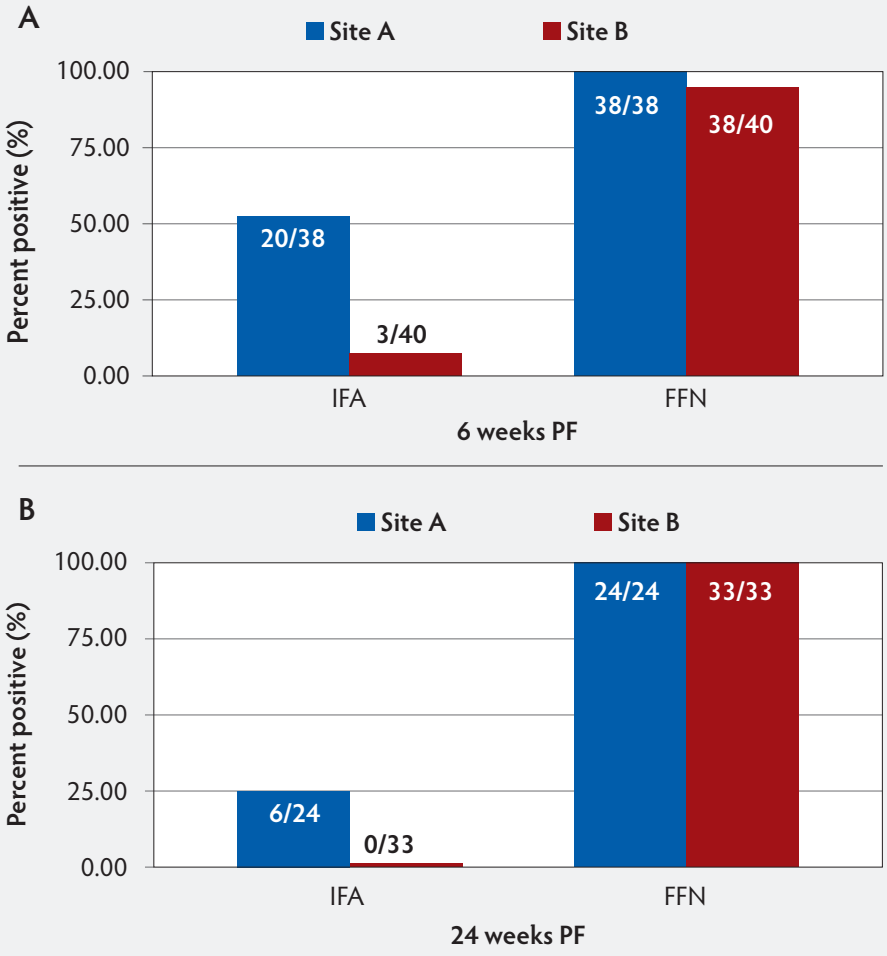
Neutralizing antibodies in piglet serum samples

To assess passive transfer of neutralizing antibodies to piglets following feedback exposure of sows, serum samples were collected from piglets. These samples were collected and selected for convenience from piglets farrowed from sows that were monitored throughout the 24-week study. At 9 to 10 weeks PF, neutralizing antibodies were detected in samples from 27 of 30 Site A piglets tested (90%) and in only 15 of 29 samples from Site B piglets tested (52%) (Figure 6, Figure 7).

Discussion

In this observational case study, we have determined that neutralizing antibodies were detectable in sow serum samples within 3 weeks after the introduction of PEDV

Figure 2: Percent positive PEDV titers using IFA and FFN tests performed on sow serum samples from 6 weeks PF (Panel A), and 24 weeks PF (Panel B) in the case study described in Figure 1. Titers to FFN were detected for the duration of 24 weeks in 100% of animals tested. PEDV = porcine epidemic diarrhea virus; IFA = indirect fluorescent antibody; FFN = fluorescent focus neutralization; PF = post feedback.



and subsequent feedback of infected material. In addition, neutralizing antibodies were detected in colostrum and milk samples of exposed sows and in serum samples of suckling piglets, suggesting that colostrum and milk are sources of neutralizing antibodies for piglets. The differences in the feedback protocols adopted by sites A and B (higher frequency and duration at Site A than at Site B) may have resulted in milder clinical signs and higher neutralizing antibody titers against PEDV for Site A versus Site B sows at 6 weeks post exposure. Subsequently, piglets in Site A had higher titers than piglets in Site B. However, other factors besides "frequency of the feedback" could have contributed to this difference, such as the homogeneity of the feedback between the two sites for consistent exposure of more sows, management practices for ensuring adequate feedback to all sows, loss of virus viability during mixing or administering the feedback, host genetic background, whether all piglets were able to nurse in order to obtain lactogenic antibodies, or other unknown factors.

Feedback of PEDV-infected intestinal homogenates was used to induce herd immunity when PEDV was first introduced into the United States. Relative success in controlling PEDV outbreaks was observed in production systems that adopted feedback exposure protocols. However, controlled experimental studies are needed to more definitively determine "success." In addition, some drawbacks related to administering PEDV-infected feedback material have to be considered, including the potential for transmission of other pathogens within the herd, the maintenance of high PEDV viral load in the environment (which could lead to co-infections with other PEDV strains circulating in the field), or increased potential for spread of PEDV to uninfected farms.[11] Therefore, it will be important to continue research on the best vaccine candidates for enteric protection against PEDV.

This case study was a comparison of two sow herds after initial PEDV infection and subsequent feedback. The titers of neutralizing antibodies in sow serum samples were compared to those in milk and colostrum samples. Results show that titers of PEDV-neutralizing antibodies in milk were at least as high as those in serum samples of feedback-exposed sows, whereas neutralizing antibody titers in colostrum samples were higher than those in serum and milk samples. The relationship between neutralizing antibody titers in serum and milk suggests that serum antibody can be used as an indicator of herd immunity. This specimen also requires less processing than milk or colostrum for higher-throughput laboratory testing. It has been determined that the major antibody isotype in sow serum and colostrum is IgG, whereas IgA is the major antibody isotype in milk.[12] In addition, using radiolabeled immunoglobulin, it was determined that all colostral IgG and most of IgM antibodies are derived from serum, suggesting that serum is a good indicator of the antibodies that are transferred to colostrum.[13] To date, the specific antibody isotype that is responsible for PEDV neutralization is unknown; however, most likely all isotypes may exert neutralizing functions.

There is a PEDV-specific S1 ELISA that measures IgA and IgG antibodies in serum and colostrum, and it is suggested that these measurements might be useful in determining passive immunity.[14] However, the FFN assay would provide a "functional" assessment of these antibodies and not just a quantitative, indirect measure. By comparison, serum IFA appears to have a lower diagnostic sensitivity, and results do not necessarily correlate with the functional antibody response indicated by the FFN assay. While the IFA appears to have reasonable diagnostic sensitivity in the weeks immediately following PEDV exposure, titers of antibody detected by the IFA assay format appear to drop below detectable levels more quickly than functional neutralizing antibodies detected by FFN. In general terms, the IFA is detecting different specific types of antibodies than the FFN and appears to have a

Figure 3: Milk and serum PEDV FFN titers from seven sows in Site A in the case study described in Figure 1. Limited milk and no colostrum samples were obtained from Site A due to the difficulty of obtaining these samples from multiple sows after farrowing. PEDV = porcine epidemic diarrhea virus; FFN = fluorescent focus neutralization.

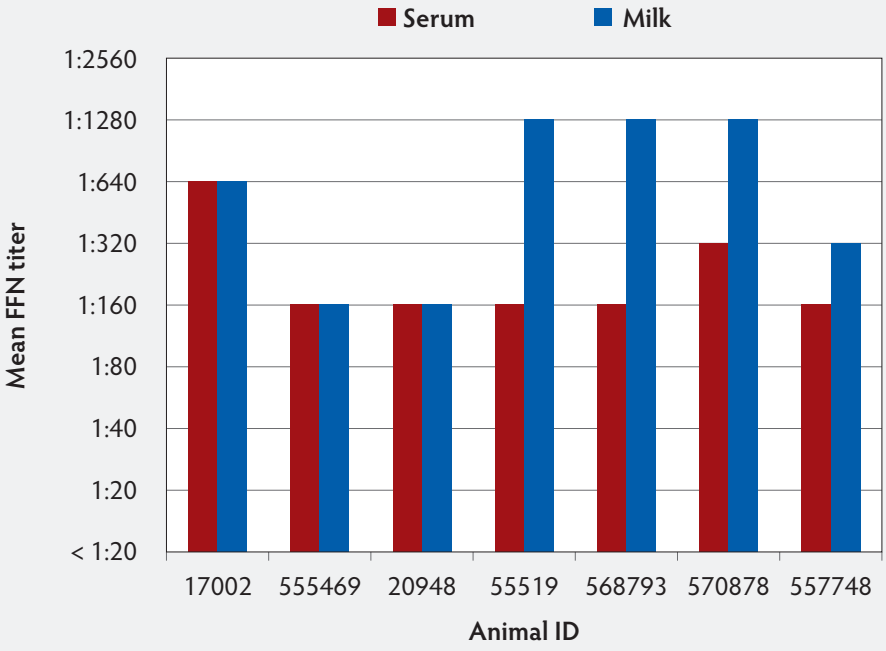
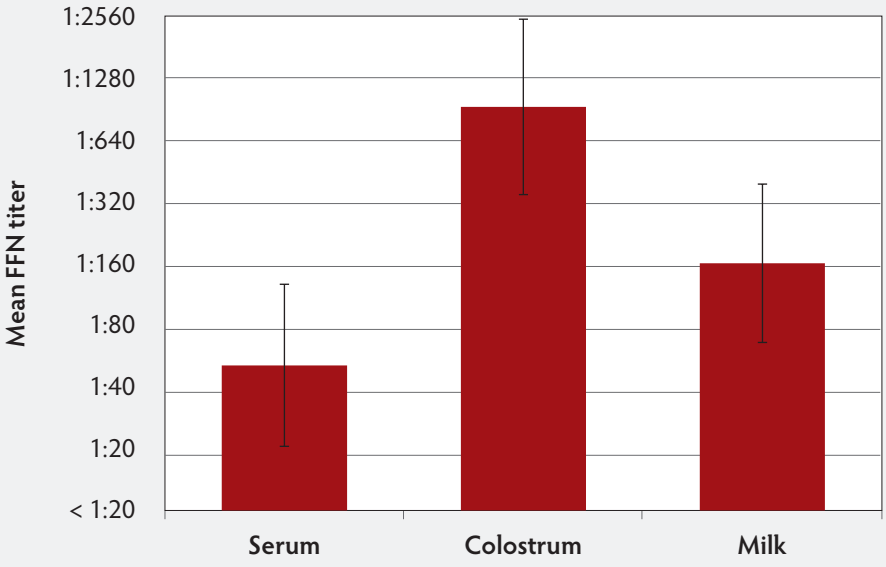


Figure 4: Mean PEDV FFN titers in sow serum (n = 38), colostrum (n = 34), and milk (n = 29) collected at 7 weeks PF from Site B in the case study described in Figure 1. PEDV = porcine epidemic diarrhea virus; FFN = fluorescent focus neutralization; PF = post feedback.



lower diagnostic sensitivity when evaluating samples collected well after PEDV exposure. Practitioners can use the knowledge gained from this study to understand that these two different test platforms, IFA and FFN, are both very useful in health management, but one should use a degree of caution when interpreting the results.

Serum samples from all sows tested from both sites in this study presented detectable neutralizing antibodies by 24 weeks PF. By this time point, both production systems had incorporated sentinel pigs into their farms and did not observe recurrence of PED, indicating that protective levels of herd immunity were reached. In an independent study conducted in approximately 800 swine herds, it was determined that the time to stability (no detectable PEDV shedding), ranged from 7 to 64 weeks, with an average time of 28 weeks.[15] These observations corroborate those in this case study. Various factors, such as feedback consistency, frequency, and coverage of the herd, are likely to contribute to the time to stability. Interestingly, in this study, we observed a correlation between the titers of PEDV-neutralizing antibodies and time to stability. The authors recognize that a limitation of the experimental design of this observational case study is the limited number of sites tested due to the extravagant cost to accomplish a broad study of this type for greater statistical power. Nonetheless, this case study provides important information on the kinetics and titers of PEDV-neutralizing antibodies developed after different feedback protocols. This information will serve as a guide that will help in the design of future studies on PEDV immunobiology conducted to elucidate the contribution of neutralizing antibody for protection and the effectiveness of feedback protocols in the control of the disease.

Implications

- Under the conditions of this study, introduction of PEDV in sow farms with subsequent feedback of PEDV-infected material is associated with increased PEDV-specific neutralizing antibodies.
- Under the conditions of this study, neutralizing antibodies to PEDV are transferred from sow milk and colostrum to piglets.
- After PEDV introduction and feedback in a herd, PEDV-neutralizing antibodies may be detected in serum samples from pigs up to 24 weeks post feedback.

Figure 5: Comparison of PEDV mean FFN titers for site A (serum and milk samples) and B (serum, milk, and colostrum samples) at 7 weeks PF. Case study described in Figure 1. PEDV = porcine epidemic diarrhea virus; FFN = fluorescent focus neutralization; PF = post feedback.

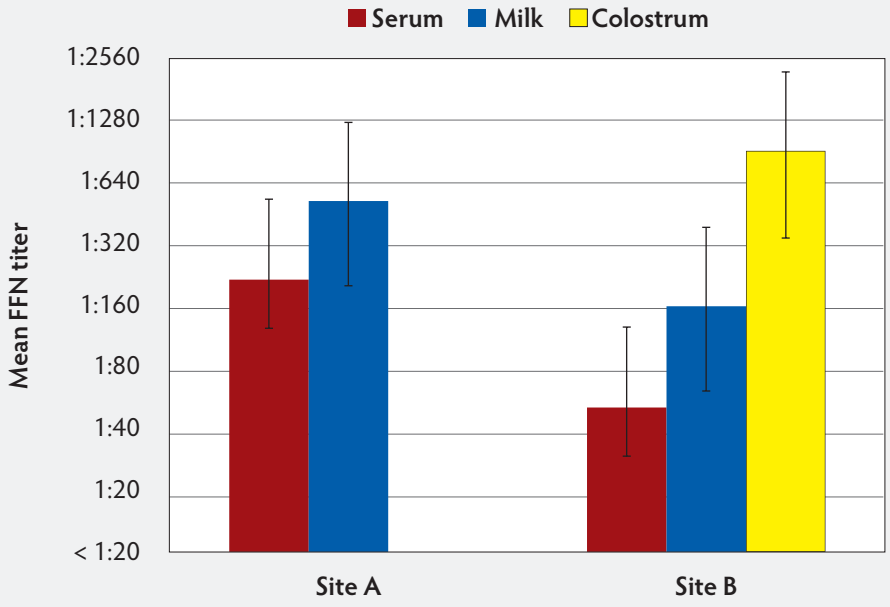
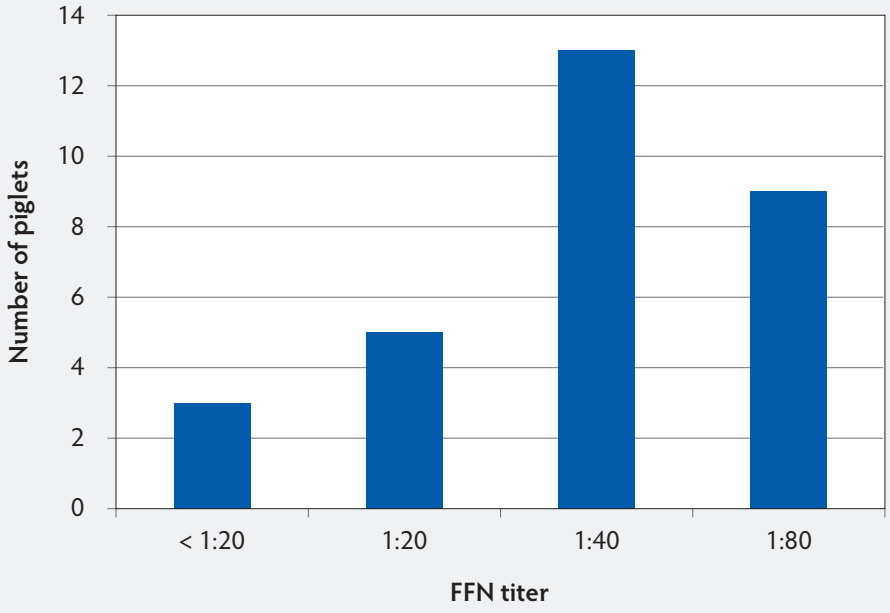


Figure 6: Site A piglet serum PEDV FFN titers at ages 12-14 days of age (9 weeks PF in the case study described in Figure 1) demonstrating 27 of 30 piglets (90%) with positive FFN titers. PEDV = porcine epidemic diarrhea virus; FFN = fluorescent focus neutralization; PF = post feedback.



- Functional neutralizing antibody titers, as detected by the FFN, are detectable for a longer duration than are IFA titers. Practitioners should exercise caution when interpreting results between these two different testing platforms.

Acknowledgements

We would like to thank the companies, staff, and veterinarians that contributed to this project. Their dedication and persistence in providing the samples and information was greatly appreciated. This project was funded through National Pork Board Research Grant # 13-263, the South Dakota Agricultural Experimental Station, USDA Hatch Program, and the Animal Disease Research and Diagnostic Laboratory.

Conflict of interest

None reported.

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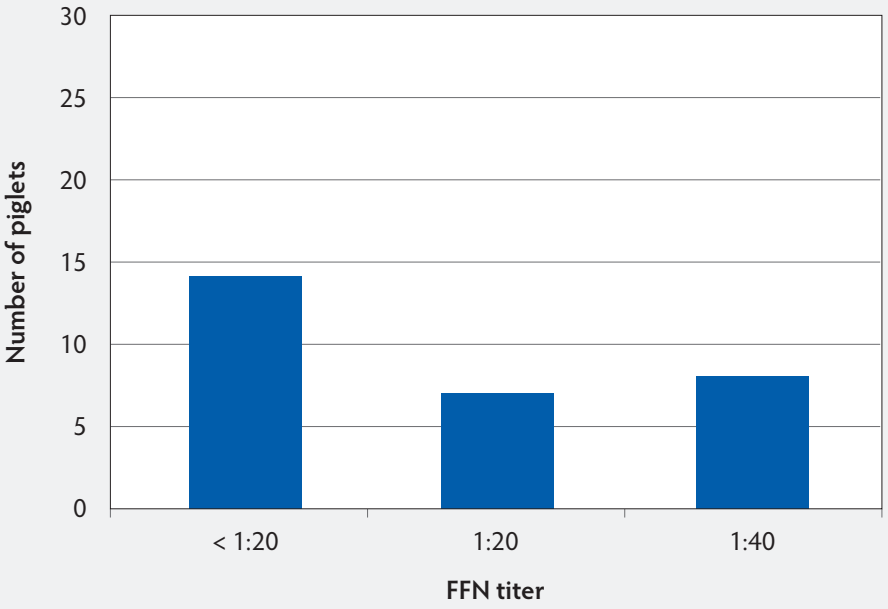
Figure 7: Site B piglet serum PEDV FFN titers at 18 days of age (10 weeks PF in the case study described in Figure 1) demonstrating 15 of 29 of piglets (52%) with positive FFN titers. PEDV = porcine epidemic diarrhea virus; FFN = fluorescent focus neutralization; PF = post feedback.



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Commentary

Peer reviewed

Feed mill biosecurity plans: A systematic approach to prevent biological pathogens in swine feed

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Summary

Development of a feed mill biosecurity plan can minimize risk of introduction of biologic hazards and limit potential economic losses from animal or human pathogens such as *Salmonella* and porcine epidemic diarrhea virus. A biosecurity plan should be detailed and contain hazard controls at each step of the manufacturing process. Biologic hazards can cause illness or injury in humans or animals. These hazards can be introduced through a number of means, including ingredients, manufacturing equipment, or people, so controls must aim to prevent or reduce their prevalence. The Food Safety Modernization Act requires most feed mills to identify and control hazards. A biosecurity plan can serve as an effective prerequisite program to reduce the likelihood of a biological hazard occurrence by identifying ingredient specifications, sampling methods, analytical procedures, receiving guidelines, equipment cleanout, production parameters, load-out, and sanitation procedures. The objective of this review is to describe biological hazards that may be present in swine feed, locations of their potential entry, and suggested practices for a successful biosecurity plan for feed mills manufacturing swine feed.

Keywords: swine, feed, biosecurity, hazard analysis, pathogen control

Received: October 26, 2015
Accepted: December 2, 2015

Resumen - Planes de bioseguridad de los molinos de alimento: un acercamiento sistemático para prevenir los patógenos biológicos en alimento porcino

El desarrollo de un plan de bioseguridad para la planta de alimento puede minimizar el riesgo de introducción de peligros biológicos y limitar pérdidas económicas potenciales de patógenos humanos o animales tales como la *Salmonella* y el virus de la diarrea epidémica porcina. Un plan de bioseguridad debe ser muy detallado y contener los controles de riesgos para cada paso del proceso de manufactura. Los riesgos biológicos pueden causar enfermedad o lesión en humanos o animales. Estos riesgos pueden introducirse a través de varios vías, incluyendo los ingredientes, equipo de manufactura, o gente, por lo que los controles deben buscar prevenir o reducir su prevalencia. La Ley de Modernización de Seguridad de Alimento requiere que la mayoría de las plantas de alimento identifiquen y controlen los riesgos. Un plan de bioseguridad puede servir como un programa de prerrequisito efectivo para reducir la posibilidad de que ocurra un riesgo biológico al identificar las especificaciones de los ingredientes, métodos de muestreo, procedimientos analíticos, normas de recepción, limpieza de equipo, parámetros de producción, descarga, y procedimientos de saneamiento. El objetivo de esta revisión es describir los riesgos biológicos que pueden presentarse en el alimento porcino, localización de su potencial entrada, y prácticas sugeridas para un plan de bioseguridad exitoso para las plantas de alimento que manufacturan alimento porcino.

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Contribution no. 16-111-J from the Kansas Agric Exp Stn, Manhattan, KS 66506-0210.

This article is available online at http://www.aasv.org/shap.html.

Cochrane RA, Dritz SS, Woodworth JC, et al. Feed mill biosecurity plans: A systematic approach to prevent biological pathogens in swine feed. *J Swine Health Prod.* 2016;24(3):154–164.

Résumé - Plans de biosécurité à la meunerie: une approche systématique afin de prévenir les agents pathogènes biologiques dans la nourriture des porcs

La mise au point d'un plan de biosécurité à la meunerie peut minimiser le risque d'introduction de risques biologiques et minimiser le potentiel de pertes économiques dues à des agents pathogènes animal ou humain tel que Salmonella et le virus de la diarrhée épidémique porcine. Un plan de biosécurité devrait être détaillé et posséder des points de maitrise des risques à chaque étape du processus de fabrication. Les risques biologiques peuvent causer des maladies ou blessures chez les humains ou les animaux. Comme ces risques peuvent être introduits de plusieurs façons, incluant les ingrédients, l'équipement manufacturier, ou les personnes, les mesures de maitrise doivent viser à prévenir ou réduire leur prévalence. La règlementation du Food Safety Modernization Act exige que la majorité des meuneries identifie et maitrise les risques. Un plan de biosécurité peut agir comme un programme prérequis efficace pour réduire la possibilité d'apparition d'un risque biologique en identifiant les spécifications des ingrédients, les méthodes d'échantillonnage, les procédures analytiques, les directives pour la réception, le nettoyage de l'équipement, les paramètres de production, le chargement, et les procédures de désinfection. L'objectif de la présente revue est de décrire les risques biologiques qui peuvent être présents dans une meunerie d'alimentation porcine, la localisation de leur entrée possible, et suggérer des pratiques pour un plan de biosécurité réussi pour une meunerie produisant de la nourriture pour les porcs.

Feed mill biosecurity is important to the feed and animal-agriculture industries as a way to control the spread of feedborne diseases and other hazards. Recent outbreaks of porcine epidemic diarrhea virus (PEDV) in the swine industry have increased awareness that biological hazards may be of concern in animal food manufacturing, which has stressed the importance of extending biosecurity procedures to the feed mill. According to the Food and Drug Administration (FDA), a hazard is "any biological, chemical (including radiological), or physical agent that has the potential to cause illness or injury in humans or animals."[1] Of course, implementing a biosecurity plan to mitigate biological hazards in a feed mill is challenging because of differences in facility design, manufacturing operations, and significant risk factors among feed mills.[2] Regardless of those differences, a trained individual should first identify the potential hazards for the feed mill, evaluate their risks, and devise control measures to prevent or reduce their presence or severity. For hazards that are biological in nature, it is also important to consider methods to prevent cross-contamination throughout manufacturing. If at any point a biological hazard does enter the feed mill, feed recall and facility decontamination should be considered.

Most hazard analysis systems, including those required by the Food Safety Modernization Act (FSMA), allow facilities to consider prerequisite programs, such as a biosecurity plan, in their assessment of hazard probability. A properly designed and implemented feed-mill biosecurity plan minimizes the risk of biological pathogens in animal feed, which protects herd health, minimizes economic losses, and ultimately helps ensure farm-to-fork food safety.[3] The objective of this review is to identify and evaluate potential biological hazards that may be present in swine feed, locations of potential entry of these hazards, and suggested practices for a feed mill biosecurity plan.

Hazards analysis

Identify ingredients and process steps

The first step of hazard analysis is to identify ingredients and process steps, which is usually most easily accomplished by creating a block flow diagram to visualize the major manufacturing processes within the feed mill (Figure 1). This diagram, which will vary by feed mill, allows one to easily identify the major processing steps that should be considered in a biosecurity plan for both points of potential hazard entry and control. Common categories in the diagram include receiving, processing, storage, packaging, loading, and delivery.[3] A more complex flow with conveying systems can help to identify areas of higher risk for cross-contamination, but may also overcomplicate the process. The key is to accurately identify and list all ingredients and major steps in feed manufacturing.

Hazard identification

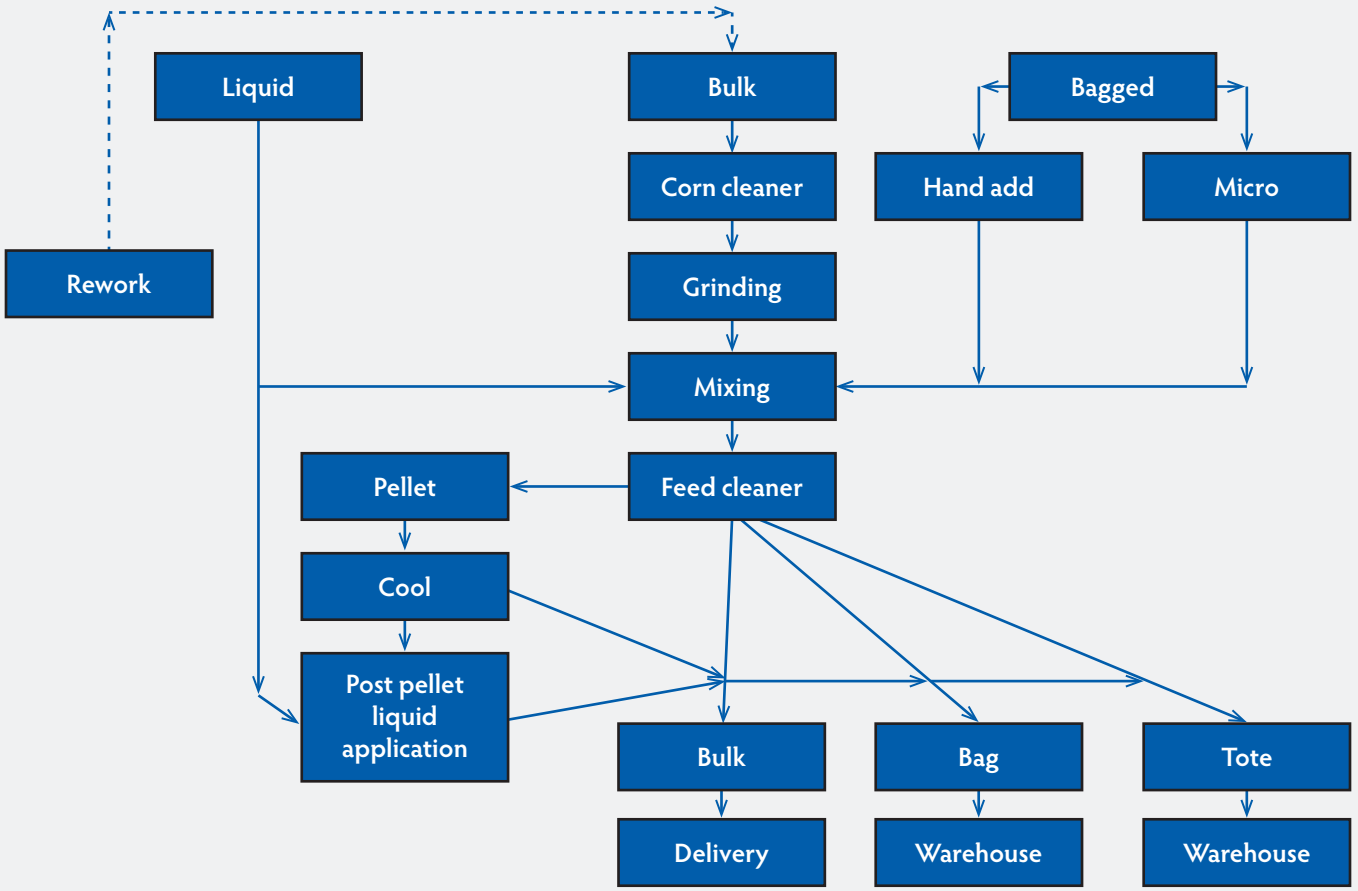
Once the ingredients and process steps are identified, potential hazards associated with each should be determined. The comprehensiveness of this list can vary, but hazard identification is generally a brainstorming of all potential hazards that are known or reasonably foreseeable in the type of animal feed manufactured. That list of potential hazards is then evaluated for severity and probability to determine those that require control. According to FSMA, there are specific criteria that must be considered during hazard identification. These include the formulation, condition, function, and design of the facility and equipment, ingredients, transportation, processing procedures, packaging and labeling activities, storage and distribution, intended or reasonably foreseeable use of the feed, sanitation, and other relevant factors, as necessary.[1] Resources are available to help individuals during this process, including scientific literature, FDA recalls,[4] and FDA or other regulatory guidance.

Scientific literature demonstrating significant biological hazards in swine feed was limited prior to the introduction of PEDV to the United States in 2013. The virus causes diarrhea and vomiting in pigs of all life stages, but is most severe in suckling pigs, with mortality reaching close to 100% for 3 to 5 weeks and generating significant economic losses in North America.[5] This coronavirus has also been found in Europe and Southeast Asia.[6,7] Porcine epidemic diarrhea virus is primarily transmitted by the fecal-oral route.[8-12] While pig-to-pig transmission is by far the most likely method of transmission, epidemiological evidence suggests that transport vehicles, fomites, feed, and aerosols may be involved in viral transmission due to cross-contamination with fecal material.[9-11] Controlled research has confirmed that PEDV contamination in complete swine feed and ingredients can result in PEDV transmission.[8-10]

While PEDV was the first substantial biological hazard of concern in swine feed, other potential biological hazards exist. For example, mammalian orthoreovirus has recently been shown to be present in blood meal and result in infectivity.[13] The most prevalent biological hazard in all animal feeds is undoubtedly *Salmonella*. Surveillance data from FDA cites that the contamination rate of *Salmonella* in all categories of animal feed and ingredients surveyed from 2002 to 2006 was 30.9%, but it dropped to 19.4% from 2007 to 2009.[14] Contamination rate in complete feeds was much lower; it was 9.4% from 2002 to 2006 and 5.6% from 2007 to 2009.[14]

Outside of scientific literature, other resources, such as those from the FDA and other regulatory bodies, may be helpful during hazard identification. The FDA maintains a database of recalls and withdrawals, as well as the Reportable Food Registry, which documents facilities that report when there is a "reasonable probability that the use of, or exposure to, an article of food will cause serious adverse health consequences or death to humans or animals."[4] These lists may be helpful to help individuals conducting the hazard identification to understand hazards previously associated with the type of animal feed being manufactured. The FDA is actively developing guidance on hazards associated with different types of animal feed, but that has not been published at the time of this publication. Previously, the FDA has released a "Draft list of potentially hazardous contaminants in animal feed and feed ingredients" in 2006.[15] While not comprehensive in nature, this list is a good resource for the hazard identification process, as it categorizes hazards into those that are physical, chemical, and biological in nature. The biological hazards are grouped into two categories: transmissible spongiform encephalopathies, including bovine spongiform encephalopathy and chronic wasting disease, and biological contaminants, including *Bacillus* species, *Clostridium* species, *Escherichia coli*, *Mycobacterium* species, *Pseudomonas* species, *Salmonella enterica* serovars, and *Staphylococcus* species.[15] This list was established prior to the introduction of PEDV to the United States, and thus this potential hazard was not included on the list. Furthermore, many potential hazards included on the list are not known or reasonably foreseeable in swine feed. This emphasizes that multiple resources may be necessary for thorough hazard identification.

Figure 1: Block flow diagram of a feed manufacturing process. Creating a flow diagram of a facility is an easy way to visualize which processes must be considered in the biosecurity plan. A more complex flow that includes conveying equipment may help isolate locations where cross-contamination is at higher risk to occur.



Hazard evaluation

The second step of hazard analysis is to evaluate the hazard's severity and probability of occurrence within a single facility. As is the case with hazard identification, the determination of the severity and probability of each hazard is different for each facility because of multiple variables that change from one feed mill to another. The combination of severity and probability is used to set a threshold likely to require control.

The severity determination according to FSMA must assess the severity of illness or injury if the hazard were to occur.[1] This severity assessment is flexible, but hazards that cause short-term injury or illness in a single animal would likely have a lower severity assessment than those that have the potential to cause widespread mortality. For example, the presence of metal in swine feed would likely have a lower severity than PEDV, because a metal bolt from a piece of manufacturing equipment is not likely consumed by an animal. If it is, the hazard is limited to a single animal and does not impact overall herd health. The presence of PEDV in swine feed would typically be evaluated as having greater severity than metal because of the likelihood for multiple deaths. Outside of the severity of the illness or injury and the potential number of animals affected, other factors can be considered in the overall severity assessment of the hazard. Depending on the facility, these may include the value of the animal to the production system or a hazard's potential impact on human health.

In addition to evaluating the severity of a hazard, the individual conducting hazard analysis should also consider its probability of occurrence. This step is also required by FSMA, where individuals must "assess the probability that the hazard will occur in the absence of preventive controls."[1] Notably, the FDA has recognized that prerequisite programs, such as a biosecurity plan, can be considered during this probability assessment. Individuals conducting the probability assessment may also need to utilize resources such as those from FDA recalls or the Reportable Food Registry, as well as their own facility history, to make this determination. As in the assessment of severity, the probability of hazard occurrence is highly dependent upon the facility. For example, *Salmonella* contamination is a concern across animal feed in general, but its prevalence and severity in swine feed is lower than in many non-livestock species. This is demonstrated by the FDA *Salmonella* Compliance Policy Guide,[16] which describes that pet food is considered adulterated when it is contaminated with *Salmonella* and will not subsequently undergo a commercial heat step or other commercial process that will destroy the salmonellae. However, feed for other animals is considered to be adulterated only when it is contaminated with a *Salmonella* serotype that is considered to be pathogenic to the animal intended to consume the feed and the feed will not subsequently undergo a commercial heat step or other commercial process that will kill the salmonellae.[16] The

only pathogenic *Salmonella* serotype that has been associated with salmonellosis is *Salmonella enterica* serovar Choleraesuis, which is rarely found in the environment outside of the pig, and the probability for this serotype transmission through feed and ingredients is negligible.[16] Still, *Salmonella* may be a hazard of importance for individual feed mills that manufacture feed for other species if their prohibited serotypes are more probable to occur or if the mill exports feed to countries with more stringent standards, such as those in many European countries. Depending upon the serotype, the facility design, its ingredients, and its customers, assessment of the severity of *Salmonella* and other hazards will likely differ among feed mills.

Once hazards are identified and their severity and predictability are established, it must be determined if their combination requires specific controls. Preventive controls according to FSMA require stringent management components, such as monitoring, validation, verification, corrective action, and a recall plan.[1] While many of these control strategies are useful, most feed mills manufacturing solely swine feed will likely have no hazards with the combination of probability and severity that requires a preventive control. Instead, most facilities will likely choose to mitigate hazards by reducing their probability with prerequisite programs, such as a biosecurity program. The following strategies describe these potential biosecurity program components that may be used to reduce the probability of biological hazards such as PEDV in swine feed.

Hazard mitigation

Prevention of hazard entry during ingredient receiving

One of the most effective components of feed mill biosecurity is prevention of hazard entry during the receiving of ingredients.[3] There is incentive to prevent a hazard's entry into a facility altogether, because the European Food Safety Authority (EFSA) has shown that the introduction of a contaminated material into a feed mill can lead to the mill being contaminated for an extended period.[17] The first step for hazard prevention during receiving is to develop a supplier program that includes purchase specifications clearly communicating your expectations for the safety of inbound ingredients. This may also include verification of ingredient-supplier protocols and on-site manufacturing facility reviews and assessments. Once those specifications are in place, it is important to communicate and enforce them. It should be noted that methods employed on hazards evaluated to not require a preventive control can be mitigated through a biosecurity plan. However, these same activities used to control a hazard that requires a preventive control would require a supply-chain program as a supply-chain-applied control, which requires a number of management components and documentation under FSMA.[1]

Regardless of the hazard evaluation determination, prevention of a biological hazard typically includes a sampling and analytical schedule for its presence in high-risk ingredients. Sampling protocols should be constructed to identify sampling method, quantity needed to collect, sample labeling, retention procedures, and directions for analysis.[3] The Association of American Feed Control Officials' "Good Samples: Guidance" on obtaining defensible samples outlines aseptic sampling methods to obtain a high-quality representative sample from various types of ingredients.[18,19] Aseptic sampling is required for biological pathogens, because there is a high potential for cross-contamination of samples during the collection process. The schedule should also include testing and holding procedures, as well as instructions for appropriate analysis. The sampling and analytical schedule will again be dependent upon each feed mill's assessment of hazards, its potential risk in ingredients, and its available analytic capabilities. If an ingredient is considered high risk, every lot should be analyzed separately. If it is lower risk, it may be more practical to collect samples and pool them for more intermittent analysis.

The receiving process is also an area where emphasis can be placed on requirements for inbound trucks. Instructions for appropriate security measures for truck drivers and visitors should also be posted on proper signage (Figure 2).[3] Ideally, drivers should stay inside their trucks at all times to minimize foot traffic. If the driver must exit the vehicle, he or she should wear disposable plastic boots or cover-ups to limit their potential for introducing hazards from their shoes.[20] Recommendations for feed mills producing feed for high-risk facilities, such as those supplying breeding-stock multipliers, have been established by PIC North America.[20] Their suggestions to maintain biosecurity are applicable to many swine feed mills trying to mitigate biological hazards through a biosecurity plan. All trucks entering the feed mill should have mud and sludge removed from the trailer opening before the vehicle reaches the pit, and the pit should remain covered until the truck is ready to unload (Figure 3).[20] Appropriate documentation, such as receiving records that include the date, time, and lot number during unloading, should also be gathered in order to allow traceability of feed and ingredients. Documentation from inbound trucks regarding previous loads should also be collected. Regardless, if ingredients enter the feed mill in bagged, bulk, or liquid form, particular emphasis should be placed on sampling and hazard analysis of high-risk ingredients prior to unloading. This is particularly true for bulk ingredients that typically enter through a central pit and travel through bucket elevators, turn heads, and conveyors to storage bins. Ingredients may be contaminated prior to unloading, but they may also be contaminated during the unloading process due to mud or floor sweepings intermingling with ingredients in the pit. Cones and funneling devices (Figure 4) can also be used to limit the quantity of material that spills during unloading and prevent people from sweeping spilled ingredients into the pit.[20] Floor sweepings, including those from the unloading process, should be disposed of and not swept into the pit. Historically, there has been little emphasis on the unloading and sequencing of high-risk ingredients or the disposal of floor sweepings in other locations, but these practices should be considered to reduce the risk of undesirable microorganism contamination in inbound ingredients.[17] This is particularly true because it is not practical to clean the receiving pit and the conveying equipment on a frequent basis, and they may have ingredient residue that can lead to ingredient-to-ingredient cross-contamination (figures 5 to 7).

Bagged ingredients are typically stored in their original bags within the warehouse until used, while liquids are unloaded into a storage tank that may or may not be heated. Segregation of bagged ingredients into heated storage areas with holding times have been implemented in some production systems to reduce the risk of hazard probability. For example, some feed mills hold high-risk ingredients for 2 weeks at room temperature prior to use to decrease their risk of containing PEDV.[21] Bagged ingredients should also be checked to ensure that bags are intact and dry. Lot numbers should be recorded and

Figure 2: Example biosecurity sign with directions for truck drivers

Figure 3: Example of potential contamination entering the dump pit by truck

bins should be emptied and documented when changing lots to improve traceability. Finally, liquid ingredient valves should be locked when not in use to reduce the risk of incorrect addition into a specific tank. If the ingredient is heated, steps should be taken to prevent microbial growth in the water fraction of the liquid as necessary.

Prevention of hazard entry due to people

One of the most overlooked areas and greatest risk of hazard entry is people. Those working in the feed mill and visitors such as guests, truck drivers, and subcontractors have the ability to introduce contaminants into a system. Some of the most common breaches in biosecurity occur when visitors such as subcontractors enter the facility. People may unknowingly carry fecal, dirt, or dust particles contaminated with undesirable microorganisms on the bottoms of their shoes or on clothing, and are at a particularly higher risk if they are coming from another farm or feed mill where the hazard is present.[22] People movement considerations for biosecurity on swine farms were refined to reduce the transmission of porcine reproduction and respiratory syndrome (PRRS) virus, but those procedures were not often extended to the feed mill because it was not a high risk factor for PRRS virus transmission.[22,23] However, the research associated with that virus demonstrates how biosecurity programs help reduce transmission from viral particles on shoes, clothing, and the human body.[22,23] The concept of biosecurity protocols to reduce the risk of biological hazard transmission by restricting personnel movement is relevant to apply to the feed production system now that PEDV has been shown to be potentially transmitted through feed. These protocols can help reduce the risk of hazard introduction by truck drivers and other non-mill employees, as previously discussed, or by reducing the likelihood that a feed mill employee will track a potential hazard throughout the mill. To better understand the magnitude of the potential risks of foot traffic, recent research with PEDV can be used as an example. No-walk zones or even hygienic zoning may be appropriate to include in biosecurity plans in feed mills that have a high probability of having PEDV because such a low concentration of the virus can result in widespread disease. On the basis of the known minimum infectious dose of PEDV, 1 gram of contaminated

Figure 4: Funneling cone to limit spills at the receiving pit

Figure 5: Screw conveyor with potential contamination

pig feces has enough viral particles to result in 500 tons of potentially infectious feed.[24] Thus, it is imperative to reduce the probability of even a seemingly insignificant amount of feces, particularly at open locations such as receiving-pit grates or hand-add ports. Controlling foot traffic across these grates is a logical, low-cost method to reduce pathogen transmission risk.

When considering the control of individuals, it is also recommended that log books be available to document the entry and exit times of visitors.[3] Procedures should outline that visitors must be accompanied at all times by a trained employee to help prevent biosecurity breaches. Visitors should be provided clean footwear, plastic boots, or boot coverups to limit the entry of outside hazards.[3] Finally, signage should be displayed in appropriate areas to communicate off-limit areas.[3]

Prevention of cross-contamination hazards during production

Along with their direct presence in the feed, a concern with biological hazards is potential for long-term cross-contamination in the feed mill. In one study,[14] 8.8% of ingredients of animal origin collected from three feed mills were found to be contaminated with *Salmonella*, but dust samples had a contamination rate of 18.5%. If biosecurity measures fail and undesirable microorganisms enter the facility, it is very difficult to remove those hazards from the system.[14] Any location where there is the propensity for residual organic matter to remain within equipment after processing can lead to cross-contamination of subsequent batches or runs. Due to their designs, the highest risk for this to occur may be inside screw conveyers (Figure 5), inside coolers and storage bins (Figure 6), and in the boot pits of bucket elevators (Figure 7).

This type of carryover cross-contamination can be minimized by employing flushing and sequencing schedules as part of a biosecurity plan. By definition, flushing is "the process of running an ingredient, usually an abrasive-type material such as corn, soybean meal, peanut hulls, etc, through the manufacturing equipment and associated handling equipment after the production of a batch of feed, for the purpose of cleaning out any drug residue."[25] Alternatively, sequencing is "the preplanned order of production, storage, and distribution of different animal feeds designed to direct

Figure 6: Surge bin with potential contamination

drug carryover into subsequent feeds which will not result in unsafe contamination."[26] Flushing and sequencing protocols have been used for years to reduce the risk of batch-to-batch drug carryover, and the same concepts can be applied to mitigate biological hazards. The flushing or sequencing protocol should consider all parts of the manufacturing process, from receiving through load-out. In specific high-risk instances, both flushing and sequencing, or multiple sequences, may be required. Preliminary data from our laboratory indicates that infective PEDV is still present in the second feed batch sequenced after the manufacturing of a contaminated batch (unpublished data). Thus, sequencing should be considered a risk-reduction procedure but not a risk-elimination procedure.

In addition to sequencing and flushing, the maintenance of a housekeeping schedule can also help prevent cross-contamination of biological hazards.[3,20] This schedule can include sweeping production areas such as the floors and hand-add areas on a regular basis and disposal of the sweepings into the trash, not into the next batch of feed. Particular emphasis on housekeeping should occur in high-traffic areas and locations with entry into feed-contact surfaces. An important part of housekeeping is dust collection. Notably, many feed mills place dust from the air-collection systems and floor sweepings directly back into the feed system to limit shrink. However, this dust should be considered high risk and discarded.[17] Recent data[27] evaluating the environmental contamination when manufacturing PEDV-infected feed suggests that potentially infective dust particles can be widely dispersed throughout the feed manufacturing area.

Prevention of cross-contamination hazards during load-out and delivery

Reducing the risk of hazard introduction by potential cross-contamination from outbound trucks is important to ensure feed safety. The exterior, top, and interior compartments of trucks may contain residual feed or ingredients that, if infectious, may lead to contamination of newly manufactured feed during the loading and delivery process (Figure 8). It is suggested that documentation is maintained to improve traceability, including the previous load hauled, shipment lot number and location, and time of loading.[3] Feed-truck delivery should be coordinated so that feed is delivered to lower-risk farms prior to higher-risk farms, particularly if a single load must visit multiple locations.[17] Some facilities have effectively incorporated truck washes, thermo-assisted decontamination drying, and sanitation methods for feed trucks to minimize the risk of contamination of the feed mill, feed, and farms.[20]

A biosecurity plan should also include specific directions for driver behavior during delivery. A contaminated environment around feed bins on farms can potentially result in the feed-truck driver transferring this contaminant to another location or back to the feed mill. Drivers should ideally stay in their vehicles during delivery, and an on-site worker should open bin lids.[17] This is still relatively impractical for most sites, so drivers exiting vehicles should wear clean shoe covers or boots when exiting the vehicle and remove the shoe covers and sanitize their hands prior to re-entering their truck.[3,20] Drivers that exit feed trucks should never directly enter barns or have direct contact with pigs or fecal material. Particular attention should be paid to avoiding areas around exhaust fans, dead-stock disposal areas, and livestock-contact areas where the driver may come in contact with infective fecal or other material, such as load-out chutes. Protocols for reporting and addressing feed spills should be in place.

Drivers should be aware that survival of most biological hazards is greatest during cold conditions, so winter may require enhanced protocols. In addition, manure disposal periods may create particularly challenging times for preventing cross-contamination during feed delivery. Large volumes of infectious fecal material may be present, and cross-traffic with manure-application equipment may be unavoidable, again requiring enhanced sanitation protocols.

Finally, it is critical that farm personnel communicate herd-health status to feed-mill personnel. Pathogen shedding is greatest during the early stages of infections. This increased

load of undesirable microorganisms can lead to elevated contamination of the environment around the farm, which may include the areas around feed bins. Knowing the status of a site is important for assessing risk and scheduling of deliveries to reduce risk of inadvertently contaminating other sites through subsequent deliveries. Another responsibility of farm personnel is to communicate to feed-mill staff the potential consequences of risk of infection to the site. On sites that are particularly sensitive due a high economic cost of infection or potential downstream implications, eg, boar studs or multiplier farms, protocols may be justified that might not be practical on many commercial sites.

Proactive reduction of biological hazards

Beyond prevention of entry and cross-contamination, proactive activities help reduce the risk of undesirable microorganisms. For example, thermal processing by pelleting has been demonstrated to mitigate the quantity of PEDV and *Salmonella*.[24,28] While pelleting does not result in complete eradication of most bacterial pathogens, it serves to significantly reduce most biological hazards. However, it must be recognized that pelleting is a point-in-time mitigation step that does not prevent subsequent recontamination during the manufacturing or delivery process.[24,28] For example, immediately after exiting the pellet mill, pellets are typically discharged into a cooler where the air used to bring pellets to ambient temperature has been drawn from inside the mill.

An option to reduce the likelihood of this cross-contamination after pelleting or in mash feeds or ingredients is to include a chemical additive. The chemicals, such as formaldehyde and medium-chain fatty acids, often carry residual activity that may reduce or prevent post-processing cross-contamination.[29,30] Formaldehyde is an approved feed additive to prevent contamination of animal feed with *Salmonella*, but proper application requires appropriate equipment and a high level of training to prevent worker health and environmental dangers. Other chemical additives, such as medium-chain fatty acids, appear to be more user-friendly and have efficacies similar to that of formaldehyde, but current tested concentrations are uneconomical and impractical for implementation.[29,30] Further research is important to evaluate the value of more practical inclusion levels of these feed additives.

In summary, prevention of the biological hazard entry is the first priority of a biosecurity plan. However, an effective plan should also address methods to reduce cross-contamination or to proactively mitigate the hazard if it enters the facility. A holistic approach to feed mill biosecurity is necessary to maximize risk reduction of microbial hazards.

Assessments

The final step of a biosecurity plan should be an assessment to evaluate the effectiveness of the implementation plan and expose areas of risk that should be addressed.[3,20] It is helpful to design a self-assessment with simple "Yes" and "No" answers and space for further documentation. An example form is available at **http://picgenus.com/health.aspx** (click on Feed Mill Assessment Form). We have found that a preprinted form is useful in the field when performing assessments to ensure all areas of concern are covered and to provide a framework for developing ongoing improvement in protocols. The written assessment can be used as a basis for modifying behaviors to improve animal feed safety. Proactive assessments are most useful if conducted at 3- to 12-month intervals or prior to high-risk transmission seasons.[20] The assessor should first assess effectiveness of biosecurity plans, but also should identify opportunities for improvement of the efficacy

Figure 7: Bucket elevator with potential contamination

Figure 8: Potential contamination from leftover material in the top of a bulk feed truck

and feasibility of these plans. This assessment may be performed by an employee directly from the mill, from someone in the company that is employed outside the mill, or by a third party. In addition to assessments for biosecurity, several other certification programs, such as Safe Feed/Safe Food and Hazard Analysis Critical Control Point (HACCP), that include concepts of a biosecurity plan, may help reduce the probability of biological hazards.

Conclusions and future approaches

The emphasis on feed mill biosecurity has increased due to research demonstrating that feed can be a potential vector for biological hazards such as PEDV. A biosecurity plan requires identification and evaluation of hazards, as well as methods to reduce the probability of occurrence of biological hazards that are known or reasonably foreseeable. A summary of suggested practices and key points is provided in Box 1, and an example assessment form is available at **http://picgenus.com/health.aspx** (click on the Feed Mill Assessment Form). An assessment strategy may help facilities to evaluate effectiveness and identify gaps in their biosecurity plans. Future research is needed to continue to quantify the relative risk of pathogens in various feeds and ingredients to particular species, and to elucidate improved mitigation methods. Still, employing a biosecurity plan is a key method to extend biosecurity concepts from the farm to the feed mill, which may reduce the probability of biological hazards in feed and therefore improve herd health, economic security, and farm-to-fork food safety. It is important to note that implementation of these biosecurity measures will have certain costs associated with them, but strategic implementation of even some recommendations will reduce the level of risk.

It is important to point out that this review was written using a systematic approach to describe key concepts used in developing specific swine feed mill biosecurity plans. The listed recommendations should not be viewed as requirements unless noted. It is also important to understand that implementation of some of these recommendations may result in added costs to the feed mill and require additional employees and training. Not all these recommendations are appropriate for all facilities, but utilization of a biosecurity plan is a valuable tool to help improve animal feed safety.

Conflict of interest

Dr Fahrenholz certifies that his affiliation with or financial involvement with the subject matter of materials discussed in the manuscript is disclosed and described fully as follows: assistant professor, North Carolina State University, extension acitivities related to feed milling; and private consultant to the feed-milling industry.

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Box 1: Summary of suggested practices and key points for assessment of feed-mill biosecurity

1. Complete a hazard identification and evaluation process to understand key hazards that require mitigation within a feed mill.
2. Dump pits, screw conveyors, and bucket elevators are difficult to clean once contaminated: preventing entry of contaminated ingredients into the mill should be a high priority.
    a. Develop purchase specifications with safety expectations of inbound ingredients and communicate those expectations to trusted suppliers.
    b. Create ingredient and finished-feed delivery expectations, such as truck sanitation and delivery sequencing procedures, and specify required documentation, such as previous load tracking and confirmation of truck cleanliness.
    c. Covers should remain over the dump pit until the truck is ready to unload, and care should be taken to prevent material (eg, sweepings) from entering the dump pit.
    d. Use flushing and sequencing to reduce the probability of batch-to-batch cross-contamination.
3. Reduce the likelihood of cross-contamination by people.
    a. Post signage to communicate zoning expectations for truck drivers and guests.
    b. Providing clean footwear, plastic boots, or covers within feed mills or during delivery can reduce pathogen transfer.
    c. Require farms to report sites with clinical disease outbreaks and appropriately sequence truck delivery to reduce the risk of biological-hazard transfer back to the feed mill.
    d. Do not accept rejected feed previously in a bin on a farm.
    e. If possible, require drivers to remain inside trucks during feed loading and delivery, or at least utilize segregated boots or boot covers and hand sanitation.
    f. Prohibit feed-truck drivers from entering barns and request their avoidance of exhaust fans, dead-stock disposal, or cross-traffic with manure disposal equipment.
4. Reduce the probability of environmental cross-contamination.
    a. Develop housekeeping schedules that require regular cleaning of equipment and sweeping floors.
    b. Dust is capable of carrying high numbers of undesirable microorganisms; collected dust should not be placed into the manufacturing system.
5. Proactively mitigate biological hazards when appropriate.
    a. Thermal processing significantly minimizes the presence of many biological hazards, but is a point-in-time mitigation step that does not prevent post-processing cross-contamination.
    b. Chemical treatment of ingredients or feeds may provide residual ability to prevent cross-contamination, but many current chemical-additive options require specific equipment or specialized permits, or may not be economically feasible.
6. An assessment helps determine effectiveness of a biosecurity plan and identifies gaps.
    a. A self-audit should be conducted every 3 to 12 months, depending upon the risks of the feed mill.
    b. Second- and third-party audits and certification programs are helpful to more aggressively evaluate the biosecurity plan.

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Pork Checkoff continues to add value by producing practical research outcomes

"As always, the producer-led science and technology continues to focus its efforts on creating value for its producer stakeholders by leading the pork industry in subject-matter expertise and knowledge," said Dave Pyburn, the National Pork Board's senior vice president of science and technology. He says this stems from decades of leadership from its associated committees and unwavering dedication to funding valuable research that benefits the entire industry.

Pyburn cites these figures as further proof of Checkoff's success:

- 74 science-related projects funded by the National Pork Board in 2015;
- $5.7 million in total funds allocated in 2015 for 74 projects;
- $579 thousand in foreign-animal disease research funded in 2015;
- $750 thousand in funds allocated in 2016 for antibiotics research.

"Checkoff-funded research in the science and technology area will be critical to the success of the National Pork Board's 5-year strategic plan," Pyburn said.

For more information, contact Dave Pyburn at **DPyburn@pork.org** or 515-223-2634.

Antibiotics: Blue-ribbon Panel gets to work

In its first face-to-face meeting on February 1-2 in Dallas, the Pork Checkoff's independent Blue-ribbon Panel on Antibiotics covered a lot of ground, including everything from standard operating procedures for today's pig farms to antibiotic resistance and consumer research. These sessions were designed to aid the panel's work on its four key objectives:

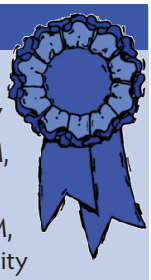
- Review the status of antibiotic use in the pork industry;
- Review industry efforts in antibiotic research and producer education;
- Identify opportunities for improvement in current antibiotic practices;
- Provide input on how to improve antibiotic stewardship in the pork industry.

"We're pleased that the third-party panel has begun its work so quickly on the critically important issue of antibiotics," said John Johnson, National Pork Board chief operating officer.

"We're proud to have played a role in bringing this level of talent and expertise together," he said. "These experts will be addressing this issue in a comprehensive way that will help the industry improve our stewardship of antibiotics."

For more information, contact Jennifer Koeman, director of producer and public health, at **JKoeman@pork.org** or 515-223-2633.

Panel Members:



- **Mike Apley**, DVM, Kansas State University
- **Bonnie Buntain**, DVM, University of Arizona
- **Mike Chaddock**, DVM, Michigan State University
- **Chris Cochran**, Walmart
- **Justin Ransom**, McDonald's
- **Steve Sollomon**, MD, Global Public Health Consulting
- **Elizabeth Stewart**, Subway

Pork Checkoff offers crisis texting

The National Pork Board now offers PorkCrisis Alert, a news texting service that will immediately notify any opted-in producers or veterinarians of a crisis or emergency of national scope. Text PorkCrisis (no space) to 97296 to opt in for the Pork Checkoff's new crisis-emergency alert system. As is usually the case, message and data rates may apply. Text HELP to 97296 for help. Text STOP to 97296 to cancel. For terms and privacy: **pork.org/smsterms**.

For more information, contact Cindy Cunningham, Pork Checkoff's assistant vice president of communications at **CCunningham@pork.org** or 515-223-2600.

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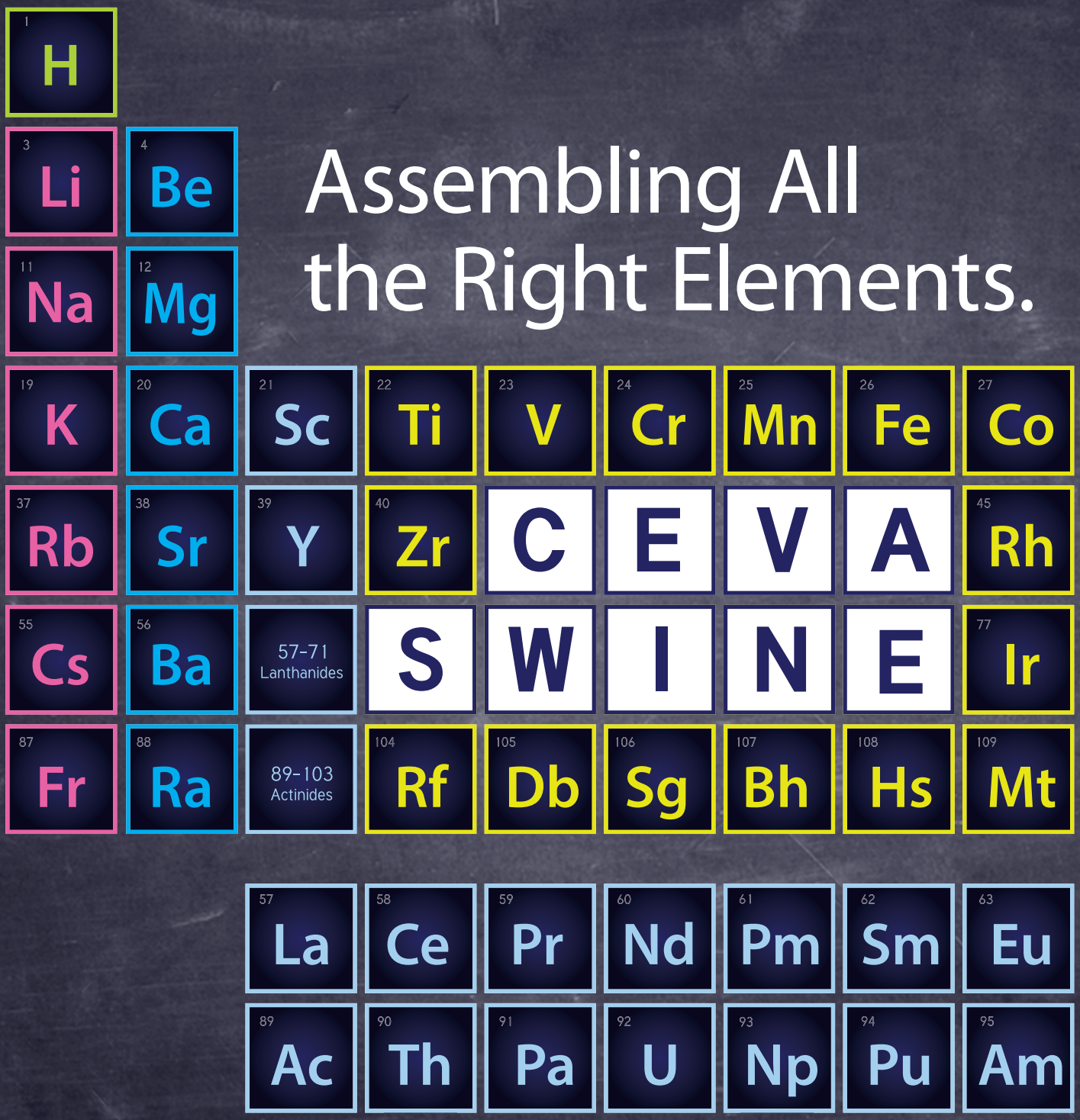

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Pork Checkoff's VFD and antibiotics materials available now

If you need to help get the word out to pork producers about the new FDA antibiotic regulations, consider using the Pork Checkoff's producer-focused education materials. "We've developed these tools specifically to help guide pork producers through these big changes that will affect the way they use antibiotics," said Mike King, director of science communications for the National Pork Board.

For more information, visit **www.pork.org/antibiotics** and order or download materials at the Pork Store, which is accessible via **pork.org**. For other inquiries, contact Mike King at **MKing@pork.org** or 515-223-3532.

More robust Common Swine Industry Audit adds clarity

The Common Swine Industry Audit has been updated for 2016 to provide a clearer road map for producers to prepare for their next audit. This audit tool builds on the existing Pork Quality Assurance Plus (PQA Plus) program and expands it to serve as a single common audit platform for the pork industry.

The overarching goal of the common audit process remains unchanged: to provide consumers greater assurance of the care taken by farmers and pork processors to improve animal well-being and food safety.

"The majority of the changes to the 2016 edition of the audit are mainly for clarification, with the format, sections, and scoring remaining the same," said Jamee Amundson, animal welfare manager for the Pork Checkoff.

The two most significant changes involve clarifications for record-keeping and the on-farm use of needles to treat pigs.

"The updates to the Common Swine Industry Audit are part of the industry's focus on continuous improvement," Amundson said. "By constantly focusing on how to do things better, producers are helping build consumer trust in how pigs are raised on farms today."

Adjustments made this year, with input from the Common Swine Industry Audit Task Force, include

- **Willful acts of abuse or neglect –** Defined as acts outside of normally accepted production practices that intentionally cause pain and suffering. Willful acts of abuse now also include intentional out-of-feed events.
- **Timely euthanasia of animals –** A new broader definition increases the parameters in which euthanasia is required.
- **Internal site assessments –** More details are now included on what an internal site assessment should include.
- **Caretaker PQA Plus certification –** Animal caretakers must be certified within 90 days of employment. Before, it was within 6 months.
- **Mortality records –** Mortality records (including those for animals that die or are euthanized) must be kept for 12 months. This aligns with the retention policies for daily observation records.
- **Needle use –** Caretakers must receive and be able to articulate training specific to broken needles according to the site's standard operating procedure.
- **Needle requirements –** Needles that are 16-gauge or larger need to be labeled as highly detectable. As a new addition, producers with questions on highly detectable needles should contact their veterinarian or PQA Plus advisor.
- **Biosecurity –** Restrictions to control access to a site to support biosecurity practices now include security cameras and locked gates, doors, or both.

For a detailed list of updates, go to **www.pork.org/commonaudit**.

For more information, contact Jamee Amundson at **JAmundson@pork.org** or 515-223-3534.

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AASV NEWS

AASV installs 2016 officers

Dr George Charbonneau was installed as the president of the American Association of Swine Veterinarians at the association's 47th annual meeting in New Orleans, Louisiana. He succeeds Dr Ron Brodersen, who is now immediate past president. Dr Alex Ramirez has ascended to president-elect. The newly elected vice president is Dr Scanlon Daniels.

AASV officers (left to right) Dr George Charbonneau, Dr Alex Ramirez, Dr Scanlon Daniels, and Dr Ron Brodersen

AASV President Dr George Charbonneau (OVC '81) grew up in Arnprior, Ontario. He obtained his Doctor of Veterinary Medicine degree from the Ontario Veterinary College and established a veterinary practice serving southwestern Ontario. George is currently a veterinarian at South West Ontario Veterinary Services and is based in White Lake, Ontario. Dr Charbonneau has served as the president of the Canadian Association of Swine Veterinarians and the Ontario Association of Swine Veterinarians. He was involved in the formation of the Ontario Pork Industry Council and served as its initial chairman. He also represented Canadian swine veterinarians as a district representative on the board of directors of the American Association of Swine Veterinarians. He was the 2012 recipient of the AASV Swine Practitioner of the Year award.

When asked to comment on his thoughts about the future of AASV and his tenure as president, Dr Charbonneau said, "In 2015, the National Pork Board made a significant investment in the formation of the Swine Health Information Center. The AASV is honored to participate, along with our industry partners at the National Pork Board and the National Pork Producers Council, in preparing for and responding to emerging diseases. Our AASV members play an important role in managing emerging diseases. The AASV will provide support to our members in this effort, while continuing to be active in managing other issues such as antimicrobial resistance, foreign-animal disease, and animal welfare."

AASV President-elect Dr Alejandro "Alex" Ramirez (ISU '93) grew up in Guadalajara, Mexico. He obtained his Doctor of Veterinary Medicine degree from the Iowa State University (ISU) College of Veterinary Medicine and joined Valley Veterinary Center, a mixed-animal practice, in Cherokee, Iowa. In 2004, Alex left practice and returned to ISU to pursue a teaching career. He obtained a Master of Public Health degree from the University of Iowa and concluded a PhD at ISU in 2011.

Dr Ramirez joined AASV in 2002. He first served as a substitute judge for the student presentations at the AASV Annual Meeting. Shortly thereafter he was asked to co-chair the student oral competitions. He has also co-chaired the Collegiate Activities Committee for the past few years and has served on the *Journal of Swine Health and Production* Editorial Board since 2010. He has represented District 6 on the AASV Board of Directors since 2013.

AASV Vice President Dr C. Scanlon Daniels (ISU '98) grew up on a family-owned and operated livestock enterprise in central Iowa. He attended Iowa State University where he received a BS degree in Animal Science and a Doctor of Veterinary Medicine degree. He also has a Master of Business Administration from the University of Guelph. Dr Daniels has been previously employed as a staff veterinarian by Iowa Select Farms and Seaboard Foods. Currently, he and his wife, Dr Angela Daniels, operate a diversified food-animal veterinary practice, laboratory, and multi-species contract research organization in Dalhart, Texas.
Dr Daniels has been active in multiple AASV committees and has served on the AASV Board of Directors representing District 7 on two occasions.

AASV Past President Dr Ron Brodersen (ISU '79) grew up on a livestock farm near Coleridge, Nebraska. He attended the

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One injection of EXCEDE® for Swine (ceftiofur crystalline free acid) treats and controls swine respiratory disease for 7 days. It continuously attacks a broad range of pathogens.* And EXCEDE is proven effective for both weaning and nursery—the 2 critical stages in a young pig's development. So you can have a healthy pig—and a healthy herd—for the long term.

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University of Nebraska-Lincoln and Iowa State University, where he received a Doctor of Veterinary Medicine degree, and also attended the University of Illinois Executive Veterinary Program. Dr Brodersen has been providing swine veterinary services in Hartington, Nebraska, since 1990. His veterinary practice recently became a part of Suidae Health & Production. He also owns Whole Hog Genetics. He was active on the Nebraska Pseudorabies Eradication Task Force in the 1990's. Dr Brodersen has been active in the AASV, serving on the board of directors as well as the pharmaceutical and boar stud committees. He has also served as chairman of the AASV Foundation. The AASV recognized him as the Swine Practitioner of the Year in 2003.

AASV to publish 2016 membership directory

In keeping with its traditional every-other-year schedule, the AASV is preparing to publish the 2016 Membership Directory. The association requests that AASV members take a few moments to verify their directory listing at **https://www.aasv.org/members/only/directory.php**. When the member's username and password are entered, his or her contact information automatically appears, along with a response box for the submission of additions, deletions, or other corrections. Lately, the most common changes have been the removal of fax and land-line phone numbers and the addition of mobile phone numbers.

The typical directory entry includes the member's name, mailing address (two lines plus city, state, postal code, and country), business phone, fax, mobile phone, home phone, and one e-mail address. The directory does not list multiple e-mail addresses.

Print copies of the directory will be distributed to AASV members in late summer.

AASV proceedings

Don't wait by the mailbox …

Again this year, you won't find a 3-pound AASV proceedings book in your mailbox, but you can download all 434 pages (many in full color) from the Web site in mere seconds. Additionally, all of the pre-conference seminar booklets are available for download at no extra charge! To download the PDF files for viewing on your favorite electronic device, visit **https://www.aasv.org/library/proceedings/** or look under the "Resources" menu tab on the AASV Web site for "AASV Meeting Proceedings."

To access the files, your 2016 AASV membership dues must be current, and you'll need to enter your AASV username and password: if they're not handy, use the "Reset Password" link in the upper right of the AASV Web site (**https://www.aasv.org**) to have them e-mailed to you, or contact the AASV office for assistance.

As in the past, PDFs for each of the individual proceedings papers will continue to be available as part of the AASV Swine Information Library, **https://www.aasv.org/library/swineinfo/**. This fully searchable, online library of more than 12,000 proceedings papers and journal articles is just one of the many benefits enjoyed by AASV members.

Call for papers – AASV 2017 Student Seminar

Veterinary Student Scholarships

The American Association of Swine Veterinarians announces an opportunity for veterinary students to make a scientific presentation during the Student Seminar at the AASV Annual Meeting in Denver, Colorado, on Sunday, February 26, 2017. Interested students are invited to submit a one-page abstract of a research paper, clinical case study, or literature review for consideration. The submitting student must be a current (2016-2017) student member of the AASV at the time of submission and must not have graduated from veterinary school prior to February 26, 2017. Submissions are limited to one (1) abstract per student.

Abstracts and supplementary materials must be received by Dr Maria Pieters (**pieters@aasv.org**) by 11:59 PM Central Daylight Time on Wednesday, September 21, 2016 (firm deadline). All material must be submitted electronically. Late abstracts will not be considered. Students will receive an e-mail confirming the receipt of their submission. If they do not receive this confirmation e-mail, they must contact Dr Maria Pieters (**pieters@aasv.org**) by Friday, September 23, 2016, with supporting evidence that the submission was made in time; otherwise, the submission will not be considered for judging. The abstracts will be reviewed by an unbiased professional panel consisting of a private practitioner, an academician, and an industry veterinarian. Fifteen abstracts will be selected for oral presentation in the Student Seminar at the AASV Annual Meeting. Students will be notified by October 14, 2016, and those selected to participate will be expected to provide the complete paper or abstract, reformatted for publication, by November 15, 2016.

As sponsor of the Student Seminar, Zoetis provides a total of $20,000 in support to fund travel stipends and the Top Student Presenter scholarship. The student presenter of each paper selected for oral presentation receives a $750 stipend to help defray the costs of attending the AASV meeting.

Each veterinary student whose paper is selected for oral presentation competes for one of several veterinary student scholarships awarded through the AASV Foundation. The oral presentations will be judged to determine the amount of the scholarship awarded. Zoetis funds the $5000 scholarship for the student whose paper, oral presentation, and supporting information are judged best overall. Elanco Animal Health provides $20,000 in additional funding, enabling the AASV Foundation to award $2500 each for 2nd through 5th place, $1500 each for 6th through 10th place, and $500 each for 11th through 15th place.

Abstracts that are not selected for oral presentation in the Student Seminar will be considered for participation in a poster session at the annual meeting. Zoetis and the AASV fund a stipend of $250 for each student who is selected and participates in the poster presentation. In addition, the presenters of the top 15 poster abstracts compete for awards ranging from $200 to $500 in the Veterinary Student Poster Competition sponsored by Newport Laboratories.

Complete information for preparing and submitting abstracts is available on the AASV Web site at **www.aasv.org/annmtg/2017/studentseminar.htm**. Please note: the rules for submission should be followed carefully. For more information, contact the AASV office (Tel: 515-465-5255; Fax: 515-465-3832; E-mail: **aasv@aasv.org**).

AASV Annual Meeting sets records again

The American Association of Swine Veterinarians (AASV) held its 47th annual meeting in New Orleans, Louisiana, February 27 to March 1, 2016. The meeting, held at the Hyatt Regency New Orleans, drew record attendance of 1160 total attendees, including 696 paid registrants (also a record), 278 international members (24% of the total attendees), and 148 students. The participants represented 31 countries, including the United States. Total attendance included 243 allied industry representatives from 85 exhibitors. The students in attendance represented 25 veterinary schools!

The meeting participants attended numerous educational sessions, including 10 pre-conference workshops, two general sessions, three break-out sessions, research topics, industrial partner sessions, 15 Student Seminar presentations, and 73 posters. In addition, 13 AASV committees met during the conference.

Dr John Harding opened the Monday General Session with the Howard Dunne Memorial Lecture. His presentation, entitled "Emergence of *Brachyspira hampsonii* in western Canada: A collaborative success" described the multidisciplinary collaborative approach employed by researchers at the University of Saskatchewan when faced with the emergence of an enteric pathogen. One of the key takeaways from Dr Harding's talk is his commentary on the essential elements of collaboration. These elements are applicable to anyone working with groups of individuals with varying backgrounds. He concluded by encouraging the audience to "strive to be a pioneer; strive to make a lasting difference in your professional and personal lives."

Dr Peggy Anne Hawkins presented the Alex Hogg Memorial Lecture entitled "Whose shoulders are we standing on?" Her presentation explored the issues of collaboration within the profession of swine veterinary medicine, given the diversity of our individual members. She described the personality types and generational values that make up the membership of the AASV as a facet of our collaborative spirit.

The second half of the Monday morning session focused on a variety of topics, including neonatal immunity, public perception of pork production, welfare audits, and collaboration. Monday afternoon concurrent sessions allowed attendees the opportunity to delve deeper into the broad topics of enteric coronaviruses, respiratory diseases, and antibiotic use. The Tuesday General Session addressed the issues associated with the introduction of transboundary and emerging swine diseases. The Howard Dunne and Alex Hogg Memorial Lectures were video recorded and have been posted in the video library on the AASV Web site.

The AASV Awards Reception was held Monday night, followed by the AASV Foundation's annual fund-raising auction. Dr Tara Donovan, 2012 AASV president and chair of the 2016 Awards Selection Committee, presented the recipients of the Swine Practitioner of the Year (Dr Luc Dufresne), the Howard Dunne Memorial Award (Dr Scott Dee), the Meritorious Service Award (Dr Patrick Webb), the Young Swine Veterinarian of the Year Award (Dr Chase Stahl), and the Technical Services/Allied Industry Veterinarian of the Year Award (Dr Bob Thompson).

Swine Practitioner of the Year

Dr Luc Dufresne was named 2016 **Swine Practitioner of the Year**. The award is given to the swine practitioner who has demonstrated an unusual degree of proficiency and effectiveness in the delivery of veterinary service to clients.

Dr Dufresne obtained his Doctor of Veterinary Medicine degree from the University of Montreal in 1988. Following graduation, he accepted a position as staff veterinarian with Shur-Gain in St-Hughes, Quebec, Canada. In this position, his responsibilities included supervision of the health of the swine multiplication pyramid and commercial herd. In 1990, he transitioned into the role of swine consultant with Shur-Gain in Brossard, Quebec, Canada, where he supervised the veterinary staff and was the health advisor for the company's internal swine production unit, as well as a customer network of 50,000 sows.

Dr Dufresne moved to Warsaw, North Carolina, in 1997 to become the director of health services at Brown's of Carolina. He supervised the swine health department and personnel for a 115,000-sow pyramid in North Carolina. Since leaving Brown's in 2001, Dufresne served as a technical services veterinarian for Boehringer Ingelheim and then for Pig Improvement Company before joining Seaboard Foods as the Director of Health Assurance in 2004.

Dr Luc Dufresne, recipient of the AASV Practitioner of the Year Award

Dr Dufresne joined AASV in 1989. He received the Al Leman Science in Practice Award from the University of Minnesota in 2014.

Asked to comment about receiving this award, Dr Dufresne replied, "I am truly honoured to receive that award. Being a swine veterinarian has been a wonderful and rewarding career. I want to thank my wife and family that have supported me throughout my career and all the veterinarians, producers, and swine-production specialists that I had the chance to work and interact with during the last 28 years. It is their willingness to share their knowledge that allows me to do what I do today."

Dr Dufresne and his wife, Genevieve, reside in Kansas City, Missouri. They have three children: Edouard, William, and Thomas.

Howard Dunne Memorial Award

Dr Scott Dee received the American Association of Swine Veterinarians' 2016 **Howard Dunne Memorial Award.** The award recognizes an AASV member who has made important contributions and provided outstanding service to the association and the swine industry.

Dr Dee was born in Rochester, Minnesota, and gained exposure to the research opportunities in veterinary medicine working on the Mayo Clinic research farm. He received a master's degree in veterinary microbiology in 1985 and his DVM in 1987, both from the University of Minnesota. Following graduation, Dee practiced for the next 12 years in a swine-specific practice in Morris, Minnesota. While in practice, he earned board certification in veterinary microbiology (1993) and obtained a PhD in veterinary medicine from the University of Minnesota (1996).

Dr Dee left practice in 1999 to join the swine medicine faculty as an associate professor at the University of Minnesota College of Veterinary Medicine. While at the university, he conducted research in the areas of porcine reproductive and respiratory syndrome virus transmission and biosecurity. He served as a full professor in the Department of Veterinary Population Medicine from 2005 until he left the university in 2011 to accept his current position as the director of research for Pipestone Veterinary Services in Pipestone, Minnesota. Currently, he oversees the Pipestone Applied Research division, as well as conducting research in the areas of air filtration and porcine epidemic diarrhea virus transmission and biosecurity.

Dr Dee has received numerous awards, including the AASV Swine Practitioner of the Year Award (1996), the AD Leman Science in Practice award (1996), the University of Minnesota College of Veterinary Medicine Distinguished Alumnus award (1996), the AVMA Practitioner Research Award (1998), University of Minnesota College of Veterinary Medicine Teaching Incentive awards (1999 and 2000), University of Minnesota College of Veterinary Medicine Mark of Excellence Award (2005), University of Minnesota College of Veterinary Medicine Pfizer Award for Research Excellence (2007), and the Gustavus Adolphus College Distinguished Alumni Certificate in Veterinary Medicine and Sesquicentennial Award (2012). Dr Dee has served on the AASV board of directors and as president of the association in 2006.

When asked what it meant to him to receive the Howard Dunne Memorial Award he responded, "I am both honored and humbled that my peers would consider me for this award. It is also highly motivational and will re-energize me to continue to bring value to the AASV membership and the swine industry. I have a great deal of work left to do."

Scott, his wife Lisa, and their two children, Nicholas and Ellen, live in Alexandria, Minnesota.

Dr Scott Dee, recipient of the Howard Dunne Memorial Award

Meritorious Service Award

Dr Patrick Webb was named the 2016 recipient of the American Association of Swine Veterinarians **Meritorious Service Award**. The award recognizes individuals who have provided outstanding service to the AASV.

Although born in Idaho, Dr Webb spent his formative years in Virginia, North Carolina, and Tennessee. He had his first exposure to swine production while attending Scattergood Friends School in West Branch, Iowa. The school maintained a 100-sow farrow-to-finish operation. He earned his DVM degree from Iowa State University in 1998. Following graduation, he joined Red Oak Veterinary Clinic in Red Oak, Iowa, where he practiced for a year. In 1999, he left Red Oak to join Stuart Veterinary Clinic in Stuart, Iowa, prior to opening his own veterinary consulting and contracting service in 2001. Webb served as the assistant state fair veterinarian at the Iowa State Fair for a number of years and worked for Iowa's Department of Agriculture and Land Stewardship as foreign animal disease program coordinator, where he developed the department's emergency preparedness plan for animal-disease disasters. He joined the National Pork Board as director of swine health, his current position, in 2005.

Throughout his career, Dr Webb has worked extensively on emergency preparedness and planning at the local, state, and federal levels. He has developed and delivered numerous educational programs directed at training producers, veterinarians, county emergency managers, and first responders on how to respond to foreign-animal disease disasters. Dr Webb joined AASV in 2006. He currently chairs the AASV Foreign Animal Disease Committee.

When asked to comment about receiving the award, Webb responded, "It is truly an honor to receive this award from such a prestigious association. I greatly appreciate the recognition, and this award will always rank as one of the most significant events in my career."

Dr Webb and his wife, Sherrie, reside in Dexter, Iowa, with their newborn son, Bennett.

Dr Patrick Webb, recipient of the AASV Meritorious Service Award

Young Swine Veterinarian of the Year Award

The American Association of Swine Veterinarian's **Young Swine Veterinarian of the Year Award** was presented to **Dr Chase Stahl**. It is given annually to an AASV member, 5 or fewer years post graduation, who has demonstrated the ideals of exemplary service and proficiency early in his or her career.

Dr Stahl is a 2012 graduate of Iowa State University College of Veterinary Medicine. He was raised on a farm near Clarion, Iowa, where his parents, Nick and Kathy, still reside. Although his family did not raise livestock, he was fortunate to have the opportunity to assist friends and neighbors with their livestock operations. It wasn't until he had a summer job at Iowa State's diagnostic laboratory that he became determined to pursue a career in swine veterinary medicine.

Dr Stahl spent his first year following veterinary school practicing as a staff veterinarian with Iowa Select Farms. In 2013, he joined the Fairmont Veterinary Clinic in Fairmont, Minnesota, where he and his seven partners and two associate veterinarians focus on serving swine and beef producers in Iowa, Minnesota, South Dakota, and Nebraska. Dr Stahl has the great privilege of assisting many independent swine producers with their health, production, marketing, and nutritional needs. He takes immense pride in getting to know his clients on a personal level, listening to their needs, and developing and implementing a plan, all grounded in the understanding that the pig has to come first in whatever decision is made.

Dr Chase Stahl, recipient of the AASV Young Swine Veterinarian of the Year Award

Dr Stahl has been a member of AASV since he began veterinary school in 2008. He is an active committee member on the AASV's Student Recruitment Committee and has helped organize the annual National Pork Industry Foundation veterinary student internship program. This program focuses on providing first- and second-year veterinary students with an opportunity to gain more swine veterinary experience through a month-long mentorship program alongside a practicing swine veterinarian. He and his wife, Summer, are also board members of the local Martin County Pork Producers chapter.

At acceptance of the award, Dr Stahl commented, "I am very humbled and deeply honored to be the recipient of this award. The swine industry and AASV have provided me a unique opportunity to build professional and personal relationships with many producers and employees. I am extremely grateful to my wife, my parents, former mentors, and the Fairmont Veterinary Clinic/Preferred Capital Management family for their guidance and support during the last 4 years. I am also infinitely indebted to all the producers and employees who have made me a better veterinarian by challenging me to approach any recommendations from both a producer and veterinarian perspective."

Chase and his wife, Summer, reside in Fairmont, Minnesota, along with their two yellow Labradors, Kia and Stella.

Technical Services/Allied Industry Veterinarian of the Year Award

Dr Bob Thompson received the American Association of Swine Veterinarians' **Technical Services/Allied Industry Veterinarian of the Year Award**. Established in 2008, the award recognizes swine industry veterinarians who have demonstrated an unusual degree of proficiency and effectiveness in delivery of veterinary service to their companies and their clients, as well as given tirelessly in service to the AASV and the swine industry.

Dr Thompson was recognized for his years in technical service at Pig Improvement Company (PIC). Since joining PIC in 1991, he has served numerous roles, initially as manager of transportation and supply chain, then as production manager of PIC's owned production in the eastern United States, western region contract multiplication, health assurance, and currently health services for North America. His current title is Coordinator of Health Services for North America. In this role, he works with PIC's other technical service teams to improve performance of their products in customer systems.

Dr Thompson has worked extensively with the PIC affiliate and user-group boar stud system and served as an adjunct professor at the University of Illinois in the integrated food animal management systems (IFAMS) program. Achievements in his tenure at PIC have been conversion of PIC's Owned and Multiplication System from 98% PRRSV-positive to 100% negative and establishment of two PRRS-negative genetic nucleus herds from positive sources in the late 90's, along with the production and health assurance team at the time. In 2008, he had the opportunity to work with the establishment of Apex as a new genetic nucleus in South Dakota.

Dr Thompson has been influential in coordinating research with universities on inactivation of PRRSV and PEDV in transportation trailers using disinfection and heat, termed temperature assisted drying and decontamination (TADD). Previously he received two technical service awards from PIC's Global Technical Service Team.

Dr Thompson was born in Huron, South Dakota, but spent his formative years in Sioux Center, Iowa. He received his DVM from Iowa State University. Following graduation, he joined the Columbus Veterinary Hospital in Columbus, Nebraska, focusing on mixed animal, and later purchased a practice in Osceola, Nebraska. In 1989, he was accepted into the IFAMS program at the University of Illinois before joining PIC in 1991.

Dr Thompson currently serves on the Trucker Quality Assurance Advisory Board and the Swine Health Committee for the National Pork Board. He was also recently named to the newly formed Secure Pork Supply Implementation Taskforce.

When asked to comment on what the award meant to him, Dr Thompson said, "It is an honor to be recognized by your peers for working in the industry. I've had the

Dr Bob Thompson, recipient of the AASV Technical Services/Allied Industry Veterinarian of the Year Award

opportunity to work with many of the leaders of our time in practice, industry, and research. My goal has been to share my knowledge along with other PIC team members to help our customers be more successful, ultimately doing what's right for the pigs."

Dr Thompson and his wife, Debra, reside in Franklin, Kentucky. They have two daughters, Kasey and Leslie.

AASV Foundation announces student scholarships

The American Association of Swine Veterinarians Foundation awarded scholarships totaling $25,000 to 15 veterinary students.

Christine Mainquist-Whigham, Iowa State University, received the $5000 scholarship for top student presentation. Her presentation was titled "Residue depletion profile of ampicillin trihydrate in cull sows." Zoetis provided the financial support for the **Top Student Presenter Award**.

Additional scholarships totaling $20,000 were funded by Elanco Animal Health. Four veterinary student presenters received $2500 scholarships: **Sara Davenport**, University of Pennsylvania; **Taylor Engle**, Virginia-Maryland Regional College of Veterinary Medicine; **Holly Salzbrenner**, Iowa State University; and **Ryan Strobel**, University of Minnesota.

Five veterinary student presenters received $1500 scholarships: **Alyssa Anderson**, University of Minnesota; **Victoria Foerster**, Iowa State University; **Olivia Myers**, North Carolina State University; **Quynn Steichen**, Kansas State University; and **Kathleen Wood**, North Carolina State University.

Student presenters receiving $500 scholarships were **Sindu Manoharan**, University of Pennsylvania; **Timothy Pearson**, University of Tennessee; **Eric Perrin**, University of Guelph; **Scott Radke**, Iowa State University; and **Brent Sexton**, Iowa State University.

Fifty-five veterinary students from 16 universities submitted abstracts for consideration. From those submissions, 15 students were selected to present during the annual meeting. Zoetis, sponsor of the Student Seminar, provided a $750 travel stipend to each student selected to participate.

AASV announces Veterinary Student Poster Competition awardees

The American Association of Swine Veterinarians (AASV) provided an opportunity for 15 veterinary students to compete for awards in the Veterinary Student Poster Competition. Newport Laboratories sponsored the competition, offering awards totaling $3600.

Recipient of the $5000 scholarship for Top Student Presenter during AASV's Student Seminar, Christine Mainquist-Whigham, Iowa State University. Pictured with Christine is Dr Lucina Galina (left) of Zoetis, sponsor of the Student Seminar and Top Student Presenter Award.

On the basis of scores received in the original judging of abstracts submitted for the AASV Student Seminar, the top 15 abstracts not selected for oral presentation at the annual meeting were eligible to compete in the poster competition.

Newport Laboratories announced the following awards during the AASV Luncheon on Monday, February 29:

$500 scholarship: **Daniel Gascho**, Purdue University – top student poster entitled "Effect of pre-farrow ceftiofur sodium administration on *Streptococcus suis* colonization of periparturient females and their litters;"

Kim Lawson (far right) presented scholarships sponsored by Elanco Animal Health. Recipients of the $2500 AASV Foundation scholarships were (from left) Ryan Strobel, University of Minnesota; Holly Salzbrenner, Iowa State University; Sara Davenport, University of Pennsylvania (not pictured: Taylor Engle, Virginia-Maryland Regional College of Veterinary Medicine).

Kim Lawson (far right) presented scholarships sponsored by Elanco Animal Health. Recipients of the $1500 AASV Foundation scholarships were (from left) Kathleen Wood, North Carolina State University; Olivia Myers, North Carolina State University; Alyssa Anderson, University of Minnesota; Quynn Steichen, Kansas State University; and Victoria Foerster, Iowa State University.

Kim Lawson (far right) presented scholarships sponsored by Elanco Animal Health. Recipients of the $500 AASV Foundation scholarships were (from left) Scott Radke, Iowa State University; Brent Sexton, Iowa State University; Timothy Pearson, University of Tennessee; Eric Perrin, University of Guelph; and Sindu Manoharan, University of Pennsylvania.

$400 scholarships: **Kayla Blake**, Auburn University; **T'Lee Girard**, Iowa State University;

$300 scholarships: **Donna Drebes**, University of Minnesota; **Katharine Kancer**, University of Illinois; **Megan Pieters**, Iowa State University; and

$200 scholarships: **Chris Deegan**, University of Minnesota; **Kathryn Duda**, University of Illinois; **Emily Mahan-Riggs**, North Carolina State University; **Jessica Piergiovanni**, University of Pennsylvania; **Kara Telfer**, Iowa State University; **Ryan Tenbergen**, University of Guelph; **Thomas Wurtz**, Washington State University.

In addition to the poster competition awards, each student poster participant received a $250 travel stipend from Zoetis and the AASV.

Annual Business Breakfast

American Association of Swine Veterinarians President Dr Ron Brodersen reported on the association's membership and activities during the annual breakfast on Tuesday, March 1. He stated that there were 1734 members, including 316 student members. Dr Brodersen thanked outgoing directors Dr Bill Starke (District 3), Dr Brian Schantz (District 8), and Chris Sievers, student delegate to the board, for their service. He welcomed incoming directors, District 3, Dr Greg Cline and District 8, Dr Monte Fuhrman, and incoming Alternate Student Delegate Brent Sexton (ISU '18). Dr Brodersen announced that there would be an election to replace Dr Daniels (District 7), given his election as vice president. Honored guests at the business breakfast included Dr Joe Kinnarney (AVMA president), Dr John Howe (AVMA executive board representative), Dr David Pyburn (NPB senior vice president of science and technology), and Dr Liz Wagstrom (National Pork Producers Council chief veterinarian). The audience heard updates from each respective organization. Approximately 160 people attended the breakfast.

Daniel Gascho, Purdue University, winner of the top prize of $500 for best poster

The $400 poster competition winners: T'Lee Girard, Iowa State University and Kayla Blake, Auburn University (not pictured)

The $200 poster competition winners (from left): Thomas Wurtz, Washington State University; Jessica Piergiovanni, University of Pennsylvania; Emily Mahan-Riggs, North Carolina State University; and Chris Deegan, University of Minnesota (not pictured: Kathryn Duda, University of Illinois; Kara Telfer, Iowa State University; and Ryan Tenbergen, University of Guelph)

New officers

Dr George Charbonneau was installed as president, succeeding Dr Ron Brodersen, who is now immediate past president. Dr Alejandro "Alex" Ramirez has ascended to president-elect. The newly elected vice president is Dr Scanlon Daniels.

Save the date

The 2017 annual meeting is scheduled for February 25 to February 28, 2017, in Denver, Colorado.

Photo courtesy statement

Photos are courtesy of Tina Smith.

INFORM, SHARE, LEARN

Thank you, AASV Annual Meeting sponsors!

AASV members attending the annual meeting make a substantial investment in the form of registration fees, travel, lodging, meals, and potential loss of income while away from work. However, the cost of attendance would be even greater – or the quality of the meeting experience reduced – if it were not for the financial support provided by corporate sponsors for refreshments, meals, and social activities, as well as scholarships and travel stipends for veterinary students. The AASV extends its sincere appreciation for the sponsorship of meeting events by the following companies:

- Boehringer Ingelheim Vetmedica, Inc (AASV Luncheon)
- CEVA Animal Health (Refreshment Break)
- Elanco Animal Health (AASV Awards Reception and AASV Foundation Veterinary Student Scholarships)
- Harrisvaccines (Refreshment Break)
- Hog Slat (Refreshment Break)
- Merck Animal Health (Student Reception, Student Swine Trivia Event, Merck Veterinary Student Scholarships)
- Newport Laboratories (Veterinary Student Travel Stipends and Veterinary Student Poster Scholarships)
- Stuart Products (Praise Breakfast)
- Zoetis (Welcome Reception, AASV Student Seminar and Student Poster Session, AASV Foundation Top Student Presenter Scholarship)

The AASV is also grateful to the 85 companies and organizations that provided support through their participation in the 2016 Technical Tables exhibit. Thank you all!

SKILLS FOR LIFE

AASV FOUNDATION NEWS

AASVF-Merck Veterinary Student Scholarships awarded

Thanks to the generosity of Merck Animal Health, the American Association of Swine Veterinarians Foundation (AASVF) awarded $5000 scholarships to each of five veterinary students during the AASV Annual Meeting February 29 in New Orleans, Louisiana. Merck Animal Health provided $25,000 to support the AASVF-Merck Veterinary Student Scholarship Program to identify and assist future swine veterinarians with their educational expenses.

Second- and third-year veterinary students enrolled in AVMA-accredited or -recognized colleges of veterinary medicine in the United States, Canada, Mexico, South America, and the Caribbean Islands were eligible to apply. All applicants were required to be current student members of AASV. Each applicant submitted a resume and the name of a faculty member or a member of the AASV to serve as a reference, and answered four essay questions. A committee of four, including two AASV Foundation Board members and two AASV members-at-large, reviewed the applications.

The 2016 AASVF-Merck Veterinary Student Scholarship recipients are

Dr James Lehman (far right), representing Merck Animal Health, presented the $5000 scholarships to (from left) Thomas Wurtz, Washington State University; Daniel Carreno, North Carolina State University; Alyssa Anderson, University of Minnesota; Emily Mahan-Riggs, North Carolina State University; and Rachel Schulte, Iowa State University.

- Alyssa Anderson (University of Minnesota);
- Daniel Carreno (North Carolina State University);
- Emily Mahan-Riggs (North Carolina State University);
- Rachel Schulte (Iowa State University);
- Thomas Wurtz (Washington State University).

The AASVF wishes to thank Merck Animal Health for their support of this program and the members of the review committee for their work to evaluate the applications and select the scholarship recipients.

AASV Foundation announces research funding for 2016

The AASV Foundation selected four research proposals to receive a total of $60,000 in funding for 2016. The research will study a wide range of topics important to swine veterinarians, including emerging diseases, disease introduction into the US swine herd, vaccine efficacy, and biosecurity. Dr Daryl Olsen, chairman of the AASV Foundation, announced the proposals selected for funding during the foundation's annual luncheon on February 28 in New Orleans, Louisiana.

A grant of $17,500 was awarded to Dr Steve Tousignant at Swine Vet Center to fund a proposal designed to determine the seroprevalence of Seneca Valley A virus in a convenience sample collected from US sow farms. The research will also explore risk factors associated with the presence of the Seneca Valley A virus in sow farms.

Dr Scott Dee at Pipestone Veterinary Services was awarded a grant of $15,000 to assist with funding for a study to evaluate a shipping model using viral proxies to investigate whether foreign-animal diseases could survive in feed ingredients shipped from Asia to the United States. The study will also evaluate whether two chemical mitigants could reduce the risk of pathogen survival.

The foundation allocated $15,000 to fund a proposal submitted by Dr Mike Murtaugh at the University of Minnesota toward designing a challenge-free model to predict vaccine efficacy.

The fourth research grant, totaling $12,500, was awarded to Dr Derald Holtkamp at Iowa State University to support a study to compare the effectiveness of standard entry versus bench entry biosecurity protocols in a commercial swine facility.

Dr Nathan Winkelman chaired the scientific subcommittee responsible for reviewing and scoring the proposals received for consideration, and he joins the foundation in thanking Drs John Baker, Tim Blackwell, Tom Gillespie, Peggy Anne Hawkins, and Jerry Torrison for their service on the subcommittee. The subcommittee considered a record 17 proposals.

An overview of past and current projects funded by the foundation is available at `https://www.aasv.org/foundation/research.htm`. The foundation will issue its next call for research proposals in the fall of 2016.

Foundation news continued on page 183

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1. Thacker, B. and Creel, J. PCV2 vaccination update: Field experiences. 2015.
2. Thacker, B., Blomme, R., Holtkamp, D. and Creel, J. Field comparison of PCV2 vaccines: A retrospective production data analysis. Proc. 45th Annual Meeting of the American Association of Swine Veterinarians, Dallas, Texas. 2014. pp. 139-143.

MERCK Animal Health

Foundation news continued from page 181

AASV Foundation Auction and Mini raffle

The 2016 American Association of Swine Veterinarians (AASV) Foundation held its annual fundraising auction on February 29 during the 47th AASV Annual Meeting in New Orleans, Louisiana. This year's auction raised $96,812! This tremendous effort was aided by the generosity of MVP Laboratories/Phibro Animal Health through the donation of a 2016 Mini Cooper which raised $26,100! The raffle drawing was held during the AASV Board of Directors meeting in Perry, Iowa on March 21. Dr John Howe, American Veterinary Medical Association Executive Board liaison to AASV, drew the winning ticket belonging to Dr Jodie Pettit.

Dr John Howe, AASV's liaison on the AVMA Executive Board, holds up the winning Mini Cooper raffle ticket

The funds raised during the auction support foundation programs, including student travel stipends, research projects, scholarships, student externships, summer internships, awards, and other opportunities to enhance the personal and professional aspects of swine veterinary medicine.

Auctioneer and AASV Executive Director Dr Tom Burkgren called the auction with the assistance of Dr Shamus Brown. The spirited live auction raised $41,850. This was in addition to the $16,362 collected during the silent auction and $12,500 in generous cash donations. The foundation thanks all those who participated in the auction by bidding on or donating items, as well as those who served on the auction committee chaired by Dr Daryl Olsen. Visit the AASV Foundation Auction page on the AASV Web site at **https://www.aasv.org/foundation/2016/auctionlist.php** to view auction wrap-up.

A special thanks goes to the ring men: Drs Butch Baker, Shamus Brown, Tom Gillespie, Darrell Neuberger, David Reeves, Craig Rowles, and John Waddell, who kept the bids coming. In addition, the following folks were invaluable behind-the-scenes and front-end help: Wes Johnson, Joel Burkgren, Sue Kimpston, Kay Kimpston-Burkgren, Karen Menz, Karen Richardson, Lee Schulteis, Sue Schulteis, Tina Smith, and Harry Snelson.

Dr Tom Burkgren, AASV Foundation Secretary-Treasurer, delivers the Mini Cooper and hands the keys to raffle winner Dr Jodie Pettit.

An extra-special thanks goes out to Lee Schulteis for driving the truck and trailer containing all the auction items and meeting materials from Perry, Iowa, to New Orleans and back again.

The AASV Foundation Auction Committee is grateful to everyone who made a contribution, purchased a raffle ticket, or bid on items in the live and silent auctions. Thanks to your support, the foundation raised $96,812! We are pleased to recognize the bidders listed below who purchased one or more items at the auction. In addition, PIC, Automated Production, and Hog Slat made financial contributions to enhance the auction proceeds. Thank you all!

Matt Anderson
Paul Armbrecht
Andrea Baker
R. B. "Butch" Baker
Joel Burkgren
Angela Daniels
C. Scanlon Daniels
Jim Dick
Tara Donovan
Paul Flint
Denise Gillespie
Tom Gillespie
Daryl Hammer
Jennifer Hasty
Peggy Anne Hawkins
Dale Hendrickson
Daniel Hendrickson
J. Tyler Holck
Bill Hollis
Andy Holtcamp
Megan Inskeep
Kerry Keffaber
Sue Kimpston
Jim Kober
Mike Kuhn
Chris Kuster
Tim Loula
Jim Lowe
Dale Mechler
Karen Menz
Michelle "Mitch" Michalak
Luke Minion
Bill Minton
Larry Moore
Mary Jo Moore
Gene Nemechek
Jodie Pettit
Doug Powers
Todd Price
Sarah Probst Miller
David Reeves
Gary Robertson
Conrad Schmidt
Jane Schmitz
Sue Schulteis
Kent Schwartz
Edward Seed
Katie Sinclair
Tina Smith
Linda Sornsen
Mike Strobel
Rexanne Struve
Matthew Turner
Kurt VanHulzen
Carol Waddell
Douglas Weiss
Ron White
Nathan Winkelman
Teddi Wolff
Paul Yeske

Winkelman establishes foundation's first Legacy Fund

During the recent AASV Foundation luncheon in New Orleans, chairman Dr Daryl Olsen announced the creation of the first Legacy Fund, established by Dr Nathan L. Winkelman. The Legacy Fund represents the highest level of the foundation's triad of endowed giving programs (Leman-Heritage-Legacy), with a minimum $50,000 contribution required to establish a named endowment. The foundation board instituted the Legacy giving level 2 years ago.

In making the contribution to establish the fund, Winkelman noted "The AASV is important enough to me to not have missed a meeting since 1982, when I was a sophomore at the University of Minnesota. The organization keeps me educated and motivated. Its members are my mentors, colleagues, past and present dear friends, and our industry's future."

"It is for this reason that my wife (also a veterinarian) and I are proud and privileged to be able to donate to the AASV Foundation's Legacy Fund. My hope is that the foundation will reach its financial goals to be self-sufficient to achieve its mission to fund research, education, and the long-range issues of the swine veterinary profession."

As Legacy Fund is an endowed giving program, contributions are invested to generate income in the form of interest, dividends, and capital gains. The income is used to fund foundation activities, while the original contribution is conserved, helping to assure the organization's long-term stability and success.

The foundation board created the Legacy program in 2014 to provide an opportunity to recognize a principal donor – or an honoree – through a significant contribution. A donor (or multiple donors) may establish and name a Legacy Fund with a gift of $50,000 or more. The fund may be named after the donor or another individual or group. Additionally, the donor has the opportunity to designate which of three foundation mission categories the fund proceeds will support: research, education, or long-range issues.

The AASV Foundation has set a goal to establish a $2 million endowment by the 2019 celebration of AASV's 50th Anniversary, while at the same time maintaining its ongoing commitment to fund research, scholarships, externships, tuition grants, and other programs and activities that benefit the profession of swine veterinary medicine. For more information about the AASV Foundation, see **www.aasv.org/foundation**.

Dr Nathan Winkelman received the Legacy Fund donor award in recognition of his contribution during the AASV Foundation luncheon in New Orleans.

Common Swine Industry Audit – What you need to know

I remember traveling in Europe a few years ago and walking into the supermarket to check out the meat counter. One of the things that struck me, beyond the price per kilogram, was the number and variety of auditing logos on each pack of meat. There were often so many logos, it sometimes seemed hard to actually see the product. I thought at the time "Wouldn't it make more sense to combine all this effort into just one overarching audit program?" Fast-forward to recent times in the United States' meat counters and things look very similar.

Consumers are challenging pork producers to provide third-party audits of on-farm practices to ensure animal well-being and pre-harvest food safety. In 2013, producers passed a resolution at the National Pork Industry Forum charging the National Pork Board with addressing these challenges. Thus was born the Industry Audit Task Force. The task force comprised producer and veterinary representatives, researchers, retailers, and packer representatives from most of the major processing facilities.

The objective of the task force was to formulate a comprehensive on-farm auditing program and develop consensus among the stakeholders. At the 2015 World Pork Expo, Pork Checkoff introduced the resulting Common Swine Industry Audit (CSIA) that is based on the standards set forth in the Pork Quality Assurance Plus (PQA+) and Trucker Quality Assurance programs and certified by the Professional Animal Auditor Certification Organization. Since then, the producer-led initiative has received extensive on-farm testing and is now available for use by the pork industry.

"[The Common Swine Industry Audit] is a monumental step forward to enhance consumer confidence and address customer expectations."

The goals of the CSIA are to

- Provide stakeholders with a consistent, reliable, and verifiable system that assures on-farm animal well-being and pre-harvest food safety,
- Eliminate duplication and minimize the administrative burden placed on producers,
- Develop consensus about consistent standards between and among various independent audit programs, and
- Create a standard process that results in observer consistency and protection of herd health through biosecurity protocols.

A certified third-party auditor, with no association with the farm or its employees, conducts the audit, which focuses on 27 key aspects associated with five primary areas of production, including records, animals, facilities, caretakers, and loading and transport. The audit, designed to be independent of facility size or design, assesses all phases of production, including load-out. The audit process may take up to 4 hours, depending on the production phase or phases evaluated.

The auditor will conduct a thorough examination of the farm, including record-keeping, biosecurity protocols, and training records. While on-site, the auditor will observe animal conditions and caretaker interactions. He or she will conduct an exit meeting to discuss the findings and allow for any necessary clarification, but cannot provide guidance relative to the findings.

The audit questions each have assigned point values. The site, as defined by the premises identification number, receives the full point value if it meets the approved standard. The scoring is broken down into each of the five production areas evaluated. Packers and customers can interpret the individual site's overall and individual section scores against industry-wide aggregated scores.

Although there is no established minimum passing score, willful acts of abuse or failure to euthanize animals in a timely manner will result in the site failing the audit automatically. If the audit finds something unacceptable, the producer will have 10 days to complete corrective actions for critical issues. The farm's customers review the audit results and determine if corrective actions have been taken and whether or not a follow-up audit is necessary.

The CSIA does not replace the PQA+ site assessment, which serves as an educational and benchmarking tool to ensure pig well-being. The assessment provides an opportunity for the PQA+ advisor to educate the producer on issues associated with animal well-being, pork quality, and safety. The CSIA, on the other hand, does not have an educational component, but rather is a method to provide independent verification that the animal well-being system is working.

The development of the CSIA was a producer-led initiative. Its adoption by the industry, in association with PQA+, provides an opportunity to educate producers and verify compliance with industry-established standards for animal well-being and the promotion of pork safety and quality. It is a monumental step forward to enhance consumer confidence and address customer expectations.

All of the materials for the Common Swine Industry Audit are available online at `http://www.pork.org/commonaudit`.

Harry Snelson, DVM
Director of Communications

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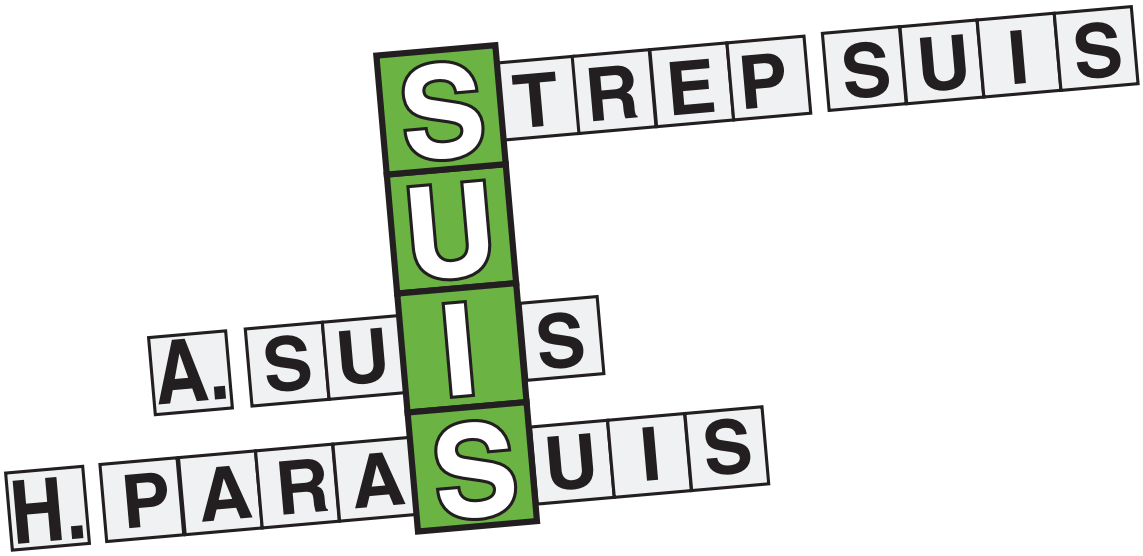

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For more information:
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