September and October 2019 • Volume 27, Number 5

Journal of Swine Health & Production

The Journal of the American Association of Swine Veterinarians

Journal of Swine Health and Production

(**ISSN 1537-209X**) Volume 27, Number 5; September and October 2019

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

Opinions expressed in this publication are those of the individual authors and do not necessarily reflect the endorsement, official attitude, or position of the American Association of Swine Veterinarians, the *Journal of Swine Health and Production*, or any Industry Support Council member.

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 non-members at $150.00 per year (six issues) for United States, Canada, and Mexico. The cost is $185.00 for all countries outside North America. For inquiries regarding membership or subscriptions, please contact

AASV
830 26th Street, Perry, IA 50220-2328
Tel: 515-465-5255; Fax: 515-465-3832
Email: aasv@aasv.org

Editorial questions, comments, and inquiries should be addressed to Karen Richardson, Publications Manager:
Tel: 519-856-2089;
Email: jshap@aasv.org

DISCLAIMER

Scientific manuscripts published in the *Journal of Swine Health and Production* are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

Journal of Swine Health and Production is indexed in ISI® *Focus On: Veterinary Science & Medicine,*® and in *CAB Abstracts*, Euroscience VETLINE on CD-ROM

Download this issue to your iPad or Android tablet at
www.aasv.org/shap/issues/v27n5/v27n5jshap.pdf

About the cover…

Weaned pigs in Northwest Iowa.

Photo courtesy of Dr Mandi Neujahr

AASV Resources online at www.aasv.org

Author guidelines
www.aasv.org/shap/guidelines

Journal of Swine Health and Production
www.aasv.org/shap

Membership information
www.aasv.org/aasv/membership

Subscription information
ecom.aasv.org/journal

Upcoming meetings
www.aasv.org/meetings

Table of contents

"...it is imperative that veterinarians work with their clients to facilitate planning for depopulation and disposal that meets the needs of the animals, the farmers, and the regulators."

quoted from the Executive Director's message, page 253

YOUR WAIT IS OVER.

We're back!

Take control of swine dysentery and bacterial enteritis while maximizing feed efficiency with Mecadox®. Built on over 45 years of effective, consistent and reliable performance,

Mecadox – Taking control of enteric disease.

*No VFD required. Do not feed ***Mecadox*** to swine within 42 days before slaughter and do not use in feeds containing bentonite. Not for use in pregnant swine intended for breeding purposes.

Phibro ANIMAL HEALTH CORPORATION™

Talk With a Phibro Expert
888.475.7355 | pahc.com

HEALTHY ANIMALS. HEALTHY FOOD. HEALTHY WORLD.®

Glass half full (Part 1) – ASF Prevention

Prior to 2018, foreign animal disease (FAD) prevention, preparedness, and response discussions in case of an emergency outbreak revolved around foot-and-mouth disease (FMD), thinking the United States was most at risk of contracting this FAD compared to others. Now of course, due to the recent rapid global spread of African swine fever (ASF) in China, Southeast Asia, and parts of Europe and Africa, our focus has changed. There are more than 40 countries infected with ASF, and the latest data collected on June 28 from the World Organization for Animal Health shows 14 countries and territories currently suffering from new or ongoing outbreaks of the disease.[1]

This increased risk puts our industry in significant jeopardy of an ASF outbreak which could cost billions of dollars annually.[2] During a two-day ASF planning meeting in May, the audience of state and federal officials, academicians, swine producers, and veterinarians was asked, "How many of you think the US swine industry will have an ASF outbreak within the next 5 years?" The resulting show of hands indicated 40% think the crisis would happen; it is not if, but when. The remaining 60% had their "glass half full", believing it would never happen, or at least not within the near future. Either way, it's just speculation. An FAD could happen tomorrow or never. But realize the US government and swine industry leadership are making tremendous efforts to prevent it from happening.

First line of defense

US Customs and Border Protection (CBP). The most likely path for ASF to enter the United States would be via contaminated pork products through one of the 328 US land, air, or sea ports of entry, 186 of which allow agricultural imports. In a conversation with Kevin Harringer (April 2019), CBP's executive director for the Agriculture Programs and Trade Liaison office, the AASV Executive Board learned:

- On a typical day, these inspectors process more than 1 million passengers and 98,000 truck, rail, and sea containers carrying goods worth $7.2 billion.
- There were 6400 agriculture canine generated seizures of pork products in the first quarter of 2019. These seizures occur in the passenger baggage and pedestrian land border pathways.
- There were 882 cargo seizures of pork products in the first quarter of 2019. The vast majority of these occur in the express consignment environment.
- Civil penalties are $300 for the first offence, and up to $1000 for repeat violations of passengers failing to declare items. These fines are considerably low compared to other countries.[3]
- The USDA has funded the addition of 15 to 20 more beagle brigades per year over the next 4 years to a total of 184 canine units.
- There is a workforce shortage of about 700 CBP agricultural inspectors. Currently there are 2500. In July, a bipartisan senate bill was introduced to authorize 240 agriculture inspectors per year until the shortage is filled.
- Inspection emphasis is on passengers from FAD-positive countries.

"Therefore, strict biosecurity standard operating procedures are the second line of defense to prevent any FAD crisis."

The CPB is doing an excellent job, however, they need more agriculture inspectors, beagles, and traveler awareness to continue to mitigate FAD risk at our borders. All confiscated food products are incinerated, but not tested for specific FADs using polymerase chain reaction (PCR). Other at-risk countries, such as Australia, Japan, Taiwan, South Korea, and Thailand, all have intercepted many PCR-positive ASF pork products coming from China at their ports of entry. It is very possible ASF-positive pork products have already crossed our borders as well. African swine fever is a global phenomenon and all these countries are helping to make travelers aware of the dangers and to stop bringing in food/meat/pork.

Plate waste feeding and Swine Health Protection Act. Via the Swine Health Protection Act, the US Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) has had controls in place for decades on international garbage, including waste from ships, airlines, and international conveyances. Controls require all international garbage to be disposed of appropriately and under APHIS supervision. For example, transported under seal to approved incineration facilities. Epidemiological studies have shown that contaminated garbage from international airports and ports is an important source of the virus.[4] The ASF virus can persist for weeks, or even months, in frozen or uncooked meat. It is very stable in cured or smoked pork products. Virus was found to be inactive in Parma ham after 300 days[5] and in Iberian loins after 112 days.[6]

Although garbage feeding may be a less likely source of ASF entry into the United States, it still is a significant risk. Remember, a pig finishing unit licensed to feed airport

President's message continued on page 251

Newport Laboratories
A Boehringer Ingelheim Company

FILLING THE GAPS IN DISEASE PREVENTION

Commercial vaccines are a vital part of any swine health program, but sometimes disease prevention requires a different approach. Newport Laboratories, Inc., creates custom-made vaccines designed to help fight the specific pathogens challenging your herd, ensuring your veterinary toolbox is always complete.

Learn more about custom-made vaccines at **NewportLabs.com**.

PERFORM PARTNER PROTECT

Ingelvac PRRS®

FLEX

ENTERISOL® Ileitis

ENTERISOL® Salmonella T/C

Ingelvac MycoMAX™

Boehringer Ingelheim

President's message continued from page 249

waste containing FMD contaminated meat was the index case for the 2001 FMD epidemic in the United Kingdom,[7] which cost the public sector £3 billion (US $3.7 billion) and the private sector more than £5 billion (US $6.2 billion).[8]

Imported feed ingredient risk of FAD. Importation of pigs or fresh pork products into the United States from ASF-positive countries is regulated by APHIS. The agency does not regulate importation of feed ingredients from these countries, so the industry will need to respond. We are aware of the models showing the ASF virus ability to survive in feed ingredients in trans-Pacific transit from Beijing to Des Moines.[9] We are aware of the environmental stability and the low infectious dose of 10^3 in feed and 10^0 in water to infect pigs.[10] The United States imports significant amounts of vitamins, amino acids, and soybean products from China. The Swine Health Information Center (SHIC), along with the University of Minnesota, have sponsored workshops to increase our understanding of the vitamin supply chain and the soybean supply chain regarding the ASF risk to US agriculture:

- Vitamins from China appear to have low risk factors for ASF, except for vitamins purchased from unconventional brokers without necessary documentation, cross contamination of vitamin premixes with other feed ingredients (particularly porcine-derived ingredients), porcine derived gelatin used in Vitamins A and D3, and ground corn cobs used as carriers during the choline chloride manufacturing process.[11]
- Soybean meal and organic soybean meal continue to be a significant risk. Importers need to be better informed about ASF and associated actions to prevent disease transmission. This includes biosecurity and pre-screening protocols for importers.[12] The entire industry has a lot to learn and a lot of research to do to fill the knowledge gaps in this ASF risk area.

Second line of defense

Farm and feed mill biosecurity. African swine fever is anticipated to become endemic in China. The threat will not go away. If ASF were ever to enter the United States via contaminated pork products, restaurant waste, or feed ingredients, it would still have to make the giant leap onto at least one pig farm. Therefore, strict biosecurity standard operating procedures are the second line of defense to prevent any FAD crisis. This is where all pork producers, swine veterinarians, and feed suppliers are ultimately responsible and critically important to prevent a potential disaster. Educate your clients on FADs. Enroll them in the Secure Pork Supply Plan; the biosecurity discussion itself is worth the effort to implement this program. Feed mill biosecurity needs to change from an oxymoron to a reality. Adhering to recommended feed holding times to mitigate virus transmission is an important biosecurity step.[13]

Because of AASV, the National Pork Board, the National Pork Producers Council, and SHIC actively working together and the tremendous support of APHIS, CPB, allied industries, and coalition groups, we are all doing our utmost to prevent ASF entry. This gives me optimism, confidence, and keeps my glass half full.

References

*1. Perez S, Brihn A, Perez A. Swine Disease Global Surveillance Report Monday, June 3, 2019 – Monday, July 1, 2019. **https://www.swinehealth.org/wp-content/uploads/2019/07/SHIC-109-GSD-MR-July-2019-7-1-19.pdf**. Published July 2, 2019. Accessed July 17, 2019.

*2. 5m Editor. Special report: FAD outbreak could cost US agriculture $200 billion over 10 years. *The Pig Site*. February 13, 2019. **https://thepigsite.com/news/2019/02/special-report-fad-outbreak-could-cost-us-agriculture-200-billion-over-10-years**. Accessed July 25, 2019.

*3. DeAeth D. South Korea to increase fines for travelers carrying pork products. *Taiwan News*. May 21, 2019. **https://www.taiwannews.com.tw/en/news/3707443**. Accessed July 17, 2019.

*4. European Food Safety Authority Panel on Animal Health and Welfare. Scientific opinion on African swine fever. *EFSA J*. 2010;8(3):149. doi:10.2903/j.efsa.2010.1556

5. McKercher PD, Yedloutschnig RJ, Callis JJ, Murphy R, Panina GF, Civardi A, Bugnetti M, Foni E, Laddomada A, Scarano C, Scatozza F. Survival of viruses in "Prosciutto di Parma" (Parma ham). *Can Inst Food Sci Technol J*. 1987;20:267-272.

6. Mebus CA, House C, Ruiz Gonzalo F, Pineda JM, Tapiador J, Pire JJ, Bergada J, Yedloutschnig RJ, Sahu S, Becerra V, Sanchez-Vizcaino JM. Survival of foot-and-mouth disease, African swine fever, and hog cholera viruses in Spanish serrano cured hams and Iberian cured hams, shoulders and loins. *Food Microbiol*. 1993;10:133-143.

*7. Scudamore JM. Department for Environment, Food and Rural Affairs. Origin of the UK foot and mouth disease epidemic in 2001. **http://adlib.everysite.co.uk/resources/000/095/936/fmdorigins1.pdf**. Published 2002. Accessed July 17, 2019.

*8. National Audit Office. The 2001 outbreak of foot and mouth disease. **https://www.nao.org.uk/wp-content/uploads/2002/06/0102939.pdf**. Published June 18, 2002. Accessed July 25, 2019.

9. Dee SA, Bauerman FV, Niederwerder MC, Singrey A, Clement T, de Lima M, Long C, Patterson G, Sheahan MA, Stoian AMM, Petrovan V, Jones CK, De Jong J, Ji J, Spronk GD, Minion L, Christopher-Hennings J, Zimmerman JJ, Rowland RRR, Nelson E, Sundberg P, Diel DG. Survival of viral pathogens in animal feed ingredients under transboundary shipping models. *PLOS ONE*. 2018;13(3):e0194509. doi:10.1371/journal.pone.0194509

10. Niederwerder MC, Stoian AMM, Rowland RRR, Dritz SS, Petrovan V, Constance LA, Gebhardt JT, Olcha M, Jones CK, Woodworth JC, Fang Y, Liang J, Hefley TJ. Infectious dose of Africa swine fever virus when consumed naturally in liquid or feed. *Emerg Infect Dis*. 2019;25(5):891-897. doi:10.3201/eid2505.181495

*11. Shurson J, Urriola P. Understanding the vitamin supply chain and relative risk or transmission of foreign animal diseases. **https://www.swinehealth.org/wp-content/uploads/2019/07/Understanding-the-vitamin-supply-chain-and-relative-risk-of-transmission-of-foreign-animal-diseases-6-28-19-final.pdf**. Swine Health Information Center. Published May 2019. Accessed July 17, 2019.

*12. Sundberg P. Second SHIC-sponsored workshop addresses soybean supply chain and ASF feed risk. American Association of Swine Veterinarians web site. **https://www.aasv.org/news/story.php?id=11846**. Published July 17, 2019. Accessed July 17, 2019.

*13. National Pork Board. Holding time calculations for feed ingredients to mitigate virus transmission. **https://library.pork.org/media/?mediaId=0B9B2956-6474-41D8-B6BA5A7F8FB4C6A3**. Published October 8, 2018. Updated May 6, 2019. Accessed July 17, 2019.

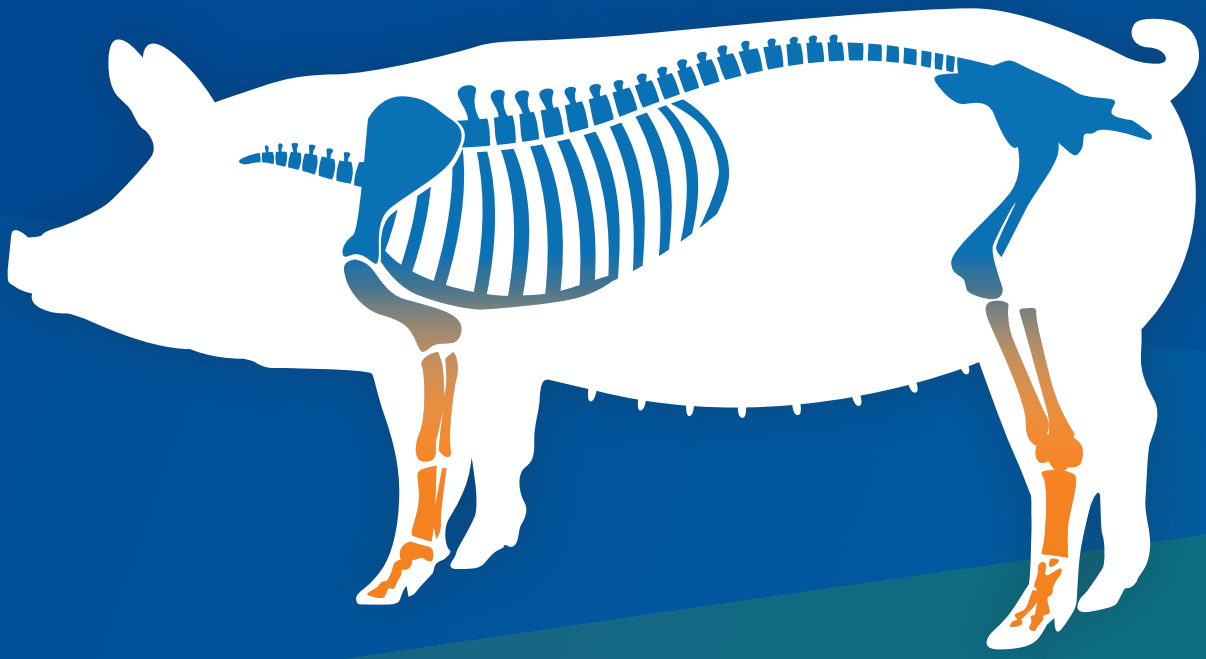
* Non-refereed references.

Nathan Winkelman, DVM
AASV President

Hy•D®

STAND STRONG

FOR A LIFETIME OF PRODUCTIVITY



Is your sow herd's vitamin D status high enough to ensure strong skeletal development, bone health and mobility? Hy•D®, a pure and proprietary vitamin D metabolite called 25-OH D3, works better than supplementing with vitamin D alone. Its unique mode of action eliminates the need for the conversion of D3 in the liver, allowing 25-OH D3 to be absorbed more quickly and consistently. Help your sows Stand Strong with Hy•D, your vitamin D solution for improving lifetime productivity.

See your DSM representative or visit DSM.com

- Reduced bone lesions
- Improved gilt selection rates
- Reduced farrowing difficulties due to mobility issues
- Heavier birth and weaning weights

Bright Science. Brighter Living.™

DSM

ASF arrived and, yada yada, we responded

I'm writing this column on the 30th anniversary of the Seinfeld television show. While many of you are probably too young to remember the show (a fair number of you were not even born, I am shocked to say), I am pretty sure you have all probably used at least one catch phrase from the show. In one episode, the characters fall into the habit of relaying intricate stories about their lives by saying "yada yada" over the most important aspects of the story. In one scene, Elaine is describing to Jerry a recent date she had been on saying, "We went out to dinner, I had the lobster bisque, we went back to my place, yada yada yada, I never heard from him again." To which Jerry notes that she "yada yada'd over the best part." Elaine responded, "No, I mentioned the bisque."

I bring this up to highlight one of the things I have noticed over the last year as the swine industry has worked with state and federal animal health officials to coordinate emerging and foreign animal disease response plans. A lot of effort has been focused on the overarching plan to address the introduction of a foreign animal disease into the US swine herd and I think the conceptual plan is a well-designed and reasoned approach. Unfortunately, the real devil is, in fact, in the details and it seems that we all-to-often tend to yada yada or gloss over these details. For example,

the very thorny issue of exactly how to carry out mass depopulation and disposal on a large scale or, in some cases, even a small scale.

We all seem to agree that, at least in the case of African swine fever (ASF) where disease control options are limited, depopulation is the most reasonable scenario to facilitate disease control. The problem is, we don't know how to get it done or what to do with the carcasses. This results in hours of debate over how to balance the human well-being, animal welfare, resource availability, practicality, timeliness, and environmental concerns associated with the unpleasant task necessary to control disease spread. There are numerous options to achieve depopulation and disposal but none that check all the boxes in every case. What this means is that the methodology is going to vary depending on circumstances on individual farms and states. For this reason, it is imperative that veterinarians work with their clients to facilitate planning for depopulation and disposal that meets the needs of the animals, the farmers, and the regulators. Producers should have a plan for how they will conduct depopulation and disposal of the animals on their farm.

Depopulation and disposal are perhaps the most obvious, but there are other, more subtle, examples of "yada yada planning." How long will a stop movement last? How many samples will we have to test to prove a farm is negative? What information is necessary in order to permit the movement of animals or products? Can we regionalize or compartmentalize to facilitate interstate movement and international trade? If vaccine is available, who gets vaccinated? How do we manage livestock shows and exhibitions? What do we do about feral swine? What about indemnity – how much will I get paid and based on what? And, the list goes on. The answer to many of these questions is outbreak dependent and the details will, hopefully, fall into place as we understand more about the outbreak. Unfortunately, all decisions are likely subject to political whims.

"I encourage all our members to contact your state animal health official and find out where they will be gathering to conduct the exercise and plan to participate."

The United States Department of Agriculture, at the request of the AASV and the swine industry, has held a series of ASF exercises over the last year in preparation for a fully functional national exercise to be held in late September. At the time of this writing, 14 states (including all the key swine states) have agreed to participate in the exercise which will cover many of these key topic areas over 4 days. It is my hope that this exercise will force at least a focused discussion, if not decisions, on these issues and realization that challenges remain to be answered.

Hopefully, this exercise will raise awareness among animal health officials, farmers, and veterinarians about the challenges facing the industry at all levels and stimulate the search for solutions to the identified gaps where possible. I encourage all our members to contact your state animal health official and find out where they will be gathering to conduct the exercise and plan to participate. To continue the Seinfeld analogy, let's strive to fill in the yada yada so we can all become the masters of our domain.

Harry Snelson, DVM
Executive Director

PROUD SUPPORTERS OF SWINE VETERINARIANS

Norbrook.com

Norbrook®

Cost of living

Have you noticed that everything seems to cost more and more money these days? A loaded question, I know. The increased price of fuel, groceries, utility bills, etc, the cost of living certainly seems to be on the rise. To save a bit of money, just this week I decided to cancel my landline telephone. The only calls I receive on my landline are from telemarketers trying to sell me something, and my Mom. I really only use my mobile phone, and I think I am the last person that still has a landline. Not anymore, I have trained my Mom to call my mobile phone and my landline is officially disconnected. Welcome to 2019, Terri! But that is not really what I wanted to talk about. Rather, I want to talk about another rising cost of living, the cost of publishing in academic journals. In the academic world the number of published papers is a common measure of productivity, which makes the topic of publication fees an important one. You have probably heard the phrase "publish or perish." The more papers published, the more productive the academic is considered. Publications are "academic currency" so to speak. There is no single common model for publication fees used by journals, and they range from affordable, to special rates for members only, to increased page costs for color, all the way to Open Access fees. Many Open Access journals promise a quick (ie, 2 week) peer-review process followed by immediate online publication upon acceptance. For journals to be able to do this quick turn-around and rapid publication, it comes with a price tag and this is passed on to the authors. Many journals are about making money.

I have discussed in previous messages the decision-making process that occurs when authors choose where to submit a paper. Issues like journal impact factor,[1] time to publication,[2] and journal readership, or the target audience, for the type of information. Another important factor considered, probably more than ever before, is the publication cost. If a journal has the ideal readership, a valued impact factor, and quick turn-around time to publication but the publication fees are high, the challenge then becomes how often can an author afford to publish in that journal. This probably also depends on the funding source(s) for the work the paper is presenting. Many different funding agencies also have budgets from which to work within. If publication fees are very high, then that funding agency technically has less money to fund applications or less money to go around.

We are very fortunate here at the *Journal of Swine Health and Production* (JSHAP) that we currently do not charge authors a publication fee. We have sufficient funding through our AASV Industry Support Council members. The ability to not charge a publication fee allows JSHAP to remain competitive in attracting manuscript submissions, and it also allows us to do a thorough job with our peer-review process. We are very aware of turn-around times that are required to peer-review manuscripts, but without the high pressure associated with high publication fees we also do not promise short peer-review times and subsequent immediate online access upon acceptance. I do not think all readers appreciate that there is a cost associated with submitting a manuscript to many journals and that publication costs are not immune to rising prices, which greatly influence the cost of living for academics.

"We have sufficient funding through our AASV Industry Support Council members."

Thank you to our journal supporters as well as all the editorial board members, reviewers, and staff that work hard to put each JSHAP issue together. We are very fortunate!

Terri O'Sullivan, DVM, PhD
Executive Editor

References

*1. O'Sullivan T. Impact! [editorial]. *J Swine Health Prod.* 2013;21:239.

*2. O'Sullivan T. The peer-review process [editorial]. *J Swine Health Prod*. 2013;21:299.

* Non-refereed references.

Original Research

Peer Reviewed

Efficacy of a commercial porcine epidemic diarrhea virus vaccine at reducing duration of viral shedding in gilts

Justin Brown, DVM; Chris Rademacher, DVM; Samuel Baker, BS; Korakrit Poonsuk, DVM, PhD; Ting-Yu Cheng DVM, MS; Kristin Skoland, BS; Paisley Canning, DVM, PhD; Anna Forseth, DVM; Locke Karriker, DVM, MS

Summary

Objective: To evaluate if the use of a commercially available killed porcine epidemic diarrhea virus (PEDV) vaccine shortens the duration of PEDV shedding in replacement gilts.

Materials and methods: Four treatment groups composed of 20 females were utilized for this study. Gilts in the CONTROL group had no previous exposure to PEDV, the nonvaccinated (NV) group had been previously exposed, and the PRE and POST groups received two doses of a commercial, killed PEDV vaccine either prior to or following a challenge with PEDV, respectively. Individual fecal samples were collected weekly and tested by real-time reverse transcription-polymerase chain reaction (rRT-PCR) for virus detection.

Results: Previous exposure to PEDV was found to shorten the time that virus can be detected in the feces compared to fecal samples of naïve animals ($P < .001$). Vaccination, either prior to or following the challenge, was not found to shorten the duration of PEDV shedding in feces.

Implications: These results showed that vaccination of gilts, either prior to the challenge or afterwards, with a killed commerical PEDV vaccine did not shorten the period that virus was detectable in the feces by rRT-PCR suggesting that viral shedding in feces was not influenced by administration of a killed commercial vaccine. While previous infection with virulent PEDV did not prevent re-infection, it did have a significant effect on the amount of time virus was detected following a subsequent exposure.

Keywords: swine, porcine epidemic diarrhea virus, vaccine, acclimatization, shedding

Received: December 4, 2018
Accepted: April 4, 2019

Resumen - Eficacia de una vacuna comercial contra el virus de la diarrea epidémica porcina en la reducción de la duración de excreción viral en primerizas

Objetivo: Evaluar si el uso de una vacuna inactivada del virus de la diarrea epidémica porcina (PEDV, por sus siglas en inglés) disponible comercialmente acorta la duración de la excreción del PEDV en cerdas primerizas.

Materiales y métodos: Se utilizaron cuatro grupos de tratamiento formados por 20 hembras para este estudio. Las primerizas en el grupo CONTROL no tenían exposición previa al PEDV, el grupo no vacunado (NV) había sido expuesto previamente, y los grupos PRE y POST recibieron dos dosis de una vacuna inactivada comercial del PEDV antes o después del reto con el PEDV, respectivamente. Las muestras fecales individuales se recolectaron semanalmente y se analizaron mediante reacción en cadena de la polimerasa de transcripción inversa en tiempo real (rRT-PCR) para la detección de virus.

Resultados: Se observó que la exposición previa al PEDV acorta el tiempo en que el virus se puede detectar en las heces en comparación con las muestras fecales de animales no expuestos ($P < .001$). No se encontró que la vacunación, ya sea antes o después del desafío, acorte la duración de la eliminación del PEDV en las heces.

Implicaciones: Estos resultados mostraron que la vacunación de primerizas, ya sea antes o después de la exposición, con una vacuna inactivada comercial del PEDV no acorta el período en que el virus se detecta en las heces mediante la rRT-PCR, lo que sugiere que la excreción viral en las heces no fue influida por la administración de una vacuna inactivada comercial. Mientras que la infección previa con el PEDV virulento no previno la reinfección, si tuvo un efecto significativo en el tiempo en que se detectó el virus después de una exposición posterior.

Résumé – Efficacité d'un vaccin commercial contre le virus de la diarrhée épidémique porcine à réduire la durée d'excrétion virale chez des cochettes

Objectif: Évaluer si l'utilisation d'un vaccin tué commercialement disponible contre le virus de la diarrhée épidémique porcine (VDEP) raccourci la durée d'excrétion du VDEP chez des cochettes de remplacement.

Matériels et méthodes: Quatre groupes de traitement composés de 20 femelles furent utilisés pour cette étude. Les cochettes du groupe TÉMOIN n'avaient pas eu

JB, KS, PC, AF, LK: Swine Medicine Education Center, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

CR, SB, KP, TC: Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

Corresponding author: Dr Locke Karriker, 2227 Lloyd Vet Med Center, 1809 S Riverside Dr, Ames, IA 50011; Tel: 515-294-2283; Fax: 515-294-1072; Email: karriker@iastate.edu.

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

Brown J, Rademacher C, Baker S, et al. Efficacy of a commercial porcine epidemic diarrhea virus vaccine at reducing duration of viral shedding in gilts. *J Swine Health Prod.* 2019;27(5):256-264.

d'exposition préalable au VDEP, le groupe non-vacciné (NV) avait préalablement été exposé, et les groupes PRE et POST reçurent deux doses d'un vaccin commercial de VDEP tué soit avant ou à la suite d'une infection défi avec le VDEP, respectivement. Des échantillons fécaux individuels furent obtenus à chaque semaine et testés pour détecter le virus par réaction en temps réel d'amplification en chaîne avec la polymérase reverse (rRT-PCR).

Résultats: On nota qu'une exposition préalable au VDEP raccourcissait le temps que le virus pouvait être détecté dans les fèces comparativement aux échantillons fécaux des animaux naïfs ($P < .001$). La vaccination, soit avant ou après l'infection défi, n'a pas permis de réduire la durée d'excrétion du VDEP dans les fèces.

Implications: Ces résultats démontrent que la vaccination des cochettes, soit avant ou après une infection défi, avec un vaccin tué commercial contre le VDEP n'a pas raccourci la période que le virus était détectable dans les fèces par rRT-PCR, ce qui suggère que l'excrétion virale dans les fèces n'était pas influencée par l'administration d'un vaccin tué commercial. Bien qu'une infection préalable avec un VDEP virulent n'ait pas empêché une réinfection, elle avait un effet significatif sur la durée pendant laquelle le virus était détecté suite à une exposition subséquente.

During May 2013, porcine epidemic diarrhea virus (PEDV) was diagnosed in an acute outbreak of diarrhea and vomiting affecting most sows and nearly 100% of piglets on a commercial breeding farm in the United States.[1] Nearly 100% of affected piglets died due to extreme dehydration secondary to the disease during the first 4 weeks of the outbreak. This was the first time PEDV was detected in the United States. Breeding farms have recovered after intentional herd exposure to the virus, allowing herd immunity[2] to develop, in addition to the use of sanitation protocols to control the virus.

For breeding herds previously infected with PEDV, some producers have chosen to acclimate their replacement gilts off-site prior to introduction to the herd. If gilts are introduced to a breeding herd too soon after intentional PEDV exposure, there is a risk that the animals will be actively shedding the virus. Exposed gilts could serve as a vector for PEDV and re-infect the resident sow and piglet populations, leading to clinical disease.

Commercially available PEDV vaccines effectively increase antibody levels developed from natural exposure.[3-5] However, killed vaccines have not shown to produce protective immunity against clinical disease in PEDV-naïve animals.[5,6] Acclimating replacement gilts with PEDV and allowing them the proper period to cease shedding has anecdotally been reported as a successful strategy for introducing replacement females into previously infected herds. Bjustrom-Kraft et al[7] examined the duration of shedding in commercial wean-to-finish pigs and found positive fecal swab and oral fluid samples collected at the pen level at 69 days post PEDV exposure. This information could be extrapolated to suggest that gilts should be isolated for a minimum of 10 weeks before introduction to the herd, but direct measurement of replacement gilts would be preferable. Given that gilt acclimation is time dependent and has associated costs, the opportunity for a commercially available vaccine to reduce the duration of PEDV shedding, thereby reducing the time needed for acclimation, would be a valuable resource to producers.

Our hypothesis was that gilts vaccinated with a killed PEDV vaccine would shed virus in feces for a shorter duration than unvaccinated gilts. Therefore, the objective of this study was to evaluate if the use of a commercially available killed PEDV vaccine (Porcine Epidemic Diarrhea Vaccine, Zoetis, Inc, Florham Park, New Jersey) influences the duration of PEDV shedding in replacement gilts, which would subsequently shorten the time that intentionally infected replacement gilts must be isolated before introduction into a breeding herd.

Materials and Methods

All procedures were approved by the Iowa State University Animal Care and Use Committee.

This study utilized 4 treatment groups (Table 1), each composed of 20, commercial crossbred, PEDV naïve gilts. Sixty gilts were conveniently selected from a commercial producer located in central Iowa that had no clinical or diagnostic history of PEDV infection. The 60 gilts were evenly split into 3 groups each composed of 20 females. Twenty naïve gilts, (CONTROL), were moved to an isolated research facility while the remaining 40 stayed at the farm of origin. At the research site, an ear tag (Integra Hog, Allflex, Dallas, Texas) was placed in the right ear of each gilt for individual identification and 12 mL of blood was collected via jugular venipuncture utilizing a 16 gauge, 1.5-inch needle and syringe. Serum samples were tested with a whole virus enzyme-linked immunosorbent assay (ELISA) developed at the Iowa State University Veterinary Diagnostic Laboratory (VDL) to confirm PEDV naïve status prior to the challenge. Following a 4-day acclimation period, each gilt was challenged orally with PEDV. A tissue homogenate of PEDV was obtained from a confirmed, clinical outbreak of PEDV, which had been collected on farm and frozen at -80° C. Ten milliliters of the homogenate were mixed with 590 mL of phosphate buffered saline and 30 mL were administered oronasally to each gilt. The final diluted inoculum was confirmed to be PEDV positive by real-time, reverse transcriptase-polymerase chain reaction

Table 1: Definition of study treatment groups

Group	Definition
CONTROL	No vaccine and no previous PEDV exposure
NV	No vaccine with previous PEDV exposure
PRE	No previous PEDV exposure Vaccinated at 5 and 2 weeks prior to PEDV challenge
POST	No previous PEDV exposure Vaccinated at 1 and 3 weeks following PEDV challenge

PEDV = porcine epidemic diarrhea virus.

(rRT-PCR) with a cycle threshold (Ct) value of 19.6 and identified as the prototype strain of PEDV by virus isolation and sequencing performed at the VDL. Following the challenge, individual fecal samples were collected from each gilt utilizing a fecal loop (VETONE, Boise, Idaho) every 7 days and submitted to the VDL for PEDV rRT-PCR testing. Individual fecal samples were collected every 7 days until a gilt had 3 consecutive negative rRT-PCR results. A cutoff Ct value ≥ 36 was used to assign negative PEDV rRT-PCR status. Pens were observed daily for evidence of diarrhea and a fecal score, adapted from Thomas et al[8] (Table 2), was assigned to the pen.

Following the 9-week duration of testing for the CONTROL group, 18 of the 20 CONTROL gilts subsequently became the nonvaccinated (NV) group (Tables 1 and 3). Two gilts were removed from the study for reasons unrelated to the study. The 40 remaining conspecifics were moved from the source farm to the same research site. Twenty of these gilts each received a dose (2 mL administered intramuscularly in the neck) of a commercial PEDV vaccine at 5 and 2 weeks before being moved to the research site and were designated the PRE group. The remaining 20 gilts served as the POST group and each received a dose (2 mL administered intramuscularly in the neck) of a commercial PEDV vaccine at 1 and 3 weeks following the PEDV challenge. Upon arrival to the research site, an ear tag was placed in the right ear of each gilt for individual identification and a blood sample was collected via jugular venipuncture for ELISA testing to confirm naïve or immunized status prior to the challenge. Blood sampling and ELISA testing was repeated for the 18 NV animals to confirm PEDV exposure following their previous enrollment as the CONTROL group. Following a 3-day acclimation period, all 58 of the gilts were individually challenged with PEDV, using the same procedures and homogenate described for the CONTROL group. The final inoculum for the NV,

Table 2: Fecal consistency scoring definition*

Score	Fecal consistency
1	Normal, no diarrhea
2	Mild diarrhea, soft (cowpie)
3	Moderate diarrhea, liquid with some solid content
4	Watery diarrhea, liquid with no solid content

* This scoring system was adapted from Thomas et al.[8]

Table 3: Timeline of events by treatment group

	Treatment group*			
Day	**CONTROL**	**NV**	**PRE**	**POST**
-4	9-week-old gilts arrive at facility			
0	Challenge			
7, 14, 21	Individual fecal sampling			
25			1st vaccine dose	
28, 35, 42	Individual fecal sampling			
44			2nd vaccine dose	
49, 56	Individual fecal sampling			
60	Individual fecal sampling		19-week-old gilts arrive at facility	19-week-old gilts arrive at facility
63	Individual fecal sampling	CONTROL transition to NV, Challenge	Challenge	Challenge
70		Individual fecal sampling	Individual fecal sampling	1st vaccine dose Individual fecal sampling
77		Individual fecal sampling	Individual fecal sampling	Individual fecal sampling
84		Individual fecal sampling	Individual fecal sampling	2nd vaccine dose Individual fecal sampling
91, 98, 105, 112, 119, 126, 133		Individual fecal sampling	Individual fecal sampling	Individual fecal sampling

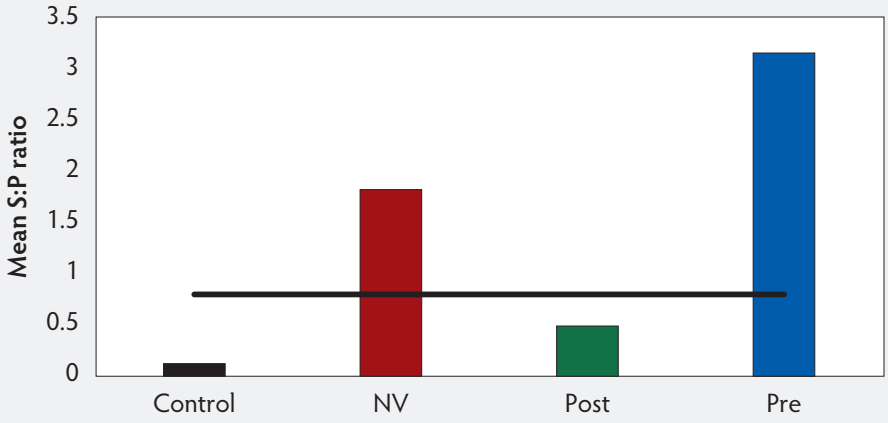
* Treatment groups are described in Table 1.

Table 4: Mean fecal rRT-PCR Ct by week post-PEDV challenge

Treatment group*	Week									
	1	2	3	4	5	6	7	8	9	10
Control	25.65	25.36	27.85	28.80	28.37	25.75	†	†	33.00	¶
NV	29.32	34.30	33.90	†	†	†	‡	‡	‡	‡
Post	19.82	28.71	30.59	†	28.40	28.10	†	†	†	‡
Pre	20.30	27.45	27.99	28.50	29.75	30.00	26.60	†	†	†

* Treatment groups are described in Table 1.
† Indicates animals tested but all Ct values ≥ 36.
‡ Indicates that no animals were tested due to all animals in the group having 3 consecutive negative tests.
¶ Indicates that no animals were tested due to animals moving into the NV group.
rRT-PCR = real-time reverse transcription-polymerase chain reaction; Ct = cycle threshold, PEDV = porcine epidemic diarrhea virus.

Figure 1: Mean S:P ratio by treatment group immediately prior to PEDV challenge. The bold horizontal line indicates the cutoff S:P value ≥ 0.8 for determining positive serological status by whole virus ELISA. Treatment groups are described in Table 1. S:P = sample to positive; PEDV = porcine epidemic diarrhea virus; ELISA = enzyme-linked immunosorbent assay.



PRE, and POST groups was confirmed to be PEDV positive using rRT-PCR with a Ct value of 21.1. Following the challenge, individual fecal samples were collected from each gilt every 7 days by utilizing a fecal loop and submitted to the VDL for rRT-PCR to assess PEDV shedding. Individual fecal samples were collected until a gilt had 3 consecutive negative rRT-PCR results. A cutoff Ct value ≥ 36 was used to assign negative PEDV rRT-PCR status. Pens were observed daily for diarrhea and assigned a fecal score.

Mean Ct values were calculated weekly following the challenge for each treatment group (Table 4). Data analysis for this study was completed using SAS software, Version 9.3 (SAS Institute Inc, Cary, North Carolina).

A survival analysis and Cox proportional hazard regression model determined if there were significant differences in the time to negative status, defined in this study as 3 consecutive negative tests, among the treatment groups (CONTROL, NV, PRE, and POST).

Results

A sample to positive ratio (S:P) value ≥ 0.8 was utilized to determine positive serological status by ELISA. Mean S:P ratios were calculated for each treatment group and are shown in Figure 1. Fecal consistency across all treatment groups was scored as 2 or 3 for 7 days following the challenge, after which the fecal consistency then returned to baseline. Mean fecal rRT-PCR Ct by week is shown in Table 4 and individual animal fecal rRT-PCR results are presented in Figure 2. Virus was not detected in the feces of a majority of the gilts in the CONTROL group by week 6 post challenge. Nor was PEDV detected in any of the 20 gilts on weeks 7 and 8 as indicated by Ct values ≥ 36. The percent of animals that tested positive for PEDV by rRT-PCR by week is presented in Figure 3. One gilt that had 2 previous negative fecal PEDV rRT-PCR tests had a positive result on fecal rRT-PCR on week 9 (Figure 2A). All NV gilts were found to be no longer shedding PEDV in their feces by week 4 post challenge (Figure 2B). Both the POST group (Figure 2C) and PRE group (Figure 2D) were found to be shedding PEDV through week 6. Virus was no longer detected via fecal rRT-PCRs for the POST group beginning on week 7 and the PRE group on week 8.

Hazard ratios (Table 5) were calculated for the NV, PRE, and POST groups compared to the CONTROL group by performing Cox proportional hazards regression modeling. A statistically significant difference ($P < .001$) between the CONTROL and NV groups was found with a hazard ratio of 4.022. Figure 4 shows a Kaplan-Meier plot for the time-to-negative PEDV status for each of the 4 treatment groups.

Discussion

Serological analysis showed an antibody response in both the NV and PRE treatment groups prior to the challenge while the CONTROL and POST groups did not show an antibody response. The CONTROL group had a negative antibody response because the gilts were naïve to PEDV. Similarly, the POST group was naïve and had

Figure 2: Individual animal fecal rRT-PCR results by treatment group: A) Control, B) NV, C) POST, and D) PRE. Treatment groups are described in Table 1. Green indicates positive test result with Ct value; red indicates negative test result; X indicates removal from study; and gray represents no testing. rRT-PCR = real-time reverse transcription-polymerase chain reaction, Ct = cycle threshold.

A

CONTROL pig	Week post challenge 1	2	3	4	5	6	7	8	9
1	19.5								
2	28.4		23.6						
3	34.9		27.2		22.1				
4	27.0							X	X
5									
6	27.8								
7	34.1	23.7							
8	32.5	26.3			28.1	27.4			
9		19.5							
10	25.5	21.5	30.8	28.8		24.1			33.0
11	30.2	30.8							
12	19.4								
13	20.1								
14	18.1								
15	27.1	20.0	33.8		34.9				
16	20.3		30.5						
17		32.6							
18	18.0		X	X	X	X	X	X	X
19	30.3	28.5	21.2						
20	22.8								

B

NV pig	Week post challenge 1	2	3	4	5	6
1						
2						
3						
5						
6	23.2					
7	33.9		33.9			
8	33.9					
9						
10	27					
11	28					
12						
13		34.3				
14						
15	29.9					
16						
17						
19						
20						

Figure 2 cont'd: Individual animal fecal rRT-PCR results by treatment group: A) Control, B) NV, C) POST, and D) PRE.

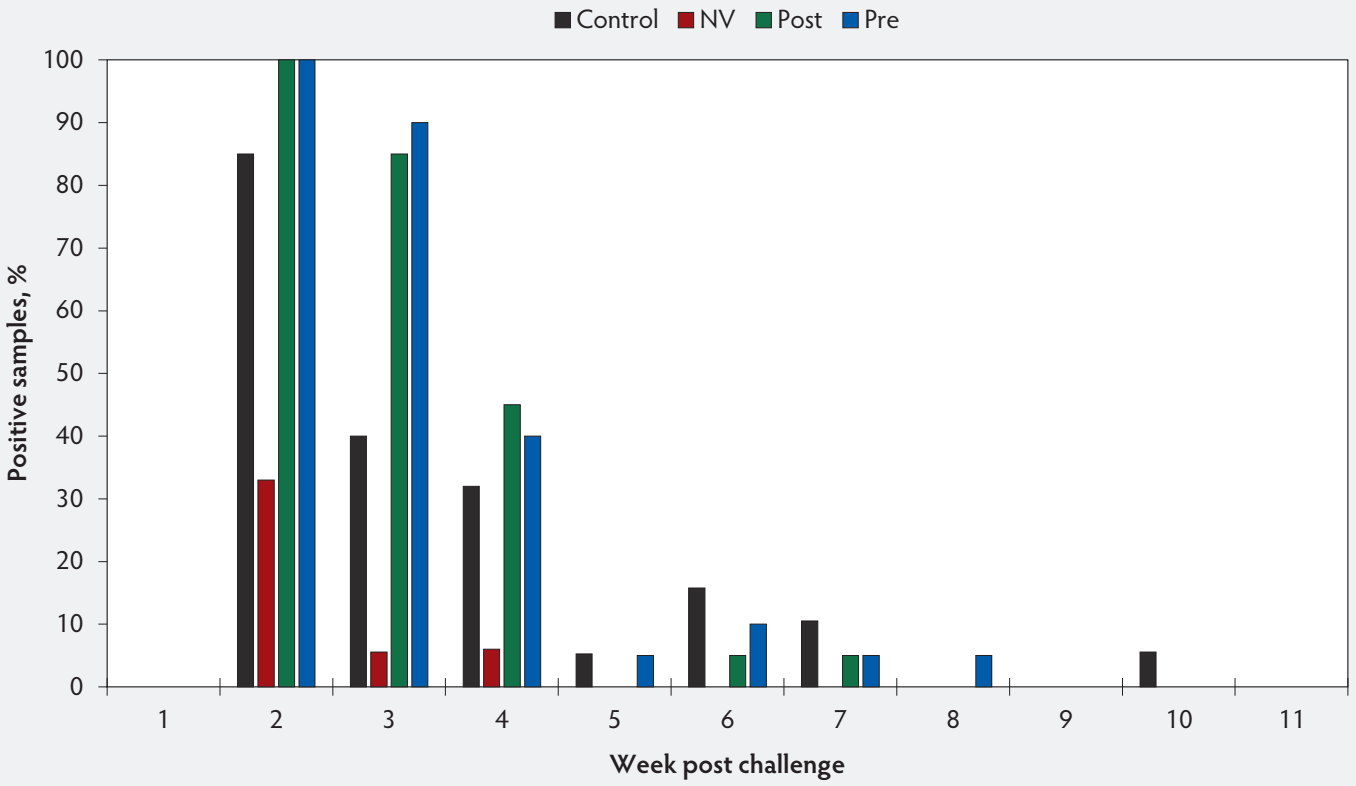
C POST

pig	Week post challenge 1	2	3	4	5	6	7	8	9
21	23.5								
22	25.8	35.0	33.4						
23	17.2								
24	14.0	31.5							
25	20.3	31.1	29.9			28.1			
26	13.3	29.8							
27	13.2	28.2	32.2						
28	22.7	27.7	28.4						
29	14.0	26.4							
30	24.4	24.9							
31	15.9	32.3							
32	15.8	35.0	29.7						
33	23.8		32.6						
34	16.0	24.2							
35	22.7	25.4	31.6		28.4				
36	26.9	30.4							
37	21.2	21.1							
38	15.6	33.3							
39	29.6	28.7	27.0						
40	20.4	23.1	30.5						

D PRE

pig	Week post challenge 1	2	3	4	5	6	7	8	9	10
41	16.8	29.4								
42	24.2		22.2							
43	23.5	26.9	25.1							
44	19.9	17.3								
45	18.5									
46	22.6	24.6		28.5						
47	15.7	27.9								
48	21.3	31.6								
49	15.8	32.5								
50	22.9	27.4								
51	21.2	29.2	25.7							
52	21.1	24.5								
53	19.8	29.1	34.6							
54	13.7	30.2			31.8					
55	17.2	32.0								
56	21.4	22.2								
57	25.6	28.6	25.6			30.0				
58	18.2	20.7	28.7							
59	23.5	33.1	34.6							
60	23.1	26.9	27.4		27.7		26.6			

Figure 3: Positive fecal rRT-PCRs by treatment group by week. Treatment groups are described in Table 1. rRT-PCR = real-time reverse transcription-polymerase chain reaction.



not been vaccinated prior to the challenge and, therefore, did not show an antibody response. The NV group was positive, as expected, because they had previously been challenged with wildtype virus as the CONTROL group. The PRE group was positive because they had received the PEDV vaccine at 5 and 2 weeks before the challenge. Although numerical differences in the S:P ratio were noted between the treatment groups, there was no observable difference in clinical signs following the challenge. A limitation of this study was that neutralizing antibody levels were not measured for the treatment groups. Further research should be conducted to determine vaccination influence on the development of neutralizing antibodies for PEDV. In this study, vaccination before or after the challenge with a commercially available killed PEDV vaccine was not observed to affect the amount of time that PEDV was shed in the feces of challenged gilts. Prior research has shown that parenteral administration of a killed PEDV vaccine to previously unexposed sows elicited an immune response but did not develop a neutralizing antibody response in milk and only weakly in colostrum.[9] Another study found that sows vaccinated with 2 doses of a killed vaccine, compared to 2 doses of a live vaccine or live vaccine followed by killed vaccine, showed the highest neutralizing antibody response in colostrum, 1:1600, compared to sera, 1:800.[10] While this study did not evaluate the amount of virus shed in the feces, a previous study found that vaccinated animals shed less virus and the duration of viral shedding was shortened.[11] The animals in the study were younger, being vaccinated at 3 and 5 weeks of age compared to 13 and 16 weeks of age (PRE) and 19 and 21 weeks of age (POST) in the present study, and were challenged with a homologous PEDV genotype 2b isolate to a commercial vaccine. Samples were also collected daily for 13 days post challenge, whereas in this study samples were collected weekly for 9 weeks post challenge.

This study also demonstrated that previous infection with PEDV does shorten the amount of time virus is detected in the feces following a second exposure. Gilts that were previously exposed were 4.022 times as likely to become negative compared to naïve and vaccinated individuals. However, previous PEDV infection does not completely prevent shedding of virus in feces. This is likely due to the protection induced by the primary exposure with a homologous strain of PEDV, and similar results have been demonstrated previously.[12,13] Gerber et al[12] described seeing no clinical signs or lesions following homologous challenge with PEDV and that shedding was observed in less than 10% of the challenged pigs. In the current study, we did observe mild clinical signs in the NV group that had been previously challenged as the CONTROL group, and observed 7 of 18 gilts (38.9%) to shed PEDV following homologous challenge.

This study observed that PEDV can be detected in the feces via rRT-PCR for up to 9 weeks post inoculation when exposed oronasally with the US prototype PEDV strain. Due to time constraints of the study, gilt 10 in the control group was not followed out for 3 consecutive negative rRT-PCR tests prior to re-challenging the group with PEDV. These findings are in congruence with results published by Bjustrom-Kraft et al[7] where individual rectal swabs were positive by rRT-PCR for 10 weeks post exposure. This study demonstrates that PEDV may be detected intermittently from individual pigs. Intermittent detection may

Table 5: Cox proportional hazards regression model analysis

Treatment group* comparison		*P* value	Hazard ratio	95% Confidence Limits
Control	NV	< .001	4.022	1.995, 8.11
Control	Post	.95	0.979	0.513, 1.869
Control	Pre	.64	0.858	0.452, 1.627

* Treatment groups are described in Table 1.

indicate intermittent shedding which has been reported in previous studies.[14,15] A limitation of this study is that we did not determine if shedding was truly intermittent or if the amount of virus present was below the detection threshold of rRT-PCR.

These results show that vaccination of gilts, either prior to challenge or afterwards, with a killed commerical PEDV vaccine does not shorten the period of time that virus is detectable in the feces by rRT-PCR suggesting that viral shedding in feces is not influenced by administration of a killed commercial vaccine. This information does not contradict the vaccine's label for protection against diarrheal disease in neonatal pigs caused by PEDV. Previous infection with virulent PEDV did have a significant effect on the amount of time virus was detected following a subsequent exposure.

Implications

- Vaccinating gilts prior or post challenge with a killed, commercial PEDV vaccine did not shorten the time that virus was detectable in feces by rRT-PCR.
- Prior PEDV infection significantly decreased the time virus was detected in feces following a subsequent exposure.
- Prior infection with PEDV did not prevent shedding in all animals following a homolgous challenge.

Acknowledgments

This work was supported by Zoetis Inc. We thank Dr Ryan Saltzman, Mike Wilgenbusch, and Vet Resources, Inc for their assistance with the study.

Conflict of interest

None reported.

Disclaimer

Scientific manuscripts published in the *Journal of Swine Health and Production* are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

References

1. Stevenson G, Hoang H, Schwartz K, Burrough E, Sun D, Madson D, Cooper V, Pillatzki A, Gauger P, Schmitt B, Koster L, Killian M, Yoon K. Emergence of porcine epidemic diarrhea virus in the United States: clinical signs, lesions, and viral genomic sequences. *J Vet Diagn Invest*. 2013; 25(5):649-654. doi:10.1177/1040638713501675

*2. Schwartz K, Henry S, Tokach L, Potter M, Davidson D, Egnor C. Exposing sows to PEDV to build herd immunity. National Hog Farmer. `http://nationalhogfarmer.com/business/exposing-sows-pedv-build-herd-immunity`. Published March 13, 2014. Accessed October 2018.

*3. Frederickson D, Bandrick M, Taylor LP, Coleman DW, Pfeiffer A, Locke CR, Huether MJ, Zhang J, Verhelle R, Hildebrandt TK, Hardham JM, Rapp-Gabrielson VJ. Safety and antibody response of pigs to an experimental porcine epidemic diarrhea virus (PEDV) vaccine, killed virus. *North Am PRRS Symp*. Chicago, Illinois. 2014:69.

*4. Rapp-Gabrielson VJ, Frederickson DF, Bandrick M, Taylor LP, Marx J, Ricker T, Coleman D, Pfieffer A, Thompson JR, Zhang J, Zager S, Huether M, Hardham JM, Sornsen S. Field efficacy of an experimental porcine epidemic diarrhea (PED) vaccine administered to pregnant sows. *North Am PRRS Symp*. Chicago, Illinois. 2014:80.

*5. Greiner L, Connor J, Graham A, Mellor J, Lowe J. Evaluation of a PED vaccine on piglet mortality and sow immunity. *Proc AASV*. Orlando, Florida. 2015:361.

*6. Schwartz TJ, Rademacher CJ, Giménez-Lirola G, Sun Y, Zimmerman J. Evaluation of the effects of PEDV vaccine on PEDV naïve and previously PEDV exposed sows in a challenge model comparing immune response and preweaning mortality. *Proc AASV*. New Orleans, Louisiana. 2016:363-366.

7. Bjustrom-Kraft J, Woodard K, Giménez-Lirola L, Rotolo M, Wang C, Sun Y, Lasley P, Zhang J, Baum D, Gauger P, Main R, Zimmerman J. Porcine epidemic diarrhea virus (PEDV) detection and antibody response in commercial growing pigs. *BMC Vet Res*. 2016;12(1):99. doi:10.1186/s12917-016-0725-5

8. Thomas J, Chen Q, Gauger P, Giménez-Lirola L, Sinha A, Harmon K, Madson D, Burrough E, Magstadt D, Zalzbrenner H, Welch M, Yoon K, Zimmerman J. Effect of porcine epidemic diarrhea virus infectious doses on infection outcomes in naïve conventional neonatal and weaned pigs. *PLoS One*. 2015;10(10):e0139266. doi:10.1371/journal.pone.0139266

9. Gillespie T, Song Q, Inskeep M, Stone S, Murtaugh M. Effect of booster vaccination with inactivated porcine epidemic diarrhea virus on neutralizing antibody response in mammary secretions. *Viral Immunol*. 2018;31(1):62-68. doi:10.1089/vim.2017.0023

10. Paudel S, Park JE, Jang H, Hyun BH, Yang DG, Shin HJ. Evaluation of antibody response of killed and live vaccines against porcine epidemic diarrhea virus in a field study. *Vet Q*. 2014;34(4):194-200. doi:10.1080/01652176.2014.973999

11. Opriessnig T, Gerber PF, Shen H, de Castro AMMG, Zhang J, Chen Q, Halbur P. Evaluation of the efficacy of a commercial inactivated genogroup 2b-based porcine epidemic diarrhea virus (PEDV) vaccine and experimental live genogroup 1b exposure against 2b challenge. *Vet Res*. 2017;48(1):69. doi:10.1186/s13567-017-0472-z

12. Gerber PF, Xiao CT, Lager K, Crawford K, Kulshreshtha V, Cao D, Meng XJ, Opriessnig T. Increased frequency of porcine epidemic diarrhea virus shedding and lesions in suckling pigs compared to nursery pigs and protective immunity in nursery pigs after homologous re-challenge. *Vet Res*. 2016;47(1):118. doi:10.1186/s13567-016-0402-5

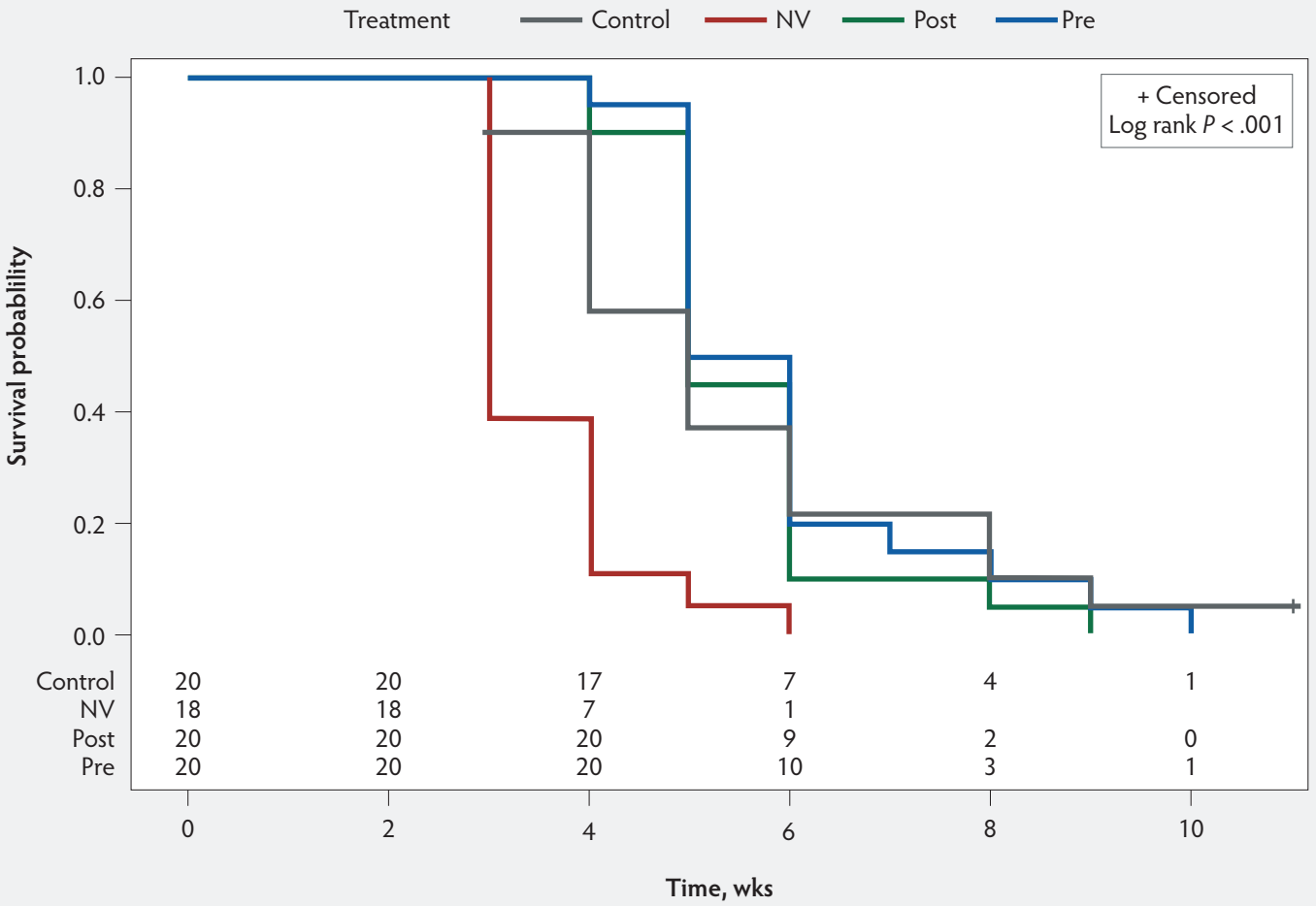
13. Srijangwad A, Stott C, Temeeyasen G, Senasuthum R, Chongcharoen W, Tantituvanont A, Nilubol D. Immune response of gilts to single and double infection with porcine epidemic diarrhea virus. *Arch Virol*. 2017;162(7):2029-2034. doi:10.1007/s00705-017-3307-3

14. Bertasio C, Giacomini E, Lazzaro M, Perulli S, Papetti A, Lavazza A, Lelli D, Alborali G, Boniotti M. Porcine epidemic diarrhea virus shedding and antibody response in swine farms: a longitudinal study. *Front Microbiol*. 2016;7:2009. doi:10.3389/fmicb.2016.02009

15. Gallien S, Moro A, Lediguerher G, Catinot V, Paboeuf F, Bigault L, Berri M, Gauger PC, Pozzi N, Authié E, Rose N, Grasland B. Evidence of porcine epidemic diarrhea virus (PEDV) shedding in semen from infected specific pathogen-free boars. *Vet Res*. 2018;49(1):7. doi:10.1186/s13567-018-0505-2

* Non-refereed references.

Figure 4: Kaplan-Meier plot showing time-to-negative PEDV status for the four treatment groups. Time is displayed on the x-axis in weeks. The y-axis shows the probability that individuals within a treatment group will have a positive status by fecal rRT-PCR by the following week. Treatment groups are described in Table 1. PEDV = porcine epidemic diarrhea virus; rRT-PCR = real-time reverse transcription-polymerase chain reaction.



Peer Reviewed Original Research

Evidence of improved reporting of swine vaccination trials in the post-REFLECT statement publication period

Cesar A. A. Moura, DVM; Sarah C. Totton, DVM, PhD; Jan M. Sargeant, DVM, PhD; Terri L. O'Sullivan, DVM, PhD; Daniel C. L. Linhares, DVM, MBA, PhD; Annette M. O'Connor MVSc, DVSc

Summary

Objectives: Describe and compare the proportion of studies reporting the method used to assign study units to treatment groups, reporting a random allocation approach, reporting 18 REFLECT items, and the proportion of studies having a low risk-of-bias assessment in swine vaccination trial studies published after the REFLECT statement, compared to studies published before.

Materials and Methods: The study population was 61 studies that evaluated vaccines targeted at pathogens affecting swine health or pork safety. Two reviewers assessed the reporting of 18 of 22 REFLECT items and 5 risk-of-bias domains.

Results: Authors reported the method used to allocate experimental units in 33 of 42 (79%) and 14 of 19 (74%) studies published prior to and following REFLECT, respectively. There has been a substantial shift in the reporting of allocation approaches. Before 2011, only 2 of 25 (8%) studies that reported using random allocation provided supporting evidence. This increased in studies published between 2011-2017 (4 of 6; 66%). Before 2011, 8 of 33 (24%) studies reported using systematic allocation, which increased to 43% (6 of 14 studies) between 2011-2017. There has also been an increase in the prevalence of reporting for 14 of the 18 REFLECT items. There was an increase in the number of studies reporting evidence to support true randomization to group and data that suggests few baseline imbalances.

Implications: Data from this study suggests swine vaccination trial reporting improved, which may be due to researchers having more access to better quality information.

Keywords: swine, REFLECT, vaccine, risk-of-bias, randomization.

Received: November 12, 2018
Accepted: May 7, 2019

Resumen - Evidencia de un mejor reporte de los estudios de vacunación porcina en el período posterior de publicación a la declaración REFLECT

Objetivos: Describir y comparar la proporción de estudios que describen el método utilizado para asignar unidades de estudio a grupos de tratamiento, que reportan un enfoque de asignación aleatoria, reportando 18 ítems REFLECT y la proporción de estudios que tienen una evaluación de bajo riesgo de parcialidad en estudios de vacunación porcina publicados después de la declaración REFLECT, comparados con estudios publicados anteriormente.

Materiales y métodos: La población del estudio fue de 61 estudios que evaluaron vacunas contra patógenos que afectan la salud de los cerdos o la seguridad de la carne. Dos revisores evaluaron el informe de 18 de los 22 elementos REFLECT y 5 áreas de riesgo de parcialidad.

Resultados: Los autores reportaron el método utilizado para asignar unidades experimentales en 33 de 42 (79%) y 14 de 19 (74%) estudios publicados antes y después de REFLECT, respectivamente. Ha habido un cambio importante en el reporte de los enfoques de asignación. Antes de 2011, solo 2 de 25 (8%) estudios que informaron el uso de una asignación aleatoria proporcionaron evidencia de apoyo. Esto aumentó en los estudios publicados entre 2011-2017 (4 de 6; 66%). Antes de 2011, 8 de 33 (24%) estudios informaron el uso sistemático, que aumentó a 43% (6 de 14 estudios) entre 2011-2017. También ha habido un aumento en la prevalencia de reporte de 14 de los 18 ítems REFLECT. Hubo un aumento en el número de estudios que informaron evidencia para respaldar la asignación al azar real al grupo y los datos que sugieren pocos desequilibrios de base.

Implicaciones: Los datos de este estudio sugieren que los reportes de los estudios de vacunación porcina mejoraron, lo que puede deberse a que los investigadores tienen más acceso a información de mejor calidad.

Résumé – Évidence d'amélioration de la publication des essais de vaccination des porcs durant la période suivant la publication de l'énoncé REFLECT

Objectifs: Décrire et comparer la proportion d'études rapportant : la méthode utilisée pour attribuer les unités à l'étude

CAAM, DCLL, AMO: Veterinary Diagnostic and Production Animal Medicine Department, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

SCT: Independent consultant, Guelph, Ontario, Canada.

JMS, TLO: Department of Population Medicine, Ontario Veterinary College, and Centre for Public Health and Zoonoses, University of Guelph, Guelph, Ontario, Canada.

Corresponding author: Dr Annette O'Connor, Ames, IA 50011; Email: oconnor@iastate.edu.

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

Moura CAA, Totton SC, Sargeant JM, et al. Evidence of improved reporting of swine vaccination trials in the post-REFLECT statement publication period. *J Swine Health Prod.* 2019;27(5):265-277.

aux groupes de traitement, une approche d'attribution aléatoire, 18 items REFLECT, et la proportion d'études ayant un risque faible de biais d'évaluation dans les essais de vaccination de porcs publiés après l'énoncé REFLECT, comparativement aux études publiées avant.

Matériels et méthodes: La population étudiée consistait en 61 études qui ont évalué des vaccins ciblant des agents pathogènes affectant la santé porcine ou la salubrité de la viande porcine. Deux réviseurs ont évalué la publication de 18 des 22 items REFLECT et cinq domaines de risque de biais.

Résultats: Les auteurs rapportaient la méthode pour distribuer les unités expérimentales dans 33 des 42 (79%) et 14 des 19 (74%) études publiées préalablement et après REFLECT, respectivement. Il y eu un changement notoire dans la publication des approches d'attribution. Avant 2011, seulement 2 des 25 (8%) des études qui rapportaient utiliser une attribution aléatoire fournissaient des preuves à cet effet. Ceci augmenta dans les études publiées entre 2011-2017 (4 de 6; 66%). Avant 2011, 8 des 33 (24%) études rapportaient utiliser une attribution aléatoire, proportion qui augmenta à 43% (6 de 14 études) entre 2011-2017. Il y eu également une augmentation de la prévalence à rapporter pour 14 des 18 items REFLECT. Il y avait une augmentation dans le nombre d'études qui rapportaient des preuves pour supporter une réelle randomisation pour regrouper et des données qui suggèrent peu de débalancements au départ.

Implications: Les données de la présente étude suggère que les rapports d'essais de vaccination chez le porc se sont améliorés, ce qui pourrait être dû au fait que les chercheurs ont accès à des information de meilleure qualité.

Infectious diseases of swine and infectious causes of foodborne illness impact the sustainability of the food supply. Diseases such as African swine fever, porcine reproductive and respiratory syndrome, and swine influenza can lead to reduced pork supply,[1] while outbreaks of foodborne pathogens associated with pork, such as *Salmonella,* lead to reduced demand and risk of public health-related problems.[2-4] Therefore, it is critical that swine veterinarians have access to comprehensive reports of vaccine efficacy, allowing them to make science-driven decisions on the best immunization process to control or eradicate diseases in the herd. Unfortunately, scientific reporting of intervention studies in swine production often lacks critical information that enables assessment of biases, and there is an apparent need to improve reporting.[5]

In 2010, the Reporting Guidelines for Randomized Controlled Trials for Livestock and Food Safety (REFLECT) statement and the companion Explanation and Elaboration document were published.[6-11] The REFLECT statement has a 22-item checklist developed by an international group to help investigators improve the reporting of livestock trials that have a production, health, or food-safety outcome. The long-term goal of reporting checklists such as the REFLECT statement and similar reporting guidelines, such as the CONSORT statement,[12] the ARRIVE statement for biomedical experiments,[13-17] and STROBE-Vet,[18-22] is to reduce research wastage and maximize research utility for decision-making through improved reporting. Therefore, it is critical to periodically evaluate reporting and determine if progress toward improved reporting is occurring. In 2018, a study was performed to assess the reporting characteristics of bovine respiratory disease clinical trials published before and following the publication of the REFLECT statement. The authors reported positive trends toward improved reporting after 2010.[23] However, to our knowledge, there are no studies in swine production assessing if reporting has improved in recent years coinciding with efforts such as the REFLECT statement and Meridian Network (**https://meridian.cvm.iastate.edu**), a website that acts as a clearinghouse for reporting guidelines related to animals used in research.

Reporting guidelines are designed to improve reporting with an underlying hope that once reporting is improved, end-users will be able to identify well-executed studies and clearly extract the results. It is also hoped that in reality the vast majority of studies are well executed, and that comprehensive reporting will enable this fact to be more obvious. Currently, it is often not possible to differentiate well-executed studies from poorly executed studies. If reporting is noncomprehensive then it is difficult, if not impossible, to differentiate between well-executed studies with a low risk-of-bias from poorly executed studies with a high risk-of-bias. For example, if 2 studies exist and one randomized properly and the other did not and neither reported randomization, then these differential risks-of-bias cannot be determined. However, not all aspects of reporting relate to risk-of-bias; some items are included to help end-users understand the generalizability of the results while other aspects are designed to help end-users properly comprehend the efficacy of the interventions. The lack of detail in reporting means that many studies with interventions of interest cannot be properly assessed by veterinarians, thus reducing the impact and utility of these studies. These aspects are still relevant as they ensure maximized utility of resources, including animals, involved in animal studies.

The objective of this study was to assess whether reporting and risk-of-bias standards have changed for swine vaccination trials in the publication period from 2011 to 2017 (post-REFLECT) compared to the publication period before 2011 (pre-REFLECT). Aim 1 described the proportion of studies reporting the allocation of study units to treatment group in studies published after the REFLECT statement compared to studies published before. Our hypothesis was that the proportion of articles reporting the allocation methods would have increased in recent years, as awareness of the impact of poor reporting has increased. Aim 2 described the proportion of studies reporting a random allocation approach in studies published after the REFLECT statement compared to studies published before. Our hypothesis was that the proportion of articles reporting a random allocation approach have increased in the last years; however, prior evidence suggests that there is some misunderstanding in the veterinary sciences of the difference between truly random and pseudo-random allocation approaches.[23] Aim 3 sought to describe the reporting prevalence of 18 REFLECT items in studies published after the REFLECT statement compared to studies published before. Our hypothesis was that the proportion of articles reporting the REFLECT items have increased over the years. Aim 4 sought to describe the proportion of studies having a low risk-of-bias assessment in studies published after the REFLECT statement compared to studies published before. Our hypothesis was that the proportion of articles having a low risk-of-bias assessment have increased over the years.

Materials and methods

Study protocol

A study protocol was developed and registered with the Open Science Framework.[24] For all aspects of the project (title and abstract screening, full-text screening, and risk-of-bias assessment), 2 reviewers independently completed forms in DistillerSR (Evidence Partners, Ottawa, Canada). Conflicts between reviewers were resolved by discussion or, when consensus could not be reached, by consulting a third reviewer. The authorship on the title page of each article was redacted before evaluation; however, because of the small community of researchers in this subject area, it was not possible to ensure that blinding occurred. Additionally, the reviewers could not be blinded to publication dates because the date on which the study was conducted was usually reported in the Methods section and was part of the comprehensive reporting assessment (Items 3 and 14). The screening form, the reporting assessment form, and the risk-of-bias form were pretested on 20, 2, and 4 studies respectively. All forms are provided in the online supplementary materials (**https://doi.org/10.25380/iastate.7946732.v1**).

Study population

For this cross-sectional observational survey, the population of interest was controlled trials where at least one study group received a vaccine targeting pathogens associated with swine health or food safety in pork. Further, the study had to be published in 1 of the 5 journals that published the REFLECT statement: *Preventive Veterinary Medicine*, *Journal of Food Protection*, *Journal of Veterinary Internal Medicine*, *Journal of Swine Health and Production*, and *Zoonoses and Public Health*. These journals were selected because they recommend authors to use the REFLECT statement. The outcome reported by the investigators did not impact eligibility. Controlled trials were defined as having a concurrent/parallel comparison arm with either artificial challenge or natural infection. The publication periods were defined as pre-REFLECT, which included 2010 and earlier, and post-REFLECT, which was 2011 and later. As REFLECT was published in 2010, we considered studies published in 2010 as being written before REFLECT.

Screening assessment

The literature search was conducted in Web of Science (Clarivate Analytics, United States) using the Centre for Agriculture and Bioscience International database using the search strategy presented in Table 1. Two levels of screening were used to identify eligible manuscripts: title and abstract followed by the full text.

Comprehensive reporting assessment

The reporting assessment form was based on a form developed for a bovine respiratory disease study,[23] which was in turn based on the REFLECT Statement[6-11] and was modified for use in swine. We assessed reporting 18 of the 22 REFLECT items (items 1 and 3-19). Items 2, 20, 21, and 22 were considered too subjective for a consistent and valid assessment. Signaling questions and notes that guided the consistent assessment of the items are included with the forms in the online supplementary materials (**https://doi.org/10.25380/iastate.7946732.v1**).

Risk-of-bias assessment

We used the Cochrane risk-of-bias 2.0 algorithm[25] to assess the risk-of-bias that arose from deviations from intended interventions, from missing outcome data, from measurement of the outcome, and from selection of the reported results. However, for assessing the risk-of-bias due to randomization process, we modified the algorithm so that it followed the schema in Figure 1. The risk-of-bias algorithm we used did not consider failure to report allocation concealment to be critical to assessing bias in swine vaccine trials, as is suggested by the Cochrane risk-of-bias algorithm. We would propose that the Cochrane risk-of-bias algorithm authors consider the allocation concealment important in human health because the knowledge of potential intervention might cause some recruiters to modify the allocation schedule. For example, Kahan et al,[26] described the following:

> If a recruiter believes the next allocation will be the intervention, they may wait to enroll a very sick patient, as they do not want to 'waste' an intervention allocation on a relatively healthy patient who is less likely to need it.

However, in swine vaccine studies, which are the topic of this study, we considered the probability that the recruiter had either differential personal attachment to the pig or *a priori* knowledge of the pig potential production value to be low.

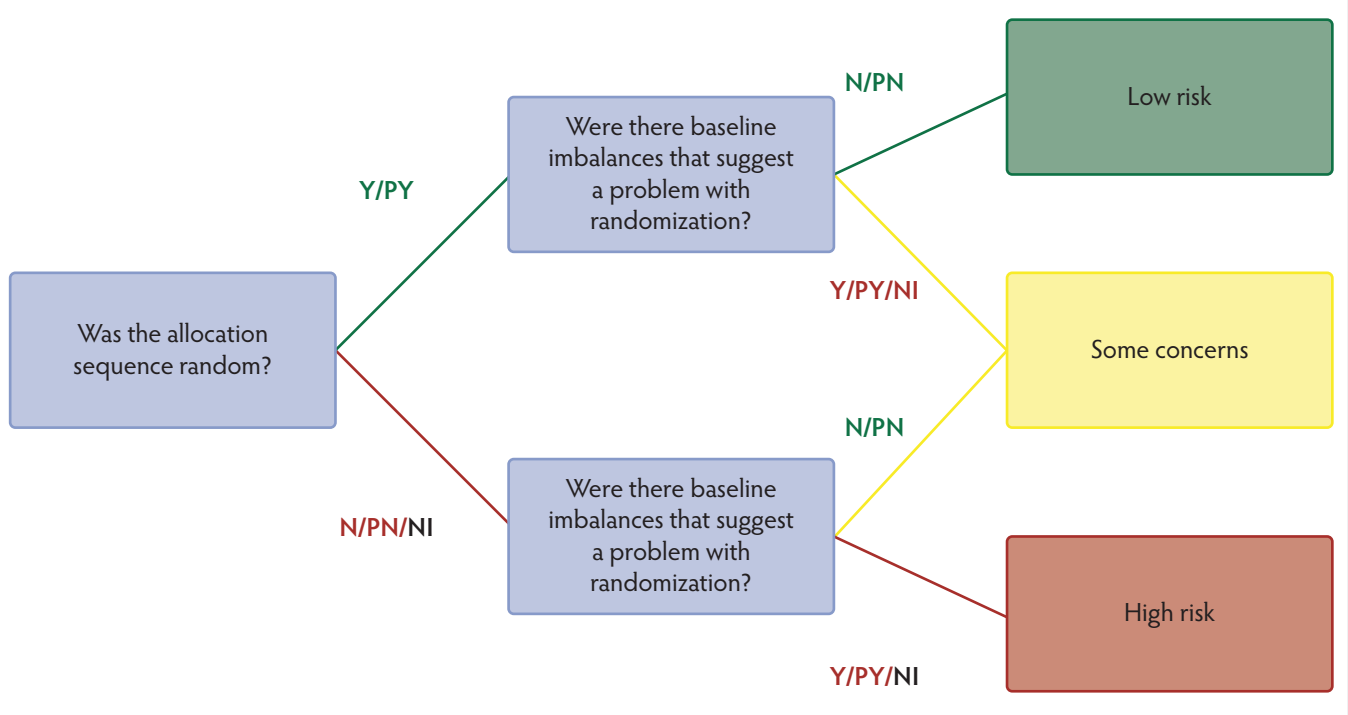
Therefore, we included the scenario where studies could fail to report allocation concealment and random method of allocation and this would result in a different pathway, with lower risk-of-bias, than the Cochrane Risk of Bias (ROB) 2.0 algorithm. We also

Table 1: Literature search for vaccination trials in swine from 1982-2017 conducted in Web of Science using the CABI database*

Search No.	Search string	No. of hits
1	Topic = (swine OR pig* OR piglet* OR gilt* OR boar* OR sow* OR weaner* OR hog* OR porcine OR pork* OR *Sus scrofa* OR *Sus domesticus*)	645,575
2	Topic = (Vaccin* OR immuniz*)	149,140
3	Journals = (*Preventive Veterinary Medicine* OR *Journal of Food Protection* OR *Journal of Veterinary Internal Medicine* OR *Swine Health and Production* OR *Journal of Swine Health and Production* OR *Zoonoses and Public Health*)	17,169
4	#1 AND #2 AND #3	239

* Search was conducted September 28, 2017.
CABI = Centre for Agriculture and Bioscience International.

Figure 1: Risk-of-bias algorithm arising from the allocation process used for 61 extracted swine vaccine studies published pre- or post-REFLECT publication. Y = yes; PY = probably yes; N = no; PN = probably no; NI = no information.



considered that providing no information about baseline differences to be more similar in risk to having evidence of baseline imbalances.

Our risk-of-bias assessment algorithm for individual and cluster-randomized trials (which are the trials that conduct the randomization at the group level, instead of at the individual animal level) are the same.

Statistical analysis

We estimated the prevalence ratios for the post-REFLECT publication period (numerator) compared to the pre-REFLECT publication period (denominator) for:

- reporting of any allocation method (Aim 1),
- reporting of a valid random allocation, given an allocation approach was reported (Aim 2),
- reporting 18 of the REFLECT items (Aim 3), and
- a low risk-of-bias assessment for the five bias domains (low versus high/some concerns; Aim 4).

We did not conduct any null hypothesis testing as they have limited value in an observational study of unknown pre-planned power. Additionally, since we sampled all available papers that met our eligibility criteria, we considered the population to be a census. Therefore, we did not calculate any measures of precision (confidence intervals), because we have no uncertainty about the point estimates reported. When we could not calculate the prevalence ratio due to zeros, we reported the results of a Fisher test for binomial proportions. All statistical analyses were done using R 3.4.1 program.

Results

Screening for eligibility and characteristics of included studies

The search retrieved 239 records. One hundred seventy-two records were excluded based on the title or abstract. Six papers were excluded based on the full-text assessment. For the 61 manuscripts assessed, 42 studies[27-68] were published before the REFLECT statement (date range: 1982-2010), while 19 studies[69-87] were published between 2011 and 2017. Forty-seven trials were published in the *Journal of Swine Health and Production* (formerly published as *Swine Health and Production*), 11 in *Preventive Veterinary Medicine*, 2 in *Zoonoses and Public Health*, and 1 in *Journal of Food Protection*. Only the *Journal of Swine Health and Production* and *Preventive Veterinary Medicine* had articles published from 2011 to 2017, with 14 and 5 papers, respectively. Fifty-six studies had individual allocation to an intervention group and 5 studies were cluster-randomized trials.

Aim 1: Reporting of an allocation method

Investigators reported in the title, abstract, or methods section the method used to allocate the experimental units to the interventions in 33 of 42 (79%) and 14 of 19 (74%) studies in the pre-REFLECT and post-REFLECT publication periods, respectively (Figure 2). The prevalence ratio was 0.94.

Aim 2: Approach to allocation reported

This outcome was limited to studies that reported an allocation approach in Aim 1. For 25 of 33 (76%) studies published before 2011 and 6 of 14 (43%) studies published between 2011-2017, the approach to allocation was reported as random. Before 2011, 23 of 25 (92%) studies that reported a random allocation approach did not provide any evidence of the randomization process, for example, the method used to generate the random allocation sequence, the method

used to implement the random allocation sequence, or who conducted the randomization process. Yet, in the period from 2011-2017, this number had decreased to 2 of 6 (33%) studies (Figure 2). Before 2011, only 2 of 25 (8%) studies that reported a random allocation approach provided evidence of the randomization process, and this increased in studies published between 2011 and 2017 to 4 of 6 (67%). Of the studies that did report information about allocation, 8 of the 33 studies (24%) published before 2011 and 6 of 14 (43%) studies published between 2011 and 2017 reported using a systematic allocation method. In systematic random allocation approaches, the researcher picks the first individual at random and keeps selecting the other subjects by alternation. Two studies published post-REFLECT reported another allocation method (non-random and arbitrary selection).

Figure 2: Distribution of allocation approaches reported in 61 swine vaccine studies published pre- or post-REFLECT publication.

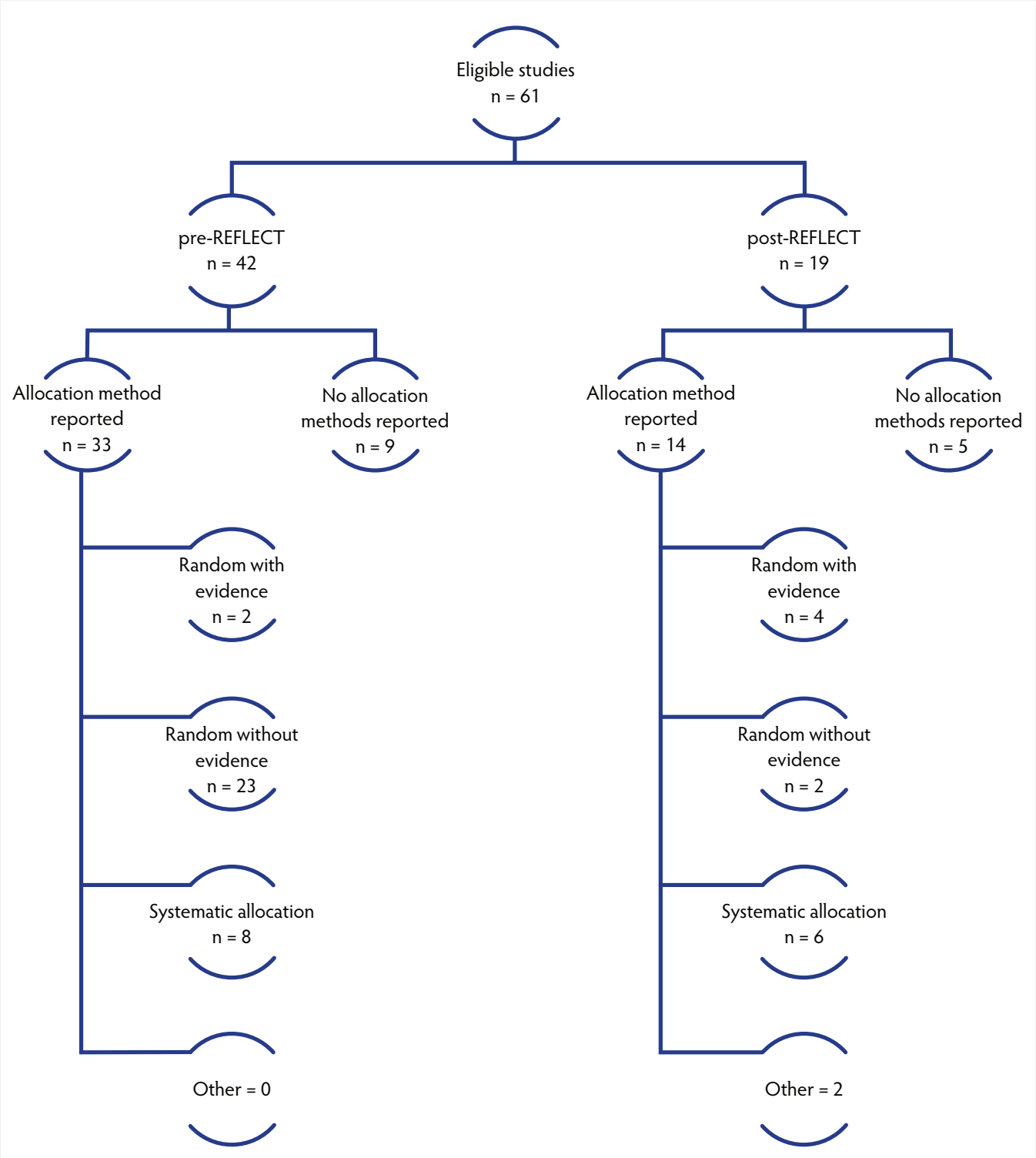


Table 2: Reporting characteristics of 18 REFLECT statement items from 61 extracted swine vaccine studies published pre- or post-REFLECT publication

REFLECT reporting items	Published studies reporting, No. (%)		Prevalence ratio
	Pre-REFLECT studies	Post-REFLECT studies	
Item 1: In the Title or Abstract, did the investigators report that the study units were randomly allocated to the interventions? (eg, "random allocation", "randomized", or "randomly assigned")	11/42 (26)	6/19 (32)	1.2
Item 3: In the Methods, did the investigators report eligibility criteria for owner/managers and study units at each level of the organizational structure, and did they describe the settings and locations where the data were collected?	2/42 (5)	4/19 (21)	4.4
Item 4: In the Methods, did the investigators give precise details of the interventions intended for each group, the level at which the intervention was allocated, and how and when interventions were administered?	28/42 (67)	15/19 (79)	1.2
Item 5: Did the investigators report the specific objectives and hypotheses of the study?	6/42 (14)	2/19 (11)	0.7
Item 6: Did the investigators give clearly defined primary outcome measures and the levels at which they were measured, and, when applicable, any methods used to enhance the quality of the measurements?	6/42 (14)	8/19 (42)	2.9
Item 7: Did the investigators report how the sample size was determined and, when applicable, explain any interim analyses and stopping rules?	7/42 (17)	7/19 (37)	2.2
Item 8: If the authors described an approach to allocation anywhere in the manuscript then did the investigators report the method used to generate the random allocation sequence at the relevant level of the organizational structure, including details of any restrictions (eg, blocking, stratification)?	2/25 (08)	4/6 (67)	8.3
Item 9: Did the investigators report the method used to implement the random allocation sequence at the relevant level of the organizational structure, (eg, numbered containers), clarifying whether the sequence was concealed until interventions were assigned?	0/25 (0)	0/6 (0)	*
Item 10: Did the investigators report who generated the allocation sequence, who enrolled study units, and who assigned study units to their groups at the relevant level of the organizational structure?	0/25 (0)	0/6 (0)	*
Item 11: Did the investigators report whether those administering the interventions, caregivers, and those assessing the outcomes were blinded to group assignment?	15/42 (36)	12/19 (63)	1.8
Item 12: Were statistical methods used to compare groups for all outcome(s)? Did the investigators clearly state the level of statistical analysis and methods used to account for the organizational structure (where applicable)? Were the methods for additional analyses, such as subgroup analyses and adjusted analyses reported?	34/42 (81)	17/19 (89)	1.1
Item 13: In the Results, did the investigators report the flow of study units through each stage for each level of the organization structure of the study (a diagram is strongly recommended)?	29/42 (69)	15/19 (79)	1.1
Item 14: Did the investigators report dates defining the periods of recruitment and follow-up?	12/42 (29)	5/19 (26)	0.9

Table 2 cont'd: Reporting characteristics of 18 REFLECT statement items from 61 extracted swine vaccine studies published pre- or post-REFLECT publication

REFLECT reporting items	Published studies reporting, No. (%)		Prevalence ratio
	Pre-REFLECT studies	Post-REFLECT studies	
Item 15: Did the investigators report the baseline demographic and clinical characteristics of each group, explicitly providing information for each relevant level of the organizational structure?	11/42 (26)	8/19 (42)	1.6
Item 16: Did the investigators report the number of study units (denominator) in each group included in each analysis?	25/42 (60)	15/19 (79)	1.3
Item 17: Did the investigators report a summary of results for each group, accounting for each relevant level of the organizational structure, and the estimated effect size and its precision?	1/42 (2)	3/19 (16)	6.6
Item 18: For the studies with 2 or more arms, did the investigators address multiplicity by reporting any other analyses performed, including subgroup analyses and adjusted analyses, indicating those pre-specified and those exploratory?	8/28 (29)	6/12 (50)	1.75
Item 19: Did the investigators report all important adverse events or side effects in each intervention group?	4/42 (10)	2/19 (11)	1.1

* not calculated

Aim 3: Reporting of REFLECT checklist items

The reporting characteristics for the REFLECT checklist items are reported in Table 2 and Figure 3. After REFLECT publication, the prevalence of reporting the following REFLECT items had improved: randomization in the title and abstract (item 1), eligibility criteria for owner/managers and study units and the description of settings (item 3), details of the interventions (item 4), primary outcome (item 6), how the sample size was calculated (item 7), method used to generate the random allocation sequence (item 8), whether or not blinding was done (item 11), whether statistical methods were used (item 12), flow of study units through the study (item 13), baseline demographic and clinical characteristics of each group (item 15), number of study units used in analysis (item 16), summary of results for each group - estimated effect size and its precision (item 17), multiplicity (item 18), and adverse events or side effects (item 19). After REFLECT publication, the prevalence of reporting the objective and hypothesis (item 5) and dates defining the periods of recruitment and follow-up (item 14) decreased. Concealment of the allocation sequence (item 9) as well as who generated the allocation sequence/who enrolled study units/who assigned study units to their groups (item 10) were not reported for any of the 61 studies reviewed. Data about reporting characteristics of the challenge models (REFLECT item 4B) are not shown in Figure 3, as it could not be dichotomized, and these results are instead reported in Table 3. The percentage of challenge model studies was higher in studies published before 2011 (21 of 42 studies; 50%) than between 2011 and 2017 (6 of 19 studies; 32%).

Aim 4: Risk-of-bias assessment

Of the 61 manuscripts assessed, 5 were cluster-randomized and published before 2011, so there were no cluster-randomized trials identified in the post-REFLECT period. The reporting characteristics of the 61 extracted studies for the risk-of-bias assessments are shown in Table 4. There was an increase in the prevalence of low risk-of-bias studies, based on the randomization process domain, between the post- and pre-REFLECT studies. All the other risk-of-bias domains appeared to be unchanged.

Discussion

One of the main advantages of randomized controlled trials is their ability to reduce confounding, a significant source of bias in the assessment of interventions.[88] It is interesting therefore that the prevalence of reporting an allocation method to study units was virtually unchanged (or decreased) in the two publication periods (79% to 74%). However, although the proportion of studies that reported using a random allocation method has decreased, the proportion of studies that reported using a systematic method has increased. This finding also occurred in other veterinary studies.[89] Two hypotheses might explain this finding: 1) that there has been a change in the approach to allocation away from random allocation to systematic allocation, and 2) that there has been a change in the language used to report systematic or haphazard allocation approaches in veterinary sciences. Studies that previously described the allocation method as random have changed the description of the method to reflect the actual approach ie, systematic allocation. The first hypothesis suggests that there was no reporting improvement on studies published after REFLECT. The second hypothesis suggests that reporting is improving, if the studies published before 2011 that used systematic or haphazard methods were misreporting or misrepresenting those approaches as random allocation. This latter hypothesis is supported by the increase in the number of studies that provided evidence for the designation of random allocation from 8% to 66%.

Figure 3: The prevalence comparison plot of 18 REFLECT items reported in 42 studies published before 2011 and 19 studies published between 2011 and 2017. Item 4B had multiple categories and is not included. Items 2 and 20 to 23 were considered too subjective for assessment and were not included.

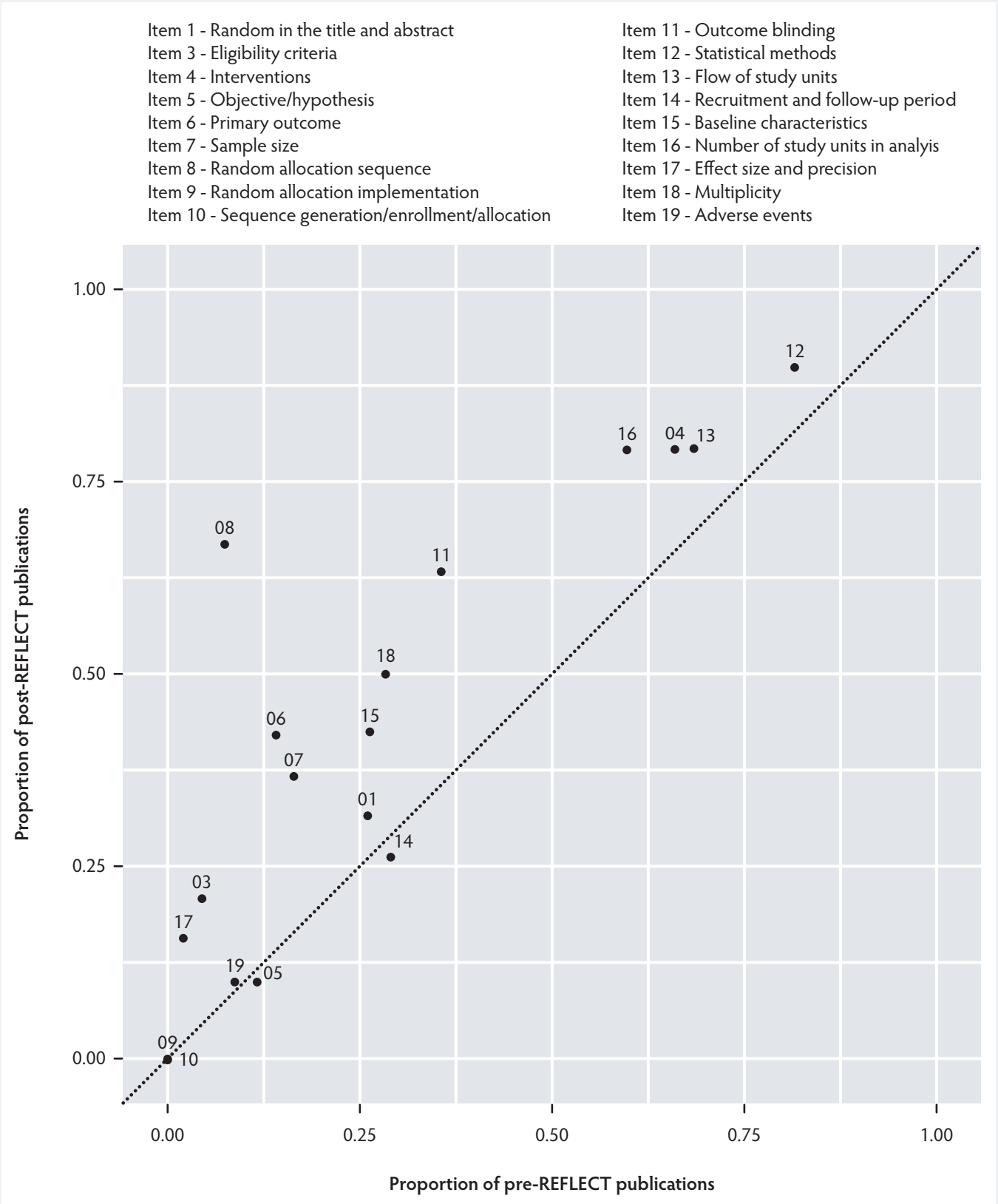


Table 3: Reporting characteristics of swine vaccine challenge studies (item 4B of REFLECT statement) published pre- or post-REFLECT publication.

Publication period	No. of challenge studies/ Total No. of studies (%)	No. of studies reporting item/ No. of challenge studies (%)
Pre-REFLECT studies	21/42 (50)	5/21 (24) – complete description: organism growth details, route of administration and dose of the organism
		13/21 (62) – partial description: route of administration and dose of the organism
		1/21 (5) – partial description: route of administration
		2/21 (10) – partial description: seeder pigs
Post-REFLECT studies	6/19 (32)	2/19 (11) – complete description: description of organism growth details, route of administration and dose of the organism
		4/19 (21) – route of administration and dose of the organism only

We attempted to identify in veterinary clinical trial texts where the concept of systematic or alternative allocation arose, and we cannot trace its origin. One study we are aware of discusses and recommends the use of alternative approaches as being equivalent to random allocation and practical, ie, every-other-calf or odd-and-even number schemes.[90] The authors suggested that valid random allocation is impractical in field settings and alternation could serve as a practical method under field conditions while still controlling confounding bias. We were not able to identify similar advice for swine studies, although apparently this approach is used commonly. What is unknown is if, and under what circumstances, a systematic allocation approach is an adequate replacement for random allocation. We were unable to find empirical evidence for this assumption.[90]

Another interesting finding is the number of studies that reported using a random allocation approach while providing no support for this statement. Although the percentage of studies reporting a random allocation approach was higher before 2011, most of those studies did not report details of the randomization process (23 of 25). The majority of studies (4 of 6) reporting a random allocation approach between 2011 and 2017 provided some information to support the randomization process. This finding suggests improved reporting.

For Aim 3, the results show an increase in the prevalence of reporting most of the REFLECT items and suggest that the overall reporting of swine intervention trials has improved. It is less clear whether improved reporting has translated into lower risk-of-bias. Although the risk-of-bias due to the randomization process appears to have decreased, the other risk-of-bias domains were unchanged. Even for the randomization process ROB domain, the evidence is poor because the low risk-of-bias was based on 2 studies published between 2011 and 2017 and 1 study before 2011.

Additional information is needed to determine if the increased reported use of systematic allocation is based on the tendencies of the industry and is, therefore, unlikely to change. It is also necessary to establish the true benefit of randomized over systematic allocation methods to determine if it is essential to use truly random approaches.[91] One approach would be to assess if there are differences in effect sizes in systematically allocated versus randomly allocated studies. Arguing against the need for such evidence is the fact that proper randomization to group is the established standard for intervention trials and the basis for inference. It is also not currently feasible to obtain empirical evidence that allocation concealment is associated with bias as there are too few studies that include this component for comparison to be made. Further, it is hard to envision veterinary schools and graduate programs teaching study design approaches that are not acceptable at the federal level for registration of drugs or vaccines, especially as so many livestock veterinarians are employed by the pharmaceutical and biologics industry to conduct trials. However, if evidence were found that some design elements identified by Cochrane ROB 2.0 are not relevant to livestock studies this would not be unprecedented. In human health, some groups have reported that some Cochrane risks-of-bias domains appear not to be related to empirical evidence of bias.[92]

Although reporting has improved, there remains room for improvement on all REFLECT items, since none of them were reported by all papers. However, it is unclear what would be the best way to make this improvement occur. The journals that published the studies all endorse the use of the REFLECT statement; however, none require a checklist be submitted or require that reviewers use REFLECT to assess the studies. Even if these journals did require that submitting authors include a completed reporting checklist there is no evidence that such an approach would improve reporting.[93] We would propose that several next steps are needed. It is essential that increased education efforts in veterinary schools, graduate programs, and groups involved in post-graduation professional development such as the American Association of Swine Veterinarians raise awareness of the value of improved reporting to veterinarians, especially as prior studies have shown that many editors are unaware of reporting guidelines.[94] These efforts will ensure that veterinarians are aware that poor reporting is associated with biased results and that veterinarians can recognize poor reporting. Further, more education of researchers

Table 4: The risk-of-bias assessment of the 61 extracted swine vaccine studies published pre- or post-REFLECT publication

	Published pre-REFLECT, No. (n = 42)			Published post-REFLECT, No. (n = 19)			Prevalence ratio*
Bias arising from ….	High	Some concerns	Low	High	Some concerns	Low	
Randomization process	32	9	1	11	6	2	4.42
Deviations from intended interventions	0	2	40	0	0	19	1.02
Missing outcome data	2	12	28	1	6	12	0.95
Measurement of the outcome	3	1	38	1	0	18	1.05
Selection of the reported results	2	40	0	1	18	0	†

* Prevalence ratio between low risk compared to some concerns and high risk combined.
† Not calculated.

about the obligation to provide stakeholders, including funding groups, veterinarians, and producers, with research reports that comprehensively describe the research is required. Providing comprehensive reports ensures that maximum value is obtained from the human and financial capital investment made in research studies. Also, very importantly, if the basic premise of the call for improved reporting is disputed, we would strongly support that such evidence be included in the peer-reviewed literature so that the role of comprehensive research reporting can be properly discussed among scientists and stakeholders.

Implications

- Substantially more studies are reporting the use of systematic allocation methods, and it is unclear if such an approach adequately ensures exchangeable groups.
- The prevalence of reporting a random allocation method decreased between the pre- and post-REFLECT studies; however, the prevalence of evidence to support a claim that valid random allocation was used has increased.
- The prevalence of reporting most REFLECT items increased between the pre- and post-REFLECT publication periods.
- The prevalence of low risk-of-bias due to the allocation approach might have increased between the pre- and post-REFLECT publication periods. Other risk-of-bias domains appear unchanged.

Acknowledgments

Contributions

Dr Moura contributed to the development of the study concept, the risk-of-bias modifications, performed data extraction, risk-of-bias assessment, data analysis, and preparation of manuscript drafts. Dr Totton performed data extraction, risk-of-bias assessment, and provided feedback on drafts of the manuscript. Dr Linhares contributed to the development of the study concept and approved the final report. Dr Sargeant contributed to the development of the study concept, the risk-of-bias modifications, and approved the final report. Dr O'Sullivan contributed to the development of the study concept, the risk-of-bias modifications, and approved the final report. Dr O'Connor contributed to the development of the study concept, the risk-of-bias modifications, data analysis, preparation of manuscript drafts, and approved the final report.

Declarations

Ethical approval for animal use or human subjects was not required for this project. All preplanned results are reported and modifications from the protocol are reported.

Funding

No external sources of funding were used for this project.

Conflict of interest

Drs O'Connor and Sargeant are co-authors of the REFLECT statement. Drs Moura, Linhares, Totton, and O'Sullivan have no conflicts of interest to declare.

Disclaimer

Scientific manuscripts published in the *Journal of Swine Health and Production* are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

References

*1. USDA Risk Management Agency. Study on Swine Catastrophic Disease. https://legacy.rma.usda.gov/pubs/2015/swinedisease.pdf. Published 2015. Accessed July 22, 2019.

2. Schroeder S, Harries M, Prager R, Höfig A, Ahrens B, Hoffmann L, Rabsch W, Mertens E, Rimek D. A prolonged outbreak of *Salmonella Infantis* associated with pork products in central Germany, April-October 2013. *Epidemiol Infect*. 2016;144(7):1429-1439.

3. Kuhn KG, Sorensen G, Torpdahl M, Kjeldsen MK, Jensen T, Gubbels S, Bjerager GO, Wingstrand A, Porsbo LJ, Ethelberg S. A long-lasting outbreak of *Salmonella* Typhimurium U323 associated with several pork products, Denmark, 2010. *Epidemiol Infect*. 2013;141(2):260-268.

4. Gossner CM, van Cauteren D, Le Hello S, Weill FX, Terrien E, Tessier S, Janin C, Brisabois A, Dusch V, Vaillant V, Jourdan-da Silva N. Nationwide outbreak of *Salmonella enterica* serotype 4,[5],12:i:-infection associated with consumption of dried pork sausage, France, November to December 2011. *Euro Surveill*. 2012;17(5):pii:20071.

5. Brace S, Taylor D, O'Connor AM. The quality of reporting and publication status of vaccines trials presented at veterinary conferences from 1988 to 2003. *Vaccine*. 2010;28(32):5306-5314.

6. O'Connor AM, Sargeant JM, Gardner IA, Dickson JS, Torrence ME, Dewey CE, Dohoo IR, Evans RB, Gray JT, Greiner M, Keefe G, Lefebvre SL, Morley PS, Ramirez A, Sischo W, Smith DR, Snedeker K, Sofos JN, Ward MP, Wills R, Consensus Meeting Participants. The REFLECT statement: methods and processes of creating reporting guidelines for randomized controlled trials for livestock and food safety. *J Food Prot*. 2010;73(1):132-139.

7. O'Connor AM, Sargeant JM, Gardner IA, Dickson JS, Torrence ME, Dewey CE, Dohoo IR, Evans RB, Gray JT, Greiner M, Keefe G, Lefebvre SL, Morley PS, Ramirez A, Sischo W, Smith DR, Snedeker K, Sofos J, Ward MP, Wills R, Steering Committee. The REFLECT statement: methods and processes of creating reporting guidelines for randomized controlled trials for livestock and food safety. *J Vet Intern Med*. 2010;24(1):57-64.

8. O'Connor AM, Sargeant JM, Gardner IA, Dickson JS, Torrence ME, Dewey CE, Dohoo IR, Evans RB, Gray JT, Greiner M, Keefe G, Lefebvre SL, Morley PS, Ramirez A, Sischo W, Smith DR, Snedeker K, Sofos J, Ward MP, Wills R. The REFLECT statement: methods and processes of creating reporting guidelines for randomized controlled trials for livestock and food safety. *Prev Vet Med*. 2010;93(1):11-18.

9. O'Connor AM, Sargeant JM, Gardner IA, Dickson JS, Torrence ME, Consensus Meeting Participants, Dewey CE, Dohoo IR, Evans RB, Gray JT, Greiner M, Keefe G, Lefebvre SL, Morley PS, Ramirez A, Sischo W, Smith DR, Snedeker K, Sofos J, Ward MP, Wills R. The REFLECT statement: methods and processes of creating reporting guidelines for randomized controlled trials for livestock and food safety by modifying the CONSORT statement. *Zoonoses Public Health*. 2010;57(2):95-104.

10. Sargeant JM, O'Connor AM, Gardner IA, Dickson JS, Torrence ME, Dohoo IR, Lefebvre SL, Morley PS, Ramirez A, Snedeker K. The REFLECT statement: reporting guidelines for randomized controlled trials in livestock and food safety: explanation and elaboration. *J Food Prot*. 2010;73(3):579-603.

11. Sargeant JM, O'Connor AM, Gardner IA, Dickson JS, Torrence ME, Consensus Meeting Participants. The REFLECT statement: reporting guidelines for randomized controlled trials in livestock and food safety: explanation and elaboration. *Zoonoses Public Health*. 2010;57(2):105-136.

12. Turner L, Shamseer L, Altman DG, Weeks L, Peters J, Kober T, Dias S, Schulz KF, Plint AC, Moher D. Consolidated standards of reporting trials (CONSORT) and the completeness of reporting of randomised controlled trials (RCTs) published in medical journals. *Cochrane Database Syst Rev*. 2012;11:MR000030.

13. Kilkenny C, Browne W, Cuthill IC, Emerson M, Altman DG, NC3Rs Reporting Guidelines Working Group. Animal research: reporting in vivo experiments: the ARRIVE guidelines. *Br J Pharmacol*. 2010;160(7):1577-1579.

14. Kilkenny C, Browne W, Cuthill IC, Emerson M, Altman DG, NC3Rs Reporting Guidelines Working Group. Animal research: reporting in vivo experiments: the ARRIVE guidelines. *J Gene Med*. 2010;12(7):561-563.

15. Kilkenny C, Browne W, Cuthill IC, Emerson M, Altman DG, National Centre for the Replacement Refinement and Reduction of Animals in Research. Animal research: reporting in vivo experiments--the ARRIVE guidelines. *J Cereb Blood Flow Metab*. 2011;31(4):991-993.

16. NC3Rs Reporting Guidelines Working Group. Animal research: reporting in vivo experiments: the ARRIVE guidelines. *J Physiol*. 2010;588(Pt 14):2519-2521.

17. NC3Rs Reporting Guidelines Working Group. Animal research: reporting in vivo experiments: the ARRIVE guidelines. *Exp Physiol*. 2010;95(8):842-844.

18. O'Connor AM, Sargeant JM, Dohoo IR, Erb HN, Cevallos M, Egger M, Ersbøll AK, Martin SW, Nielsen LR, Pearl DL, Pfeiffer DU, Sanchez J, Torrence ME, Vigre H, Waldner C, Ward MP. Explanation and elaboration document for the STROBE-Vet statement: Strengthening the reporting of observational studies in epidemiology-veterinary extension. *J Vet Intern Med*. 2016;30(6):1896-1928.

19. Sargeant JM, O'Connor AM, Dohoo IR, Erb HN, Cevallos M, Egger M, Ersbøll AK, Martin SW, Nielsen LR, Pearl DL, Pfeiffer DU, Sanchez J, Torrence ME, Vigre H, Waldner C, Ward MP. Methods and processes of developing the strengthening the reporting of observational studies in epidemiology - veterinary (STROBE-Vet) statement. *Zoonoses Public Health*. 2016;63(8):651-661.

20. Sargeant JM, O'Connor AM, Dohoo IR, Erb HN, Cevallos M, Egger M, Ersbøll AK, Martin SW, Nielsen LR, Pearl DL, Pfeiffer DU, Sanchez J, Torrence ME, Vigre H, Waldner C, Ward MP. Methods and processes of developing the strengthening the reporting of observational studies in epidemiology - veterinary (STROBE-Vet) statement. *J Vet Intern Med*. 2016;30(6):1887-1895.

21. Sargeant JM, O'Connor AM, Dohoo IR, Erb HN, Cevallos M, Egger M, Ersbøll AK, Martin SW, Nielsen LR, Pearl DL, Pfeiffer DU, Sanchez J, Torrence ME, Vigre H, Waldner C, Ward MP. Methods and processes of developing the strengthening the reporting of observational studies in epidemiology - veterinary (STROBE-Vet) statement. *Prev Vet Med*. 2016;134:188-196.

22. Sargeant JM, O'Connor AM, Dohoo IR, Erb HN, Cevallos M, Egger M, Ersbøll AK, Martin SW, Nielsen LR, Pearl DL, Pfeiffer DU, Sanchez J, Torrence ME, Vigre H, Waldner C, Ward MP. Methods and processes of developing the strengthening the reporting of observational studies in epidemiology-veterinary (STROBE-Vet) statement. *J Food Prot*. 2016;79(12):2211-2219.

23. Totton SC, Cullen JN, Sargeant JM, O'Connor AM. The reporting characteristics of bovine respiratory disease clinical intervention trials published prior to and following publication of the REFLECT statement. *Prev Vet Med*. 2018;150:117-125.

*24. O'Connor A, Moura C, Totton S, O'Sullivan T, Linhares D, Sargeant J. The reporting characteristics of swine intervention trials published prior to and following publication of the REFLECT statement. `https://osf.io/7qu8h/`. Published October 9, 2017. Updated January 28, 2019. Accessed July 22, 2019.

25. Higgins J, Sterne JA, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials. In: Chandler J, Clarke M, McKenzie J, Boutron I, Welch V, eds. Cochrane Methods. *Cochrane Database of Systematic Reviews*. 2016;10 (Suppl 1).:29-31. doi:10.1002/14651858.CD201601

26. Kahan BC, Rehal S, Cro S. Risk of selection bias in randomised trials. *Trials*. 2015;16:405.

27. Campbell TA, Garcia MR, Miller LA, Ramirez MA, Long DB, Marchand J-B, Hill F. Immunocontraception in male feral swine treated with a recombinant gonadotropin-releasing hormone vaccine. *J Swine Health Prod*. 2010;18(3):118-124.

28. King D, Painter T, Holtkamp D, DuBois P, Wang C. Effect of injection tool on incidence of head and neck abscesses at slaughter. *J Swine Health Prod*. 2010;18(6):290-293.

29. Husa JA, Edler RA, Walter DH, Holck JT, Saltzman RJ. A comparison of the safety, cross-protection, and serologic response associated with two commercial oral *Salmonella* vaccines in swine. *J Swine Health Prod*. 2009;17(1):10-21.

30. Desrosiers R, Clark E, Tremblay D, Tremblay R, Polson D. Use of a one-dose subunit vaccine to prevent losses associated with porcine circovirus type 2. *J Swine Health Prod*. 2009;17(3):148-154.

31. Schmoll F, Kauffold J, Pfützner A, Baumgartner J, Brock F, Grodzycki M, Andrews S. Growth performance and carcass traits of boars raised in Germany and either surgically castrated or vaccinated against gonadotropin-releasing hormone. *J Swine Health Prod*. 2009;17(5):250-255.

32. Najdenski H, Golkocheva-Markova E, Kussovski V, Vesselinova A, Garbom S, Wolf-Watz H. Attenuation and preserved immunogenic potential of Yersinia pseudotuberculosis mutant strains evidenced in oral pig model. *Zoonoses Public Health*. 2009;56(4):157-168.

33. Rapp-Gabrielson V, Hoover T, Sornsen S, Kesl L, Taylor L, Jolie R, Runnels P, Weigel D, Yu S, Opriessnig T, Ruebling-Jass K, Strait E, Halbur PG. Effects of *Mycoplasma hyopneumoniae* vaccination in pigs co-infected with *M hyopneumoniae* and porcine circovirus type 2. *J Swine Health Prod*. 2008;16(1):16-26.

34. Jirawattanapong P, Stockhofe-Zurwieden N, van Leengoed L, Binnendijk G, Wisselink HJ, Taymakers R, Cruijsen T, van der Peet-Schwering C, van Nes A, Nielen M. Efficacy of a subunit vaccine against *Actinobacillus pleuropneumoniae* in an endemically infected swine herd. *J Swine Health Prod*. 2008;16(4):193-199.

35. Strait E, Rapp-Gabrielson V, Erickson B, Evans RB, Taylor LP, Yonkers TK, Keich RL, Jolie R, Thacker EL. Efficacy of a *Mycoplasma hyopneumoniae* bacterin in pigs challenged with two contemporary pathogenic isolates of *M hyopneumoniae*. *J Swine Health Prod*. 2008;16(4):200-206.

36. Fangman TJ, Kleiboeker SB, Coleman M. Tonsilar crypt exudate to evaluate shedding and transmission of porcine reproductive and respiratory syndrome virus after inoculation with live field virus or vaccination with modified live virus vaccine. *J Swine Health Prod*. 2007;15(4):219-223.

37. Thomas PJ, Opriessnig T, Juhan NM, Meng XJ, Halbur PG. Planned exposure to porcine circovirus type 2 by serum injection is not effective at preventing porcine circovirus associated disease. *J Swine Health Prod*. 2007;15(6):330-338.

38. Allan GM, Caprioli A, McNair I, Lagan-Tregaskis P, Ellis J, Krakowka S, McKillen J, Ostanello F, McNeilly F. Porcine circovirus 2 replication in colostrum-deprived piglets following experimental infection and immune stimulation using a modified live vaccine against porcine respiratory and reproductive syndrome virus. *Zoonoses Public Health*. 2007;54(5):214-222.

39. Hoogland MJ, Opriessnig T, Halbur PG. Effects of adjuvants on porcine circovirus type 2-associated lesions. *J Swine Health Prod*. 2006;14(3):133-139.

40. Holyoake PK, Callinan APL. How effective is *Mycoplasma hyopneumoniae* vaccination in pigs less than three weeks of age? *J Swine Health Prod*. 2006;14(4):189-195.

41. Jones GF, Rapp-Gabrielson V, Wilke R, Thacker EL, Thacker BJ, Gergen L, Sweeney D, Wasmoen T. Intradermal vaccination for *Mycoplasma hyopneumoniae*. *J Swine Health Prod*. 2005;13(1):19-27.

42. Opriessnig T, Pallarés FJ, Nilubol D, Vincent AL, Thacker EL, Vaughn EM, Roof M, Halbur PG. Genomic homology of ORF 5 gene sequence between modified live vaccine virus and porcine reproductive and respiratory syndrome virus challenge isolates is not predictive of vaccine efficacy. *J Swine Health Prod*. 2005;13(5):246-253.

43. Loynachan AT, Nugent JM, Erdman MM, Harris DL. Acute infection of swine by various *Salmonella* serovars. *J Food Prot*. 2004;67(7):1484-1488.

44. Hodgins DC, Shewen PE, Dewey CE. Influence of age and maternal antibodies on antibody responses of neonatal piglets vaccinated against *Mycoplasma hyopneumoniae*. *J Swine Health Prod*. 2004;12(1):10-16.

45. Chernysheva L, Friendship R, Dewey C, Gyles C. The effect of dietary chicken egg-yolk antibodies on the clinical response in weaned pigs challenged with a K88$^+$ *Escherichia coli* isolate. *J Swine Health Prod*. 2004;12(3):119-122.

46. Oliveira S, Pijoan C, Morrison R. Evaluation of *Haemophilus parasuis* control in the nursery using vaccination and controlled exposure. *J Swine Health Prod*. 2004;12(3):123-128.

47. Dewulf J, Laevens H, Koenen F, Mintiens K, de Kruif A. Efficacy of E2-sub-unit marker and C-strain vaccines in reducing horizontal transmission of classical swine fever virus in weaner pigs. *Prev Vet Med*. 2004;65(3/4):121-133.

48. Dewey CE, Wilson S, Buck P, Leyenaar JAK. Effects of porcine reproductive and respiratory syndrome vaccination in breeding-age animals. *Prev Vet Med*. 2004;62(4):299-307.

49. Martens M, Rosales C, Morilla A. Evaluation of the use of a subunit classical swine fever marker vaccine under field conditions in Mexico. *J Swine Health Prod*. 2003;11(2):81-85.

50. Ruiz AR, Utrera V, Pijoan C. Effect of *Mycoplasma hyopneumoniae* sow vaccination on piglet colonization at weaning. *J Swine Health Prod*. 2003;11(3):131-135.

51. Liao C, Chiou H, Yeh K, Chen J, Weng C. Oral immunization using formalin-inactivated *Actinobacillus pleuropneumoniae* antigens entrapped in microspheres with aqueous dispersion polymers prepared using a co-spray drying process. *Prev Vet Med*. 2003;61(1):1-15.

52. Boettcher T, Thacker B, Halbur P, Waters W, Nutsch R, Thacker E. Vaccine efficacy and immune response to *Mycoplasma hyopneumoniae* challenge in pigs vaccinated against porcine reproductive and respiratory syndrome virus and *M hyopneumoniae*. *J Swine Health Prod*. 2002;10(6):259-264.

53. Charles SD, Abraham AS, Trigo ET, Jones GF, Settje TL. Reduced shedding and clinical signs of *Salmonella* Typhimurium in nursery pigs vaccinated with a *Salmonella* Choleraesuis vaccine. *Swine Health Prod*. 2000;8(3):107-112.

54. Benson JE, Yaeger MJ, Lager KM. Effect of porcine reproductive and respiratory syndrome virus (PRRSV) exposure dose on fetal infection in vaccinated and nonvaccinated swine. *Swine Health Prod*. 2000;8(4):155-160.

55. Amass SF, Stevenson GW, Vyverberg BD, Huxford TW, Knox KE, Grote LA. Administration of a homologous bacterin to sows prefarrowing provided partial protection against streptococcosis in their weaned pigs. *Swine Health Prod*. 2000;8(5):217-219.

56. Wongnarkpet S, Pfeiffer DU, Morris RS, Fenwick SG. An on-farm study of the epidemiology of *Actinobacillus pleuropneumoniae* infection in pigs as part of a vaccine efficacy trial. *Prev Vet Med*. 1999;39(1):1-11.

57. Wongnarkpet S, Morris RS, Pfeiffer DU. Field efficacy of a combined use of *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae* vaccines in growing pigs. *Prev Vet Med*. 1999;39(1):13-24.

58. Diekman MA, Scheidt AB, Grant AL, Kelly DT, Sutton AL, Martin TG, Cline TR. Effect of vaccination against *Mycoplasma hyopneumoniae* on health, growth, and pubertal status of gilts exposed to moderate ammonia concentrations in all-in-all-out versus continuous-flow systems. *Swine Health Prod*. 1999;7(2):55-61.

59. Sornsen SA, Zimmerman JJ, Polson DD, Roof MB. Effect of PRRS vaccination on average daily gain: a comparison of intranasal and intranasal-intramuscular administration. *Swine Health Prod*. 1998;6(1):13-19.

60. Thacker EL, Thacker BJ, Boettcher TB, Jayappa H. Comparison of antibody production, lymphocyte stimulation, and protection induced by four commercial *Mycoplasma hyopneumoniae* bacterins. *Swine Health Prod*. 1998;6(3):107-112.

61. Drum SD, Walker RD, Marsh WE, Mellencamp MM, King VL. Growth performance of segregated early-weaned versus conventionally weaned pigs through finishing. *Swine Health Prod*. 1998;6(5):203-210.

62. Torremorell M, Pijoan C, Trigo E. Vaccination against *Streptococcus suis*: effect on nursery mortality. *Swine Health Prod*. 1997;5(4):139-143.

63. Papatsas IC, Kyriakis SC, Papadopoulos O, Sarris KJ, Lekkas S. Intradermal vaccination against pseudorabies virus and swine influenza in growing/finishing pigs. *Swine Health Prod*. 1996;4(6):279-285.

64. Schinckel AP, Clark LK, Stevenson G, Knox KE, Nielsen J, Grant AL, Hancock DL, Turek J. Effects of antigenic challenge on growth and composition of segregated early-weaned pigs. *Swine Health Prod*. 1995;3(6):228-234.

65. Swenson SL, Hill HT, Zimmerman JJ, Evans LE, Wills RW, Yoon K-J, Schwartz KJ, Althouse GC, McGinley MJ, Brevik AK. Preliminary assessment of an inactivated PRRS virus vaccine on the excretion of virus in semen. *Swine Health Prod*. 1995;3(6):244-247.

66. Scheidt AB, Mayrose VB, van Alstine WG, Clark LK, Cline TR, Einstein ME. The effects of vaccinating pigs for mycoplasmal pneumonia in a swine herd affected by enzootic pneumonia. *Swine Health Prod*. 1994;2(1):7-11.

67. Morrow WEM, Iglesias G, Stanislaw C, Stephenson A, Erickson G. Effect of a mycoplasma vaccine on average daily weight gain in swine. *Swine Health Prod*. 1994;2(6):13-18.

68. Nabuurs MJA, Bokhout BA, van der Heijden PJ. Intraperitoneal injection of an adjuvant for the prevention of post-weaning diarrhea and oedema disease in piglets: a field study. *Prev Vet Med*. 1982;1(1):65-76.

69. Nielsen GB, Nielsen JP, Haugegaard J, Denwood MJ, Houe H. Effect of vaccination against sub-clinical porcine circovirus type 2 infection in a high-health finishing pig herd: a randomised clinical field trial. *Prev Vet Med*. 2017;141:14-21.

70. Kang I, Kang H, Jeong J, Park C, Choi K, Park S-J, Sung HJ, Park EK, Oh B, Kim S-H, Chae C. Comparison of growth performance under field conditions in growing pigs each vaccinated with one of two commercial modified-live porcine reproductive and respiratory syndrome vaccines. *J Swine Health Prod*. 2017;25(1):24-28.

71. Jeong J, Kang H, Park C, Seo HW, Kang I, Choi K, Chae C. 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.

72. O'Sullivan TL, Johnson R, Poljak Z, Gu Y, DeLay J, Friendship RM. An experimental study with a vaccine strain of porcine reproductive and respiratory syndrome virus to determine effects on viremia assessed by reverse transcriptase-polymerase chain reaction in pigs fed rations medicated with tilmicosin or non-medicated. *J Swine Health Prod*. 2016;24(2):81-92.

73. Young MG, Cunningham GL, Sanford SE. Circovirus vaccination in pigs with subclinical porcine circovirus type 2 infection complicated by ileitis. *J Swine Health Prod*. 2011;19(3):175-180.

74. Scherba G, Bromfield CR, Jarrell VL, Shipley CF. Evaluation of responses to both oral and parenteral immunization modalities for porcine epidemic diarrhea virus in production units. *J Swine Health Prod*. 2016;24(1):29-35.

75. Palzer A, Eddicks M, Zoels S, Stark J, Reese S, Strutzberg-Minder K, Fiebig K, Ritzmann M. Field evaluation of the efficacy, compatibility and serologic profiling of a combined vaccine against porcine reproductive and respiratory syndrome and *Haemophilus parasuis* in nursery pigs. *Prev Vet Med*. 2015;119(3/4):134-140.

76. Fraile L, Segalés J, Ticó G, López-Soria S, Valero O, Nofrarias M, Huerta E, Llorens A, López-Jiménez R, Pérez D, Sibila M. Virological and serological characterization of vaccinated and non-vaccinated piglet subpopulations coming from vaccinated and non-vaccinated sows. *Prev Vet Med*. 2015;119(3-4):153-161.

77. Seo H, Lee J, Park C, Kim HJ, Kwak T-K, Kim S-H, Chae C. Comparison of commercial one-dose and two-dose baculovirus-expressed porcine circovirus type 2 subunit vaccines. *J Swine Health Prod*. 2014;22(6):291-295.

78. Linhares DCL, Cano JP, Torremorell M, Morrison RB. Comparison of time to PRRSv-stability and production losses between two exposure programs to control PRRSv in sow herds. *Prev Vet Med*. 2014;116(1-2):111-119.

79. Scheid IR, Oliveira FTT Jr, Borges AC, Braga TF, Soncini RA, Mathur S, Allison JR, Hennessy DP. A single dose of a commercial anti-gonadotropin releasing factor vaccine has no effect on testicular development, libido, or sperm characteristics in young boars. *J Swine Health Prod*. 2014;22(4):185-192.

80. Hillen S, von Berg S, Kohler K, Reinacher M, Willems H, Reiner G. Occurrence and severity of lung lesions in slaughter pigs vaccinated against *Mycoplasma hyopneumoniae* with different strategies. *Prev Vet Med*. 2014;113(4):580-588.

81. Beckler DC, Segal MU, Weiss DL, Nimmo RD, Guggenbiller DJ. Virginiamycin: lack of interference with *Lawsonia intracellularis* immunization. *J Swine Health Prod*. 2013;21(5):253-260.

82. Baker SR, Mondaca E, Polson D, Dee SA. Evaluation of a needle-free injection device to prevent hematogenous transmission of porcine reproductive and respiratory syndrome virus. *J Swine Health Prod*. 2012;20(3):123-128.

83. Shen HG, Loiacono CM, Halbur PG, Opriessnig T. Age-dependent susceptibility to porcine circovirus type 2 infections is likely associated with declining levels of maternal antibodies. *J Swine Health Prod*. 2012;20(1):17-24.

84. Potter ML, Tokach LM, Dritz SS, Henry SC, DeRouchey JM, Tokach MD, Goodband RD, Nelssen JL, Rowland RRR, Hesse RA, Oberst R, Anderson J, Hays M. Genetic line influences pig growth rate responses to vaccination for porcine circovirus type 2. *J Swine Health Prod*. 2012;20(1):34-43.

85. Venegas-Vargas MC, Bates R, Morrison R, Villani D, Straw B. Effect of porcine circovirus type 2 vaccine on postweaning performance and carcass composition. *J Swine Health Prod*. 2011;19(4):233-237.

86. Jacela JY, Dritz SS, DeRouchey JM, Tokach MD, Goodband RD, Nelssen JL. Field evaluation of the effects of a porcine circovirus type 2 vaccine on finishing pig growth performance, carcass characteristics, and mortality rate in a herd with a history of porcine circovirus-associated disease. *J Swine Health Prod*. 2011;19(1):10-18.

87. Fangman TJ, Johnson AK, Okones J, Edler RA. Willingness-to-approach behavior of weaned pigs after injection with *Mycoplasma hyopneumoniae* vaccines. *J Swine Health Prod*. 2011;19(1):19-25.

88. Dohoo IR. The design of randomized controlled trials of veterinary vaccines. *Anim Health Res Rev*. 2004;5(2):235-238.

89. Yuan C, Krull A, Wang C, Erdman M, Fedorka-Cray PJ, Logue CM, O'Connor AM. Changes in the prevalence of *Salmonella* serovars associated swine production and correlations of avian, bovine and swine-associated serovars with human-associated serovars in the United States (1997-2015). *Zoonoses Public Health*. 2018;65(6):648-661.

90. Perino LJ, Apley MD. Clinical trial design in feedlots. *Vet Clin North Am Food Anim Pract*. 1998;14(2):343-365.

91. Mansournia MA, Higgins JP, Sterne JA, Hernan MA. Biases in randomized trials: A conversation between trialists and epidemiologists. *Epidemiology*. 2017;28(1):54-59.

92. Bolvig J, Juhl CB, Boutron I, Tugwell P, Ghogomu EAT, Pardo JP, Rader T, Wells GA, Mayhew A, Maxwell L, Lund H, Bliddal H, Christensen R, Editorial Board of the Cochrane Musculoskeletal Group. Some Cochrane risk-of-bias items are not important in osteoarthritis trials: a meta-epidemiological study based on Cochrane reviews. *J Clin Epidemiol*. 2018;95:128-136.

93. Hair K, Macleod MR, Sena ES. A randomised controlled trial of an intervention to improve compliance with the ARRIVE guidelines (IICARus). *Res Integr Peer Rev*. 2019;4:12.

94. Grindlay DJ, Dean RS, Christopher MM, Brennan ML. A survey of the awareness, knowledge, policies and views of veterinary journal Editors-in-Chief on reporting guidelines for publication of research. *BMC Vet Res*. 2014;10:10.

* Non-refereed references.

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

Modified wean-to-finish mat as an alternative handling tool for moving grow-finish pig cadavers: A pilot study

Ella E. Akin BS; Anna K. Johnson, PhD; Jason W. Ross, PhD; Suzanne T. Millman, PhD; Cassandra D. Jass, DVM; John P. Stinn, PhD; Kenneth J. Stalder, PhD

Summary

Through the National Pork Board, the US pork industry provides recommendations for humane handling tools and acceptable non-ambulatory pig handling methods. While these recommendations are useful, there is a lack of published evidence regarding the efficacy of humane handling tools commercially available for moving non-ambulatory pigs. Wean-to-finish mats are commonly used on-farm to provide comfortable resting areas for newly weaned pigs and to minimize feed waste around feeders. The objective of this project was to test a commercial wean-to-finish mat as a humane handling tool for non-ambulatory grow-finish pigs. On-farm testing was accomplished using pig cadavers (n = 3; 135, 118, and 68 kg) to evaluate mat effectiveness based on employee effort and preference. Our results do not support wean-to-finish mats as effective handling tools for moving non-ambulatory grow-finish pigs.

Keywords: swine, caretakers, grow-finish pig, handling tools, non-ambulatory pigs

Received: February 4, 2019
Accepted: May 2, 2019

Resumen - Tapete modificado de destete a finalización como herramienta alternativa de manejo para mover cadáveres de cerdos de crecimiento-finalización: un estudio piloto

A través de la National Pork Board (NPB por sus siglas en inglés), la industria porcina de Estados Unidos ofrece recomendaciones para herramientas de manejo humanitario y métodos aceptables de manejo para cerdos no-ambulatorios. Si bien estas recomendaciones son útiles, hay una falta de evidencia publicada sobre la eficacia de las herramientas de manejo humanitario disponibles comercialmente para mover cerdos no-ambulatorios. Los tapetes de destete-finalización se usan comúnmente en la granja para proporcionar áreas de descanso cómodas para cerdos recién destetados y para minimizar el desperdicio de alimento alrededor de los comederos. El objetivo de este estudio fue probar un tapete comercial de destete-finalización como una herramienta de manejo humanitario para cerdos no-ambulatorios en el crecimiento. Las pruebas en la granja se realizaron con cadáveres de cerdos (n = 3; 135, 118, 68 kg) para evaluar la efectividad del tapete en función del esfuerzo y la preferencia de los empleados. Nuestros resultados no apoyan a los tapetes de destete-finalización como una herramienta de manejo efectiva para mover cerdos no-ambulatorios en crecimiento a finalización.

Résumé - Tapis pour porcs en pouponnière-finition comme moyen alternatif pour déplacer les cadavres de porcs en croissance-finition: Étude pilote

Via le Conseil National du Porc, l'industrie porcine des États-Unis fournie des recommandations sur des outils de manipulation humanitaires et des méthodes de manipulation acceptables pour les porcs non-ambulatoires. Bien que ces recommandations soient utiles, il y a un manque de preuves publiées concernant l'efficacité des outils de manipulation humanitaires commerciale-ment disponibles pour déplacer les porcs non-ambulatoires. Les tapis pour porcs en pouponnière-finition sont fréquemment utilisés pour fournir des zones de repos confortables pour les porcs récemment sevrés et pour minimiser le gaspillage d'aliments autour des trémies. L'objectif de ce projet était de tester un matelas commercial pour les porcs en pouponnière-finition comme outil de manipulation humanitaire pour des porcs non-ambulatoires en croissance-finition. Des tests à la ferme ont été réalisés en utilisant des cadavres de porcs (n = 3; 135, 118, 68 kg) afin d'évaluer l'efficacité de tapis basée sur les efforts des employés et les préférences. Nos résultats permettent de conclure que les tapis pour porcs en pouponnière-finition ne sont pas des outils de manipulation efficaces pour déplacer des porcs non-ambulatoires en croissance-finition.

The National Pork Board provides recommendations for humane handling of non-ambulatory swine through the Pork Quality Assurance Plus and Transport Quality Assurance programs.[1,2] Building on these educational programs, the Common Swine Industry Audit (CSIA) is an audit tool designed to meet company and customer needs by validation of on-farm practices impacting animal welfare and food safety and includes requirements for humane swine handling.[3] As a critical element of the CSIA, willful acts of abuse and neglect are strictly prohibited and can result in automatic audit failure.

EEA, AKJ, JWR, KJS: Department of Animal Science, College of Agriculture and Life Sciences, Iowa State University, Ames, Iowa.

STM: Department of Veterinary Diagnostic and Production Animal Medicine and Biomedical Sciences, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

CDJ, JPS: Iowa Select Farms, Iowa Falls, Iowa.

Corresponding author: Dr Anna K. Johnson, 2356F Kildee Hall, Department of Animal Science, Iowa State University, Ames, IA 50011; Tel: 515-294-2098; Fax: 515-294-4471; Email: johnsona@iastate.edu.

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

Akin EE, Johnson AK, Ross JW, et al. Modified wean-to-finish mat as an alternative handling tool for moving grow-finish pig cadavers: A pilot study. *J Swine Health Prod.* 2019;27(5):278-283.

Willful acts of abuse and neglect is partially defined as "[d]ragging of conscious animals by any part of their body except in the rare case where a non-ambulatory animal must be moved from a life-threatening situation. Non-ambulatory pigs may be moved by using a drag mat."[3] Despite this requirement, there is a lack of published evidence to guide producers on commercially available options and efficacy of humane handling tools available for use with non-ambulatory pigs, including design of drag mats.

Non-ambulatory pigs can occur on-farm due to injury, illness, or fatigue during daily operations or loading and unloading from transport trailers. Hence, employees may be required to move non-ambulatory pigs into or out of pens, alleys, and load-out areas. Wean-to-finish mats are commonly used on-farm to provide comfortable resting areas for newly weaned pigs, to minimize waste around feeders, and for lame pigs.[4-9] The objective of this project was to test a commercial wean-to-finish mat as a humane handling tool for non-ambulatory grow-finish pigs.

Materials and methods

All research was approved by Iowa State University Institutional Review Board for Human Subject Research (Approval No. 18-003). On-farm testing was accomplished using pig cadavers rather than live animals, therefore, Institutional Animal Care and Use Committee approval was not needed.

Wean-to-finish mat and modifications

Four wean-to-finish mats were purchased from Hog Slat (SKU: 544187F, Humboldt, Iowa). Each mat weighed 23.1 kg, measured 1.8 m long × 1.2 m wide × 1.3 cm deep, and were made of Nyracord rubber (Figure 1A). Modifications were performed to reduce mat width, improve stability, and to affix handles. These modifications took approximately 45 minutes to complete for each mat. Modifications consisted of cutting a mat down its length to produce 2 separate drag mats. To add stability to each wean-to-finish mat, two PVC trim boards (55.9 cm long × 8.9 cm wide × 2.5 cm deep) were centered and attached 12.7 cm from the top of the mat on the top and bottom surfaces. The PVC trim boards were affixed using 2 carriage bolts (1.3×7.6 cm^2), 2 flat washers (1.3 cm), and 2 hex nuts (1.3 cm; 13 thread size) and 4 exterior wood screws (8×5.1 cm^2) were drilled into the PVC trim boards. To affix handles, 2 holes were drilled into the PVC trim boards and a 2.7 m polypropylene rope was inserted and knotted on the top surface. The final modified wean-to-finish mat dimensions were 1.8 m long × 60.9 cm wide (Figures 1B and 1C). Each mat cost $44 plus modification costs of $31 for a total cost of $75 per mat.

Animals and facilities

The study was conducted on a commercial grow-finish site in central Iowa (Table 1). Three commercial crossbred pigs identified as euthanasia candidates were selected from the hospital pen by the company veterinarian. Two pigs had a belly rupture as a result of abdominal contents passing through the midline defect of the umbilicus and the third pig had a chronic illness due to poor body condition, injury, or bacteria/virus disease. The 3 compromised pigs were euthanized according to company protocols, which were consistent with industry guidelines.[10] Prior to euthanasia, pigs were able to individually walk to a weigh scale (Raytec WayPig 300; AGRIsales Inc, Ceresco, Nebraska) where body weights were collected and rounded up to the nearest whole number. The cadavers weighed 68 kg, 118 kg, and 135 kg.

Employee enrollment

Six English-speaking employees (five male and one female) were enrolled in the study by the company veterinarian. Employees ranged in age from 23 to 60 years, in height from 106.2 to 195.6 cm, in weight from 63.5 to 133.8 kg, and in experience from 1 to 30 years. The employees comprised members of the production well-being team, the engineering team, and the farm manager. On the day of the study, each employee was asked to complete a demographics questionnaire prior to completing the cadaver movements using the mat.

Cadaver movement

Two empty pens were designated as the home pen (start) and hospital pen (end). Both pens were fully slatted (12.7 cm slat width × 2.5 cm slot width) and the alley was partially slatted with a solid concrete center (115.8 m × 30.3 cm). The distance between the entrance of the home pen and entrance of the hospital pen was 57.9 m. Each cadaver was positioned inside the home pen, 2.8 m from the alleyway gate and 2.3 m from the right pen divider, and oriented with the head towards the alleyway. At the start of each cadaver movement, the employee was asked to roll the cadaver onto the mat and move it from the home pen to the hospital pen. For all employees, the cadaver movements were performed using the heaviest to the lightest cadavers. Time to complete cadaver movement was measured at three time points: 1) Duration to roll cadaver from home pen floor onto the mat. 2) Duration to move mat and cadaver from the home pen into the alleyway, defined as the mat being entirely inside the alley and oriented towards the hospital pen. 3) Duration to move mat and cadaver along the alleyway and into the hospital pen, defined as the mat being entirely inside the hospital pen.

Peak exertion force

An FGV-HXY High Capacity Digital Force Gauge (Nidec-SHIMPO America Corporation, Itasca, Illinois) was attached to the mat handle to record peak force applied by the employee while moving the cadaver. Each employee held his or her arms with the force gauge positioned at waist height and pulled for 5 continuous seconds. Peak force was collected during the cadaver movement in 2 locations: in the alleyway immediately outside the home pen and inside the hospital pen.

Employee physiologic measures

One researcher collected each employee's physiologic measures at 2 different time points: baseline resting levels in the home pen and post exertion levels collected immediately after moving each cadaver. A pulse oximeter (Pulse Oximeter 50DL; Clinical Guard, Atlanta, Georgia) was placed onto the employee's index finger to collect heart rate and oxygen saturation. Consistent with other studies,[11,12] a minimum 5-minute resting period was provided between movement of each cadaver to allow physiologic measures to return to baseline levels.

Employee evaluation and mat durability

During each resting period, employees were asked to evaluate the mat using the survey described in Table 2. The mat was moved 3 times per employee resulting in the mat tool evaluation being completed 18 times. Comments were also solicited for each question to collect qualitative data.

Durability of the mat was evaluated by one of the researchers for presence of holes, rips, and creases at the conclusion of each cadaver movement. If observed, these were counted, measured, and photographed.

Statistical analysis

The mat tool survey responses were evaluated by calculating the mean and standard

Figure 1: A) The wean-to-finish mat was modified in order to safely move a grow-finish pig cadaver from the home pen to the hospital pen. The original wean-to-finish mat dimensions were 1.8 m long × 1.2 m wide × 1.3 cm deep. B) Top side of the modified mat. The mat was modified by adding two 55.9 cm pieces of PVC trim board (one located on the top and one on the bottom), 2 carriage bolts, 2 flat washers, 2 hex nuts, and 4 exterior screws to provide a durable re-enforcement. A 2.7 m polypropylene rope was attached to create a handle using the 2 empty holes located to the inside of the carriage bolts. The final mat dimensions were 1.8 m long × 0.6 m wide × 1.3 deep. C) Bottom side of the mat had the second PVC trim board and 2 hollow holes where the 2.7 m polypropylene rope was attached.

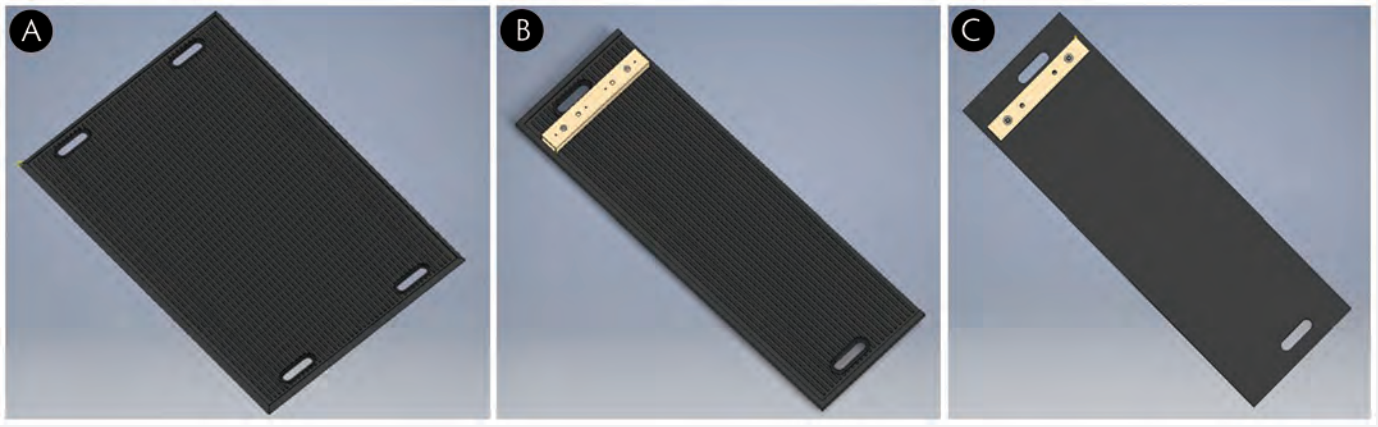


Table 1: Building and production specifications of the central Iowa commercial grow-finish site where the mat was evaluated as a handling tool to move grow-finish pig cadavers

Measure	Details
Site capacity, No. pigs	5,350
Projected market weight, kg	127
No. of barns	1
Rooms per barn	1
Space allowance, m^2	0.67
No. pigs/pen	30
Barn width, m	12.5
Barn length, m	115.8
Pens/barn	64
Pen width, m	3.1
Pen depth, m	5.8
Pen flooring	Fully slatted concrete
Slat width, cm	12.7
Slot width, cm	2.5
Alley width, cm	53.3
Gate width, cm	82.6
Gate length, m	2.7
Distance of cadaver movement, m	57.9

deviation of 6 employees. Mat durability was evaluated by counting and measuring holes, rips, and creases after movement from the home pen to the hospital pen. Two new variables were created for employee heart rate and oxygen saturation:

Change in heart rate (bpm) = hospital pen heart rate – baseline resting heart rate

Change in oxygen saturation (%) = hospital pen post exertion oxygen saturation – baseline resting oxygen saturation

The distribution of the peak exertion force, cadaver movement duration, change in heart rate, and change in oxygen saturation were evaluated using the PROC UNIVARIATE procedure (SAS v 9.2, SAS Inst, Inc, Cary, North Carolina). Data met the assumption of normality and were analyzed using a mixed model method (PROC MIXED) for parametric data. Employee was the experimental unit. The statistical design was a complete randomized design with the statistical model including the fixed effect of employee (n = 6) and cadaver (n = 3). A $P \leq .05$ was considered significant and PDIFF option was used to separate means when fixed effects were significant sources of variation.

Results and discussion

Duration of cadaver movement

Time to move the cadaver onto the mat did not differ between employees ($P = .87$) or

Table 2: Employee mat tool survey*

Questions†					
1. Rate mat for:					
a) Rolling cadaver from home pen floor onto mat	5	4	3	2	1
2. Positioning ease of cadaver onto mat:‡					
a) Home pen	5	4	3	2	1
b) Alley	5	4	3	2	1
3. Rate mat for:					
a) Moving mat in home pen towards pen gate	5	4	3	2	1
b) Moving mat out of home pen and into alley	5	4	3	2	1
c) Moving mat down the alley to hospital pen	5	4	3	2	1
4. Rate mat for:					
a) Mat size to move cadaver§	5	4	3	2	1
b) Mat weight to move cadaver¶	5	4	3	2	1
5. Do you think the mat could easily be used to move a non-ambulatory market-weight pig		Yes		No	
6. Would you recommend this mat to other producers to move a non-ambulatory market-weight pig		Yes		No	

* During each resting period, employees were asked to evaluate the mat using the mat tool survey. Each employee (n = 6) filled out 3 surveys, one per cadaver (n = 3), for a total of 18 surveys completed.
† Survey responses were scored on a 5-point scale (5 = very easy, 4 = easy, 3 = neutral, 2 = difficult, and 1 = very difficult) for questions 1 through 4. Questions 5 and 6 were scored as Yes or No.
‡ Positioning defined as cadaver head positioned toward handle and legs/body centered on the mat.
§ Mat size defined as whether the length and width affected movement ease.
¶ Mat weight defined as whether the weight affected movement ease.

cadavers ($P = .30$). Mean duration (SE) to move cadavers onto the mat was 5.7 (4.6) seconds (range, 2-13 seconds; 135 kg), 7.5 (3.6) seconds (range, 3-13 seconds; 118 kg) and 3.7 (1.9) seconds (range, 2-7 seconds; 68 kg).

No employee was able to complete the entire movement such that none of the cadavers were moved into the hospital pen using the mat. The mean duration for failed attempts was 9.0 seconds.

Only 1 employee was able to move all cadavers into the alleyway with a mean (SE) duration of 37.3 (12.7) seconds; 2 employees were able to move the heavier and lighter cadaver into the alleyway (mean [SE] duration; 68 kg: 11 [5.7] seconds; 135 kg: 39.5 [34.6] seconds).

Peak exertion force

Since employees were unable to move cadavers into the hospital pen, peak exertion force was measured only once at the furthest location reached for each cadaver movement. Employees did not differ for force used ($P = .40$). Mean (SE) peak exertion force was 592.0 (41.2) N and ranged from 357.8 to 835.7 N. Less peak force was used for the lightest cadaver (mean [SE]; 68 kg: 393.7 [38.8] N; 118 kg: 647.3 [46.5] N; 135 kg: 735.1 [48.8] N; $P < .001$).

Employee physiologic measures

Employees did not differ in baseline resting heart rate ($P = .23$) or baseline oxygen saturation ($P = .25$). Similarly, change in heart rate ($P = .23$) and oxygen saturation ($P = .09$) did not differ between employees moving cadavers. Mean (SE; range) duration for change in heart rate was 49.0 (13.1; 35-71 bpm, 38.8 (12.7; 19-53) bpm, and 39.5 (8.8; 29-52) bpm for 135, 118, and 68 kg cadavers, respectively. Mean (SE; range) change in oxygen saturation was 0.8% (1.3%; 0%-3%), -0.5% (1.0%; -2% to 1%), and -0.2% (0.75%; -1% to 1%) for 135, 118, and 68 kg cadavers, respectively.

Mat tool durability

There were no rips, holes, or creases after being used in 18 cadaver movements.

Employee evaluation

Surveys were obtained from all 6 employees for all 3 cadaver movements (Tables 3 and 4). Feedback from employees on the potential of the mat as a handling tool was mixed. Employees agreed that moving the mat in the home pen was very difficult, and the 3 employees who were able to move the mat out of the pen into the alley scored it as very difficult, even with the lightest cadaver. Employees commented that the mat was stiff and lacked movement ease. These comments support the researchers' casual observations of employee frustration during cadaver movement.

Rolling cadavers onto the mat was ranked as neutral or easy in 9 of 18 surveys (50.0%). In the home pen, positioning cadavers onto the mat was ranked as easy (72.2%). In the alley, repositioning cadavers onto the mat was ranked as neutral (31.3%) or difficult (31.3%).

Three employees ranked the mat size as difficult and commented that the mat was awkward to carry throughout the barn and was a little too wide to fit in the alley (2 employees). All employees ranked the mat weight as difficult or very difficult and commented that the mat itself was too heavy to move, a problem that increased with the addition of a cadaver (3 employees).

All employees felt strongly that the mat would not easily move a non-ambulatory market-weight pig and would not recommend this mat to other employees for moving a non-ambulatory market-weight pig.

Table 3: Employee (n = 6) responses to the mat tool survey

Questions*	Score frequency, No. (%)				
	5	4	3	2	1
1. Rate mat for:					
a) Rolling cadaver from home pen floor onto mat	4 (22.2)	9 (50)	2 (11.1)	0 (0)	3 (16.7)
2. Positioning ease of cadaver onto mat:					
a) Home pen	2 (11.1)	13 (72.2)	2 (11.1)	0 (0)	1 (5.6)
b) Alley	2 (12.5)	4 (25.0)	5 (31.3)	0 (0)	5 (31.3)
3. Rate mat for:					
a) Moving mat in home pen towards pen gate†	0 (0)	0 (0)	0 (0)	3 (33.3)	6 (66.7)
b) Moving mat out of home pen and into alley‡	0 (0)	0 (0)	0 (0)	4 (44.4)	5 (55.6)
c) Moving mat down the alley to hospital pen§	NA	NA	NA	NA	NA
4. Rate mat for:					
a) Mat size to move cadaver	1 (5.6)	5 (27.8)	5 (27.8)	1 (5.6)	6 (33.3)
b) Mat weight to move cadaver	1 (5.6)	2 (11.1)	1 (5.6)	7 (38.9)	7 (38.9)

* Questions 1 through 4 of the mat tool survey were scored using a 5-point scale: 5 = very easy, 4 = easy, 3 = neutral, 2 = difficult, and 1 = very difficult.
† Results are from five employees who were able to move at least one of the three cadavers in the home pen towards the alley.
‡ Defined as mat being entirely inside the alley and oriented towards the hospital pen. Results are from five employees who were able to move at least one of the three cadavers out of the pen into the alley.
§ No results are available for moving the mat down alley into the hospital pen, as no employees were able to complete this cadaver movement.
NA = not applicable.

Conclusions

Field expertise associated with moving non-ambulatory pigs has resulted in several guidance documents. The American Meat Institute[13] recommends using slide boards, sleds, and cripple carts to move non-ambulatory pigs within meat processing plants. Similarly, the Transport Quality Assurance program[2] recommends stretchers, sleds, hand carts, and specialized skid loaders for moving non-ambulatory pigs. When non-ambulatory pigs occur on farms, the Pork Quality Assurance Plus program[1] recommends using plastic sleds or drag mats. Despite these recommendations, science-based publications validating different handling tools recommended for moving non-ambulatory pigs is lacking.

A pitfall to this wean-to-finish mat was the starting weight at 23.1 kg. A lighter mat (eg, a polyethylene wean-to-finish mat weighing 7.7 kg) could be an option to test when moving grow-finish pig cadavers and hence other options should be investigated. Different modifications to this wean-to-finish mat could improve ease of movement (eg, adding a slick surface underneath the mat) and adding buckle restraint straps could help to keep pigs secure. Without inclusion of restraint straps, the pig's head and legs could catch in penning when moving from the home pen to the hospital pen.

The mat was durable within the context of being used 18 times with pig cadavers since there were no rips, holes, or creases. This mat needs to be tested in a wider context to determine the durability over extended use.

It is important to test potential on-farm handling tools for ease of use, employee safety,[14] and pig welfare.[15,16] To ensure pig and employee safety, it is important for facilities to have wide enough alleys and pen openings, appropriate and durable handling equipment, and correctly trained employees.[17] The purpose of this study was to determine if this mat could be a suitable handling tool for live non-ambulatory pigs on-farm. If feasible, this mat could have multiple uses (provide comfortable resting areas for newly weaned pigs, to minimize waste around feeders, and for lame pigs)[4-9] and would be cost effective since it was relatively economical to modify (approximately $100). Unfortunately, based on our findings the current mat is not recommended as a suitable handling tool to move cadavers or non-ambulatory pigs on-farm.

Implications

- This mat was not suitable for manually moving non-ambulatory grow-finish pigs.
- Further mat modifications could improve ease of movement and positioning to keep the pig secured.

Acknowledgments

Iowa Pork Producers Association supported this work. The authors would like to thank Iowa Select Farms for the use of the farm sites, Drs Jass and Stinn for assistance throughout the project, and the study participants for their assistance in data collection.

Conflict of interest

None reported.

Disclaimer

Scientific manuscripts published in the *Journal of Swine Health and Production* are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

Table 4: Employee responses to the mat tool survey by cadaver weight

	Cadaver weight, kg		
	135	118	68
Questions*	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
1. Rate mat for:			
a) Rolling cadaver from home pen floor onto mat	3.2 (1.7)	4.2 (0.8)	3.5 (1.4)
2. Positioning ease of cadaver onto mat:			
a) Home pen	4.0 (0.6)	3.8 (0.4)	3.7 (1.4)
b) Alley	3.4 (1.5)	3.0 (1.2)	2.3 (1.6)
3. Rate mat for:			
a) Moving mat in home pen towards pen gate	1.0 (0)§	1.0¶	1.6 (0.5)**
b) Moving mat out of home pen and into alley†	1.0 (0)§	1.0¶	1.8 (0.4)**
c) Moving mat down the alley to hospital pen‡	NA	NA	NA
4. Rate mat for:			
a) Mat size to move cadaver	2.7 (1.4)	3.3 (1.4)	2.0 (1.3)
b) Mat weight to move cadaver	1.8 (1.2)	2.8 (1.5)	1.5 (0.5)

* Questions 1 through 4 of the mat tool survey were scored using a 5-point scale: 5 = very easy, 4 = easy, 3 = neutral, 2 = difficult, and 1 = very difficult.
† Defined as mat being entirely inside the alley and oriented towards the hospital pen.
‡ Defined as mat being entirely inside the hospital pen. No results are available for moving the mat down alley into the hospital pen, as no employees were able to complete this cadaver movement.
§ Results shown are from the 3 employees who were able to complete the 135 kg cadaver movement.
¶ Results shown are from 1 employee that was able to complete the 118 kg cadaver movement, therefore an SD could not be calculated.
** Results shown are from 5 employees who were able to complete the 68 kg cadaver movements.
NA = not applicable.

References

*1. National Pork Board. Pork Quality Assurance Plus Version 3 Handbook. **https://d3fns0a45gcgla.cloudfront.net/sites/all/files/documents/PQAPlus/V3.0/BinderMaterial/Tab%202/1%20PQAhandbook.pdf**. Published June 2016. Accessed January 1, 2018.

*2. National Pork Board. Transport Quality Assurance Version 6 Handbook. **https://d3fns0a45gcgla.cloudfront.net/sites/all/files/documents/TQA/2017-Version6/TQA.V6_Handbook.pdf**. Published January 2017. Accessed September 14, 2017.

*3. National Pork Board. Common Swine Industry Audit. **https://d3fns0a45gcgla.cloudfront.net/sites/all/files/documents/CommonSwineIndustryAudit/CSIA-English.pdf**. Published January 2019. Accessed February 1, 2019.

4. Boylet LA, Regan D, Leonard FC, Lynch PB, Brophy P. The effect of mats on the welfare of sows and piglets in the farrowing house. *Anim Welf.* 2000;9:39-48.

5. Calderón-Díaz JA, Boyle LA. Effect of rubber slat mats on the behavior and welfare of group housed pregnant sows. *Appl Anim Behav Sci.* 2014;151:13-23. doi:doi.org/10.1016/j.applanim.2013.11.016

6. Campler M, Pairis-Garcia M, Stalder KJ, Johnson AK. Rubber mat placement in a farrowing and lactation facility: Tips and techniques. *J Swine Health Prod.* 2016;24:142-146.

7. Gu Z, Xin H, Wang C, Shi Z, Liu Z, Yang F, Lin B, Wang C, Li B. Effects of neoprene mat on diarrhea, mortality and foreleg abrasion of pre-weaning piglets. *Prev Vet Med.* 2010;95:16-22.

8. Tokach MD, Goodband RD, DeRouchey JM, Dritz SS, Nelssen JL. Feeding and barn management strategies that maximize feed efficiency. In: Patience JF, ed. *Feed efficiency in swine*. Wageningen, The Netherlands: Wageningen Academic Publishers; 2012:41-62.

9. Elmore MRP, Garner JP, Johnson AK, Richert BT, Pajor EA. A flooring comparison: The impact of rubber mats on the health, behavior, and welfare of group-housed sows at breeding. *Appl Anim Behav Sci.* 2010;123:7-15.

*10. American Association of Swine Veterinarians. On-Farm Euthanasia of Swine: Recommendations for the Producer. **https://www.aasv.org/documents/2016EuthRec-EN.pdf**. Published November 2016. Accessed September 25, 2018.

*11. Berkeley Wellness. Your heartbeat and your health. University of California. **http://www.berkeleywellness.com/fitness/exercise/article/your-heartbeat-and-your-health**. Published January 2013. Updated February 2019. Accessed May 7, 2019.

*12. Dray T. How long after working out does your heart rate return to base? Livestrong.com. **https://www.livestrong.com/article/448974-how-long-after-working-out-does-your-heart-rate-return-to-base/**. Accessed 15 June 2018.

*13. Grandin T, American Meat Institute Animal Welfare Committee. Recommended Animal Handling Guidelines & Audit Guide: A Systematic Approach to Animal Welfare. Rev 1. 2013;1-121.

*14. Hill J, Berry N, Johnson AK. Handling and loadout of the finisher pig. **http://porkgateway.org/resource/handling-and-loadout-of-the-finisher-pig/**. Pork Information Gateway Factsheet. Published April 2007. Accessed January 1, 2018.

15. Ritter MJ, Ellis M, Berry NL, Curtis SE, Anil L, Berg E, Benjamin M, Butler D, Dewey C, Driessen B, DuBois P, Hill JD, Marchant-Forde JN, Matzat P, McGlone J, Mormede P, Moyer T, Pfalzgraf K, Salak-Johnson J, Siemens M, Sterle J, Stull C, Whiting T, Wolter B, Niekamp SR, Johnson AK. Review: Transport losses in market weight pigs: I. A review of definitions, incidence, and economic impact. *Prof Anim Sci.* 2009;25:404-414. doi:doi.org/10.15232/S1080-7446(15)30735-X

16. Johnson AK, Gesing LM, Ellis M, McGlone JJ, Berg E, Lonergan SM, Fitzgerald R, Karriker LA, Ramirez A, Stalder KJ, Sapkota A, Kephart R, Selsby JT, Sadler LJ, Ritter MJ. Farm and pig factors affecting welfare during the marketing process. *J Anim Sci.* 2013;91:2481-2491. doi:10.2527/jas.2012-6114

17. Doonan G, Appelt M, Corbin A. Nonambulatory livestock transport: The need for consensus. *Can Vet J.* 2003;44:667-672.

* Non-refereed references.

Build a productive herd with a healthy gut.

Lawsonia and *Salmonella* work together to destroy the microbiome of a pig's gut, which can slow ADG. If you only protect from one, profit may be left on the table. Vaccinate against *Lawsonia* with Porcilis® Ileitis and *Salmonella* with Argus® SC/ST to complete your herd's gut protection and help establish operation efficiency.

Porcilis® ILEITIS

Argus® SC/ST

Talk to your Merck Animal Health representative about updating your operation's gut health protocols.

DRIVEN BY PREVENTION™
drivenbyprevention.com

MERCK Animal Health

merck-animal-health-usa.com 800-521-5767

US-ARG-19040001

Pork Checkoff names 2019-2020 officers

David Newman, a pork producer from Arkansas, was elected president of the National Pork Board at the organization's June board meeting in Des Moines, Iowa. The National Pork Board's 15 producer-directors represent America's pig farmers.

"The US pork industry is facing a time of unprecedented change and I look forward to serving America's 60,000 pig farmers in the year ahead," Newman said. "From preparing the global food industry for the threats facing us from foreign animal disease, implementing our Secure Pork Supply plan, and driving home our messages of what sustainable pig production looks like in the United States and abroad, I cannot wait to lead the Pork Checkoff in delivering value to our producers."

Newman is in his second term as a board member and owns and operates a farrow-to-finish Berkshire farm in Myrtle, Missouri that markets pork directly to consumers throughout the United States. Serving with Newman on Pork Checkoff's executive officer team are Vice-president **Mike Skahill** from Williamsburg, Virginia; Treasurer **Gene Noem** from Ames, Iowa; and Immediate Past President **Steve Rommereim** from Alcester, South Dakota.

Registration open for second Pig Welfare Symposium

The National Pork Board has announced that its second Pig Welfare Symposium will take place November 13-14 in Minneapolis, Minnesota. The biennial forum, which debuted in 2017, is designed to help improve the well-being of pigs by disseminating recent research findings and recommendations, raising awareness of current and emerging issues, and identifying potential solutions.

"We are pleased to be building on the initial success of the 2017 symposium," said Sara Crawford, assistant vice president of animal welfare for the Pork Checkoff. "We will continue to make the sharing of ideas and information about animal well-being the focus of this meeting. We expect and encourage producers, veterinarians, academia, packers and processors, and allied industry partners to attend."

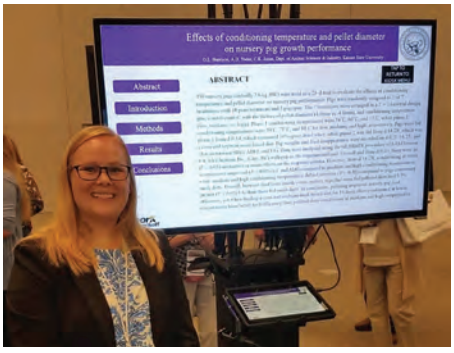
The symposium will provide presentations from experts on past, current, and future animal welfare issues, including looking at the evolution of animal welfare in the supply chain and understanding consumer choices. The speakers will offer their perspectives on how the pork industry can continue to evolve to meet the needs of animals, producers, and consumers.

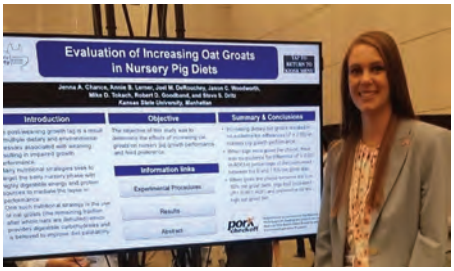
For more information or to register, visit `www.pork.org/pws` or contact Dr Sara Crawford at `SCrawford@pork.org` or at 515-223-2790.

Checkoff interns win national Undergraduate Research Competition

Two past interns in the Pork Checkoff's Science and Technology department have won awards at the American Society of Animal Science 2019 Annual Meeting in Austin, Texas, held in July. Olivia Harrison and Jenna Chance won second and third place respectively in the Undergraduate Research Competition. Each student conducted a research project and presented a poster of their findings in a competition against other students from across the country. The scientific meeting is the largest within the animal science discipline and had more than 1500 registrants. Student travel was sponsored by the Dr Mark and Kim Young Undergraduate Research Fund in Animal Science. Harrison, a senior from Saybrook, Illinois, presented her research, "Effects of conditioning temperature and pellet diameter on nursery pig growth performance." Her research was sponsored by the National Pork Board's Swine Research and Education Experience. After graduating in May 2020, Harrison plans to attend graduate school in feed safety at Kansas State University. In third place was Chance, a senior from Lebanon, Indiana, with her poster, "Evaluation of increasing oat groats in nursery pig diets." Her research was also sponsored by the National Pork Board's Swine Research and Education Experience. After graduating in December 2019, Chance plans to attend graduate school in swine nutrition at Kansas State University.

For more information, contact Chris Hostetler at `CHostetler@pork.org` or 515-223-2606.





Protection.

Healthy Animals. Healthy Bottom Line.

CircoGard® | Circo/MycoGard® | MycoGard®

Pharmgate® vaccines have shielded more than 400 million pigs and countless bottom lines around the world from the ravages of respiratory disease complex:

- Mycoplasma hyopneumoniae
- PCV2

and coming soon:

- PRRS

Choose Pharmgate.
The Shield You Need.
Protection You Can Trust.

Pharmgate
ANIMAL HEALTH

pharmgate.com 1(800) 380-6099

2020: A VISION FOR THE FUTURE

Reserve lodging now
for the

51st AASV Annual Meeting

March 7-10, 2020
Atlanta, Georgia

HYATT REGENCY ATLANTA

265 Peachtree Street NE
Atlanta, Georgia 30303
404-577-1234

AASV room rate:
$189 plus tax (single/double)

Photos courtesy of Hyatt Regency Atlanta.

aasv.org/annmtg

African Swine Fever Update

JULY 2019

The U.S. pork industry has been actively working to prevent and prepare for a potential African swine fever (ASF) outbreak in the U.S. To date, several industry coalition groups have coordinated efforts to prevent ASF entry into the U.S. and prepare farmers and allied industry.

COALITION GROUPS

- **African Swine Fever Crisis Team** keeps the coalition informed and will maintain consumer confidence and industry reputation.
- **African Swine Fever Task Force** drives prevention activities.
- **American Association of Swine Veterinarians (AASV) Committee on Emerging and Transmissible Diseases** shares information with the swine veterinary community.
- **Depopulation/Disposal Group** *(including government, veterinary and producer stakeholders)* recommends depopulation and disposal plans.
- **Feed Risk Task Force** *(including ag and feed industry representatives and both the Food and Drug Administration and U.S. Department of Agriculture)* evaluates virus introduction via feed and assesses knowledge gaps and next steps.
- **National Pork Board Swine Health Committee** prioritizes and implements research.
- **National Swine Disease Council** represents the pork industry and coordinates and facilitates decision making.
- **Packer Business Continuity Task Force** focuses on restarting trade in the face of an outbreak.

RESEARCH

- Feed/dust sampling methods and protocols
- Validation of extraction process for the detection of virus in feed and feed ingredients
- Feed half-life studies
- Feed additive mitigation – formaldehyde and medium chain fatty acid products
- Oral infectious dose – liquids and feeds
- Disinfectants studies
- Epidemiology and diagnostics work (Vietnam)
- Swine Health Committee has Request for Proposals on ASF-feed testing, diagnostics and vaccine.

EDUCATION

- Questions for pork producers to ask their feed suppliers
- Feedstuffs holding-time calculation and ingredient biosecurity information
- Biosecurity at exhibitions – biosecurity information and *Champions Guide* booklet
- Country disease status information
- NPB Foreign Animal Disease (FAD) Preparation Bulletin (monthly via email)
- SHIC Global Disease Monitoring Report (monthly via email)
- NPPC Meat of the Matter newsletter (via email)
- Revised international travel and host visitor's biosecurity information
- Study trips to Baltic states, Germany and Denmark
- Preparation of consumer confidence information
- Dedicated websites, including **pork.org/fad**, **factsaboutpork.com, nppc.org/asf, swinehealth.org**

with support from the U.S. Department of Agriculture, U.S. Customs and Border Protection and the Food and Drug Administration

African Swine Fever Update

JULY 2019

PREPAREDNESS

- Border awareness – government effort and industry travelers
  - Requested increase in number of U.S. Customs and Border Protection (CBP) inspectors
  - Reviewed penalty/fine levels
  - Addition of 60 beagle teams
  - Communication about inspection performance at airports
  - Review and revise Customs' questions on declaration forms
- Veterinarian network – first-hand accounts
- FAD Diagnostics – expansion of validated samples and oral fluids validation
- Enhanced surveillance program – implemented by U.S. Department of Agriculture
- Feed and feedstuffs transmission
  - Sampling, testing and mitigation research
  - Industry holding-time information
  - Imported feedstuffs risk assessment
  - Porcine origin ingredients
- Inspections of Chinese casings facilities
- Increased attention on garbage-feeder and ethnic market inspections
- Data-sharing between government and industry to facilitate safe animal movement during outbreak
- Development of bilateral agreements to facilitate trade
- FAD Exercise planning and testing (U.S., Canada and Mexico)
  - Completed: Nov. 28, 2018, and Feb. 27 and April 25, 2019 / Planned: Sept. 23, 2019
  - Regional planning in Colorado/Kansas/Oklahoma/Texas and Illinois/Indiana/Michigan/Ohio

NEXT STEPS

- Lab capacity to test both surveillance samples and proof of negative samples
- AgView and EMRS compatibility
- Define how permitted movements take place in the face of an outbreak
- Develop CBP metrics and determine how to measure effectiveness/improvement
- Develop garbage feeder and ethnic market inspection metrics and measurements
- Depopulation and disposal base standards and state plans
- Oral fluids sampling and chain-of-custody plans
- Regionalization and compartmentalization planning
- Integration of industry with Incident Command structure in outbreak

INTRODUCING THE NATIONAL SWINE DISEASE COUNCIL

- **MISSION** – Provide recommendations to animal health officials and industry stakeholders to mitigate threats and negative impacts to the U.S. pork industry from diseases of concern
- **OBJECTIVES**
  - Coordinate industry preparedness and response activities
  - Protect trade and interstate commerce of pigs, pork and pork products
  - Build capacity to rapidly detect diseases of concern and limit the scope of a disease outbreak
- **ROLE** – Serve as the industry touchpoint and make recommendations for regulatory officials

with support from the U.S. Department of Agriculture, U.S. Customs and Border Protection and the Food and Drug Administration

Innovate. Investigate. Invigorate.

The numbers are in your favor with PROMOTE®. You can count on PROMOTE for research-based feed additive solutions. Supported by the vast global network of research from Cargill Animal Nutrition; PROMOTE offers non-medicated products that help you meet your goals – and satisfy our growing world's demand for more protein.

600
RESEARCHERS

16
GLOBAL LABS

5 INNOVATION CENTERS

FEEDPROMOTE.COM | 866-202-9889

AOX™ | CINERGY | DEFUSION® | ENZAE® | FORAGE-MATE® | INTELLA™ | TRASIC® | VALIDO®

Cituro® provimi® Cargill®

AASV NEWS

Call for submissions – Industrial Partners

The American Association of Swine Veterinarians invites submissions for the Industrial Partners oral and poster sessions at the 51st AASV Annual Meeting. This is an opportunity for commercial companies to make brief presentations of a technical, educational nature to members of the AASV. The conference will be held March 7-10, 2020 in Atlanta, Georgia.

The oral sessions consist of a series of 15-minute presentations scheduled from 1:00 to 5:00 PM on Sunday afternoon, March 8th. A poster session takes place the same day. Poster authors will be required to be stationed with their poster from noon until 1:00 PM, and the posters will remain on display throughout the afternoon and the following day for viewing.

SUBMISSION PREREQUISITE: All companies submitting topics for presentation during the Industrial Partners sessions must register to participate in the AASV Technical Tables Exhibit before October 1st.

Restricted program space necessitates a limit on the number of presentations per company. A company that is a member of the *Journal of Swine Health and Production* (JSHAP) Industry Support Council and sponsors the AASV e-Letter may submit a maximum of 3 topics for oral presentation. A company that is either a member of the JSHAP Industry Support Council or sponsors the AASV e-Letter may submit a maximum of 2 topics. All other companies may submit 1 topic for oral presentation. In addition, every company may submit 1 topic for poster presentation, but the topic must not duplicate the oral presentation. All topics must represent information not previously presented at the AASV annual meeting or published in the meeting proceedings.

To participate, send the following information to aasv@aasv.org by October 1:
1) Company name
2) Presentation title
3) Brief description of the presentation content
4) Presenter name and contact details (mailing address, telephone number, and email address)
5) Whether the submission is intended for oral or poster presentation

Receipt of submissions will be confirmed by email. Presenters will be notified of their acceptance by October 15 and must submit a paper by November 15 for publication in the meeting proceedings. Failure to submit the paper in a timely manner will jeopardize the company's future participation in these sessions.

All presenters are required to register for the meeting, either as a Tech Table representative, or as an individual registrant (nonmember oral and poster presenters are eligible to register at the AASV regular member rate). The AASV does not provide a speaking stipend or travel reimbursement to Industrial Partners presenters.

Nominate exceptional colleagues for AASV awards

Do you know an AASV member whose dedication to the association and the swine industry is worthy of recognition? The AASV Awards Committee would like your help in identifying members who are well deserving of this "pat on the back." We would love to hear from you if you have nominations for the following 5 awards to be presented at the AASV Annual Meeting in Atlanta.

Howard Dunne Memorial Award – Given annually to an AASV member who has made a significant contribution and rendered outstanding service to the AASV and the swine industry.

Meritorious Service Award – Given annually to an individual who has consistently given time and effort to the association in the area of service to the AASV members, AASV officers, and the AASV staff.

Swine Practitioner of the Year – Given annually to the swine practitioner (AASV member) who has demonstrated an unusual degree of proficiency in the delivery of veterinary service to his or her clients.

Technical Services/Allied Industry Veterinarian of the Year – Given annually to the technical services or allied industry veterinarian who has demonstrated an unusual degree of proficiency and effectiveness in the delivery of veterinary service to his or her company and its clients as well as given tirelessly in service to the AASV and the swine industry.

Young Swine Veterinarian of the Year – Given annually to a swine veterinarian who is an AASV member, 5 years or less post-graduation, who has demonstrated the ideals of exemplary service and proficiency early in his or her career.

Nominations are due December 15. The nomination letter should specify the award and cite the qualifications of the candidate for the award. Submit to: AASV, 830 26th Street, Perry, Iowa 50220, Email: aasv@aasv.org.

AASV news continued on page 293

uniferon®200

Why A Higher Standard Is Worth Its Weight

Uniferon® is the only injectable iron supplement brand that meets both veterinary and human drug standards.[1] With demonstrated efficacy in preventing anemia and improving baby pig health, it ensures optimum average daily weight gain throughout the lactation period.[2] A second dose has demonstrated an additional weight-gain advantage throughout the feed-to-finish period.[3,4] Results like that carry the most weight of all.

Visit Uniferon.com to learn more.

[1] Radke, S.L., Olsen, C.W., Ensley, S.M., (2018) Elemental impurities in injectable iron products for swine. *The Journal of Swine Health and Production*, 26(3).

[2] Gaddy H et al. A review of recent supplemental iron industry practices and current usage of Uniferon® (iron dextran complex injection, 200 mg/mL) in baby pigs. *AASV*. 2012; 167–171.

[3] Haugegaard J et al. Effect of supplementing fast-growing, late-weaned piglets twice with 200 mg iron dextran intramuscularly. *The Pig Journal*. 2008. 61; 69–73.

[4] Olsen C and Fredericks L. Impact of iron dose and hemoglobin concentration on wean–finish weight gain. *IPVS*. 2018; 910.

PHARMACOSMOS

 PM-048-00

AASV news continued from page 291

AASV student abstracts due September 18

The American Association of Swine Veterinarians announces an opportunity for veterinary students to deliver a scientific presentation at the AASV Annual Meeting in Atlanta, Georgia, on Sunday, March 8, 2020. Interested students are invited to submit a 1-page abstract of a research paper, clinical case study, or literature review for consideration. The submitting student must be a current (2019-2020) student member of the AASV at the time of submission and must not have graduated from veterinary school prior to March 8, 2020. Submissions are limited to 1 abstract per student.

Abstract submission

Abstracts and supporting information must be submitted online at **aasv2020.exordo.com** (see **www.aasv.org/annmtg/2020/studentseminar.htm** for details). Submissions must be completed before **11:59 PM Central Daylight Time** on **Wednesday, September 18, 2019**. Late submissions will not be considered.

Students will receive an email from Ex Ordo confirming receipt of their submission. If they do not receive this confirmation email, they must contact Dr Andrew Bowman by Friday, September 20, 2019 with supporting evidence that the submission was made in time; otherwise the abstract will not be considered for judging.

The abstracts will be reviewed by an unbiased, professional panel consisting of private practitioners, academicians, and industry veterinarians. Fifteen abstracts will be selected for oral presentation in the Student Seminar at the AASV Annual Meeting. Students will be notified by October 15, 2019, and those selected to participate will be expected to provide the complete paper or abstract, formatted for publication, to AASV by November 15.

Student Seminar and Scholarships

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. Veterinary students whose papers are selected for oral presentation also compete for one of several scholarships awarded through the AASV Foundation. The oral presentations will be judged to determine the amount of the scholarship awarded. Zoetis funds a $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 scholarships of $2500 each for 2nd through 5th place, $1500 each for 6th through 10th place, and $500 each for 11th through 15th place.

Student Poster Session

Abstracts that are not selected for oral presentation in the Student Seminar will be considered for presentation in a poster session at the annual meeting. **Zoetis**, sponsor of the Student Poster Session, has joined with AASV to fund a $250 stipend for each student poster presenter who attends the meeting to participate in the session. Those selected for poster presentation will also be expected to supply a formatted paper by November 15 for publication in the conference proceedings.

Veterinary Student Poster Competition

The presenters of the top 15 poster abstracts compete for scholarship awards ranging from $200 to $500 in the Veterinary Student Poster Competition, sponsored by **United Animal Health**.

Complete information for preparing and submitting abstracts is available on the AASV Web site at **www.aasv.org/annmtg/2020/studentseminar.htm**. The rules for submission should be followed carefully. For more information, contact the AASV office (Tel: 515-465-5255; Email: **aasv@aasv.org**).

Is your practice tip in plain sight?

Have you ever looked everywhere for something, only to discover it was right there in plain sight all the time? Likewise, we are pretty sure you have the best-ever practice tip staring you in the face.

It could be sitting on the shelf at your clinic or tucked in your practice vehicle. Maybe it is an app on your phone or laptop. It might be a series of motions you go through when performing a common (or entirely new) procedure, or a set of standard operating procedures that keep things running smoothly. Whatever it is, you are probably so accustomed to using, seeing, or doing it that you did not notice it is the best thing for veterinary practice since the mobile phone.

So, take a fresh look around as you go through your day, keeping in mind the theme for the 2020 AASV Annual Meeting, "2020: A Vision for the Future." Then volunteer to share your "practice tip in plain sight" during the AASV's Got Talent seminar on Saturday afternoon, March 7 in Atlanta, Georgia. Contact Dr Tyler Bauman at **tyler.bauman@pigrus.net** or the AASV office (**aasv@aasv.org**) to volunteer, and encourage a colleague to do the same.

AASV news continued on page 295

US Trial Report

Tonisity Px™ *fed to* ***nursing pigs*** *produced* ***more weaned pigs*** *and heavier pre-harvest weights.*

1 *Tonisity Px helped improve survival to weaning, so* ***MORE weaned pigs*** *were produced.*

2 *Pigs fed Tonisity Px were* ***HEAVIER at day 168****. Growth benefits occurred in* ***ALL*** *sizes of pigs (not just small ones).*

3 *More pigs + heavier pre-harvest weights =* ***MORE lb of pork***

Summary

Study Design

An extensive research study[1] conducted at facilities of a major Midwest commercial producer investigated the effects of Tonisity Px on pre-weaning mortality and pre-harvest weight gain.

353 litters from 1st-litter gilts, composed of **3862 individually weighed piglets,** randomly assigned to 2 treatment groups:

- **Control** = routine management (n=176 litters, 1969 piglets);
- **Tonisity Px** = used per Tonisity recommendations at days 2-8 and again pre- and post-weaning (n=177 litters, 1893 piglets).

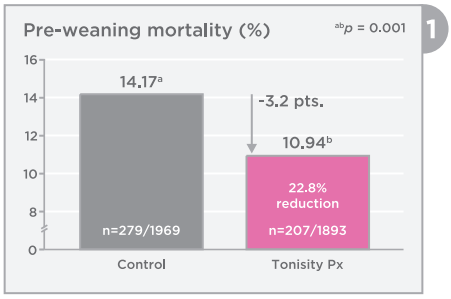
Pigs moved to finisher units at 68 days of age, weighed at 168 days of age.

Individual weights of all pigs measured **4 times:** at birth, weaning, end of nursery, and at day 168, thereby providing exceptional statistical power for analysis of study outcomes.

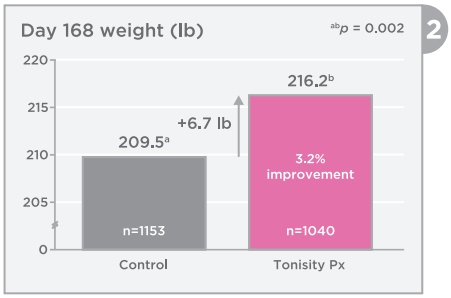
Tonisity Px is an isotonic nutritional supplement designed specifically for pigs. It is not a drug and it does not contain ingredients with drug-like properties. It is not intended to diagnose, treat, cure, or prevent any disease. Any observed differences in performance are due to the nutritional and hydration properties of Tonisity Px.

Results

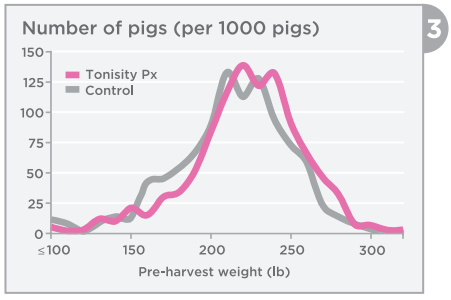
Pre-weaning mortality fell **22.8%** in the **Tonisity Px** group compared to controls, yielding **3.8%** more weaned pigs.



Tonisity Px pigs averaged **6.7 lb (3.2%) heavier** at 168 days.

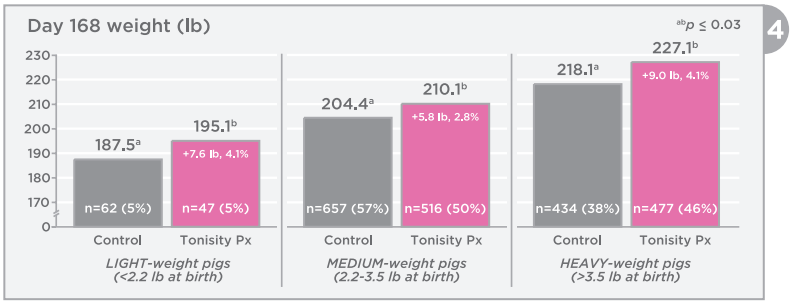


Tonisity Px pigs were 5.8 to 9.0 lb heavier at 168 days **regardless** of birth weight.



The populations of pigs fed **Tonisity Px** demonstrated a clear shift to heavier pre-harvest weights compared to controls.

- This favorable shift in pre-harvest weight distribution further confirms the **more-pigs/heavier-pigs** benefits of **Tonisity Px**.



1. Data on file, Study Report PRO-18-020. Tonisity Int. Ltd.

4221 Mitchell Ave, Suite 2A
St. Joseph, MO 64507

816.749.4318 | www.tonisity.com

AASV news continued from page 293

Need something to listen to? Play an AASV Podcast!

During the AASV Annual Meeting, veterinary students research a presenter's topic, prepare questions, and interview conference speakers to gain additional information about their presentation topics. Each 5- to 15-minute audio interview is produced as an MP3 podcast. More than 300 AASV podcasts are available at no cost to AASV members on the website at **www.aasv.org/podcast/**. Did you miss this year's meeting? Do you wish you could listen to a talk from a past meeting? Hear conference speaker interviews from 2007-2019 AASV Annual Meetings.

Also available to AASV members as MP3 podcasts are recordings from The Swine Medicine Talks. This swine medicine seminar series is hosted by the AASV student chapter and the Swine Medicine Education Center at Iowa State University and funded by the AASV Student Recruitment Committee. Find the free podcasts on the AASV website at **www.aasv.org/members/only/video/smecast/**.

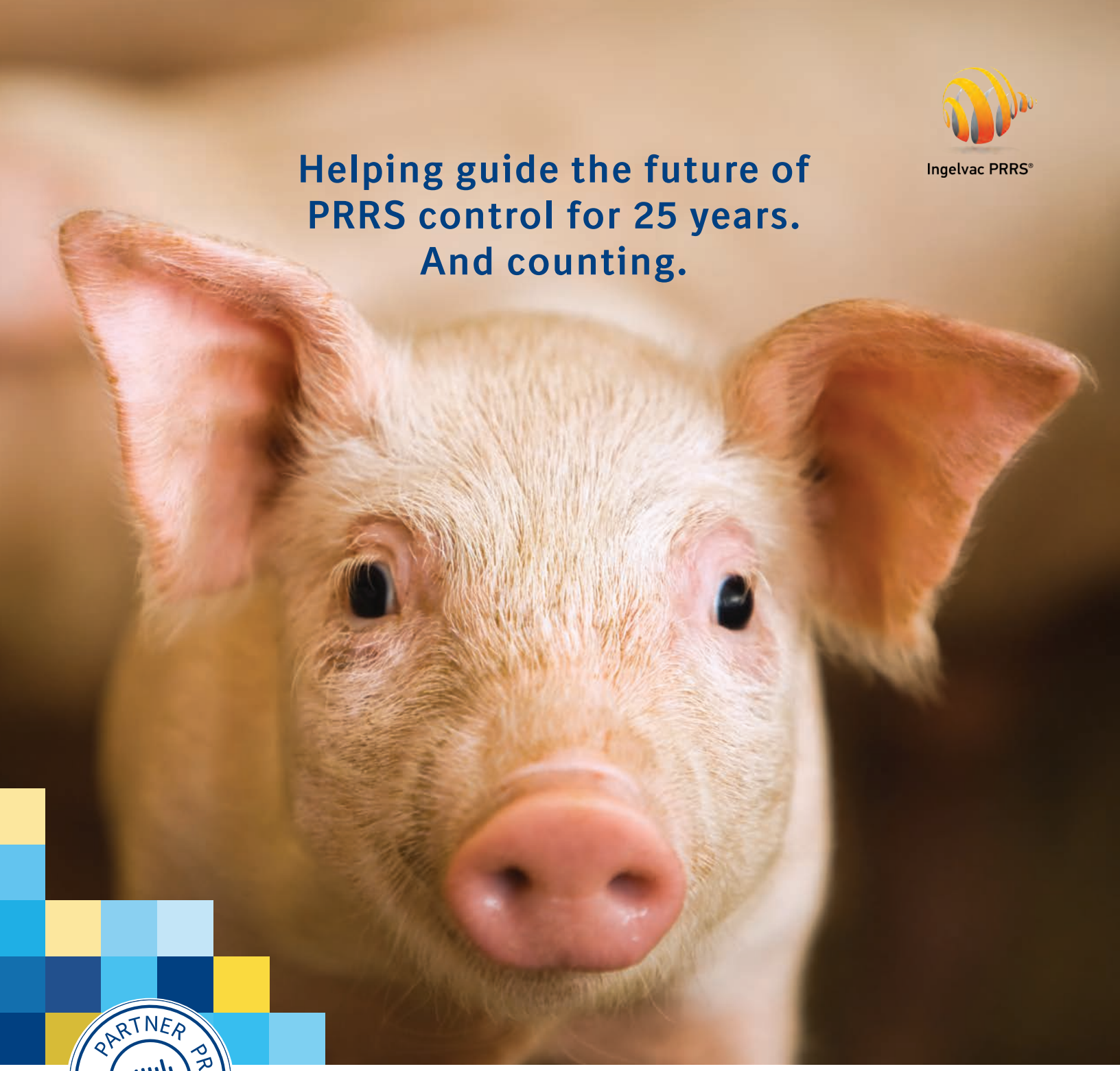
Video resources for AASV members

Many resources, including videos, are available to AASV members in the Resources Library at **www.aasv.org/members/only/video/**.

Annual Meeting videos. AASV members can view keynote addresses and other selected presentations from 2005-2019 annual meetings. Special 50th anniversary videos produced by AgCreate Solutions, Inc, under the direction of AASV member Dr Sarah Probst-Miller, celebrate the accomplishments, lessons learned, and memories of AASV members. The Golden Anniversary documentary, the Veterinarian's Oath, the Veterinarian Wellbeing video, session introduction videos, and the general session presentation recordings are available for AASV members to view.

The Swine Medicine Talks. Free video recordings from the 2015-2019 Swine Medicine Talks seminar series are available to AASV members. Recent topics include central nervous system disease in swine, feed mill biosecurity, and the diversity of swine veterinarians.

Heritage videos. To preserve some of the personal histories and capture the human element of swine veterinary medicine, distinguished AASV members recollect their experiences in the Heritage video series. The latest Heritage video features Dr Tom Burkgren, recently retired AASV Executive Director. Listen to the life stories of Dr Burkgren and 22 other distinguished AASV members.



Ingelvac PRRS®

Helping guide the future of PRRS control for 25 years. And counting.

PERFORM PARTNER PROTECT

Ingelvac Provenza®

FLEX

ENTERISOL® Ileitis

ENTERISOL® Salmonella T/C

Ingelvac MycoMAX®

Newport Laboratories
A Boehringer Ingelheim Company

Boehringer Ingelheim is proud to celebrate 25 years of partnering with veterinarians and producers to combat PRRS. In addition to offering a leading modified-live vaccine, Ingelvac PRRS® MLV, we offer unmatched technical expertise, collaborative research and diagnostic advancements. Together, we're improving pig performance, production and profit – today and into tomorrow.

To learn more, contact your Boehringer Ingelheim representative or visit **www.bi-vetmedica.com/swine.**

Boehringer Ingelheim

American College of Animal Welfare

The American Veterinary Medical Association's (AVMA) American Board of Veterinary Specialties (ABVS) currently recognizes 22 specialty organizations comprising 40 veterinary specialties. More than 11,000 veterinarians, several of which are AASV members, have been awarded diplomate status in one or more of these organizations. While AASV members may be most familiar with the American Board of Veterinary Practitioners Swine Health Management or the American College of Veterinary Preventative Medicine, the American College of Animal Welfare (ACAW) became provisionally recognized by ABVS in 2012.

The ACAW offers veterinarians advanced animal welfare training, education, and board certification to ensure they continue to lead in advancing animal welfare knowledge for the benefit of the public and the profession. Veterinarians interested in seeking board certification in ACAW must identify an ACAW Diplomate mentor and develop a rigorous program of study to complete the training requirements. Additional credentialing requirements include publication and examination.

The comprehensive training covers on 9 key areas:

- The concepts and history of animal welfare including the Five Freedoms, the 3R's (reduction, replacement, and refinement), and society's changing perceptions toward animals.
- Ethical issues associated with animal use with emphasis on philosophical principles, cultural, societal, and religious perspectives affecting animals, quality of life, population management, emerging animal technologies, and society uses of animals and alternatives.
- Designing and conducting scientific research to assess animal welfare using measures of health, physiology, and behavior.
- The elements of animal environments that can influence their welfare including housing and habitat, environmental complexity, social dynamics, and husbandry practices.
- The role of the veterinary profession in promoting animal welfare through care and use recommendations, participation in the legislative, regulatory, and policy-setting process, and educating stakeholder groups, the media, and the public.
- The individual veterinarian's role in promoting animal welfare through disease diagnosis, treatment, and prevention; recognition, assessment, prevention, and management of pain, stress, and distress; euthanasia procedures; and disaster and emergency preparedness and response.
- The impacts of human/animal/environment interactions on animal welfare with focus on animal abuse or neglect, environmental changes, and training of animal caretakers.
- The international, federal, state, and local laws, regulations, policies, and guidelines related to the care and use of animals.
- Overarching and species-specific contemporary animal welfare issues for companion animals, poultry, hooved stock, equids, laboratory animals, and zoo animals. Candidates must also have knowledge of at least 2 of the 6 additional classes: aquatic animals, aquaculture and fisheries, wildlife/exotic animals, animals in entertainment and exhibition, animals in education, and working and assistance animals.

Veterinarians who attain this advanced level of training in all aspects of animal welfare science and ethics are uniquely positioned to provide the public, general veterinary practitioners, and other stakeholders with accurate information and expertise concerning animal welfare. Swine veterinarians should consider pursuing board certification to serve as leaders in the domestic and global discussions of swine welfare. Because the ACAW curriculum is diverse in scope, it is essential that the diplomate body of the college be equally as diverse. As of December 2018, there are 53 board-certified diplomates in ACAW, of which at least 5 are AASV members (Drs John Deen, Tom Parsons, Hans Coetzee, Meghann Pierdon, and Monique Pairis-Garcia).

The AASV Foundation recognizes the importance of having ACAW board-certified swine veterinarians and offers a scholarship program for AASV members. The scholarship provides annual reimbursements for actual expenses related to the ACAW program with a $20,000 maximum reimbursement. An additional incentive payment of $10,000 will be paid upon successful and timely completion of the ACAW Board Certification. Veterinarians with at least 5 years of continuous AASV membership are eligible for the scholarship. For more information about scholarship eligibility and the application process, visit `aasv.org/foundation/ACAW_Scholarship.php`. Visit `acaw.clubexpress.com/content.aspx?page_id=22&club_id=863788&module_id=274610` for complete details on becoming a diplomate of ACAW.

Sherrie Webb, MSc
Director of Swine Welfare


Be
Certain.
POWERED BY
ACCELERATED®
HYDROGEN PEROXIDE
Patented
INTERVENTION™ DISINFECTANTS
As a veterinarian, your job is to be certain. You're trained to eliminate the unknown, diagnose, and deliver care. So, you have to be certain about the environment in which you work. Intervention™ Disinfectants help prevent outbreaks before they start and create a clean, safe environment for all. And that's something to be certain about.
InterventionDisinfectants.com
Intervention
Farm Animal Care
Disinfectant Cleaner & Deodorizer
Ready To Use Wipes
Intervention
Farm Animal Care
Disinfectant Cleaner & Deodorizer
Concentrate
CAUTION
1G
Proceed
With Certainty.

Upcoming meetings

Allen D. Leman Swine Conference

September 14-17, 2019 (Sat-Tue)
Saint Paul RiverCentre
Saint Paul, Minnesota
Hosted by the University of Minnesota

For more information:
Tel: 612-624-4754
Email: vetmedccaps@umn.edu
Web: ccaps.umn.edu/allen-d-leman-swine-conference

2019 Leman China Swine Conference

October 19-21, 2019 (Sat-Mon)
Zhengzhou International Convention and Exhibition Center
Zhengzhou, China

For more information:
Web: vetmed.umn.edu/nmews-events/leman-china-swine-conference

2019 North American PRRS Symposium

November 2-3, 2019 (Sat-Sun)
Chicago Marriott, Downtown Magnificent Mile
Chicago, Illinois

For more information:
Email: frowland@vet.k-state.edu
Web: www.vet.k-state.edu/na-prrs/index.html
To register:
Web: crwad.org/crwad2019/registration/

2019 ISU James D. McKean Swine Disease Conference

November 7-8, 2019 (Thu-Fri)
Scheman Building
Iowa State University
Ames, Iowa

For registration information:
Registration Services
Iowa State University
1601 Golden Aspen Drive #110
Ames, Iowa 50010
Tel: 515-294-6222
Fax: 515-294-6223
Email: registrations@iastate.edu

For questions about program content:
Dr Chris Rademacher
Conference Chair
Iowa State University
Email: cjrdvm@iastate.edu

Pig Welfare Symposium

November 13-15, 2019 (Wed-Fri)
Minneapolis Marriott City Center
Minneapolis, Minnesota
Hosted by the National Pork Board

For more information:
Web: www.pork.org/pws

American Association of Swine Veterinarians 51st Annual Meeting

March 7-10, 2020 (Sat-Tue)
Hyatt Regency Atlanta
Atlanta, Georgia

For more information:
American Association of Swine Veterinarians
830 26th Street
Perry, Iowa
Tel: 515-465-5255
Email: aasv@aasv.org
Web: www.aasv.org/annmtg

26th International Pig Veterinary Society Congress

June 2-5, 2020 (Tue-Fri)
Florianopolis, Brazil

For more information:
Tel: +55 31 3360 3663
Email: ipvs2020@ipvs2020.com
Web: ipvs2020.com

International Conference on Pig Survivability

October 28-29, 2020 (Wed-Thu)
Omaha, Nebraska
Hosted by Iowa State University, Kansas State University, and Purdue University

For more information:
Email: jderouch@ksu.edu
Web: www.piglivability.org/conference

For additional information on upcoming meetings: www.aasv.org/meetings

AASV Industry Support Council

The JSHAP is made possible by the generous support of these Industry Support Council members.

Boehringer Ingelheim	DSM BRIGHT SCIENCE. BRIGHTER LIVING.	MERCK Animal Health
Newport Laboratories	Norbrook®	PHARMACOSMOS Committed to Quality
Pharmgate ANIMAL HEALTH	Phibro ANIMAL HEALTH CORPORATION™	provimi®
Tonisity	VIROX™ ANIMAL HEALTH	zoetis™

Photo Corner

Weaned pigs in Northwest Iowa.

Photo courtesy of Dr Mandi Neujahr