The Journal of the American Association of Swine Veterinarians

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JSHAP SPOTLIGHT
Dr Phil Gauger
Iowa State University

Dr Phil Gauger earned a BS ('90), a DVM ('94), an MS ('08), and a PhD ('12) from Iowa State University (ISU). He is a diagnostic pathologist and head of the molecular section at the ISU Veterinary Diagnostic Laboratory where he coordinates pathology submissions, oversees PCR testing, and researches the pathogenesis of swine viruses. He joined the JSHAP Editorial Board as an opportunity to participate in the review process of manuscripts that contain information relevant to swine production medicine. Dr Gauger encourages veterinarians to submit case reports and diagnostic notes to JSHAP for publication as these are important sources of information for industry stakeholders.

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Thank you for your contribution

We are very fortunate to have a highly qualified and dedicated team with Harry Snelson, Sue Schulteis, Sherrie Webb, and Abbey Canon. Not to mention all those who work behind the scene to keep us informed and connected; our webmaster and IT specialist Dave Brown and our JSHAP staff Terri O'Sullivan, Sherrie Webb, Karen Richardson, Tina Smith, Zvonimir Poljak, Serge Messier, and Laura Batista.

What makes the AASV truly successful is the involvement of its members. For those of you who serve as officers, district directors, as a leader or member of an AASV committee, the AASV Foundation, JSHAP reviewers, or keep a watchful eye on our investments, we are all most appreciative of your time and effort!

We are also very grateful for the continued support we receive from our sponsors. Their contributions provide opportunities to socialize, share ideas and knowledge, and stay connected with them as well as with each other.

In addition to AASV functions, several of our members and staff have been actively involved in foreign animal disease prevention and preparedness through working groups with the US Department of Agriculture's Animal and Plant Health Inspection Service, National Pork Board, the Swine Health Information Center, or the Swine Health Improvement Program. We will all benefit from the added responsibilities you have so generously assumed. Our members openly and graciously shared their experiences with packing plant closures, a new strain of porcine reproductive and respiratory syndrome virus (PRRSV), and other challenges facing our industry to assist their colleagues. We should all take great pride in the efforts made to fulfill our AASV mission statement.

It is the mission of the American Association of Swine Veterinarians to:

- increase the knowledge of swine veterinarians
- protect and promote the health and well-being of pigs
- advocate science-based approaches to veterinary, industry, and public health issues
- promote the development and availability of resources that enhance the effectiveness of professional activities
- create opportunities that inspire personal and professional growth and interaction
- mentor students, encouraging lifelong careers as swine veterinarians

The past couple of years have certainly been fraught with challenges. The COVID-19 pandemic and the multitude of unintended consequences the mitigations have generated still haunt us, and it appears they will continue to do so for some time. Protests, riots, political turmoil, and I believe an erosion of core values that tend to unite us as a nation have many people living in fear. In our industry, our animals live under the constant threat of African swine fever, and its recent discovery in the western hemisphere has heightened our concern. It's difficult to stay positive even knowing we have so very much to be grateful for.

I have no idea what the landscape will look like by the time this message reaches you, but I do know we are resilient.

We have faced challenges before and emerged from them more knowledgeable, stronger, and united. I was reminiscing with some colleagues the other day about the multitude of opportunities our industry has faced during my professional career. Pseudorabies, *Salmonella cholerasuis*, transmissible gastroenteritis, edema disease, ileitis, porcine circovirus, porcine epidemic diarrhea, delta coronavirus, and some very virulent PRRSV strains have all been major topics of conversation at AASV Annual Meetings over the past 26 years. Yet, look at that list. Two of those diseases no longer plague us, and although we don't have all the answers, we have made tremendous strides in reducing the incidence, severity, duration, or spread of the others through preventative vaccinations or management strategies and enhanced biosecurity. None of that progress was made in a bubble. We reached out to others, asked for assistance, learned from others' experiences, and made progress to improve the health and well-being of our animals. I am so very proud to be a member of this great profession and the AASV.

History tells us more challenges lie ahead. I am thankful we have each other, a talented group of individuals that assess the situation and find solutions. Know that you are never on the journey alone, and you can count on the AASV to assist when possible.

Again, we are in some troubling times. There is no shame if you find yourself struggling emotionally. The AASV website has several tools on veterinary well-being under the Resources tab to assist you. If that is not your style, talk to a friend, family member, religious leader, or counselor. Please keep reaching out until you find the assistance you need. You have friends and colleagues who care about you.

Mary Battrell, DVM
AASV President

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1: Perri A et al. An investigation of iron deficiency and anemia in piglets and the effect of iron status at weaning on post-weaning performance. JSHAP. 2016;24:10–20.

2: Fredericks L et al. Evaluation of the impact of iron dosage on post- weaning weight gain, and mortality. AASV. 2018;315

3: Olsen, C. (2019) The economics of iron deficiency anemia on US swine production: An annual impact of 46-335 million US dollars. American Association of Swine Veterinarians. Orlando. Florida.

* Industry Standards for Blood Hb Levels (g/L)

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PM-060-00

What's new?

It is Friday in late September as I sit here writing this article. The kind folks from JSHAP have been reminding me for 3 weeks now to get this done so they can wrap up the November/December issue and send it off to the printer. As I was pondering what to write this month, it occurred to me that this is the 97th article I have written for JSHAP. I have to tell you that after that many articles, it is becoming difficult to find something new to write about, so I won't even try.

African swine fever (ASF). It's still the topic that occupies much of my time. As you know, the virus is now in the Western Hemisphere for the first time in 40 years. There is still no vaccine available. The AASV, in collaboration with National Pork Board (NPB), National Pork Producers Council, and Swine Health Information Center (SHIC), continues to work diligently with our industry partners, regulators, and legislators to focus on preventing the introduction of ASF into the North American swine herd. I am comfortable saying we are better prepared than we have ever been while acknowledging that we are not as prepared as we would like to be.

In 2019, during a pre-dinner gathering of our industry friends, I raised the idea that it might be worthwhile to have a third party take a look at our national biosecurity safeguards and identify potential risk factors associated with the introduction of ASF into the United States. After further discussion, NPB and SHIC agreed to fund a study conducted by Epix Analytics to do just that. Epix recently completed that study and has presented the results. This was a very comprehensive examination of potential routes of introduction and dissemination of the ASF virus.

The study looked at eight pathways of introduction including legal and illegal importation of live swine, illegal importation of pork products, importation of feed and feed ingredients, international travelers, fomites associated with international movements, feral swine, and intentional or accidental release of the virus. The researchers identified 6 susceptible swine populations at risk in the United States: commercial herds, show pigs, outdoor farms, feral pigs, pet pigs, and zoos. They evaluated the routes by which each of these populations could be exposed to the ASF virus and then considered three types of actions (short-term mitigations, education, and research/development) that could be implemented to address each of the identified biosecurity gaps.

Suffice to say, I was encouraged and somewhat disappointed. Encouraged in that they did not identify any routes of introduction that we had not already considered and that were not already being addressed or discussed. Although, I was hoping they might identify something we had not thought about so we could start addressing that gap as well. Given this is the 20th anniversary of September 11th, I could not help but think about how we had failed to recognize the threat of using planes to attack our country or how feed ingredients had been the vehicle by which porcine epidemic diarrhea virus had entered our pig herd. The study, however, was well done and has value in that it was a third party look at our industry safeguards. That process offers some validation that we are working on the right challenges while keeping our eyes out for the unexpected.

"That process offers some validation that we are working on the right challenges while keeping our eyes out for the unexpected."

The other thing keeping me busy (and, when I say "me", I mean Sue) these days is planning for the 2022 AASV Annual Meeting in Indianapolis. We are looking forward to once again getting together and having an in-person meeting. I have missed all you guys! As we plan the meeting, we are continuing to monitor COVID-19 and any federal, state, or local restrictions and guidelines that might force us to change our plans. We want to ensure, to the best of our ability, that everyone has a safe, enjoyable, and productive meeting. To that end, we will be following any public health guidelines regarding vaccination, social distancing, and masking. I hope you will join us February 26 - March 1, 2022 at the JW Marriott Indianapolis for the 53rd AASV Annual Meeting.

As I was wrapping this up, I looked up at the wall in front of my desk. The only thing hanging on that wall is a calendar. I just noticed that I have not changed the calendar in three months. I flipped the calendar over to September and that is when I found inspiration: today, September 24, 2021, is National Punctuation Day! And, on a Friday no less! What better way to end a week? Period! Go ahead, celebrate. Use that extra exclamation point!!

Harry Snelson, DVM
Executive Director

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Another year of thanks!

The November issue of the *Journal of Swine Health and Production* (JSHAP) is always one of my annual favorites as it is the issue of thanks! I have said it before and I will say it again, that it is a team effort to manage, peer-review, and publish the journal.

Last year when I wrote my November/December issue message, I was sincerely grateful that I could share with you that the journal had been thriving during the pandemic. This continues to be the case. The pandemic has affected people very differently depending on where you live, job demands, and life responsibilities. Our reviewers reside across North America and beyond our continental boarders. Yet, we almost always receive a whole-hearted "yes, I will review a paper for you" when we reach out to reviewers. It is imperative to have comprehensive peer-reviews of our publications and our reviewers take their job seriously. In my mind, this reflects the commitment our reviewers and authors have towards maintaining the high quality of our reviews and final publications.

While I usually only put my "thank you" formally into print for my November/December issue message, please know that the gratitude is there all year. Everyone's contribution to the journal is one step forward towards sharing and advancing our knowledge. Once again, I would like to draw your attention to the list of people on page 357 of this issue who offered their time to conduct peer-reviews. Thank you to those who found time in their schedules to conduct a peer-review for the journal.

Another important aspect of high-quality peer-reviewed manuscripts (and research) is the quality of the reporting of the research. The journal has published peer-reviewed articles under the heading of Special Topic before. This issue brings another Special Topic related to reporting guidelines. The journal does not require authors to strictly adhere to different reporting guidelines, but it is encouraged that authors, and peer-reviewers, take these guidelines into consideration. For a busy practitioner reading and interpreting manuscripts,

"I have said it before and I will say it again, that it is a team effort to manage, peer-review, and publish the journal."

these reporting guidelines can also help you critically evaluate the literature that comes across your desk. The author guidelines section of the journal website contains templates for manuscript submissions. The different types of reporting guidelines are also available on the journal website to facilitate locating them and encourage their use.

I hope you enjoy this issue.

Terri O'Sullivan, DVM, PhD
Executive Editor

Virulence genes of *Escherichia coli* vaginal isolates associated with postpartum dysgalactia syndrome in sows

Branko Angjelovski, DVM, PhD; Branko Atanasov, DVM, MS, PhD; Miroslav Kjosevski, DVM, PhD

Summary

Objective: Identify the occurrence of certain virulence genes of *Escherichia coli* vaginal isolates associated with postpartum dysgalactia syndrome (PDS) in sows.

Materials and methods: Two hundred and two sows from 5 Macedonian pig farms were clinically examined for PDS 12 to 24 hours after farrowing. Vaginal swabs for bacteriological testing were taken from PDS-affected (PDSA, n = 47) and PDS-unaffected (PDSU, n = 155) sows. In total, 74 isolates of *E coli* were tested by multiplex polymerase chain reaction for the presence of virulence genes related to specific pathogenic strains.

Results: Genes associated with extra-intestinal pathogenic *E coli* (ExPEC) strains were the most prevalent among all tested *E coli* isolates. The most dominant gene among all *E coli* isolates was *fimC*. The *iss* gene was more prevalent in PDSA sows compared to PDSU sows (*P* = .02). Multivariable logistic regression showed that lower parity sows (*P* ≤ .001) and presence of the *iss* (*P* = .003) and *astA* genes (*P* = .03) were correlated with the occurrence of PDS.

Implications: Lower parity sows vaginally infected with *E coli* associated with particular ExPEC strains are at higher risk of developing PDS. Positive vaginal swabs for *E coli* and *iss* gene found early after farrowing were associated with PDS in sows. Classification of *E coli* into specific ExPEC pathotype was not possible by virulence genotyping only.

Resumen - Genes de virulencia de aislamientos vaginales de *Escherichia coli* asociados con el síndrome de disgalaxia posparto en cerdas

Objetivo: Identificar la incidencia de ciertos genes de virulencia de aislamientos vaginales de *Escherichia coli* asociados con el síndrome de disgalaxia posparto (PDS) en cerdas.

Materiales y métodos: Se examinaron clínicamente doscientas dos cerdas de 5 granjas de cerdos de Macedonia para detectar el PDS entre 12 y 24 horas después del parto. Se tomaron hisopos vaginales para pruebas bacteriológicas de cerdas afectadas por PDS (PDSA; n = 47) y no afectadas (PDSU; n = 155). En total, 74 cepas de *E coli* se analizaron mediante la reacción en cadena de la polimerasa multiplex para detectar la presencia de genes de virulencia relacionados con cepas patógenas específicas.

Resultados: Los genes asociados con cepas de *E coli* patógenas extraintestinales (ExPEC) fueron los más prevalentes entre todos los aislados de *E coli* analizados. El gen más dominante entre todos los aislados de *E coli* fue *fimC*. El gen *iss* fue más prevalente en las cerdas PDSA en comparación con las cerdas PDSU (*P* = .02). La regresión logística multivariable mostró que las cerdas de menor paridad (*P* ≤ .001) y la presencia de los genes *iss* (*P* = .003) y *astA* (*P* = .03) se correlacionaron con la aparición de PDS.

Implicaciones: Las cerdas de menor paridad infectadas por vía vaginal con *E coli* asociadas con cepas específicas de ExPEC tienen un mayor riesgo de desarrollar PDS. Los hisopos vaginales positivos para *E coli* y el gen *iss* encontrados poco después del parto se asociaron con el PDS en las cerdas. La clasificación de *E coli* en un patotipo específico de ExPEC no fue posible mediante genotipificación de virulencia únicamente.

Résumé - Gènes de virulence des isolats vaginaux d'*Escherichia coli* associés au syndrome de dysgalactie post-partum chez les truies

Objectif: Identifier la présence de certains gènes de virulence d'isolats vaginaux d'*Escherichia coli* associés au syndrome de dysgalactie post-partum (PDS) chez les truies.

Matériel et méthodes: Deux cent deux truies de cinq élevages de porcs macédoniens ont été examinées cliniquement pour le PDS 12 à 24 heures après la mise bas. Des écouvillons vaginaux pour les tests bactériologiques ont été prélevés sur des truies atteintes de PDS (PDSA; n = 47)

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

et non atteintes de PDS (PDSU; n = 155). Au total, 74 isolats d'*E coli* ont été testés par réaction d'amplification en chaîne par la polymérase multiplex pour la présence de gènes de virulence liés à des souches pathogènes spécifiques.

Résultats: Les gènes associés aux souches d'*E coli* pathogènes extra-intestinaux (ExPEC) étaient les plus répandus parmi tous les isolats d'*E coli* testés. Le gène le plus dominant parmi tous les isolats d'*E coli* était le *fimC*. Le gène *iss* était plus répandu chez les truies PDSA que chez les truies PDSU (*P* = .02). La régression logistique multivariée a montré que les truies de parité plus faible (*P* ≤ .001) et la présence des gènes *iss* (*P* = .003) et *astA* (*P* = .03) étaient corrélées à l'apparition de PDS.

Implications: Les truies à parité inférieure infectées par voie vaginale par *E coli* associées à des souches d'ExPEC particulières courent un risque plus élevé de développer un PDS. Des prélèvements vaginaux positifs pour *E coli* et le gène *iss* trouvés tôt après la mise bas ont été associés à la PDS chez les truies. La classification d'*E coli* en pathotype ExPEC spécifique n'a pas été possible uniquement par le génotypage de virulence.

Postpartum dysgalactia syndrome (PDS) in sows is one of the main health concerns characterized by fever, endometritis, and insufficient colostrum and milk production during the first days after farrowing.[1-3] The syndrome decreases growth rate and increases mortality in preweaning piglets due to reduced lactation performance of sows in the first 48 to 72 hours post partum.[1,4,5] It is associated with huge financial losses and negatively affects animal welfare in intensive pig production worldwide.[5,6] The incidence at herd level depends on criteria used to assess the occurrence of PDS and is estimated to vary between 0.5% and 60%, with an average of 13%.[4-8]

Although it is considered a multifactorial disease, coliform bacteria such as *Escherichia*, *Enterobacter*, *Citrobacter,* and *Klebsiella* play a major role in the etiology of the infection.[6,8-11] The importance of *Escherichia coli* in the clinical manifestation of PDS has been reported in few experimental studies.[10-12] Recent studies demonstrated that endometritis in sows shortly after farrowing is considered to be a risk for development of PDS.[1,3]

Additionally, the dominance of *E coli* in the genital tract of affected sows highlights its potential role in the clinical manifestation of the syndrome.[6,8,13,14] However, to our knowledge, *E coli* isolates obtained from the vaginal swabs of PDS diseased sows have not been analyzed for presence of virulence genes.

Based on location, clinical diseases, and virulence characteristics, strains of *E coli* can be classified into intestinal pathogenic *E coli* (IPEC), extraintestinal pathogenic *E coli* (ExPEC) and commensal *E coli*.[15] Enterotoxigenic *E coli* (ETEC) and shiga toxin-producing *E coli* (STEC) pathotypes of IPEC in pigs are well demonstrated as etiological agents for diarrhea and edema diseases in piglets.[16] Additionally, urogenital infections caused by uropathogenic *E coli* (UPEC) and septicemia in pigs are correlated with ExPEC pathotypes.[17,18] In the study of Gerjets et al,[19] *E coli* isolates from milk samples of healthy sows and sows with coliform mastitis were examined for the presence of virulence genes associated with ExPEC, ETEC, and other pathogenic *E coli*. Nevertheless, there is a lack of information about the virulence genes of *E coli* recovered from the genital tract of sows and the occurrence of PDS.

The aim of this study was to determine the presence of virulence genes related to ExPEC and ETEC in vaginal isolates of sows with clinical PDS.

Animal care and use

This work was performed in accordance with the Macedonian Legislation on protection and welfare of animals and approved by the Faculty of Veterinary Medicine, Ss. Cyril and Methodius University in Skopje, Macedonia (Decision No. 0202-418/6).

Materials and methods

Animals

The study was carried out between July 2014 and August 2016 on 5 commercial pig farms in Macedonia. In total, 202 sows with available reproductive data of different parities (1-9) and different genetic lines (Landrace-Yorkshire F1 and Dalland hybrid) were recruited for this study. Sows with unknown reproductive records (parity number and time of farrowing completion) were excluded from the study.

All sows and their litters were clinically examined for the presence of PDS 12 to 24 hours after farrowing (8 AM to 10 AM) based on predetermined clinical signs (Table 1). During clinical inspection, sows were defined as PDS-affected (PDSA) when they showed pathological vulvar discharge or mastitis and had at least one or more clinical signs listed in Table 1.

After clinical assessment, 47 sows were identified as PDSA, while 155 sows were declared as healthy, or PDS-unaffected (PDSU), and showing none of the clinical signs previously described. On the same day following clinical examination, vaginal swabs were taken for bacteriological testing. In total, 202 samples were taken from 47 PDSA and 155 PDSU sows. Before sampling, the vulva was cleaned and disinfected with 10% iodine solution. Vaginal swabs were taken using sterile metal speculums with 3-cm external diameter and 30 to 40 cm in length, deeply inserted into the vagina, by thorough contact with the ventral mucosa for at least 10 seconds. Swabs were stored at 4°C and transported to the laboratory within 2 hours.

Bacteriological analysis

Bacteriological testing was performed by using routine diagnostic procedures. The initial inoculation of the samples was performed on 5% sheep blood agar (blood agar base; Merck) and selective media for gram-negative bacteria (Xylose Lysine Deoxycholate, MacConkey, and Tryptone Bile X-Glucuronide Agar; Merck). After 24 hours of aerobic incubation at 37°C, the grown bacteria were distinguished by their morphology, hemolysis on blood agar catalase reaction, Gram staining, and growth on selective media. Selected colonies were subcultivated on blood agar for another 24 hours at 37°C to obtain pure cultures. The final identification was performed by automated system VITEK2 Compact (BioMérieux). Obtained *E coli* isolates were selected for further investigations.

Bacterial DNA of *E coli* strains was prepared by dissolving 2 to 3 colonies in 200 µL of distilled water. After 30 minutes of heating at 95°C, 2.5 µL of the supernatant was used for polymerase chain reaction (PCR) analyses. In total, 74 *E coli* isolates were examined using multiplex PCR assays for the presence of 27 virulence genes encoding virulence factors associated with ExPEC, ETEC, and STEC strains as described by Ewers et al[15] and Casey and Bosworth.[16] The complete list of targeted virulence genes and primer sequences used for amplification procedures are shown in Table 2. Avian pathogenic *E coli* (APEC) strain IMT 2470, UPEC

Table 1: Frequency of clinical signs observed in PDSA sows (n = 47)

Clinical sign	Description	PDSA sows, No. (%)
Pathological vulvar discharge	Copious purulent vulvar discharge	30 (63.8)
Mastitis	Warm, painful, swollen, and firm mammary glands	20 (42.6)
Fever	Increased rectal temperature (≥ 39.5°C)	17 (36.2)
Reduced appetite	Consumed less than half the quantity of feed provided	16 (34.0)
Hypogalactia	Reduced milk flow (drops of milk)	30 (63.8)
Depression in sow	Lethargy and sternal recumbency	28 (59.6)
Altered piglet behavior	Lethargy, restlessness, vigorous nursing efforts	32 (68.1)

PDSA = postpartum dysgalactia syndrome-affected.

strains[15] IMT7920 and IMT9267, and ETEC strains[16] IMT204, IMT19, IMT4830, and IMT3838 served as controls for molecular assays and were kindly provided by the Institute of Microbiology and Epizootics of the Free University Berlin.

Statistical analysis

Statistical analyses were performed using STATISTICA (version 8.0; StatSoft, Inc). The prevalence of *E coli* was calculated at sow level and descriptive statistics (Mean [SD]) were applied for the parity of sows positive for *E coli*. The Mann-Whitney test was used to detect significant differences between the parity of PDSA and PDSU sows positive for *E coli*. Frequency of detected virulence genes was calculated for *E coli* isolates in both PDSA and PDSU sows. A Chi square-test and the Fisher's exact test were preformed to find the differences in the frequency of the *E coli* virulence genes between PDSA and PDSU sows. The results were considered statistically significant at *P* < .05.

Multivariable logistic regression was applied to parity and the presence of *E coli* virulence genes as independent variables with regard to the PDS status. The dependent variable was the occurrence of PDS as a binary trait (PDSA sows or PDSU sows). The presence of the virulence genes and parity with *P* ≤ .25 were selected to be used in the multivariable logistic model. The final logistic model was developed by following a forward stepwise approach using parity and virulence genes as predictors for PDS. The final model consisted of significant variables with *P* < .05. The strength of relationships was expressed using odds ratio (OR).

Results

The prevalence of *E coli* was significantly higher (χ_4^2 = 16.287, *P* < .001) in the PDSA sows (57.45%; 27 of 47) compared to the PDSU sows (26.45%; 41 of 155).The PDSA sows positive for *E coli* had significantly lower parity (3.18 [1.94]) than the parity observed in PDSU sows (5.21 [2.53]) positive for *E coli* (*U* = 293.00; *P* < .001). From PDSA sows, 33 *E coli* isolates were recovered from the vaginal swabs, while 41 isolates were detected in vaginal swabs of PDSU sows. Of the 74 *E coli* isolates, 70 isolates had at least one virulence gene. From the 32 *E coli* isolates from PDSA sows, 113 virulence genes were identified compared with 138 virulence genes detected in 38 isolates from PDSU sow samples.

The number of virulence genes per isolate ranged from 1 to 10 and 96.41% (242 of 251) of genes were associated with ExPEC strains. The most dominant virulence gene in all *E coli* isolates was *fimC* (94.29%; 66 of 70) with prevalence of 90.63% (29 of 32) in isolates of PDSA sows and 97.37% (37 of 38) in isolates from vaginal swabs of PDSU sows. The lowest prevalence of 1.42% was found for *K88 (F5)* and *kpsMTII*, while genes *irp2*, *papC, vat, F18, Stx2e, STb, LTI, 987P (F6), K99 (F4),* and *afa/draB* were not found in any of the isolates. Concerning the prevalence of virulence genes between the two groups of sows positive for *E coli*, *fimC* was the most dominant gene in both groups of sows, while significance was observed only for *iss* gene with higher prevalence found in PDSA sow samples (*P* = .02; Table 3).

Parity and presence of virulence genes *iss, iucD, astA, hlyA, sfa/foc, pic,* and *iha* with *P* ≤ .25 were included in the logistic regression. The multivariable logistic

regression model showed that parity associated with the presence of virulence genes *iss, sfa/foc, astA,* and *hlyA* were significantly associated with PDS occurrence (R^2 = 0.373; *P* < .001; Table 4).

Discussion

In this study, *E coli* isolates from vaginal tracts of PDSA and PDSU sows were compared to get information on differences in the *E coli* virulence genes regarding PDS. We found significantly lower parity for PDSA sows positive for *E coli* in contrast to parity for PDSU sows positive for *E coli*. This finding is in accordance with the study conducted by Bostedt et al,[14] where *E coli* was the predominant bacterium in the genital tract of 78 gilts suffering from puerperal septicemia.

Virulence genes belonging to ExPEC strains were the most frequent genes detected in all *E coli* isolates similar to the results reported by Gerjets et al.[19] Uropathogenic *E coli* strains, members of ExPEC, are the main causative agents associated with urogenital tract infections (UGTI).[15,20] Colonization of the urogenital tract by UPEC strains are associated with certain virulence genes encoding virulent capsule antigens, iron acquisition systems, adhesions, and secreted toxins.[20] The *fimC* gene, described as a urovirulence factor playing an important role in urinary tract infection,[20] was also detected in a high percentage in our study. This finding is in agreement with other studies.[19,21] In a survey conducted by Gerjets et al,[19] *fimC* was found in 84.7% of the isolates from the milk of sows with coliform mastitis and in 82.3% of the isolates from the milk of healthy sows. Similarly, high prevalence of *fimC* (91.3%) was found in *E coli* isolates recovered from sows with UGTI.[21] In another study, *fimC* was highly prevalent in *E coli* isolates obtained from

Table 2: Primers used for detection of 27 virulence genes associated with ETEC, STEC, and ExPEC strains

Virulence factor	Forward primer	Reverse primer	Product size	Pathotype	Reference
STb	TGCCTATGCATCTACACAAT	CTCCAGCAGTACCATCTCTA	113	ETEC	16
STaP	CAACTGAATCACTTGACTCTT	TTAATAACATCCAGCACAGG	158	ETEC	16
LT	GGCGTTACTATCCTCTCTAT	TGGTCTCGGTCAGATATGT	272	ETEC	16
Adhesins					
K99 (F4)	AATACTTGTTCAGGGAGAAA	AACTTTGTGGTTAACTTCCT	230	ETEC	16
F18	TGGTAACGTATCAGCAACTA	ACTTACAGTGCTATTCGACG	313	ETEC	16
987P (F6)	AAGTTACTGCCAGTCTATGC	GTAACTCCACCGTTTGTATC	409	ETEC	16
K88 (F5)	GTTGGTACAGGTCTTAATGG	GAATCTGTCCGAGAATATCA	499	ETEC	16
F41	AGTATCTGGTTCAGTGATGG	CCACTATAAGAGGTTGAAGC	612	ETEC	16
afa/draB	TAAGGAAGTGAAGGAGCGTG	CCAGTAACTGTCCGTGACA	810	ExPEC	15
iha	TAGTGCGTTGGGTTATCGCTC	AAGCCAGAGTGGTTATTCGC	609	ExPEC	15
fimC	GGGTAGAAAATGCCGATGGTG	CGTCATTTTGGGGGTAAGTGC	477	ExPEC	15
sfa/foc	GTCCTGACTCATCTGAAACTGCA	CGGAGAACTGGGTGCATCTTA	1242	ExPEC	15
hra	TCACTTGCAGACCAGCGTTTC	GTAACTCACACTGCTGTCACCT	537	ExPEC	15
tsh	ACTATTCTCTGCAGGAAGTC	CTTCCGATGTTCTGAACGT	824	ExPEC	15
papC	AAGCCAGAGTGGTTATTCGC	TGATATCACGCAGTCAGTAGC	501	ExPEC	15
Protectins					
neuC	GGTGGTACATTCCGGGATGTC	AGGTGAAAAGCCTGGTAGTGTG	676	ExPEC	15
kpsMT II	CAGGTAGCGTCGAACTGTA	CATCCAGACGATAAGCATGAGCA	280	ExPEC	15
cvi/cva	TCCAAGCGGACCCCTTATAG	CGCAGCATAGTTCCATGCT	598	ExPEC	15
iss	ATCACATAGGATTCTGCCG	CAGCGGAGTATAGATGCCA	309	ExPEC	15
Iron acquisition					
Irp2	AAGGATTCGCTGTTACCGGAC	TCGTCGGGCAGCGTTTCTTCT	413	ExPEC	15
iucD	ACAAAAAGTTCTATCGCTTCC	CCTGATCCAGATGATGCTC	714	ExPEC	15
Toxins					
hlyA	GTCCATTGCCGATAAGTTT	AAGTAATTTTTGCCGTGTTTT	352	ExPEC	15
astA	TGCCATCAACACAGTATATCC	TAGGATCCTCAGGTCGCGAGTGACGGC	116	ExPEC	15
vat	TCCTGGGACATAATGGCTAG	GTGTCAGAACGGAATTGTC	981	ExPEC	15
Stx2e	AATAGTATACGGACAGCGAT	TCTGACATTCTGGTTGACTC	733	STEC	16
Miscellaneous					
malX	GGACATCCTGTTACAGCGCGCA	TCGCCACCAATCACAGCCGAAC	922	ExPEC	15
pic	ACTGGATCTTAAGGCTCAGG	TGGAATATCAGGGTGCCACT	409	ExPEC	15

ETEC = Enterotoxigenic *Escherichia coli*; STEC = shiga toxin-producing *E coli*; ExPEC = extraintestinal pathogenic *E coli*; *STb* = Thermo stable toxin b; *STaP* = Thermo stable toxin b; *LT* = Thermo labile toxin; *K99* (*F4*) = Fimbrial adhesin F4; *F18* = Fimbrial adhesin *F18*; *987P* (*F6*) = Fimbrial adhesin F6; *K88* (*F5*) = Fimbrial adhesin F5; *F41* = Fimbrial adhesin F41; *afa/draB* = Afimbrial/Dr antigen-specific adhesin; *iha* = Iron-regulated-gene-homologue adhesin; *fimC* = Type 1 fimbriae (d-mannose-specific adhesin); *sfa/foc* = S fimbriae (sialic acid-specific) and F1C fimbriae; *hra* = Heat-resistant agglutinin; *tsh* = Temperature-sensitive haemagglutinin; *papC* = Pilus associated with pyelonephritis; *neuC* = K1 capsular polysaccharide; *kpsMT II* = Group II capsule antigens; *cvi/cva* = Structural genes of colicin V operon (microcin ColV); *iss* = Increased serum survival; *Irp2* = Iron-repressible protein (yersiniabactin synthesis); *iucD* = Aerobactin synthesis; *hlyA* = Hemolysin A; *astA* = EAST1 (heat-stable cytotoxin associated with enteroaggregative *E coli*); *vat* = Vacuolating autotransporter toxin; *Stx2e* = Shiga-like toxin II; *malX* = Pathogenicity-associated island marker CFT073; *pic* = Serin protease autotransporter.

Table 3: Prevalence of *Escherichia coli* virulence genes in PDSA (n = 27) and PDSU sows (n = 41)

Virulence gene	PDSA sows, No. (%)	PDSU sows, No. (%)	P*
fimC	23 (85.18)	36 (87.80)	.75
iss	18 (66.66)	16 (39.02)	.02
iucD	14 (51.85)	15 (36.58)	.21
cvi/cva	9 (33.33)	15 (36.58)	.78
hra	9 (33.33)	12 (29.26)	.72
astA	9 (33.33)	7 (17.07)	.12
tsh	7 (25.92)	10 (24.39)	.88
malX	4 (14.81)	6 (14.63)	.98
neuC	2 (7.40)	2 (4.87)	.66
F41	1 (3.70)	4 (9.75)	.39
hlyA	0 (0.00)	4 (9.75)	.09
STaP	1 (3.70)	2 (4.87)	.81
sfa/foc	0 (0.00)	3 (7.31)	.15
iha	0 (0.00)	3 (7.31)	.15
pic	0 (0.00)	2 (4.87)	.24
kpsMT II	1 (3.70)	0 (0.00)	.21
K88 (F5)	0 (0.00)	1 (2.43)	.41

* The *P* value for the prevalence of *E coli* virulence genes between PDSA and PDSU sows was obtained using Chi square-test. Level of significance is *P* < .05.

PDSA = postpartum dysgalactia syndrome-affected; PDSU = postpartum dysgalactia syndrome-unaffected; *fimC* = Type 1 fimbriae (d-mannose-specific adhesin); *iss* = Increased serum survival; *iucD* = Aerobactin synthesis; *cvi/cva* = Structural genes of colicin V operon (microcin ColV); *hra* = Heat-resistant agglutinin; *astA* = EAST1 (heat-stable cytotoxin associated with enteroaggregative *E coli*); *tsh* = Temperature-sensitive haemagglutinin; *malX* = Pathogenicity-associated island marker CFT073; *neuC* = K1 capsular polysaccharide; *F41* = Fimbrial adhesin F41; *hlyA* = Hemolysin A; *STaP* = Thermo stable toxin b; *sfa/foc* = S fimbriae (sialic acid-specific) and F1C fimbriae; *iha* = Iron-regulated-gene-homologue adhesin; *pic* = Serin protease autotransporter; *kpsMT II* = Group II capsule antigens; *K88 (F5)* = Fimbrial adhesin F5.

Table 4: Association of virulence genes (*P* < .05) and sow parity (*P* < .001) with occurrence of PDS in sows

Variable	β	OR (95% CI)	SE	P*
Parity number	-0.43	0.65 (0.53-0.79)	0.10	< .001
iss gene	0.39	1.48 (1.21-1.80)	0.10	< .001
sfa/foc gene	-0.30	0.73 (0.60-0.89)	0.10	.003
astA gene	0.23	1.25 (1.02-1.52)	0.10	.02
hlyA gene	-0.22	0.79 (0.66-0.96)	0.10	.03

* The *P* values were obtained using multivariable logistic regression with a binary trait of PDS as dependent variable and sow parity and virulence genes as independent variables. In the logistic regression PDSA group was coded 1 and PDSU group was coded 0.

PDS = postpartum dysgalactia syndrome; OR = Odds ratio; *iss* = Increased serum survival; *sfa/foc* = S fimbriae (sialic acid-specific) and F1C fimbriae; *astA* = EAST1 (heat-stable cytotoxin associated with enteroaggregative *Escherichia coli*); *hlyA* = Hemolysin A; PDSA = PDS-affected; PDSU = PDS-unaffected.

both septicemic and healthy chickens.[22] Weak association of the prevalence of *fimC* and occurrence of PDS was also confirmed in our study where high prevalence (97.4%) of this fimbrial gene was also identified in PDSU sows.

Bacterial serum resistance has been reported as an important virulence factor since it enables bacteria to avoid the bactericidal effect of a serum.[23] Without this virulence factor, bacteria are being lysed by complement, which is more often activated through surface bacterial antigens via an alternative pathway.[24] The C3b component plays an important part in the alternative pathway mechanism enabling adherence of bacteria to C5 to C9 bacteriolytic membrane attack complex (MAC).[24]

Higher prevalence of *iss* gene in PDSA sows in our research confirms the findings of other researchers.[23-26] Pedersen Mörner et al[23] found that serum resistance virulence factor was more frequently detected in *E coli* isolates obtained from sows with coliform mastitis. Moreover, this virulence factor was often detected in strains isolated from the milk of mastitic cows.[25] Kassé et al[26] found that the *iss* gene was detected in 70% of *E coli* isolates found in dairy cows with postpartum metritis. The *iss* gene is more frequently distributed in APEC strains and is closely associated with large transmissible R plasmids or ColV plasmids in APEC (pAPEC-O1, pAPEC-O2-ColBM and pTJ100).[27] However, some studies have documented contradictory findings regarding the prevalence of *iss* between different *E coli* populations. In the study conducted by Rodriguez-Siek et al,[28] *iss* gene was found in 81% of APEC and in 60% of the UPEC isolates. In addition, this gene was confirmed in 56% of the newborn meningitis *E coli* (NMEC) strains[15] and in a few human fecal commensal *E coli* isolates.[29] Thus, more frequent presence of *iss* gene in ExPEC strains may be related to their ability to survive in extraintestinal conditions.[29]

The virulence genes related to APEC strain IMT2470 that we frequently detected in PDSA sows were found in UPEC strains too.[15,30] In the research of Ewers et al[30] at least one virulence gene related with APEC strain IMT2470 was found in all five UPEC isolates. In the survey of Ewers et al,[15] a substantial number of APEC associated genes (*iss, iucD, iroN, traT*) were also detected in UPEC strains. However, we could not categorize the detected *E coli* strains into specific ExPEC pathotype by virulence genotyping only.

Many virulence features such as iron-uptake systems, protectins, fimbriae, and other adhesins are essential for fitness properties of the bacteria to enable them to efficiently adapt and colonize the host rather than their classical virulence factors primarily included in infection.[31]

In our study, we found that the presence of *iss* and *astA* and lower parity increased the clinical manifestation of PDS in sows. Moreover, the adjusted R^2 of 0.373 obtained for lower parity, presence of *iss* and *astA*, and absence of *sfa/foc* and *hlyA* were associated with the occurrence of PDS. Scientific data regarding the effect of parity as a risk factor on the occurrence of PDS are inconsistent. While Baer and Bilkei[32] reported that higher (> 4) parity sows had increased risk from reciDiving mastitis-metritis-agalactia syndrome, other authors found greater risk of postparturient disorders for lower parity sows.[14,33,34]

We also found that younger sows vaginally infected by *E coli* were more prone to disease. According to Hoy,[35] higher parity sows have a more developed immune system than lower parity sows primarily due to their wider contact with microbiological agents during their lifetime. Nevertheless, our results could lead to potential biases, such as not having representative samples of virulence factors for the general sow population. This is certainly a weakness of the current study and additional research with adequate sample size is required to determine the biological associations of detected virulence genes and PDS in sows.

In summary, this study found that virulence genes associated with ExPEC were the most frequently detected among *E coli* isolates recovered from the vaginal swabs of both PDSA and PDSU sows. Lower parity and certain virulence genes related to ExPEC strains were strongly associated with clinical PDS in sows. This study gives novel information about virulence genes of *E coli* isolated from the genital tract of sows and PDS. The number of sows selected for this research corresponded to the available reproductive data obtained by the commercial pig farms included in the study. However, further research with large and equal sample sizes should be conducted to identify whether specific virulence gene profiles of ExPEC strains recovered from the genital tract are in line with the clinical appearance of PDS. The prevalence of virulence genes from other coliform bacteria and PDS in sows should be considered in future studies.

Implications

Under the conditions of this study:

- Vaginal swabs positive for *E coli* and *iss* were associated with PDS in sows.
- Younger sows with certain ExPEC strains were more likely to have clinical PDS.
- *Escherichia coli* pathotypes could not be categorized by virulence genotyping.

Conflict of interest

None reported.

Disclaimer

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*Non-refereed reference.

CONVERSION TABLES

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28.35
1 lb (16 oz)	0.45 kg	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)	0.3 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	35.3
1 gal (128 fl oz)	3.8 L	gal to L	3.8
0.26 gal	1 L	L to gal	0.26
1 qt (32 fl oz)	0.95 L	qt to L	0.95
1.06 qt	1 L	L to qt	1.06

Temperature equivalents (approx)

°F	°C
32	0
50	10.0
60	15.5
61	16.1
65	18.3
70	21.1
75	23.8
80	26.6
82	27.7
85	29.4
90	32.2
102	38.8
103	39.4
104	40.0
105	40.5
106	41.1
212	100.0

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

Conversion calculator available at: amamanualofstyle.com/page/si-conversion-calculator

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	136
	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

Swine behavioral and physiological response to increasing sodium nitrite oral drench administration and resulting tissue residues

Brent J. Pepin, DVM, MS; Carissa Odland, DVM; Taylor Spronk, DVM; Roy Edler, MS; Todd Williams, DVM

Summary

Objectives: This study aimed to evaluate the physiological and behavioral responses of pigs administered sodium nitrite, determine an ideal dosing rate by oral drenching of sodium nitrite for depopulation events, and evaluate the nitrite residue present in the ocular fluid and skeletal muscle after sodium nitrite administration.

Materials and methods: Four groups of 10 market weight pigs (40 market weight pigs total) and 1 group of 10 sows were used. Each group of market weight animals received a different oral drench dose of sodium nitrite solution (1× [400-441 mg/kg], 2× [800-882 mg/kg], 2.5× [1000-1102 mg/kg], and 3× [1200-1323 mg/kg]) and was observed for distress behaviors. Two market weight animals in each treatment group were implanted with a monitor to measure body temperature, heart rate, and activity levels. The dosing rate with apparent best behavioral and physiological response was applied to the 10 sows and the same behaviors monitored. After death was confirmed, ocular fluid and skeletal muscle samples were collected from the sows.

Results: An increased dosage of sodium nitrite greatly reduced the time to distress with a significant linear relationship. A higher frequency of vocalizations and the most frequent spikes in activity levels were observed in the lowest dosing group. No correlation was found between ocular fluid nitrite and skeletal muscle sodium nitrite concentrations.

Implications: Oral drenching of sodium nitrite is a viable method for swine depopulation events. Higher doses of sodium nitrite have better welfare associations. Ocular fluid nitrite anion concentrations do not correlate with sodium nitrite skeletal muscle concentrations.

Keywords: swine, sodium nitrite, depopulation, oral drench, welfare

Resumen - Respuesta fisiológica y de comportamiento de los cerdos al aumento de la administración oral de nitrito de sodio y los residuos tisulares consiguientes

Objetivos: Este estudio tuvo como objetivo evaluar las respuestas fisiológicas y de comportamiento de los cerdos a los que se les administró nitrito de sodio, determinar una dosis ideal oral de nitrito de sodio en programas de despoblación y evaluar el residuo de nitrito presente en el líquido ocular y en el músculo esquelético después de la administración de nitrito de sodio.

Materiales y métodos: Se utilizaron cuatro grupos de 10 cerdos con peso de venta (40 cerdos en total, con peso de venta) y 1 grupo de 10 cerdas adultas. Cada grupo de animales con peso de venta recibió una dosis diferente de una solución de nitrito de sodio (1× [400-441 mg/kg], 2× [800-882 mg/kg], 2.5× [1000-1102 mg/kg], y 3× [1200-1323 mg/kg]) y se monitoreó sus conductas de ansiedad. En cada grupo, dos animales con peso de venta de cada grupo de tratamiento se les implantó un monitor para medir la temperatura corporal, la frecuencia cardíaca y los niveles de actividad. La dosis con la mejor respuesta fisiológica aparente y de comportamiento se utilizó en las 10 cerdas y se monitorearon los mismos comportamientos. Después de que se confirmó la muerte, se tomaron muestras de líquido ocular y músculo esquelético de las cerdas.

Resultados: Una dosis aumentada de nitrito de sodio redujo en gran medida el tiempo de ansiedad con una relación lineal significativa. En el grupo con la dosis más baja, se observó una mayor frecuencia de vocalizaciones y picos más frecuentes en los niveles de actividad. No se encontró correlación entre las concentraciones de nitrito en el líquido ocular y de nitrito de sodio en el músculo esquelético.

Implicaciones: La ingesta oral de nitrito de sodio es un método viable para programas de despoblación porcina. Las dosis más altas de nitrito de sodio tienen una mejor asociación al bienestar. Las concentraciones de aniones de nitrito en el fluido ocular no se correlacionan con las concentraciones de nitrito de sodio en el músculo esquelético.

Résumé - Réponse comportementale et physiologique du porc à l'administration orale de doses croissantes de nitrite de sodium et résidus tissulaires résultants

Objectifs: Cette étude visait à évaluer les réponses physiologiques et comportementales des porcs auxquels du nitrite de sodium a été administré, à

déterminer un taux de dosage idéal par administration orale de nitrite de sodium pour les procédures de dépeuplement et à évaluer le résidu de nitrite présent dans le liquide oculaire et le muscle squelettique après l'administration de nitrite de sodium.

Matériels et méthodes: Quatre groupes de 10 porcs de poids de marché (40 porcs de poids de marché au total) et un groupe de 10 truies ont été utilisés. Chaque groupe d'animaux de poids commercial a reçu une dose différente de solution de nitrite de sodium (1× [400-441 mg/kg], 2× [800-882 mg/kg], 2.5× [1000-1102 mg/kg], et 3× [1200-1323 mg/kg]) et a été observé pour les comportements de détresse. Deux animaux de poids commercial dans chaque groupe de traitement ont été implantés avec un moniteur pour mesurer la température corporelle, la fréquence cardiaque et les niveaux d'activité. Le taux de dosage avec la meilleure réponse comportementale et physiologique apparente a été appliqué aux 10 truies et les mêmes comportements ont été surveillés. Une fois la mort confirmée, des échantillons de liquide oculaire et de muscle squelettique ont été prélevés sur les truies.

Résultats: Une dose accrue de nitrite de sodium a considérablement réduit le temps de détresse avec une relation linéaire significative. Une fréquence plus élevée de vocalisations et les pics d'activité les plus fréquents ont été observés dans le groupe recevant la dose la plus faible. Aucune corrélation n'a été trouvée entre les concentrations de nitrite dans le liquide oculaire et les concentrations de nitrite de sodium dans le muscle squelettique.

Implications: L'administration orale de nitrite de sodium est une méthode viable pour les procédures de dépeuplement porcin. Des doses plus élevées de nitrite de sodium ont de meilleures associations avec le bien-être. Les concentrations d'anions de nitrite dans le liquide oculaire ne sont pas corrélées avec les concentrations de nitrite de sodium dans les muscles squelettiques.

A foreign animal disease (FAD) diagnosis like African swine fever or foot-and-mouth disease in the United States will likely evoke a "stamping-out policy," implementing depopulation of all confirmed positive and exposed swine.[1,2] Depopulation is the first line of defense in eradicating an FAD to prevent further spread to at-risk animals.[2] For the most flexibility to fit different farm designs and practices, different depopulation options

will be required. Research in depopulation methods is needed to develop these options.

Sodium nitrite ($NaNO_2$) has been researched in the United States and utilized by other countries to control feral swine (*Sus scrofa*) and other pest species.[3-6] Sodium nitrite ingestion causes a lethal rise in methemoglobin from the iron oxidation inside the oxygen-carrying red blood cells.[6,7] This oxidation prevents the release of oxygen into the animal's tissues leading to death at toxic levels.[6,7] The reported lethal oral dose of sodium nitrite is 400 mg/kg (181 mg/lb of body weight) for feral hog bait consumption. The lethal dose to kill 50% of the test population (LD_{50}) in the literature varies from 80 to 132.9 mg/kg, while the lethal dose for 95% is estimated to be 145 mg/kg.[3,4,6] Under trial conditions, hogs have been reported to die anywhere from 39 minutes to over 3 hours after oral consumption of a lethal dose of sodium nitrite.[3,6,8] The time-lapse between dosing and death is a potential advantage for depopulation events for allowing time to walk animals out of the barn before death occurs. However, getting animals to consume the product is problematic due to taste aversion to its bitter and salty properties.[3,9] This taste aversion is why bait is commonly used to mask the taste and encourage consumption.[3,9] To convince animals to drink nitrite solution freely, withholding water may be required. Withholding water can create welfare concerns and inefficiencies in time-sensitive events.

The knowledge for the potential use of sodium nitrite in domestic swine for depopulation events (eg, FAD outbreak) is limited.[6] Oral dosing through consumption and oral gavage (passing a tube down the throat to the stomach) of sodium nitrite has been explored in the literature, but not oral drenching of the product in solution. Oral drench provides a method for administration that does not depend on free choice consumption or passing of an oral tube for gavage. Convulsions, vomiting, gasping, and loss of coordination have all been reported as clinical signs of sodium nitrite intoxication in swine but not evaluated as a sign of distress under a predefined ethogram.[6] Sodium nitrite administration needs re-evaluation under specific ethogram definitions used in previous swine euthanasia studies to assess its impact on animal welfare.[10-12]

This study assesses the novel approach of oral drenching sodium nitrite to market weight animals (mean = 131 kg)

at 4 different dosing rates. The starting dosing rate is based on the targeted oral dose for feral hog bait consumption from the literature (400 mg/kg).[4] This study is the first to measure behavioral responses of swine to sodium nitrite administration using a predefined ethogram. The first objective of this project was to establish the best dosing rate of sodium nitrite for animal welfare by observing market weight animals using the predefined ethogram. The best dose rate to achieve the shortest time to death was applied to adult swine (136-181 kg) for evaluation using the same ethogram. To assess the potential nitrite residue of the best dosing rate, ocular fluid and skeletal muscle samples were collected from the adult swine after death.

Animal care and use

Animal use was conducted under the guidance and approval of the Pipestone Research Institutional Animal Care and Use Committee (IACUC) protocol ID No. 2020-008.

Materials and Methods

Animals

Forty market weight pigs (mean weight = 131 kg) and 10 sows (mean weight = 174 kg) were used in this study. Of the 40 market weight pigs, 10 were assigned to each treatment group. The market animals selected were allocated conveniently by gate cut from healthy animals with no observable health issues or defects from a commercial finisher barn. The sows were cull sows from commercial facilities with no observable health or body condition issues. This sample size is similar to the number of animals used per treatment in previous swine euthanasia and behavior studies.[10-12] The study was conducted in the summer months at commercial barn locations in northwest Iowa. Animals were housed indoors until moved outside after each treatment was administered for observation.

Sodium nitrite solution

Granular, free-flowing 99% food grade sodium nitrite (Chemtrade Logistics Inc) was used for the solution preparation. Solutions were prepared by pre-weighing milligrams of sodium nitrite combined with 3.79 L of water using the assumed solubility of approximately 70 to 85 g/100 mL with 20°C to 25°C water.[13] For every 3.79 L of solution prepared for dosing, 2649.5 g of sodium nitrite powder

was added, providing a final sodium nitrite concentration of 0.7g/mL of solution. The solution was made fresh immediately before each treatment group dosing procedure began.

Sodium nitrite dosing

A starting dosing range of 400 to 441 mg/kg of body weight was targeted to provide 400 mg/kg of sodium nitrite solution to a market weight pig. This extended range tries to account for the volume of solution that the pig may not swallow during dosing. The treatment groups of 1× (400-441 mg/kg), 2× (800-882 mg/kg), 2.5× (1000-1102 mg/kg), and 3× (1200-1323 mg/kg) were used in this study. The 1× group received 80 mL of sodium nitrite solution by oral drench, the 2× group received 150 mL, the 2.5× group received 200 mL, and the 3× group received 238 mL of sodium nitrite solution.

Five animals from each treatment group (n = 20) were withheld from feed for 24 hours with *ad libitum* access to water. The other 5 animals in each treatment group were allowed *ad libitum* feed and water until the sodium nitrite administration.

The dosing level used for the sows was determined by observations of the market weight animals. The dosing level selected for use provided market animals the shortest time to death while still allowing adequate time to walk them out of a building. The same solution and dosing method were used for administration to both sows and market weight animals. Sows were dosed at 1200 to 1323 mg/kg based on their individual weight (range, 141-202 kg), and therefore received a dose ranging from 250 mL to 350 mL.

An air-compressor powered hooked drench gun designed for liquid dewormer administration to cattle was used (Valbazen; Zoetis) to administer the oral drench. Pigs were restrained individually in the corner of a pen using a hinged sort panel. Each animal had the drench hook placed in its mouth and was administered their calculated dose. Immediately after administration, pigs were numbered on their backs with livestock marker spray (Prima Tech Prima Glo Fluorescent Marking Spray) and walked into a corralled outdoor area for monitoring.

Behavior observations and death confirmation

The behavioral response of each animal after sodium nitrite administration was recorded according to the ethogram in

Table 1. Each behavior was selected as an indicator of distress in swine based on previous studies except for the definition of retching, which was derived from the vomiting description for the conditions of this study.[10-12] Prior to the start of the study, a team of 5 individuals were familiarized with the ethogram. Each group of 10 pigs had 1 person recording and a minimum of 2 people always providing continuous observations. The observers would call out the pig's number visible on their back and the behavior being expressed. The recorder would then write the time observed, the pig number, and the behavior expressed. As confirmation, the recorder would repeat the pig number and observed behavior back to the observer. The time oral drench was administered was also recorded in the same manner, with the person administering the sodium nitrite calling out the pig's given number. Behaviors were recorded until the time of death of the individual animal was confirmed. For this study, death was equated with the observation of respiratory arrest as defined in the ethogram. Death was confirmed by the absence of a corneal reflex when touching the pig's eye immediately after observing respiratory arrest.

Any pig alive 2 hours after sodium nitrite dosing was euthanized via a penetrative captive bolt. The 2-hour timepoint was selected to prevent unnecessary and prolonged stress due to pigs being confined outdoors in warm summer weather during the observation period.

Heart rate, activity, and body temperature monitoring

Forty-eight hours before sodium nitrite administration, one fasted pig and one *ad libitum* fed pig in each dosing category (n = 8) were sedated for installation of an internal implant monitor (DST centri-HRT ACT; Star-Oddi) to record the animal's heart rate (beats per minute [bpm] derived from ECG), activity (measured as external acceleration > 1 standard gravity), and body temperature. Activity was measured with the implant by calculating the external acceleration of the *g*-force above the standard gravity from a 3-axis accelerometer. The implant was installed subcutaneously over the xiphoid process of the sternum. Implant readings were taken once every 30 minutes until the day of sodium nitrite administration, when readings were taken every 13 seconds.

Ocular fluid and skeletal muscle residues

Residue testing only occurred in the 10 sows. After death was confirmed in the sows, ocular fluid and skeletal muscle samples were collected from each animal. The ocular fluid was collected by inserting an 18-gauge needle into the eye with vacuum pressure from the attached syringe. Ocular fluids were kept cold until testing. Ocular fluid nitrite anion concentrations were measured under standard diagnostic laboratory procedures at Iowa State University Veterinary Diagnostic Laboratory by high pressure liquid chromatography. Skeletal muscle was collected by dissection of the animal's ham to attain a 10.16 cm × 10.16 cm × 2.54 cm section of skeletal muscle. Skeletal muscle samples were kept frozen until testing. Sodium nitrite skeletal muscle concentrations were tested at Eurofins Microbiology Laboratory under standard diagnostic laboratory procedures for sodium nitrite concentration by ion-exchange chromatographic analysis.

Statistical analysis

Behavior observations were analyzed using a generalized linear model where dose, feed, and dose × feed interaction were held as fixed effects. Polynomial contrasts were used to determine linear and quadratic effects on increasing sodium nitrite dosage. A student *t* test was used to look for differences in response between the market weight pigs and sows to sodium nitrite administration. Nitrite anion concentration (ppm) between ocular fluid and sodium nitrite level in skeletal muscle were compared using Pearson's correlation analysis.

Results

Death rate by dosage

Table 2 shows the death rate and mean time to death after sodium nitrite administration by dosage rate. Not all the animals died from sodium nitrite administration under the confines of this study and 7 had to be euthanized by captive bolt. The animals in this study that were euthanized by captive bolt did not express any distress behaviors within 10 minutes of the end of the 2-hour observation period and were of normal mentation and activity at the time of euthanasia.

Table 1: Ethogram of pig behaviors indicating distress recorded after sodium nitrite administration

Behavior	Definition	Variables recorded
Convulsions	Involuntary contraction of skeletal muscles (tonic, clonic, or both) and paddling*	Latency to onset and frequency
Gasping	Low frequency, very deep breathing through the wide-open mouth with large abdominal movements and stretching of the neck	Latency to onset
Head shaking	Vigorous, rapid, and purposeful movements of the head from side to side (at least two consecutive movements)	Frequency
Loss of coordination	Loss of balance, stumbling, or diminished muscle control	Latency to onset
Loss of posture	Animal collapses into recumbent position with no evidence of posture control and does not regain posture or show further evidence of awareness	Latency to onset
Respiratory arrest (death[†])	Permanent cessation of respiratory movements (minimum of 60 seconds without a breath)	Latency to onset
Vocalization	Pig emits an audible bout of a squeal or grunt[‡]	Frequency of bouts
Vomiting	Ejection of gastrointestinal contents through the mouth	Latency to onset and frequency
Retching	Making the sounds and movements of vomiting but not ejecting gastrointestinal contents from the mouth[§]	Frequency

*   Tonic defined as prolonged generalized contraction. Clonic defined as alternating contraction/relaxation in quick succession. Paddling defined as involuntary walking/running/galloping motion of the limbs.

[†]   Following respiratory arrest, death was confirmed by verifying the absence of a corneal reflex.

[‡]   A bout is defined as a single discreet event or a period of a continuous event with a < 1-second pause. A pause > 1-second is the end of the bout.

[§]   Definition for the purposes of our study was derived from the description of vomiting.

Table 2: Percent death rate and time to death after sodium nitrite administration

Group	Dose rate, mg/kg	Death rate, No. (%)	Time to death, mean, min	Time to death, range, min
1× dose	400-441	6 (60)	83	52-101
2× dose	800-882	10 (100)	47	24-92
2.5× dose	1000-1102	9 (90)	42	24-100
3× dose	1200-1323	9 (90)	34	17-58
Sows*	1200-1323	9 (90)	31	23-49

* Sows were administered the 3× dose rate

Repeated behavior results

Repeated behaviors can occur more than once in an individual animal and frequency was recorded. Table 3 shows the number of pigs in each treatment group that expressed repeated distress behaviors after sodium nitrite administration. Convulsions were observed in most pigs across the treatments, while head shaking was expressed the least. The sows showed the largest number of pigs vomiting compared to the market weight treatment groups. As shown in Table 4, the total frequency of vomiting events in sows was 17 as compared to the next highest of 6 events in the 2.5× group. The total frequency of vocalizations was highest in the 1× group with 50 vocalizations, and the next closest group being 2.5× with 16 vocalizations. The frequency and number of animals expressing convulsions, head shaking, and retching were comparable among all treatment groups.

Time to behavior onset results

Table 5 presents the linear relationship between the dosing rate and the time to onset of distress behaviors in the market weight pigs. All times are given as least squares means that reflect the best fit for the data points in the model rather than the observed values, which are presented in Table 2. Time to onset of convulsions, gasping, loss of coordination, loss of posture, respiratory arrest, and vocalization were all found to have a linear relationship. Thus, as the sodium nitrite dose increased, the time to onset of that behavior parameter decreased. Head shaking and retching did not have enough frequency among the pigs to statistically model a response. Vomiting was not found to have a linear relationship with the sodium nitrite dosing rate ($P = .38$).

Market weight pigs withheld from feed for 24 hours before sodium nitrite administration expressed convulsions ($P = .01$), loss of posture ($P = .049$), respiratory arrest ($P = .02$), and vocalization ($P = .02$) sooner than the non-fasted pigs. Fasting did not appear to affect time to onset of gasping, loss of coordination, or vomiting. First sign of distress to death is defined as the length of time in minutes from the first expression of any distress behaviors defined in Table 1 to respiratory arrest. A linear relationship of shorter time to death as the dose increased was found ($P < .001$). Animals fasted for 24 hours also displayed a decreased time to death after the first sign of distress compared to non-fasted animals ($P = .005$).

A comparison of the 3× market weight group to the adult sow group dosed at the same rate (Table 6) revealed a difference in time to onset of vomiting ($P = .004$) and the first sign of distress to death ($P = .02$). Sows experienced a longer time from the first sign of distress to death than the 3× market group.

Physiological measures

Body temperature increased after sodium nitrite administration and plateaued between 40.0°C and 41.0°C. Figure 1 shows the activity level and heart rate (bpm) by dosage group over time. In the 1× group, one of the implanted pigs did not die from sodium nitrite so was euthanized by penetrative captive bolt and, therefore, not included in Figure 1. The more frequent and highest spikes of activity were seen

Table 3: Number of pigs that expressed repeated distress behaviors following sodium nitrite administration

Behavior parameter	Treatment group, No. of pigs (%)					
	1× dose*	2× dose*	2.5× dose*	3× dose*	Sows[†]	Total (N = 50)
Convulsions	7 (70)	10 (100)	9 (90)	9 (90)	8 (80)	43 (86)
Head shaking	2 (20)	0 (0)	0 (0)	0 (0)	1 (10)	3 (6)
Retching	1 (10)	1 (10)	0 (0)	2 (20)	3 (30)	7 (14)
Vocalization	9 (90)	5 (50)	5 (50)	6 (60)	4 (40)	29 (58)
Vomiting	1 (10)	2 (20)	4 (40)	4 (40)	8 (80)	19 (38)

* The dosages of sodium nitrite were: 1× = 400-441 mg/kg; 2× = 800-882 mg/kg; 2.5× = 1000-1102 mg/kg; and 3× = 1200-1323 mg/kg.
† Sows were administered the 3× dose of 1200-1323 mg/kg.

Table 4: Frequency of repeated distress behaviors expressed following sodium nitrite administration

Behavior parameter	Event frequency, No.				
	1× dose*	2× dose*	2.5× dose*	3× dose*	Sows[†]
Convulsions	19	21	25	24	19
Head shaking	3	0	0	0	1
Retching	1	2	0	2	5
Vocalization	50	8	16	8	5
Vomiting	1	4	6	4	17

* The dosages of sodium nitrite by body weight were: 1× = 400-441 mg/kg; 2× = 800-882 mg/kg; 2.5× = 1000-1102 mg/kg; and 3× = 1200-1323 mg/kg.
† Sows were administered the 3× dose of 1200-1323 mg/kg of body weight.

Table 5: Least squares means for time to onset of observed behavior by dose rate and feed-fasting status in market weight pigs

| Behavior parameter | Time to onset, min | | | | | | | |
	1× dose*	2× dose*	2.5× dose*	3× dose*	$P^‡$	On feed†	Off feed†	P
Convulsions	80.2	44.6	38.03	29.88	< .001	57.49	38.86	.01
Gasping	89.5	34.38	39.38	34.5	< .001	56.38	42.5	.19
Head shaking	Not enough frequency to calculate							
Loss of coordination	75.17	40.67	35.83	26	.005	52.29	36.54	.1
Loss of posture	83.96	34.75	46.5	23	< .001	55.44	38.67	.049
Respiratory arrest (death)	83.12	47.3	41.08	35.78	< .001	61.44	43.58	.02
Retching	Not enough frequency to calculate							
Vocalization	76.48	49	43.5	31.67	.002	62.05	38.27	.02
Vomiting	33.9	47.9	34.04	27.2	.38	39.69	31.85	.36
First sign distress to death§	53.88	25.2	16.88	11.98	< .001	35.39	18.58	.005

* The dosages of sodium nitrite by body weight were: 1× = 400-441 mg/kg; 2× = 800-882 mg/kg; 2.5× = 1000-1102 mg/kg; and 3× = 1200-1323 mg/kg.

† No interaction found between sodium nitrite dosage and the 24-hour fasting status before sodium nitrite administration. The fasting status P value compares on and off feed effects from the generalized linear model. Values are considered significant when $P < .05$

‡ Generalized linear model with fixed effects for dosage and feed status, where the P value represents a linear response for the main effect of dosage. Values were considered significant when $P < .05$.

§ First sign of distress to death defined as the length of time from the first expression of any distress behaviors defined in Table 1 to respiratory arrest.

Table 6: Least squares means for time to onset of observed behaviors of market weight pigs vs sows* after sodium nitrite administration at 1200-1323 mg/kg of body weight

| Behavior parameter | Time to onset, min | | |
	Market weight pigs	Sows	$P^†$
Convulsions	29.10	29.00	.98
Gasping	36.33	39.00	.86
Head shaking	Not enough frequency to calculate		
Loss of coordination	26.00	18.17	.23
Loss of posture	28.40	24.20	.43
Respiratory arrest (death)	34.87	31.22	.50
Retching	16.00	12.67	.64
Vocalization	31.67	27.50	.64
Vomiting	25.25	12.38	.004
First sign distress to death‡	11.56	22.22	.02

* Market pigs (n = 10) averaged 131 kg in body weight. Sows (n = 10) averaged 174 kg in body weight.

† Student t test for differences between groups. Values are considered significant when $P < .05$.

‡ First sign of distress to death is defined as the length of time from the first expression of any distress behaviors defined in Table 1 to respiratory arrest.

in the 1× dose group. Heart rates over 250 bpm were observed most frequently in the 2.5× and 3× dosage groups.

Nitrite ocular fluid anion and sodium nitrite tissue concentrations

Table 7 shows the nitrite anion concentrations present in the ocular fluid and the sodium nitrite concentration in the skeletal muscle after death. The mean (SD) ocular fluid anion and skeletal muscle sodium nitrite concentrations were 5.68 (2.88) and 25.95 (4.40), respectively. Pearson's correlation coefficient between the two concentrations revealed no correlation ($r = .331$; $P = .35$).

Discussion

Sodium nitrite is "Permitted in Constrained Circumstances" by the American Veterinary Medical Association (AVMA).[2] The most significant limitations to the effectiveness of its use in depopulation events are the lack of research in commercial pigs and the taste aversion of the product for quick ingestion.[2,6] The novel method of oral drenching explored in this study provides a way to ensure appropriate dosage ingestion in domestic pigs. As seen in Table 2, all dose rates used in this study provided enough time for animals to be walked outside the barn after dosing before death. Sodium nitrite toxicity also provides no observed blood loss, unlike other depopulation methods like penetrative captive bolt or gunshot. No blood loss is a considerable benefit as diseases like African swine fever can spread readily by blood contact.[14]

The literature suggests the sodium nitrite LD_{50} be 80 to 132.9 mg/kg for oral consumption.[3,4,6] The results of this study suggest an LD_{50} for oral drench to be closer to the 400 mg/kg dose rate (Table 2). This may be partly due to the solution not swallowed in the administration process. Under the confines of the study, the pigs were only observed up to 2 hours before being humanely euthanized. It is possible that more pigs would have died from sodium nitrite under an extended observation period as documented in the literature, with some deaths taking over 3 hours post administration.[3,6] Sodium nitrite is also documented as unstable in water solutions, requiring fresh preparation or being kept on ice before use.[15] The instability of sodium nitrite in solution is greatly influenced by the acidity of the water,

where higher acidity increases the rate of breakdown.[16] Although the current study solution was prepared immediately before administration, this instability may have affected the observed death rate. Water used was from the barn on-site, and the water's pH was not measured before the solution was prepared.

The current study suggests an improvement in animal welfare as the dose increased. Table 3 reveals that more pigs expressed vocalization in the 1× group compared to all other treatments. The dose effect is further supported by the pigs in 1× treatment having 50 recorded vocalization events compared with the next closest of 16 vocalization events in the 2.5× treatment group (Table 4). As seen in Table 5, the time between the first sign of distress (expression of any behavior from the ethogram) and death decreased as the dose increased. The time from administration to death also significantly decreased as the dose rate increased (Table 5). This quicker time interval may be more beneficial to the pig as the higher rate shortens the time the animal experienced discomfort. Despite the dosage rate applied, the body temperature of pigs all increased until the time of death. Pigs fasted for 24 hours also had a quicker death after administration (Table 5). When able, the fasting of pigs before sodium nitrite administration may also improve animal welfare by quickening sodium nitrite absorption. It is also important to note that even if an animal did not die from sodium nitrite administration, all animals except one in the 2.5× treatment group expressed at least one behavior indicating distress during the observation period.

As the time to death post administration decreased with the increased dose rate, the time to onset of distress behaviors also decreased except for vomiting, head shaking, and retching. Head shaking and retching in this study did not appear to be common observable distress behaviors with sodium nitrite administration. The number of animals expressing vomiting behavior was numerically similar among the market weight dosing groups (Table 3). The frequency of vomiting events was numerically lowest in the 1× dosing group among the market weight animals (Table 4). The low frequency in the 1× group implies that increased sodium nitrite dose may influence observed vomiting frequency, but a larger study would be needed to confirm. However, vomiting occurred in greater frequency in sows with 17

individual events from 8 of the 10 sows compared to only 4 individual vomiting events in 4 of the 10 market weight pigs at the same dosing rate (Tables 3 and 4). This difference in vomiting frequency is further supported by the significant difference between market weight pigs and sows in time to onset (Table 6). The other significant difference between market weight animals and sows administered the same dose rate was the first sign of distress to death, which was longer in sows. However, the time to respiratory arrest and the confirmation of death after dosing was not statistically different. The observed difference between sows and market pigs suggests age or animal size may affect the response to sodium nitrite toxicity. These differences in response may reveal different welfare outcomes as the size and age of the animal changes even when the dosing rate by weight remains the same. A weakness of the current study is that sex of the market weight pigs selected were not recorded; therefore, potential differences between barrows and gilts could not be examined.

The concern of secondary toxicity from sodium nitrite may limit how the carcasses can be disposed of after administration.[17] The literature documents no risk of secondary toxicity in pigs dosed at the oral dosing rate in bait stations. However, this study favored using a higher dosing rate than most bait stations target.[17] Table 7 shows sodium nitrite presence in the skeletal muscle after 3× oral dose administration to range from 18.4 to 29.9 ppm. Previous research in swine consuming the 1× dose rate revealed only 2 to 3 ppm in the skeletal muscle.[17] Sodium nitrite is a common food additive in cured meats due to its ability to prevent the growth and toxin formation of *Clostridium botulinum*.[18] During the curing process, the United States Department of Agriculture limits ingoing sodium nitrite to 200 ppm for immersion and massaged curing methods, 156 ppm for comminuted methods, 625 ppm for dry cured, and only 120 ppm specifically for bacon.[19] The detected sodium nitrite in the current study is well below the ingoing allowed amounts. The current study also revealed that ocular fluid nitrite anion concentration does not predict skeletal muscle concentration. The lack of prediction prevents the easy to collect ocular fluid nitrite anion testing from being used to estimate skeletal muscle nitrite concentrations. Further research on the residue of sodium nitrite at different dose rates in different tissues is needed.

Figure 1: Pig heart rate and activity by sodium nitrite dosing group over time of administration to death. The red lines in each graph represent heart rate and black lines represent activity measurement. Implants recorded measurements every 13 seconds. One of the two implanted pigs in the 1× group was euthanized by a captive bolt and not included in the figure. All other dose groups display two pigs, where the solid line and dotted line represent different animals. The dosages of sodium nitrite by body weight were: 1× = 400-441 mg/kg; 2× = 800-882 mg/kg; 2.5× = 1000-1102 mg/kg; and 3× = 1200-1323 mg/kg. Activity was a measured value of external acceleration > 1 standard gravity.
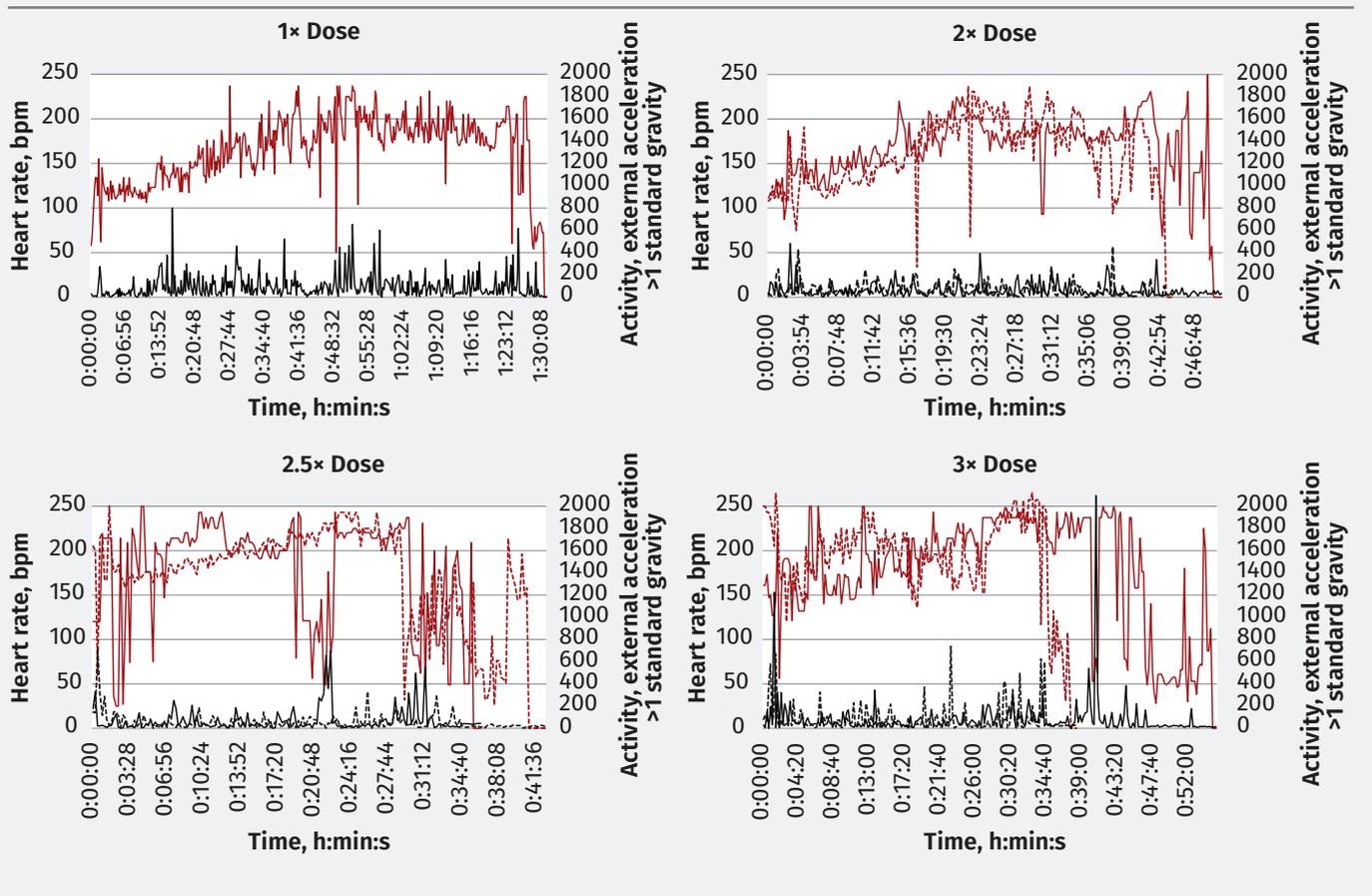
Table 7: Nitrite anion in ocular fluid and sodium nitrite concentration in skeletal muscle after death by sodium nitrite intoxication*

Individual Animal	Ocular fluid nitrite anion, ppm	Skeletal muscle sodium nitrite, ppm
Sow 1	4.1	22.0
Sow 2	3.3	28.1
Sow 3	5.6	33.5
Sow 4	5.7	18.4
Sow 5	13.5	29.9
Sow 6	3.4	27.0
Sow 7	5.6	28.6
Sow 8	7.3	26.1
Sow 9	3.5	20.0
Sow 10	4.8	25.9

* Oral drench of sodium nitrite at 1200-1323 mg/kg of body weight.

Based on the current study results, sodium nitrite by oral drench is a viable option for the depopulation of swine. However, the signs of distress experienced by swine administered sodium nitrite, including those who did not die from the administration, support the AVMA's current classification of "Permitted in Constrained Circumstances" for depopulation events.[2] Further research with sodium nitrite is needed on different application methods, how different sexes, ages, and sizes of pigs may be affected, and dosages beyond those looked at in the current study.

Implications

Under the conditions of this study:

- Sodium nitrite is a viable depopulation method for constrained circumstances.
- Higher sodium nitrite dose improved pig welfare.
- Swine age and size may affect reaction to sodium nitrite.

Acknowledgments

Conflict of interest

None reported.

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Establishing *Mycoplasma hyopneumoniae* herd status classification criteria for breeding herds

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Summary

A standardized system for classifying the *Mycoplasma hyopneumoniae* status of swine breeding herds was developed by defining a set of diagnostic guidelines to determine the exposure and shedding status of herds. The classification is based on epidemiological and ecological features of *M hyopneumoniae* and reflects current field control and elimination practices. The classification was developed by a working group composed of representatives from academia, industry, swine practitioners, American Association of Swine Veterinarians (AASV), and the National Pork Board, and approved by the AASV Board of Directors on October 2, 2019. Clear and concise terminology will facilitate communication across all stakeholders.

Keywords: swine, *Mycoplasma hyopneumoniae*, herd classification, disease status, diagnostics

Resumen - Establecimiento de los criterios de clasificación del estatus de *Mycoplasma hyopneumoniae* para piaras de reproductoras

Se desarrolló un sistema estandarizado para clasificar el estado de *Mycoplasma hyopneumoniae* en las piaras reproductoras mediante la definición de un conjunto de pautas de diagnóstico para determinar su estado de exposición y eliminación. La clasificación se basa en las características epidemiológicas y ecológicas de *M hyopneumoniae* y refleja las prácticas actuales de control y eliminación en el campo. La clasificación fue desarrollada por un grupo de trabajo integrado por representantes de la academia, la industria, los profesionales especialistas en cerdos, la Asociación Americana de Veterinarios Especialistas en Cerdos (AASV), y el Consejo Nacional de Porcicultores, y aprobada por la Junta Directiva de la AASV el 2 de octubre de 2019. Esta terminología clara y concisa facilitará la comunicación entre todas las partes interesadas.

Résumé - Établissement de critères de classification du statut des troupeaux envers *Mycoplasma hyopneumoniae* pour les troupeaux reproducteurs

Un système standardisé de classification du statut des troupeaux porcins reproducteurs envers *Mycoplasma hyopneumoniae* a été développé en définissant un ensemble de directives de diagnostic pour déterminer l'exposition et le statut d'excrétion des troupeaux. La classification est basée sur les caractéristiques épidémiologiques et écologiques de *M hyopneumoniae* et reflète les pratiques actuelles de contrôle et d'élimination sur le terrain. La classification a été élaborée par un groupe de travail composé de représentants du monde universitaire, de l'industrie, des praticiens du porc, de l'American Association of Swine Veterinarians (AASV) et du National Pork Board, et approuvée par le conseil d'administration de l'AASV le 2 octobre 2019. Une terminologie claire et concise facilitera la communication entre toutes les parties prenantes.

MJC, DJH, RM: Veterinary and Diagnostic Production Animal Medicine Department, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

MJC: Pig Improvement Company, Hendersonville, Tennessee.

LGP, TP, DB: Zoetis, Parsippany, New Jersey.

PY: Swine Veterinary Center, St. Peter, Minnesota.

CJ: Carthage Veterinary Service, Ltd, Carthage, Illinois.

MS: Audubon Manning Veterinary Clinic, LLC, Audubon, Iowa.

EF: Boehringer Ingelheim Animal Health USA Inc, Duluth, Georgia.

EM: Pipestone Veterinary Services, Pipestone, Minnesota.

LB: National Pork Board, Clive, Iowa.

LG: TriOak Foods, Oakville, Iowa.

HS: American Association of Swine Veterinarians, Perry, Iowa.

AM: The Maschhoffs, Carlyle, Illinois.

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*M*ycoplasma hyopneumoniae is the etiologic agent of porcine enzootic pneumonia, an infectious respiratory disease characterized by a nonproductive cough, reduced daily weight gain, and poor feed conversion.[1] *Mycoplasma hyopneumoniae* represents a significant burden for the swine industry, especially when combined with viral co-infections, causing losses of up to $10/pig.[2] From a system-wide perspective, control of *M hyopneumoniae*-associated disease largely depends on minimizing transmission from sow to piglet. In fact, a high prevalence of *M hyopneumoniae* in weaned pigs has been associated with elevated disease in the growing phase.[3] In another study, this significant correlation between weaning status and clinical disease at slaughter was not observed.[4] Still, efforts that largely focus on controlling transmission within the breeding herd and minimizing the prevalence at weaning likely have the highest impact on disease reduction.[5,6] In production systems where elimination is not pursued, the main focus for control programs has been on the safe exposure of young, naive gilt populations with the resident *M hyopneumoniae* strain. Promoting early gilt exposure to *M hyopneumoniae*-positive cull sows in gilt development units or implementing controlled exposure programs (intratracheal or aerosol inoculation), followed by sufficient time for the development of a robust immunity (at least 240 days) and decreased bacterial shedding, has shown to be an effective way of reducing disease in downstream populations.[5-10]

The economic impact, coupled with recent diagnostic improvements, increased knowledge on the ecology of *M hyopneumoniae,* and availability of naive breeding stock has led to an increase in the frequency of successful *M hyopneumoniae* control, prevention, and elimination programs in North America.[11] The wide implementation and continued use of the porcine reproductive and respiratory syndrome virus (PRRSV) swine herd classification system since 2011, has been proven to be a valuable tool for disease management; facilitating communication between swine producers, veterinarians, diagnosticians, and breeding stock companies, monitoring the status of herds, evaluating and executing strategies for disease control and prevention, and supporting regional control and elimination efforts.[12-15]

Our objective was to provide an updated standardized system for classifying the *M hyopneumoniae* status of swine breeding herds by defining a set of diagnostic guidelines to determine the exposure and shedding status of herds.

Methods

The classification system incorporated objective diagnostic criteria based on the relevant biological and ecological features of *M hyopneumoniae.* The previous breeding herd classification systems developed for *M hyopneumoniae* were used as the foundation, as well as standards and definitions developed for the PRRSV herd status classification for consistency between systems.[8,12,16] The working group held a workshop in Hendersonville, Tennessee on November 28-29, 2018. The terminology and classification criteria approved by the working group was presented to the American Association of Swine Veterinarians (AASV) Committee on Transboundary and Emerging Diseases (CTED) at the 50th AASV Annual Meeting in Orlando, Florida on March 9, 2019. This was followed up with the distribution of the working document to all CTED members. On August 7, 2019, an online meeting was held to further discuss the classification with all CTED members and the working group where additional input was obtained. The CTED approved the classification on September 7, 2019. The final document was approved by the AASV Board of Directors on October 2, 2019.

Considerations

Diagnostic criteria for category establishment

The two diagnostic criteria used to determine the *M hyopneumoniae* shedding and exposure status of a herd were 1) detection of the agent in the respiratory tract and 2) antibody detection. These criteria are used to frequently monitor a subpopulation of the breeding herd and determine its status. In addition to the diagnostic criteria, the use of *M hyopneumoniae* vaccine was used to determine the status of farms.

Detection of the agent in lung lesions or the respiratory tract can be achieved using a variety of tests.[6] Polymerase chain reaction (PCR) is the most common and preferred test for detection of *M hyopneumoniae* in tissue and samples from live pigs. While immunohistochemistry,

fluorescent antibody, *in situ* hybridization, and bacterial culture are used by diagnostic laboratories for detection of the agent within affected tissue, they are not frequently performed for monitoring populations.[6] To evaluate the infection and shedding status of live pigs, it is critical to sample *M hyopneumoniae* colonization sites characterized by respiratory type epithelium, such as the trachea and bronchi. Therefore, deep tracheal samples are the preferred antemortem samples for *M hyopneumoniae* detection, compared to nasal and laryngeal swabs.[17-21] While aggregate samples, such as oral fluids, are used for *M hyopneumoniae* surveillance, current knowledge suggests variable and inconsistent detection capabilities, questioning its diagnostic value for accurate determination of the shedding status of a herd.[19,22,23] Finally, the use of pooling strategies to reduce testing cost has proven to be of value and maintain diagnostic accuracy for detection of other agents, such as PRRSV and, more recently, *M hyopneumoniae*.[24,25]

To measure *M hyopneumoniae* exposure, the most performed antibody test is the enzyme-linked immunosorbent assay (ELISA). Seroconversion within a population can take several weeks to be detected by ELISA, and therefore timing should be considered. It is also important to recognize that current commercially available serological assays are unable to differentiate natural infection from vaccination, and thus alternative diagnostic tests, such as PCR, should be used to determine status correctly.[26] Evaluation and comparison of the diagnostic performance of several commercially available ELISAs is available and can aid veterinarians in determining the most suitable test, or combination of tests, for their diagnostic objectives.[27,28] As noted in previous publications, false-positive results can occur with these assays, requiring an in-series testing approach or collection of additional samples from the population to troubleshoot unexpected results. A common process carried out by veterinary diagnostic laboratories involves testing the unexpected ELISA-positive samples using a different serological assay than the one used initially. Veterinarians can also decide to collect additional samples from the reacting animals or other animals within the population, such as tracheal swabs or lung samples, which are then tested by PCR.

Clinical signs associated with *M hyopneumoniae* infection are characterized by a dry, nonproductive cough, exacerbated by physical exertion, decreased appetite, and labored breathing. Microscopic lesions consist of lobular distribution of peribronchiolar and perivascular lymphocytic cuffing.[6] Alveoli and airways may contain serous fluid with a few macrophages and neutrophils. The airway epithelium is intact and sometimes slightly hyperplastic.[6] Clinical signs and lesions are not pathognomonic of *M hyopneumoniae* infection; thus, determining the shedding and exposure status is best achieved by detection of the agent in the respiratory tract and antibodies to the bacterium in serum.

Gilt acclimation and *M hyopneumoniae* control

Control of *M hyopneumoniae* infection in pig populations is typically based on establishing sow herd immunity by means of effective gilt acclimation (ie, deliberate infection of gilts at an early age), strategic medication, and vaccination. The overarching goal of creating robust herd immunity is to minimize shedding of *M hyopneumoniae* by breeding females and vertical transmission to their piglets.[5] However, the duration of shedding in infected pigs is quite long (approximately 254 days).[29] Therefore, the goal of acclimating gilts to *M hyopneumoniae* is to allow them to become infected early in life so they can develop immunity and decrease shedding before being introduced into the sow farm.[5-10] This reduces the number of positive piglets at weaning, which can be a predictor for *M hyopneumoniae* clinical disease in grow-finish populations.[3]

Herds that have an acclimation program where replacement gilts are exposed to *M hyopneumoniae*, either naturally or through controlled exposure methods, by a maximum of 80 days of age are expected to have a low incidence of *M hyopneumoniae* disease in the breeding herd and are therefore considered *M hyopneumoniae* controlled herds.[5,9] However, the classification described herein does not require a specific gilt acclimation protocol and, thus, relies on the farm veterinarian and producer to define an acclimation program that suits their production system.

M hyopneumoniae herd status classification

The classification system focuses on the breeding herd and is divided in 4 distinct categories: positive uncontrolled (I), positive controlled (II), provisionally negative (III), and negative (IV; Table 1). Category III is subdivided into two subcategories: unvaccinated (IIIA) and vaccinated (IIIB).

Positive uncontrolled (I)

The following herds fall into category I: 1) breeding herds going through an *M hyopneumoniae* outbreak; 2) herds that have not performed the necessary testing described and the status is unknown; and 3) herds that have performed the necessary testing but do not qualify for status II, III, or IV.

Positive controlled (II)

In these herds, the agent is not detected in parity 1 (P1) sows and the herd is serologically positive. For herd classification purposes, P1 sows are those that have weaned their first litter and have not farrowed their second. Herds in this category likely have an ongoing *M hyopneumoniae* gilt acclimation program where gilts are exposed at an early age; however, this is not a requirement. This status will be considered the goal for those herds that do not wish to pursue elimination and decide to only control *M hyopneumoniae* (Figures 1 and 2). Diagnostic evidence to promote a herd to this category includes 4 consecutive negative monthly samplings of a minimum of 30 tracheal swabs from P1 sows up to 30 days post weaning. This narrows the P1 age range that is tested and avoids testing P1 sows that are close to farrowing their second litter. A sample size of 30 is based on the number of samples required to detect at least 1 positive animal if the agent is present at an expected prevalence of 10% with 95% confidence for any population size greater than 1000 assuming a diagnostic test sensitivity greater than 95% and random sampling from a population with a homogenous distribution of positive animals.[30-32] While larger sample sizes and increased sampling events would have improved the confidence level, the chosen sample size of 30 collected 4 times was carefully selected to balance cost and inconvenience of testing and the confidence to detect a low prevalence. Such evidence would suggest that efforts to reduce

shedding in replacement animals by the end of the first parity (Figures 1, 2, and 3) are succeeding. However, evidence supporting the absence of detection of the agent in P1 sows does not rule out the possibility that there is continued *M hyopneumoniae* transmission in the herd. It is presumed that, over time, category II herds will have a low level of infection in piglets at weaning.

Provisionally negative (III)

In these herds, the agent is not detected in the breeding herd population, however, the population may be serologically positive. Category III is divided into two subcategories. The first is provisional negative unvaccinated (IIIA). Herds in this subcategory have completed a whole herd elimination program, which refers to any set of procedures implemented at the sow herd level that succeeds in the complete removal of the targeted infectious agent from the population. It is not the intent of this classification system to define the procedures required to achieve whole herd elimination, but rather rely on each production system to determine the ideal program for their herds. A recent review on *M hyopneumoniae* elimination provides comprehensive information on the different approaches to disease elimination.[11]

To be classified as IIIA, herds need to meet one of two diagnostic requirements: 1) prior to introduction of negative replacement gilts, perform two consecutive negative samplings of a minimum of 60 tracheal swabs from breeding females in the last subpopulation exposed before the elimination program started or 2) two consecutive monthly negative samplings of a minimum of 30 serum samples or 30 tracheal swabs from negative replacement gilts after a minimum of 120 days post entry (Figures 1 and 3). The working group proposed the latter testing scheme to allow production systems, particularly commercial ones, to avoid delaying introduction of naive gilt replacements and, thus, achieve breeding targets. A sample size of 60 was based on the number of samples required to detect at least 1 positive animal at an expected prevalence of 5% with 95% confidence for any population size greater than 1000 assuming a diagnostic test sensitivity greater than 95% and random sampling from a population with a homogenous distribution of infection.[30-32] For the second testing scheme, a sample size of 30 might be considered small, but delaying testing to

Table 1: *Mycoplasma hyopneumoniae* breeding herd status classification criteria and summary of required supporting evidence

Breeding herd category and mapping symbol		Diagnostic criteria		Description and supporting diagnostic evidence to promote a herd into category
		Agent detection in respiratory tract	Serology	
Positive uncontrolled (I)		Positive	Positive	*M hyopneumoniae* is detected within lesions, in the respiratory tract. Most herds will be serologically positive, while farms experiencing recent outbreaks might still be seronegative. Untested herds are category I by default.
Positive controlled (II)		Negative in P1 sows	Positive	Herds implementing gilt acclimation programs where early exposure of incoming replacement gilts is achieved. Evidence to promote a herd to category II is monthly sampling of 30 tracheal swabs of P1 sows, tested individually for *M hyopneumoniae*. All samples are negative for 4 consecutive months.
Provisionally negative (III)	Unvaccinated (IIIA)	Negative	Positive	Herds that have completed a whole herd elimination program. Evidence to promote a herd to category IIIA is either: 1. Monthly sampling of 60 tracheal swabs from animals in last exposed population before herd reopening, tested individually for *M hyopneumoniae*. All samples are negative for 2 consecutive months. 2. Monthly sampling of 30 serum samples or 30 tracheal swabs from negative replacement gilts after a minimum of 120 days post entry, tested individually for *M hyopneumoniae*. All samples are negative for 2 consecutive months.
	Vaccinated (IIIB)	Negative	Positive	Herds that have completed an elimination and have satisfied diagnostic criteria for IIIA but continue to use vaccination or herds that have been stocked negative but decide to implement *M hyopneumoniae* vaccination. Evidence to promote a herd to category IIIB is the same as for category IIIA.
Negative (IV)		Negative	Negative	Herds undergoing elimination efforts should have been category IIIA and completely rolled over the breeding herd to fall into category IV. Newly established herds and herds that underwent complete depopulation and repopulation are considered Category IV. To maintain negative status, a minimum of 30 monthly negative serology or 30 tracheal swabs results from various parity sows should be obtained.

120 days post naive replacement introduction would likely ensure a detectable prevalence if *M hyopneumoniae* persisted in the herd post elimination.

Provisional negative vaccinated (IIIB) herds have completed a whole herd *M hyopneumoniae* elimination program and have fulfilled the diagnostic requirements for subcategory IIIA, but vaccination of breeding females for *M hyopneumoniae* continues. Herds that have been stocked with negative gilts but implement *M hyopneumoniae* vaccination of any type, regardless of vaccine type or brand also fall under this category. Herds may decide to continue vaccinating and remain in category IIIB indefinitely (Figures 1 and 3). Clinical signs and lesions suggestive of *M hyopneumoniae* in the breeding herd would trigger a diagnostic investigation.

Negative (IV)

In these herds, the agent is not detected in any type of sample from any subpopulation in the breeding herd and the herd is serologically negative. Herds undergoing elimination efforts will be promoted from category IIIA to category IV when all previously infected animals in the herd are removed (Figures 1 and 3). Newly established negative herds and those that went through complete depopulation and repopulation efforts fall within category IV. To maintain a negative status, a minimum of 30 monthly negative serology or tracheal PCR results from various parity sows should be obtained. A sample size of 30 is based on the number of samples required to detect at least 1 positive animal if the agent is present at an expected prevalence of 10% with 95.76% confidence for any population size greater than 1000 assuming a diagnostic test sensitivity greater than 95% and random sampling from a population with a homogenous distribution of positive animals.[30-32]

Discussion

Development of a disease status classification system must rely on the input from the end users for whom it is being developed. Thus, building on the successful and widely adopted AASV PRRSV classification efforts, an *M hyopneumoniae* working group was assembled in 2018 and composed of practitioners from private practice, industry representatives, academicians, and representatives from AASV and National Pork Board. The objective was to bring in the collective experience of the working group

Figure 1: Decision tree for *Mycoplasma hyopneumoniae* management and breeding herd status classification.
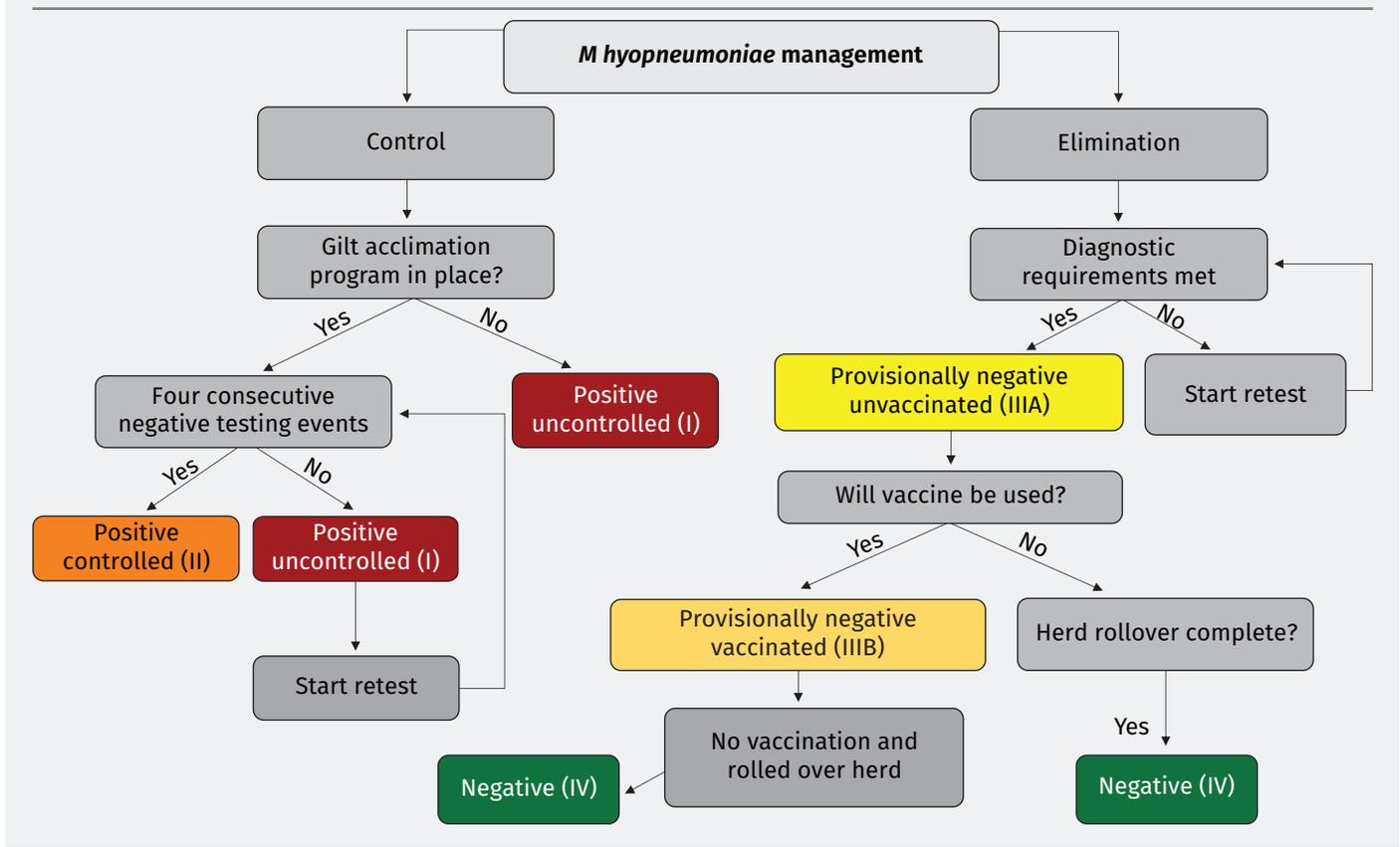

and develop an *M hyopneumoniae* classification that was practical, feasible, reliable, and easy to adopt. A standardized system for classifying the *M hyopneumoniae* status of swine breeding herds was developed by defining a set of objective diagnostic guidelines to determine the exposure and shedding status of herds. The classification is based on epidemiological and ecological features of *M hyopneumoniae* and current control and elimination programs.

The working group used two previously proposed *M hyopneumoniae* classifications as a foundation for the one presented herein. In 2016, Galina and Clavijo developed an *M hyopneumoniae* breeding herd status classification, which was part of a manual titled A Contemporary Review of *Mycoplasma hyopneumoniae* Control Strategies.[33-35] The working group identified several limitations of the 2016 Galina and Clavijo *M hyopneumoniae* classification that needed revision. For example, the classification focused on the due-to-be weaned piglet population to measure *M hyopneumoniae* transmission between sows and piglets. It classified farms as stable or unstable depending on the disease prevalence in the due-to-be weaned piglet population

based on the Fano et al[3] paper on associations between prevalence at weaning and disease downstream. However, because of recent published information about *M hyopneumoniae* epidemiology and field experience shared by members of the working group, it was determined that the due-to-be weaned piglet population was not ideal to accurately measure breeding herd pathogen shedding.[5,20,36,37] Furthermore, the use of the term stability could lead to confusion within the swine industry, since it is utilized by the PRRSV classification with a different meaning and applied to a virus with a significantly different pathogenesis and epidemiology than *M hyopneumoniae*.[12] It was decided instead to use the term controlled to better describe herds that were implementing control efforts that would reduce sow-to-piglet transmission, such as gilt acclimation practices. Thus, the P1 sow population was chosen as the more appropriate population to measure the effectiveness of those efforts. However, the suitability of this population to measure the effectiveness of gilt acclimation protocols needs further validation. Finally, the Galina and Clavijo[33] classification used clinical signs and lesions as diagnostic criteria to

define disease status. However, neither of these are pathognomonic of *M hyopneumoniae* infection and, thus, objective and measurable diagnostic criteria were favored, such as agent and antibody detection.

Garza-Moreno et al[8] published a review article titled "Acclimation strategies in gilts to control *Mycoplasma hyopneumoniae* infection." Within this review article, a subsection included an *M hyopneumoniae* classification proposal. Several critical pieces of information were not considered in the Garza-Moreno et al[8] classification, affecting its usefulness and likelihood of implementation by the swine industry. Similar to the Galina and Clavijo[33] classification, it considered subjective parameters such as clinical signs and lesions to define status. Furthermore, it did not provide specific diagnostic requirements, such as sample size, target population, and frequency of testing, which are critical for the accurate determination of the herd status and the ability to shift between statuses. The classification required postmortem samples (ie, lungs) for agent detection, rather than antemortem sample types, hindering adoption by the industry due to the impracticality and cost of

Figure 2: Schematic representation of *Mycoplasma hyopneumoniae* classification use when the goal is to control *M hyopneumoniae*.
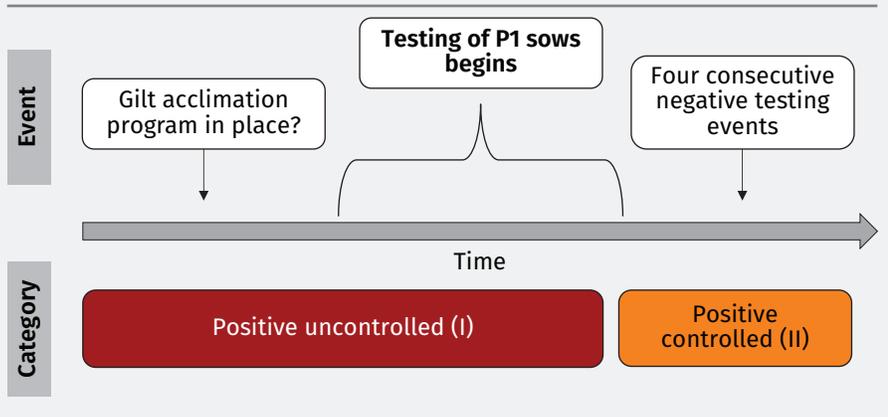
Figure 3: Schematic representation of *Mycoplasma hyopneumoniae* classification use when the goal is to eliminate *M hyopneumoniae*.
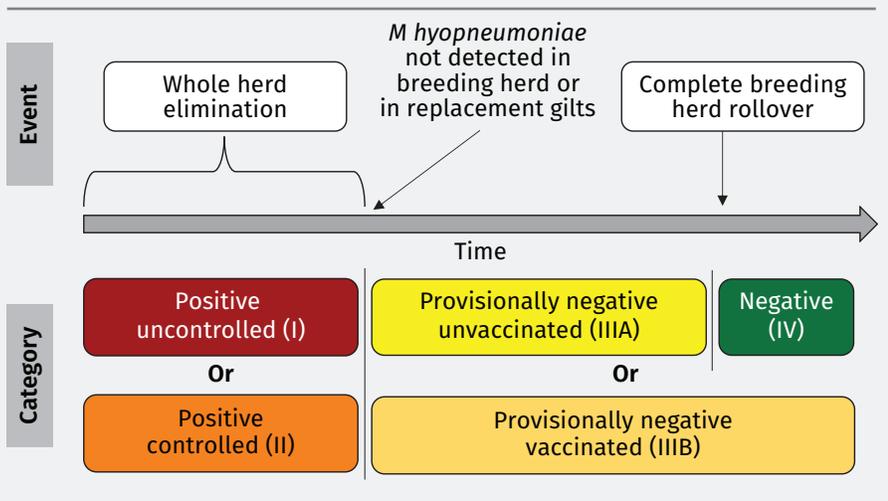
euthanizing replacement gilts or sows to determine the health status of a herd. Finally, the Garza-Moreno et al[8] classification lacked industry input for its development.

Sustained use of this new classification system by the industry will allow for the identification of knowledge gaps that warrant research and will promote refinements in diagnostic and gilt acclimation protocols. One critical area is the implementation of novel pathogen-specific sampling guidelines for timely and accurate detection of the agent at varying prevalence levels, sample types, sample sizes, and production settings. Sampling guidelines for detection of *M hyopneumoniae* in a wean-to-finish site have been recently published and support the use of larger sample sizes.[23] However, for the development of this classification, the feasibility of collecting larger sample sizes that would afford

a higher degree of confidence in determining disease status in low-prevalence scenarios was weighed against the consequences of a missed detection. Due to the increase in cost and labor required to detect disease in low-prevalence scenarios, the working group determined that a more feasible approach should be favored, encouraging adoption by the industry. Nonetheless, given the biology of *M hyopneumoniae*, swine practitioners and producers should be aware of the risk of not detecting the agent when using low sample sizes. Furthermore, it is expected that as novel information emerges, the diagnostic criteria and terminology presented here will need to be reassessed.

Standardized nomenclature and a simple classification system are fundamental for *M hyopneumoniae* management and can enable more effective communications between key industry stakeholders, such as researchers, diagnosticians,

packers, practitioners, and producers. At the herd level, this classification can be used as a roadmap for *M hyopneumoniae* management by swine producers and veterinarians to effectively characterize the health status of farms and set realistic goals for control or elimination and improve pig flow management. Veterinarians can use this tool to classify farms within a system and update their biosecurity pyramid and improve flow of personnel, multi-site commingling, transport, and feed delivery events. At the industry level, this classification would facilitate efforts to monitor the *M hyopneumoniae* status of breeding herds and their downstream pig flow and potentially lead to the establishment and successful execution of *M hyopneumoniae* regional control and elimination efforts in the future. For example, the novel *M hyopneumoniae* classification could be adopted by surveillance initiatives, such as the Morrison Swine Health Monitoring Project, that report temporal patterns of pathogen-specific outbreaks and provides the proportion of enrolled breeding herds by disease status.[14] More recently, efforts are underway to develop a US Swine Health Improvement Plan, modeled after the National Poultry Improvement Plan, that has the objective of developing and implementing certification programs for important swine pathogens, such as *M hyopneumoniae*.[38] Finally, from a business perspective, contractual arrangements could include premiums for weaned pigs from category II, III, or IV breeding herds, thus, directly incentivizing the implementation of efforts to produce *M hyopneumoniae*-negative pigs.

Implications

- Standardized terminology and diagnostic criteria for *M hyopneumoniae* are needed.
- A classification system was developed using *M hyopneumoniae* biological features.
- A valuable tool for disease management and communication across stakeholders.

Acknowledgments

Conflict of interest

None reported.

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TRaiTS: Template for Reporting of Trials in Short format - swine examples

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Summary

A checklist for guiding authors in comprehensive reporting of swine individually or cluster-randomized controlled trials for journal abstracts or conference proceedings is shown. It is recommended that authors, conference organizers, and journal editors adopt this guideline to enhance study interpretation and use and reduce research wastage.

Keywords: swine, abstracts, conference proceedings, randomized controlled trials, reporting standards

Resumen - TraiTS: Guía para la presentación de informes de estudios en formato corto - ejemplos para porcinos

Se muestra una lista de verificación para guiar a los autores para la presentación de informes de estudios aleatorios controlados en porcinos, individuales o por grupos, de resúmenes para revistas o memorias de congresos. Se recomienda que los autores, organizadores de conferencias y editores de revistas adopten esta guía para mejorar la interpretación y el uso de los estudios y reducir el desperdicio de investigación.

Résumé - TRaiTS: Gabarit de rapport d'essais en format court - exemples porcins

Une liste de vérification pour guider les auteurs lors de rapport complet d'essais contrôlés randomisés individuels ou regroupés sur le porc pour les résumés de revues ou les actes de conférence est présentée. Il est recommandé que les auteurs, les organisateurs de conférences et les éditeurs de revues adoptent cette directive pour améliorer l'interprétation et l'utilisation des études et réduire le gaspillage de la recherche.

It is important that an abbreviated study report, such as a journal abstract or conference proceeding, be as complete as possible within the word limit, as some decision-makers and practitioners may not have access to the complete study report depending on institutional subscription policies, finances, language of publication, etc. Further, some studies never have complete reports publicly available, and the conference proceeding is often the only publicly available description of the study.[1] Complete reporting in the abstract or conference proceeding also enables correct indexing in electronic databases[2] and aids in decision-making regarding inclusion into meta-analyses. However, word count limitations for abbreviated

study reports can pose challenges in this respect.[2] The intent of this template of recommended items for reporting swine randomized controlled trials (RCTs) is to help meet this challenge. It is strongly recommended that students be taught complete reporting using this template and that seasoned researchers utilize the checklist as an efficient way to verify complete reporting. Swine journal editors and conference organizers should recommend this template as part of the submission guidelines and peer reviewers of swine RCTs should refer to the template when assessing submitted manuscripts.

Since various swine conferences have different word count limits for their study reports, the guidelines for the

American Association of Swine Veterinarians veterinary student scholarships guidelines for abstracts have been used for illustrative purposes (550 words maximum, plus a visual aid [table or figure]; **https://www.aasv.org/annmtg/2019/ studentseminar.htm**).

The items recommended for inclusion in a swine abstract or conference proceeding are listed in Table 1. Comprehensive reporting of clinical trials is challenging, a task made even more difficult by a short report length. Provided here is a streamlined list of factors that should be included in an abbreviated RCT report, with examples of how these items would be addressed in a short abstract format.

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

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Table 1: Checklist for reporting randomized controlled trials in swine adapted for abbreviated study reports in journal abstracts or conference proceedings[2-7]

Item	Information to include
Title	Provide an informative title: Consider indicating the hypothesis tested, state if the study was randomized and the type of study design used eg, two-group parallel, multi-group parallel, crossover, factorial, superiority, equivalence, or noninferiority and whether experimental units were individually allocated or cluster-allocated.
Authors	For conference proceedings, the corresponding author and contact information should be listed, unless otherwise dictated by the author guidelines provided by the organizing body.
Introduction: Rationale	Provide a short rationale for the project and the design.
Introduction: Objective	Identify the objective(s) or hypothesis/es of the study. If there is more than one objective, identify which is the main objective (associated with the primary outcome of interest, which was used to determine the sample size). Also indicate the statistical hypothesis for the primary outcome (superiority, equivalence, or noninferiority). Only identify the key secondary objectives.
Methods: Study design	Indicate the allocation method (random or non-random), trial design (two-group parallel, multi-group parallel, crossover, or factorial), and experimental unit (pig, pen, barn, etc) and whether the study was individually allocated or cluster-allocated.
Methods: Participants	Report the stage of production, disease status of herd, study setting (type of swine production facility and country) and the eligibility criteria for the experimental unit such as pigs, litters, barns, or sites. If the experimental units are nested within housing units, ie, more than one site or barn, report the eligibly criteria for all housing units.
Methods: Interventions	Describe the interventions for each group, including generic name of compound, trade name (if applicable), name of manufacturer, dosage, duration, and route of administration, or procedure, as applicable.
Methods: Outcome	Define the main/primary outcome and describe when it was assessed (eg, the time frame over which it was measured). Only if space permits include key secondary outcomes of interest.
Methods: Allocation	Describe how the experimental units (pigs, pens, barns or sites) were allocated to the intervention group. If random allocation was employed, include the method used to generate the allocation sequence (eg, computer-generated, random-number table, etc), and indicate if the allocation sequence was concealed before eligibility was assessed (eg, via sealed envelopes or containers). If non-random methods were used (eg, systematic or alternation), state that non-random allocation was used. If individual allocation was done, indicate whether or not animals in different intervention groups were commingled.
Methods: Blinding	Indicate whether or not personnel applying treatments, caregivers, outcome assessors, or data analysts were blinded. Avoid non-specific terms such as "double-blinded" or "blinded" without specifying which tasks were blinded.
Methods: Analysis approach	Indicate the approach to analysis, both estimation of effect size and precision of the intervention and hypothesis-testing approach. Indicate if covariates were included and if clustering (a very common feature of livestock trials) was accounted for in the analysis. If hypothesis testing was used, discuss if adjustments for multiplicity were applied; if adjustments were applied, state the method used.
Results: Numbers allocated	Indicate the number of experimental units (pigs, pens, barns, sites, or herds) allocated to each intervention group. If nested with housing units indicate the number of housing units. If the study is still ongoing at the time of abstract submission, report the period of recruitment on which the data were based. Indicate age and/or weight of enrolled animals and stage of production of the enrolled animals.
Results: Recruitment	Indicate if the trial is still ongoing, closed to recruitment, or closed to follow-up. Indicate if the results and analysis presented are complete or preliminary.

Table 1: Continued

Item	Information to include
Results: Numbers analyzed	Report the number of experimental units (pigs, pens, barns, sites, or herds) per intervention group, used in the analysis.
Results: Outcome	For the primary outcome, report the results for each intervention group. This includes the number of experimental units with or without the event for dichotomous outcomes or the estimated mean and standard error for continuous outcomes for each intervention group. If the word limit permits, report the most critical subset of estimated effect sizes with a precision measure ie, a mean difference with confidence interval or SE, odds ratio with confidence interval or SE, or risk ratio with confidence interval or SE. Preferentially report estimates adjusted for pen (barn/site) effects if appropriate. For multi-group trials, report the most important pairwise comparisons. Give strong consideration to include a production outcome as a secondary outcome if not the primary outcome. Only if the word-limit permits include key secondary outcomes of interest in the same manner.
Results: Adverse events	Report the number of adverse events or side effects per intervention group.
Conclusions	Give a general interpretation of the results, clearly placing the findings in context for the veterinarian ie, how the results might be applied, including the uncertainty associated with unreplicated findings, sources of bias, and error. Place in context within the available body of work.
Animal use approval, registration, funding, conflicts of interest	List the source(s) of funding for the research, the animal use approval number, indicate if the trial was pre-registered and if the trial protocol is available, and declare conflicts of interest.

The adaptations made to the CONSORT and the REFLECT statement for abbreviated study reports, such as journal abstracts and conference proceedings, included using the term "experimental units" rather than "participants" to allow for studies that allocate interventions within pigs (limbs, eyes, hoofs, etc) and pen- or barn-level studies. "Blinding of participants" was removed as the pig participants in swine studies would not be expected to be aware of which intervention they received and eligibility criteria for owners or managers included since animals involved in the studies are incapable of consenting to participate in veterinary trials. Included here is information about the approach to analysis, in particular, reporting of adjustment for clustering. Grouping of experimental units within housing units such as pens, barns, or farms is a common feature of swine trials that is associated with within-cluster correlations that, if ignored, can lead to overestimation of the precision of estimates (ie, narrow confidence intervals and small standard errors). Authors should indicate if their trial protocol is available at a publicly accessible location such as Open Science, university digital depositaries, or the American Veterinary Medical Association clinical trials registry (**https://ebusiness.avma. org/aahsd/study_search.aspx**).

Deciding what to report can be difficult. Many studies have multiple outcomes, and it might not be feasible to report all outcomes and still provide adequate detail about the study design, approach to analysis, and study setting information. The interpretation of any result depends upon understanding the internal validity of the trial. Extrapolating those results to other populations relies on the external validity. Therefore, it is recommended that the focus be on ensuring end users have sufficient information to assess the validity of the primary outcome, rather than reporting multiple outcomes for which the validity cannot be assessed and for which the trials may not have been adequately powered. Anecdotally, this may present a shift away from prior approaches to reporting that focused on devoting space to results while sacrificing information about the methods that are necessary for the reader to assess validity. When word limits prevent the inclusion of factors related to validity and results for all outcomes evaluated, the primary outcome (ie, the outcome used to establish the sample size) should be reported in the results and discussion and the secondary outcome(s) dropped.

Another issue that may arise is reporting of contrast information for trials with three or more groups. As these trials have multiple possible comparisons and the space required to report all pairwise comparisons may not be available,

authors should report each group outcome and standard error or confidence interval obtained from an appropriately adjusted model. Reporting these data enables end users to calculate any contrasts they are interested in. As it is frequently necessary to adjust for the effect of non-independence in swine studies that are conducted in populations with hierarchical structures such as litters, rooms, pens, and barns, providing the standard error enables calculation of all possible contrasts. If, as often happens, only the "raw" number of experimental units experiencing the outcome and the number allocated to each group is reported, the contrasts the reader is uniquely interested in cannot be correctly calculated. For pairwise contrasts, if reported at all, only the contrast(s) identified in the hypothesis should be reported.

An illustration of the reporting of individually randomized and cluster-randomized trials are presented separately, as each type of trial has different challenges for reporting.

Individually randomized trial template

The first example (Figure 1) demonstrates the suggested reporting style for a hypothetical individually multi-group randomized trial comparing the clinical efficacy of 3 hypothetical products (A, B, and C) in swine, with an accompanying visual aid (Table 2).

Cluster-randomized trial template

An example of comprehensive, transparent reporting of a hypothetical cluster-randomized (pen-level allocation) trial comparing the clinical efficacy of 3 different doses (multi-group) of a hypothetical feed additive (product A) in swine is illustrated by Comprehensive Reporting Example B (Figure 2 and Table 3). In this example, only one outcome is presented so that sufficient information about the analysis and clustering nature of the design could be included, which is more important for reaching appropriate inference and reducing research wastage.

Terms used

- A parallel trial is where the pigs are randomized to the intervention group and pigs remain in that same group throughout the study.
- A crossover trial is where pigs receive more than one intervention during the study, with a washout period between the interventions.
- In an individually randomized trial, the interventions are allocated to individual pigs.
- In a cluster-randomized trial, the interventions are allocated to entire groups of pigs.
- A trial evaluating a superiority hypothesis assesses if at least one group is better than another group concerning the outcome of interest.
- A trial evaluating a non-inferiority hypothesis assesses if at least one group is not worse than another group concerning the outcome of interest.
- A trial evaluating an equivalence hypothesis assesses if at least one group is equal to another group concerning the outcome of interest based on an a priori determined measure of equivalence.

Figure 1: Comprehensive Reporting Example A is an abbreviated report demonstrating recommended reporting of individually randomized, multi-group parallel controlled trials in swine for journal abstracts and conference proceedings. The superscript block capital letters indicate the checklist items from Table 1. Body of text word count ≤ 550 words.

TITLE **Comparing clinical cure rate for Product A, Product B, and Product C against hypothetical swine disease: An individually randomized multi-group parallel controlled trial**

AUTHORS J. A. Smith, J. B. Smith*   word count = 550

 * Corresponding author: jbsmith@jbsmith.com

INTRODUCTION: RATIONALE Hypothetical swine disease (HSD) is associated with high mortality and morbidity in late-nursery pigs. Products A, B, and C are registered for treatment of HSD, yet the comparative efficacy of these products is unclear. OBJECTIVES and HYPOTHESIS Our primary objective was to determine if the cure rate at Day 14 was higher for Products B or C compared to Product A on an endemic farm. The secondary objective compared weight gain after 14 days.

METHODS: TRIAL DESIGN PARTICIPANTS A 3-group, parallel, individually randomized trial was conducted on crossbred pigs at a commercial farm in Ontario, Canada. Eligible pigs had a rectal temperature > 39.9°C and had not received antimicrobial treatments for 2 weeks prior to enrollment. INTERVENTIONS Pigs received either Product A intramuscular (IM) at 7.5 mg/kg once, Product B subcutaneous at 3 mg/kg daily for 3 days, or Product C IM at 5 mg/kg twice, 48 hours apart. OUTCOME Day 0 was the day of diagnosis, enrolment, and first treatment. Weight gain and clinical cure were assessed on Day 14. Clinical cure was defined as rectal temperature < 40.0°C on Day 14. ALLOCATION Pigs were allocated to treatments using a random number generator. Treatment allocation was concealed from farm staff until eligibility assessment was complete. After allocation, all pigs were returned to their original pen, where treatment groups were mingled. BLINDING Farm staff could not be blinded to treatment group due to different administration routes. Although animals bore no indicators of the treatment received, caregivers were likely aware of intervention received. The veterinarian assessing clinical cure was unaware of treatment group. The data were coded as X, Y, or Z by group until statistical analyses were complete. ANALYSIS The statistical model was disease risk (logit link) or weight gain (linear link) across treatment groups (a fixed effect) with pen as a random effect. An adjusted risk ratio (OR) and 95% CI were calculated for all pairwise comparisons. We back calculated OR using the Product A baseline risk.

RESULTS: RECRUITMENT These results are preliminary because we will be repeating the study at a different site; however, for this site the data are complete and enrolment began October 15, 2017 and ended on November 30, 2017. NUMBERS RANDOMIZED, NUMBERS ANALYZED, ADVERSE EVENTS, OUTCOMES Table 2 presents the number of animals assessed for eligibly, enrolled, lost to follow-up, analyzed, baseline characteristics, clinical cure rate, and weight gain in each group on Day 14. RESULTS: OUTCOMES Adjusted relative risk for clinical cure and mean difference in weight gain are present in Table 2.

CONCLUSIONS In this preliminary analysis Product C had a higher clinical cure rate on Day 14 against HSD compared to Products A or B, as shown by the risk ratio greater than 1. The boundaries of the CI are consistent with a positive effect. These results suggest that veterinarians might employ Product C to treat HSD and have increased cures compared to Product A or B. Our findings are consistent with Jones et al, 2013 that Product C had a higher clinical cure than Product A in a random control trial (OR = 1.5; 95% CI, 0.9-1.9). Consistency of direction and magnitude of effect increases confidence in findings, as does the use of random allocation and blinding of outcome assessors.

TRIAL REGISTRATION The trial protocol was approved by the Primary Investigator's Institutional Animal Care committee but is not available. FUNDING and CONFLICT OF INTEREST This study was funded by the Superb Swine Association. Both authors are employees of Product C manufacturer.

Implications

The main take-away points for reporting RCTs in swine abstracts or conference proceedings are:

- Student researchers should be taught reporting using this template.
- Swine journal editors and conference organizers should encourage template use.
- Peer reviewers should consider using this template when assessing swine RCTs.

Acknowledgments

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.

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Table 2: An example of how to present baseline data and results for an individually randomized multi-group parallel controlled trial in swine for journal abstracts and conference proceedings

EXAMPLE TABLE: Baseline characteristics at day 0 and results at day 14 for a randomized controlled trial comparing Products A, B, and C in late-nursery pigs			
Pigs assessed for eligibility, No.	325		
Exclusion reason pre-enrollment			
Rectal temperature < 39.9°C, No. of pigs	12		
Received antimicrobials prior to enrollment, No. of pigs	11		
Pigs enrolled in the study, No.	**302**		
	Product A	**Product B**	**Product C**
Pigs allocated at enrollment (D 0), No.	98	104	100
Adverse events, No. of pigs	5	2	3
Injection site swelling	4	2	3
Anaphylaxis	1	0	0
Age, wk	10	10	10
Weight, mean (SD), kg	23 (3)	24 (4)	22 (4)
Female, No. (%)	49 (50%)	39 (38%)	73 (73%)
Results at D 14			
Complete data analyzed, No. of pigs	95	94	100
No. clinically cured	50 (52%)	75 (80%)	99 (99%)
Unadjusted mean weight (SE), kg/day	0.5 (0.1)	0.6 (0.1)	0.8 (0.1)
Pairwise Relative Risks	**Product A**	**Product B**	**Product C**
Product A	NA	1.5 (95% CI, 1.1-2.0),	1.9 (95% CI, 1.4-2.4),
Product B	NA	NA	0.89 (95% CI, 0.62-1.31).
Pairwise differences, kg/d	**Product A**	**Product B**	**Product C**
Mean difference from Product A	NA	0.04 (95% CI, -0.3 to 0.5)	0.3 (95% CI, -0.04 to 0.7)
Mean difference from Product B	NA	NA	0.2 (95% CI, -0.2 to 0.7)

Figure 2: Comprehensive reporting example B is an abbreviated report demonstrating recommended reporting of cluster-randomized, multi-group parallel controlled trials in swine for journal abstracts and conference proceedings. The superscript block capital letters indicate the checklist items from Table 1. Body of text word count ≤ 550 words.

TITLE **Comparing weight gain due to Product A feed additive in finishing swine: a cluster-randomized, multi-group parallel controlled trial.**

AUTHORS J. A. Smith, J. B. Smith*   word count = 532

* Corresponding author: jbsmith@jbsmith.com

INTRODUCTION: RATIONALE Product A is registered as a growth promotant in swine, but efficacy of different dosages has not been compared. OBJECTIVE The primary objective was to determine if weight gain would be higher in pigs that received 50 and 100 ppm in-feed of Product A compared to no Product A.

METHODS: TRIAL DESIGN, & PARTICIPANTS A 3-group, pen-randomized trial was conducted at 2 sites. Site was a block. Animals were housed in pens, nested within rooms, nested within a barn at each site. INTERVENTIONS Product A was administered at 0, 50, or 100 ppm in the basal diet from Day 0 (first arrival) to Day 21. OUTCOME The primary outcome was individual pig weight collected 30 days after the start of the feeding trial. ALLOCATION The research facility allowed allocation of different rations to pens. Two barns were used at each site. Each barn had 2 rooms. Each room had 50 pens, only 3 pens were used in the study. Farm staff filled both rooms of the barn with pigs as per usual farm practice over 2 to 4 days ie, pigs were not randomly allocated to pens. In each room the same 3 pens were randomly allocated to one treatment for each replicate. BLINDING Due to the distinctive aroma of Product A, caregivers were aware of pens receiving Product A but not the dose. Pen weight was an objective outcome. Data analysis was not blinded. ANALYSIS APPROACH We used a generalized linear model to estimate the final mean pig weight. The explanatory variable of interest was treatment group. Site and barn were included as fixed effects, while room and pen were included as random effects. Group-level results are reported as means (SEM) and comparisons as adjusted mean differences.

RESULTS: NUMBERS RANDOMIZED These results are final. RECRUITMENT The first group was enrolled on October 7-10, 2016 and the final group on March 8-11, 2019. NUMBERS ANALYZED, BASELINE CHARACERITICS The descriptive pen-level data, adjusted estimated group effect on final weight, the fixed effects, and random effects estimates are reported in Table 3. Eighty-five enrolled animals were not included in the analysis: 35 animals died and 50 animals from one pen were excluded because double the product was delivered for the first 6 days. Despite these losses, the data suggested that randomization was associated with balanced distribution of the arrival weight, and the analyzed populations were similar for arrival weight. OUTCOME There was no evidence of a difference in pig weight by treatment (Table 3). ADVERSE EVENTS No adverse effects were noticed.

CONCLUSIONS Evaluation of the estimates of the difference in mean weight per pig for the treatments are close to 0, suggesting no treatment effect. This result suggests that unless other evidence becomes available, there is little evidence to support the inclusion of Product A at 50 or 100 ppm to increase weight gain. We are unaware that others have conducted a similar evaluation, therefore this result is the only evidence available. Although we conducted the study in a cluster-randomized trial, the evidence to conclude no effect would be strengthened by other studies evaluating the same question.

TRIAL REGISTRATION The trial was approved by the Primary Investigator's Institutional Animal Care committee and is available at that Investigator's institutional digital repository (**www.PrimaryInvestiagtors.website.edu**).

FUNDING and CONFLICT OF INTEREST This study was funded by the Superb Swine Association. The authors declare that they have no conflict of interest.

3. 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. *J Swine Health Prod*. 2010;18:18-26.

4. 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 by modifying the CONSORT statement. *Zoonoses Public Health*. 2010;57:95-104. **doi:434 10.1111/j.1863-2378.2009.01311.x**

5. 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;93:11-18. **doi:10.1016/j.prevetmed.2009.10.008**

Table 3: An example of how to present baseline data and results for a pen-randomized, multi-group parallel controlled trial in swine for journal abstracts and conference proceedings

| Baseline characteristics at D 0			
Total No of pigs eligible for enrollment	2400		
Total No. of pigs excluded at enrollment	0		
No. of site/No. of barns/No. of rooms/No. of pens enrolled in study	2/4/16/48		
No. of barns per site/No. of rooms per barn/No. of allocated pens per room	2/2/3		
No. of pigs enrolled per site/No. per barn/No. per room/No. per pen	1200/600/150/50		
Dosage of Product A	**0 ppm**	**50 ppm**	**100 ppm**
Pens allocated at enrollment	16	16	16
Pens lost to follow up	0	1	0
Pens included in analysis	16	15	16
Pigs allocated at enrollment	800	800	800
No. of pigs/pen enrolled, mean (SD)	50 (0)	50 (0)	50 (0)
No. pigs lost to follow-up (No. of pens)	16 (8)	58 (3)	11 (4)
Pigs included in the analysis	784	742	789
No. of individual pigs/pen in analysis, range	45-50	46-50	42-50
Individual pig weight at enrollment, mean (SD), kg	5.8 (0.89)	5.7 (0.89)	5.7 (0.89)
Results at D 30, kg			
Total final weight/pen, mean (SD)	950 (21.5)	894 (23.9)	928 (24.8)
Adjusted* individual pig weight, mean (SEM)	19 (0.13)	19 (0.14)	18.6 (0.13)
Pairwise differences in weight, kg	**0 ppm**	**50 ppm**	**100 ppm**
Mean difference (95% CI) from 0 ppm	NA	-0.1 (-0.46 to 0.1)	0.5 (0.1 to 0.8)
Mean difference (95% CI) from 50 ppm	NA	NA	0.5 (-0.17 to 0.91)

* Variance components: Model = final weight ~ 0 + treatment + site + nursery + (random effects for pen [room]) + error
   Fixed effects: Site (N = 2, Estimate: 0.6228, Confidence Interval: [-0.362, 1.615]), Barn (N = 4, Estimate: 0.6228, -0.4919, Confidence Interval: [0.5493, 1.134],[0.5397 ,-0.911]),
   Random effects: Room (N = 16, Variance: 12.32, ICC: 0.204), Pen (N = 48, Variance: 2.64, ICC: 0.0438), Residual (N = 2350, Variance: 60.3302)

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 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;24:57-64. **doi:10.1111/j.1939-1676.2009.0441.x**

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 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;73:132-139.

News from the National Pork Board

This fact sheet from the National Pork Board provides key insights into AgView, a Checkoff-funded, opt-in software platform that is free to use for anyone raising pigs.

AgView: A New Tool for a Unified, Real-Time Approach for Foreign Animal Disease Response

A rapid, informed response is vital for quickly containing a foreign animal disease (FAD) outbreak. While reporting protocols are in place on local and state levels, AgView is a free, opt-in technology solution that helps producers provide disease status updates and pig movement data to state animal health officials in real-time. When producers grant permission to share this data, it can be invaluable to creating a faster response to a suspected or confirmed FAD.

AgView's Value to the Industry

The AgView platform promotes business continuity for America's pig farmers by uniquely making disease traceback and pig movement data available to the USDA and state animal health officials on Day 1 of a foreign animal disease incident.

Important AgView Features

- Ties All Pig Movement to Farm Premises
- Complements Other Software Platforms (Public/Private)
- Gathers Data Prior to an Incident
- Holds All Data Securely
- Releases Data Only at Producer Request
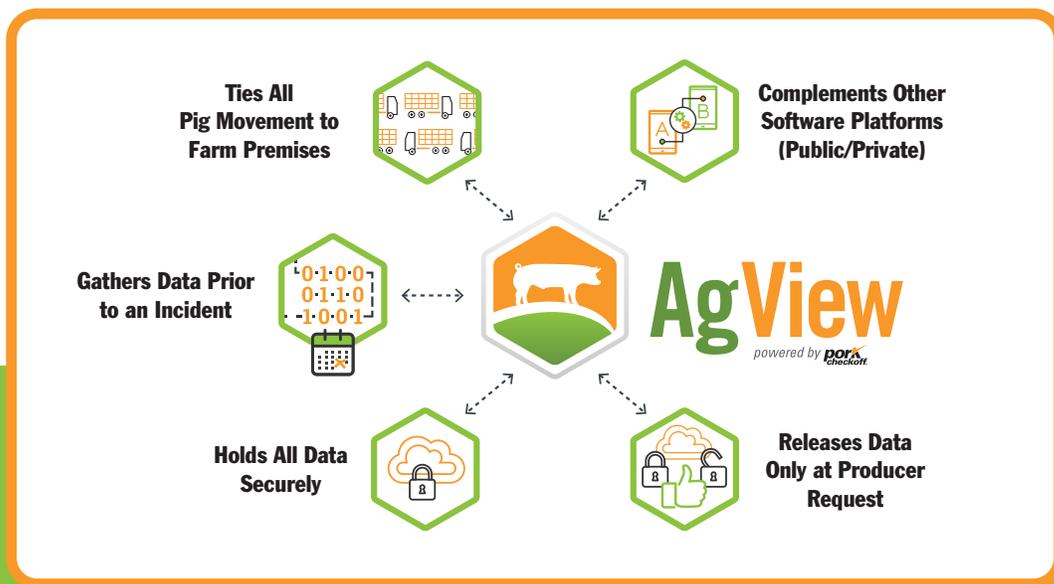
In the event of an African swine fever (ASF) or another FAD outbreak, state veterinarians and other animal health officials will rely on reviewing a massive amount of important data from producers to assist in contact tracing of infected animals/herds. AgView is a permission-based system that is able to rapidly share disease data from producers to animal health officials. Once the data-sharing is approved, AgView can quickly share this vital information, including:

- Where the pigs are and the size and types of farms state vets are dealing with
- Magnitude of animal movement, and more importantly, positive traces
- Lab results from ASF or another FAD
- Compliance with the U.S. Secure Pork Supply plan
- Verification of criteria needed for permitting movement

African Swine Fever – A Very Real Threat to the U.S. Pork Industry

A foreign animal disease (FAD) outbreak such as African swine fever (ASF) could be a major setback for the U.S. pork industry. The impact would be catastrophic on the whole supply chain — from grain farmers and pig farmers, to packers/processors and retailers — and the industry may not recover quickly.

COVID-19 ravaged the pork industry leading to billions of dollars in losses for America's pig farmers, and the threat of ASF or another FAD could be far worse. According to an April 2020 study completed by economists at Iowa State University[1], the economic impact of a hypothetical ASF outbreak could:

Cost the pork industry more than
$50 billion over 10 years

Mean a difference of
$15 billion in losses versus $50 billion in losses
for the industry in a scenario where ASF is controlled in two years versus 10 years

Equate to
140,000 job losses in the U.S.
in a scenario where it took 10 years to gain control of ASF

Cause hog prices to fall by
47% in the first year of the outbreak
with prices stabilizing to 1.8% lower in the 10-year scenario versus prices starting to climb to baseline levels as soon as pork exports begin to recover in the two-year scenario

Reduce pork production by almost
30% in the 10-year scenario
versus a very small contraction in the industry over the long term in the two-year scenario, pending export access is re-established

Integrating AgView for Producers and State Animal Health Officials

We never know when an outbreak of a FAD will occur, so everyone must be prepared and plan ahead to protect their farms, the pork industry and the agricultural economy. Routine updates on swine disease trends in a producer's area can help manage diseases more effectively. To make this easier for producers and ensure data is up to date, AgView can integrate with many systems that producers are already using. For producers that do manual record keeping, AgView also accepts imports from Excel records. With state-of-the-art features, AgView can complement existing software systems that state veterinarians may be using too. Using real-time information, state veterinarians can improve their disease response and FAD investigations.

To learn more, visit **porkcheckoff.org**.

AgView, powered by the Pork Checkoff, is our industry's *Path to Protection*.

Questions?
porkcheckoff.org | help@agview.com | 800-767-5675 M-F, 8-5 CT

pork checkoff

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 requests nominations for the following awards – including a new one – to be presented at the 53rd AASV Annual Meeting in Indianapolis. If you are wondering who has (or has not) received each award in the past, visit **aasv.org/aasv.awards.htm**.

Outstanding Swine Academic (new) - Given annually to an AASV member employed in academia who has demonstrated excellence in teaching, research, and service to the swine veterinary profession. Faculty members, graduate students, and researchers are eligible to receive this award.

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 15th. 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**.

Early-career swine vets to meet November 5

To encourage and support swine veterinarians in the early stages of their careers, AASV is offering the first-ever Early Career Swine Veterinarian Conference on November 5th in Ames, Iowa. The meeting will be held in conjunction with the James D. McKean Swine Disease Conference at Iowa State University (ISU), and is intended for AASV members who have received their veterinary degree within the past ten years.

The conference was proposed and the program prepared by AASV's recently established Early Career Committee (see agenda on facing page). The committee desired to offer a welcoming, interactive conference where early career veterinarians could socialize, collaborate, and communicate with others working in swine veterinary medicine.

The program presentations, panel discussions, one-on-one networking, and small group discussions – led by an elite group of AASV-member swine veterinarians - are designed to enable attendees to learn how to confront career development challenges with a focus on the "pearls, possibilities, and opportunities" of the swine industry.

Because the conference is being held in conjunction with the ISU-McKean Swine Disease Conference, attendees must register for the ISU meeting in order to sign up for Friday afternoon's Early Career Conference. Thanks to support from the AASV Board of Directors, registration for this first Early Career Conference is free, but attendance is limited to 50. If this inaugural event is deemed successful, the Early Career Committee hopes to continue and expand it in the future.

The afternoon's educational presentations will be followed by an evening social gathering at a local restaurant, sponsored by Boehringer Ingelheim Animal Health and Merck Animal Health.

Engage, Empower, and Elevate your Swine Career

November 5 2021

Ames, IA

AASV EARLY CAREER SWINE VETERINARIAN CONFERENCE

1:00 pm Welcome and introductions

1:15 pm Communication and leadership skills
Larry Firkins, DVM, MS, MBA

2:00 pm Financial literacy discussion
Doug Groth, DVM

3:00 pm Refreshment break

3:15 pm Case review/discussions

- Sow topics
Jeremy Pittman, DVM, MS, Dipl ABVP

- Finishing topics
Kurt Kuecker, DVM

4:30 pm Ventilation troubleshooting at a macro level
Mike Eisenmenger, DVM

5:15 pm Summary of the day and conclusions

5:30 pm Social event at Jethro's BBQ in Ames
Sponsored by *Boehringer Ingelheim Animal Health* and *Merck Animal Health*

8:00 pm Event concludes

AMERICAN ASSOCIATION SWINE VETERINARIANS

aasv.org/earlycareer

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PRRS CONTROL FROM THE START

1.22 lbs ADG · 13.9 lbs · **Day 0**
1.23 lbs ADG · 13.9 lbs

2.10 lbs ADG · 75.1 lbs · **Day 50**
2.10 lbs ADG · 75.8 lbs

1.74 lbs ADG · 232.4 lbs · **Day 125**
1.75 lbs ADG · 233.1 lbs
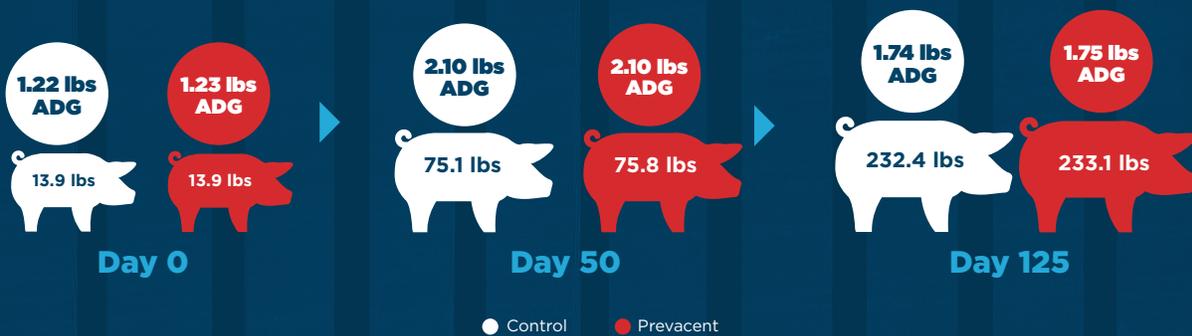
○ Control   ● Prevacent

In a commercial study, pigs vaccinated with Prevacent® PRRS showed no reduction in growth performance or difference in body weight from control pigs at day 50 or day 125.[1]

Prevacent did not shed through the air during the 28-day sampling period.[1]

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[1]Yeske PE, Betlach A, Evelsizer RW, et al. Evaluation of shedding and effect on pig performance of Prevacent PRRS vaccine in commercial conditions. AASV Annual Meeting. 2021:203.

Pigs of #instaham

Share your pig photos for the JSHAP cover
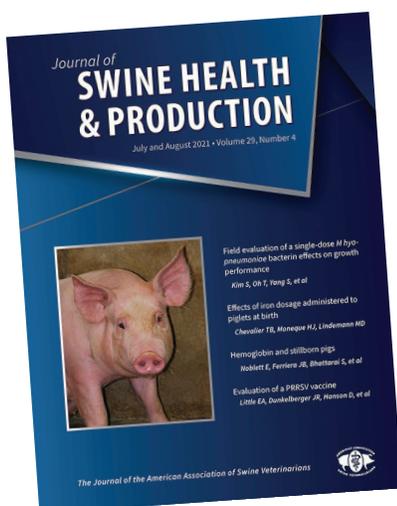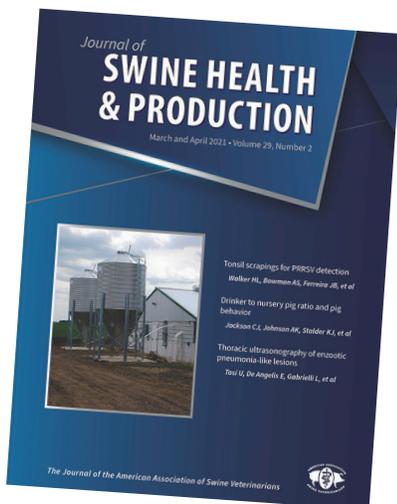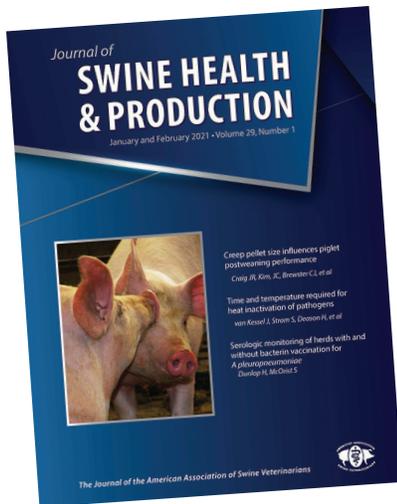
Submissions by readers are welcome!

- Photos must represent healthy pigs and modern production facilities and not include people.

- Photos must be taken using the camera's largest file size and highest resolution.

- Please send the original image(s); do not resize, crop, rotate, or color-correct the image prior to submission.

- Submit photos with your name and affiliation to **tina@aasv.org**.

DEFINING OUR FUTURE

53rd AASV Annual Meeting

February 26 – March 1, 2022
Indianapolis, Indiana
aasv.org/annmtg

Reserve lodging now:

JW Marriott Indianapolis, 10 S West Street, Indianapolis, Indiana
866-704-6162
aasv.org/annmtg/2022/lodging.php

2022 ANNUAL MEETING PROGRAM

AASV's 53rd Annual Meeting
February 26 - March 1, 2022

DEFINING OUR FUTURE

SATURDAY, FEBRUARY 26
Pre-conference seminars

1:00 PM – 5:00 PM

Seminar #1   Practice Tips: Learn from the Past and Shape Our Future
Melissa Billing, chair

Seminar #2   Influenza
Daniel Boykin, chair

Seminar #3   Diagnostics: Opportunities, Advancements, and Implementation
Brent Sexton, chair

Seminar #4   Antimicrobial Clinical Pharmacology
Justin Brown, chair

Seminar #5   Feed Risk: Transboundary and Domestic
Jordan Gebhardt, chair

Seminar #6   Applied Field Research
Gustavo Silva and Chris Rademacher, co-chairs

SUNDAY, FEBRUARY 27
Pre-conference seminars

8:00 AM – 12:00 PM

Seminar #7   Swine Health Through Nutrition: Feeding the Pig in a Changing World
Alexander Hintz, chair

Seminar #8   The Swine Vet's Toolbox in 2032
Justin Brown, chair

Seminar #9   Data-Driven Decision Making
Daniel Linhares, chair

Seminar #10   Swine Medicine for Students
Jeremy Pittman and Angela Supple, co-chairs

Seminar #11   Vet CEO 2.0: Leading Living Cultures on Teams
Sarah Probst Miller, chair

Research Topics

8:00 AM – 12:00 PM
Session chair: Chris Rademacher

8:00 AM   Breed-to-finish risk factors associated with increased proportion of lightweight pigs marketed
Edison Magalhaes

8:15 AM   A novel production model for nursing piglets from birth to the end of nursery phase
Mark Schwartz

8:30 AM   Quantification of decontamination strategies for semitruck cabs
C. Grace Elijah

8:45 AM   Early detection of trade-impacting swine pathogens: an epidemiological modeling study
Giovani Trevisan

9:00 AM   Comparison of 5 ASF point-of-care assays against a standard OIE-based laboratory PCR using field samples
Christa Goodell

9:15 AM   Efficacy of the "tooth extraction" (test and remove) protocol in commercial swine farms in Vietnam
Christa Goodell

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| 9:30 AM | Practical implications of the impact of pooling family oral fluids on the probability of PRRSV detection by PCR
Onyekachukwu Osemeke |
| 9:45 AM | REFRESHMENT BREAK |
| 10:15 AM | Detection of *Mycoplasma hyorhinis* in dams and piglets from birth to weaning age
Cipriano De Abreu |
| 10:30 AM | Characterization of an experimental *Mycoplasma hyopneumoniae* aerosol infection model in pigs
Cipriano De Abreu |
| 10:45 AM | Detection dynamics of *Mycoplasma hyopneumoniae* under controlled aerosol exposure for gilt acclimatization
Alyssa Betlach |
| 11:00 AM | Diagnostic performance of a commercial *Mycoplasma hyopneumoniae* serum antibody ELISA using processing fluids samples from three commercial swine farms
Betsy Armenta-Leyva |
| 11:15 AM | Prevention and control of *Streptococcus equi* subspecies *zooepidemicus* infection in pigs
Samantha Hau |
| 11:30 AM | Senecavirus A in the environment of sow slaughter plants
Alexandra Buckley |
| 11:45 AM | First assessment of the time-to-negative processing fluids in breeding herds after a Senecavirus A outbreak
Guilherme Milanez Preis |
| 12:00 PM | Session concludes |

Poster session: Veterinary Students, Research Topics, and Industrial Partners

12:00 PM – 5:00 PM

Poster authors present from 12:00 PM to 1:00 PM
Poster display continues on Monday, 8:00 AM to 5:00 PM

Concurrent sessions
1:00 PM – 5:15 PM

| Session #1 | **Student Seminar**
Andrew Bowman and Perle Zhitnitskiy, co-chairs |
| Session #2 | **Industrial Partners**
Mary Battrell and Jessica Risser, co-chairs |
| Session #3 | **Industrial Partners**
Attila Farkas and Jeff Harker, co-chairs |
| Session #4 | **Industrial Partners**
Rebecca Robbins and Megan Inskeep, co-chairs |

MONDAY, FEBRUARY 28
General Session
Defining Our Future

8:00 AM – 12:15 PM
Program and Session chair: Mike Senn

| 8:00 AM | **Howard Dunne Memorial Lecture**
Leaping into the future: Sit down, buckle up, and hang on
Angela Baysinger |
| 9:00 AM | **Alex Hogg Memorial Lecture**
Learning for the future
Jim Kober |
| 10:00 AM | REFRESHMENT BREAK |
| 10:30 AM | Diversity, equity, and inclusion in veterinary medicine
Fred Gingrich |
| 11:10 AM | Diversity, equity, and inclusion: Academia perspective
Alex Ramirez |
| 11:30 AM | Diversity, equity, and inclusion: Student perspective
Kelly Hewitt |
| 11:45 AM | Diversity, equity, and inclusion: Business perspective
Lisa Tokach |
| 12:15 PM | LUNCHEON |

Concurrent Session #1: PRRS RFLP 1-4-4: How are Practitioners Dealing with it and are the Strains Really Different?

2:00 PM – 5:30 PM
Session chair: Chris Sievers

2:00 PM	Practitioner's perspective of PRRSV in sow herds: What's worked, what's failed and what we still have to learn *Paul Yeske*
2:35 PM	Mitigating the downstream effects of PRRSV and secondary infections *Dyneah Classen*
3:05 PM	Managing PRRSV testing and immunity for gilt development *Kate Dion*
3:25 PM	REFRESHMENT BREAK
3:55 PM	Trading places: Valued learnings from both *Darin Madson*
4:30 PM	Understanding the emergence of a new PRRSV variant (L1C 1-4-4) through implementation of epidemiological tools *Cesar Corzo*
5:00 PM	Breaking down PRRSV next generation sequencing into a user-friendly format *Giovani Trevisan*
5:30 PM	Session concludes

Concurrent Session #2: Sustainability and Animal Welfare

2:00 PM – 5:30 PM
Session chair: Meghann Pierdon

2:00 PM	Responding to animal disease outbreaks and natural disasters with a One Health approach *Gary Flory*
2:25 PM	Resiliency debrief for triage and care: A proposed plan of action *Elizabeth Strand*
2:50 PM	Best management practices for pen gestation: Opening Pandora's box *Tom Parsons*

3:15 PM	California Proposition 12: The slat-level experience *Hyatt Frobose*
3:40 PM	REFRESHMENT BREAK
4:10 PM	The use of animal welfare as a tool to sustain public support for the use of animals in biomedical research: Lessons for the swine industry *James Marx*
4:35 PM	Statehouses and more: Proposals impacting animal agriculture *Elizabeth Rumley*
5:00 PM	Opportunities for technology to improve animal well-being *John Kolb*
5:30 PM	Session concludes

Concurrent Session #3: Disease Prevention, Control, and Elimination

2:00 PM – 5:30 PM
Session chair: Marisa Rotolo

2:00 PM	Utilizing vaccine to reduce the duration and impact of sow farm porcine epidemic diarrhea outbreaks *Brent Sexton*
2:30 PM	The next frontier in disease elimination: Tackling the endemics *Actinobacillus suis*, *Mycoplasma hyorhinis*, and *Mycoplasma hyosynoviae* *Maria Jose Clavijo*
3:00 PM	Rotavirus: Current experiences and thoughts with prevention and control *Jeremy Pittman*
3:30 PM	REFRESHMENT BREAK
4:00 PM	Sow herd influenza A virus-swine classification system *Cameron Schmitt*
4:15 PM	School of hard knocks: Disease prevention, control, and elimination *Paul Yeske*
4:45 PM	Dealing with dysentery: *Brachyspira hampsonii* within a production system *Elizabeth Noblett*

5:00 PM	A cheat sheet for *Mycoplasma hyopneumoniae* surveillance *Ana Paula Poeta Silva*
5:30 PM	Session concludes

TUESDAY, MARCH 1
General Session: Foreign Animal Disease Preparedness and Response

8:00 AM – 12:00 PM
Session Co-chairs: Scott Dee and Mike Senn

8:00 AM	State animal health officials panel discussion: Animal disease preparedness and response *Jeff Kaisand, Bret Marsh, Beth Thompson*
9:00 AM	Global feed security response *Egan Brockhoff*
9:30 AM	US feed security response *Cassie Jones*
10:00 AM	REFRESHMENT BREAK
10:30 AM	Swine Health Improvement Plan update *Rodger Main*
11:00 AM	Validation of extended storage protocols *Scott Dee*
11:15 AM	Responsible feed ingredient import program *Apoorva Shah*
11:30 AM	African swine fever: A practitioner's perspective *Joseph Yaros*
12:00 PM	Session and meeting conclude

The AASV is moving forward with plans for the 2022 AASV Annual Meeting with the understanding that guidelines associated with COVID-19 may necessitate changes yet to be determined. Please check aasv.org/annmtg regularly for updated information and revisions.

Ready, set, donate!

The AASV Foundation Auction Committee is off and running with plans to hold yet another successful fundraising auction in 2022. But they will need more than cheers from the crowd to get to the finish line next February – they will need participation from AASV members and industry stakeholders who are willing to contribute to the team effort.

This past year's auction raised over $100,000; the committee hopes to repeat that success in 2022. Donating an item or cash for the auction is one way members can help propel the foundation to its goal.

Donate auction items by December 1

The Auction Committee is reaching out to potential donors to solicit auction items or cash donations for this year's auction, but don't wait - please contact a member of the committee if you are interested in supporting the auction this year. To ask questions or discuss possibilities, contact one of the committee members listed at **aasv.org/foundation/2022/auctioninfo.php**.

To donate, download the donation form at **aasv.org/foundation/2022/Donationform.pdf** and submit a description and image of your item(s) by **December 1**. Your contribution will be recognized in the auction catalog as well as on the auction website, and your name will appear in the JSHAP full-page spread recognizing our auction item donors. Plus, there's a good chance you may read about your donation in the AASV e-Letter!

Similar to last year, the silent auction will be conducted virtually via ClickBid, and auction donors are asked to retain their donation for shipment to the winning bidder after the auction. The live auction will be held after the Monday evening awards reception at the 2022 AASV Annual Meeting, as in the past.

The auction proceeds are put to immediate use to fund the many foundation activities that receive annual support. See the sidebar for a partial list of how the foundation is currently benefiting those engaged in the swine veterinary profession.

AASV Foundation:

- Administers endowments for the Howard Dunne and Alex Hogg Memorial Lectures
- Administers the Hogg Scholarship for AASV member veterinarians to pursue advanced degrees
- Administers funding for veterinary student scholarships
- Provides funding for AASV members pursuing board certification in the American College of Animal Welfare
- Cosponsors travel stipends for veterinary students to attend the AASV Annual Meeting
- Provides grants to supplement veterinary student swine-related externships
- Administers funding for important research with direct application and benefits to our profession and swine health
- Provides support for the Heritage videos on the AASV website
- Provides tuition support for veterinary students to attend the Swine Medicine Education Center
- Administers and supports the AASV Member Student Debt Relief Scholarships funded through the Dr Conrad and Judy Schmidt Family Student Debt Relief Endowment

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Foundation seeks to support members pursuing ACAW board certification

Have you considered pursuing board certification in the American College of Animal Welfare? If so, you may qualify for financial support from the AASV Foundation.

Recognizing the need for swine veterinarians to be leaders in the field of animal welfare, the AASV Foundation continues to accept applications from AASV members seeking board certification in the American College of Animal Welfare (ACAW). Applicants must have a DVM or VMD degree and at least 5 years of continuous membership in the AASV.

To apply, the applicant must submit a curriculum vitae, an ACAW-approved program plan, and three letters of reference (one of which must come from the applicant's mentor). There is no submission due date, but there is a limit to the amount of funding available each year. A selection committee reviews applications as they are received.

The scholarship will provide annual reimbursements for actual expenses related to the ACAW program, including travel, course fees, and textbooks, with

a maximum reimbursement amount of $20,000. Reimbursement will not cover lost income. An incentive payment of $10,000 will be issued upon successful and timely completion of the ACAW Board Certification.

For more information, contact the AASV office: Tel: 515-465-5255; Email: **aasv@aasv.org.**

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Sunshine, fun, and foundation fundraising

For the third time in as many years, participants enjoyed picture-perfect weather at Veenker Memorial Golf Course for the annual AASV Foundation golf outing fundraiser. Forty-seven golfers on 12 teams vied for top honors in the best-ball contest held Wednesday, September 1st in Ames, Iowa.

The team composed of David Bomgaars, Tyler Holck, Nathan Schaefer, and Tom Wetzell bested the rest of the field, coming in at ten under par to claim first place in the top flight. Golfers Pete Houska, Jeff Kindwall, Derrick Sleezer, and Greg Thornton took second place overall (9 under par), while Daryl Hammer, Jim Lovin, and Dan Rosener combined their efforts to take third place at 5 under par.

Veenker Pro Shop gift cards were awarded to members of the first-, second-, and third-place teams in 3 flights of golfers. A variety of individual contests scattered across the course complemented the team competition and provided golfers with the opportunity to win additional prizes for exceptional driving, chipping, and putting.

The success of the fundraiser is due in no small part to the generous support of faithful sponsors. Once again, **Boehringer Ingelheim** sponsored the awards dinner, **APC** funded the box lunches, and **Zoetis** hosted the beverages for the day. Fourteen golf-hole sponsors participated in this year's event by providing on-course giveaways, raffles, games, and contests for the golfers to enjoy. Please join the foundation in thanking **AgCreate Solutions**, **Aurora Pharmaceutical**, **Chr Hansen**, **Huvepharma**, **Insight Wealth Group**, **Kemin Animal Nutrition and Health**, **LeeO**, **Merck Animal Health**, **National Pork Producers Council**, **Pharmgate Animal Health**, **Phibro Animal Health Corp**, **Ralco**, and **Topigs Norsvin USA** for their support of the 2021 outing.

Additional thanks to Dr Josh Ellingson for coordinating the golf outing (again!) and working to ensure a successful fundraiser for the foundation. Proceeds from the 2021 outing totaled more than $15,000 and will help support a variety of foundation activities, including scholarships, research grants, student debt relief, swine externship grants, travel stipends for students attending the AASV annual meeting, and more.

And the winners are:

First flight

First place team: Dave Bomgaars, Tyler Holck, Nathan Schaefer, and Tom Wetzell

Second place team, hosted by NPPC: Pete Houska, Jeff Kindwall, Derrick Sleezer, and Greg Thornton

Third place team: Daryl Hammer, Jim Lovin, and Dan Rosener

Second flight

First place team, hosted by Aurora Pharmaceutical: Keith Bretey, Jim Murray, Grant Weaver, and Mark Weaver

Second place team, hosted by Norbrook: Leland Brown, Matt Garvin, Brad Gulker, and Brian Van Beek

Third place team, hosted by Phibro Animal Health Corp: Dennis Dwyer, Ron Kaptur, Brian Roggow, and Mark Rooney

Third flight

First place team, hosted by AMVC/Zoetis: Josh Ellingson, Jason Hocker, Steve Schmitz, and Nick Weis

Second place team, hosted by Iowa State University Veterinary Diagnostic Laboratory: Marcelo Almeida, Eric Burrough, Drew Magstadt, and Loni Schumacher

Third place team, hosted by Fast Genetics: Marcus Kehrli, Kent Schwartz, Steve Sornsen, and Ron White

Individual contests

Hole #3, **Longest putt:** Amber Stricker

Hole #4, **Drawing winner**, sponsored by LeeO: Michelle Sprague

Hole #5, **Closest to the target**, Tyler Holck

Hole #6, **Closest to the pin**, sponsored by Merck Animal Health: Brian Roggow

Hole #7, **Chipping contest**, sponsored by Kemin Animal Nutrition and Health: Mike Bauer and Steve Schmitz

Hole #9, **Longest putt**, sponsored by Aurora Pharmaceutical: Brian Van Beek

Hole #11, **Closest to the pin**, sponsored by Huvepharma: Drew Magstadt

Hole #14, **Longest drive**, sponsored by Topigs Norsvin USA: Derrick Sleezer

Hole #15, **Bottle opener putting contest**, sponsored by NPPC: Brad Gulker

Hole #17, **Closest to the pin**, sponsored by Chr Hansen: Dan Rosener

Hole #18, **Longest putt:** Nathaniel Carney

Hole #18, **Raffle winner**, sponsored by Pharmgate Animal Health: Mitch Christensen

First place overall team at the 2021 AASV Foundation golf outing. Left to right: Dave Bomgaars, Tyler Holck, Nathan Schaefer, and Tom Wetzell.

Early career swine practitioners invited to apply for debt relief

Applications are now being accepted for three $5000 scholarships to be awarded to early-career swine practitioners through the Dr Conrad and Judy Schmidt Family Student Debt Relief Endowment. The scholarship recipients will be announced during the 2022 AASV Annual Meeting.

The scholarships are available to AASV members who are between 2 and 5 years post graduation from veterinary school, engaged in private practice, and who carry a significant student debt burden.

The scholarship program was initiated three years ago with a $110,000 contribution to the foundation by the Conrad Schmidt and Family Endowment. Strong interest by applicants prompted the foundation board to increase the number of scholarships awarded to three, beginning in 2021.

The scholarship application form is available at **aasv.org/foundation/debtrelief.php**. Applications are due January 31, 2022. The following criteria will be used to select the scholarship recipient:

1. Joined AASV as a student enrolled in an AVMA-recognized college of veterinary medicine
2. Attended the AASV Annual Meeting as a student
3. Maintained continuous membership in AASV since graduation from veterinary school
4. Is at least 2 years and at most 5 years post graduation from veterinary school (2017, 2018, 2019 DVM/VMD graduates)
5. Has been engaged in private veterinary practice, 50% or more devoted to swine, providing on-farm service directly to independent pork producers. Veterinarians who work for production companies, pharmaceutical companies, or universities are not eligible for the scholarship.
6. Has a significant student debt burden

For more information, contact the AASV Foundation: **aasv@aasv.org, 515-465-5255.**

Swine practitioners: Apply for Hogg Scholarship to pursue graduate degree

The American Association of Swine Veterinarians Foundation is now accepting applications for the prestigious Hogg Scholarship, established to honor the memory of longtime AASV member and swine industry leader Dr Alex Hogg.

The intent of the $10,000 scholarship is to assist a swine veterinarian in his or her efforts to return to school for graduate education (resulting in a master's degree or higher) in an academic field of study related to swine health and production. Fifteen swine practitioners, recognized at **aasv.org/foundation/hoggscholars. htm**, have been awarded the scholarship since it was established in 2008.

Applications for the scholarship will be accepted until January 31, 2022. The scholarship recipient will be announced Sunday, February 27 during the 2022 AASV Annual Meeting.

Dr Alex Hogg's career serves as the ideal model for successful applicants. After twenty years in mixed animal practice, Dr Hogg pursued a master's degree in veterinary pathology. He subsequently became Nebraska swine extension veterinarian and professor at the University of Nebraska. Upon "retirement," Dr Hogg capped off his career with his work for MVP Laboratories. Always an enthusiastic learner, at age 75 he graduated from the Executive Veterinary Program offered at the University of Illinois.

The scholarship application requirements are outlined below, and on the AASV website at **aasv.org/foundation/hoggscholarship.htm**.

Hogg Scholarship Application Requirements

An applicant for the Hogg Scholarship shall have:

1. Three or more years of experience as a swine veterinarian, either in a private practice or in an integrated production setting
2. Five or more years of continuous membership in the American Association of Swine Veterinarians

Applicants are required to submit the following for consideration as a Hogg Scholar:

1. Current curriculum vitae
2. Letter of intent detailing his or her plans for graduate education and future plans for participation and employment within the swine industry
3. Two letters of reference from AASV members attesting to the applicant's qualifications to be a Hogg Scholar

Applications and requests for information may be addressed to:

AASV Foundation
830 26th Street
Perry, IA 50220

515-465-5255
aasv@aasv.org

AASV Foundation issues call for research proposals

As part of its mission to fund research with direct application to the profession, the American Association of Swine Veterinarians Foundation seeks research proposals for funding in 2022. Proposals are due by 12:00 PM Central Time on **January 14, 2022**, and may request a maximum of $30,000 (US$) per project. The announcement of projects selected for funding will take place during the AASV Annual Meeting on Sunday, February 27, 2022. Up to $100,000 will be awarded across three or more projects.

Proposed research should fit one of the five action areas stated in the AASV Foundation mission statement (see sidebar).

The instructions for submitting proposals are available on the AASV Foundation Web site at **aasv.org/foundation/2022/research.php**.

A panel of AASV members will evaluate and select proposals for funding, based on the following scoring system:

- Potential benefit to swine veterinarians/swine industry (40 points)
- Probability of success within timeline (35 points)
- Scientific/investigative quality (15 points)
- Budget justification (5 points)
- Originality (5 points)

A summary of the research funded by the foundation over the past 15 years is available at **aasv.org/foundation/research.htm**.

For more information, or to submit a proposal:

AASV Foundation
830 26th Street
Perry, IA 50220-2328
515-465-5255
aasv@aasv.org

AASV Foundation Mission Statement

The mission of the AASV Foundation is to empower swine veterinarians to achieve a higher level of personal and professional effectiveness by:

- enhancing the image of the swine veterinary profession,
- supporting the development and scholarship of students and veterinarians interested in the swine industry,
- addressing long-range issues of the profession,
- supporting faculty and promoting excellence in the teaching of swine health and production, and
- funding research with direct application to the profession.

Ten $5000 scholarships to be awarded; Applications due December 31

In an effort to assist future swine veterinarians with their educational expenses, the AASV Foundation and Merck Animal Health are pleased to offer the AASVF-Merck Animal Health Veterinary Student Scholarships. Ten $5000 scholarships will be awarded to sophomore and junior veterinary students in 2022. Applications are due December 31, 2021 for scholarships that will be announced during the 2022 AASV Annual Meeting.

Second- and third-year veterinary students enrolled in AVMA-accredited or -recognized colleges of veterinary medicine in the US, Canada, Mexico, South America, or the Caribbean Islands are eligible to apply. All applicants must be current (2021-2022) student members of AASV. Students who have previously been awarded one of the scholarships are not eligible to reapply. Previous scholarship recipients are recognized at **aasv.org/foundation/scholarshipwinners.htm**.

To apply, students submit a resume and the name of a faculty member or AASV member to serve as a reference, along with written answers to four essay questions. The application and instructions are available at **aasv.org/foundation/2022/AASVF-MerckScholarships.php**.

A committee of four conducts the selection process. Two AASV Foundation board members and two AASV members-at-large rank the applicants by scoring their past and current activities, level of interest in swine veterinary medicine, future career plans, and financial need. The scholarship recipients will be announced during the 2022 AASV Annual Meeting in Indianapolis, and the scholarship funds will be disbursed after the conference.

The AASVF-Merck Animal Health Veterinary Student Scholarship Program is part of how Merck Animal Health and the AASV Foundation fulfill a shared mission of supporting the development and scholarship of students and veterinarians. For more information on scholarships and other AASV Foundation programs, see **aasv.org/foundation**.

Early career veterinarians – Resources coming your way

Established by the American Association of Swine Veterinarians Board of Directors in 2019, the AASV Early Career Swine Veterinarian Committee's mission is to strengthen the value of AASV membership for early career veterinarians (less than 10 years post veterinary graduation) by assessing their needs, identifying resources, and guiding AASV leadership and staff to develop and provide those resources that will assist AASV members early in their careers.

The Committee started strong with their inaugural meeting during the 2020 AASV Annual Meeting. In a full room, new and enthusiastic early career members were joined by a few more experienced veterinarians eager to offer support. Discussions during their meeting centered around identifying resources needed by early career veterinarians and how AASV can help fill those gaps.

The committee's initial goals included a more expedited and informal way for early career veterinarian peer communication, a podcast series highlighting topics for early career veterinarians beginning with financial literacy, an early career conference in conjunction with another swine conference, a mentorship program, and a directory of members willing to serve as a resource on specific topics.

The Early Career Committee is actively delivering on those goals.

Early Career Swine Veterinarian Conference

The AASV Early Career Swine Veterinarian Conference (**aasv.org/earlycareer**), to be held November 5, 2021 in conjunction with the Iowa State University James D. McKean Swine Disease Conference, is designed for AASV member swine veterinarians within 10 years of graduation. The conference presents early career swine veterinarians with the perfect opportunity to meet with other veterinarians and learn how to strengthen their skills. This welcoming and interactive conference will give early career veterinarians the chance to socialize, collaborate, and communicate with others working in swine veterinary medicine.

This year's conference will focus on the fundamentals of swine health and production. Through presentations, panel discussions, one-on-one networking, and small group discussions, the attendees will learn how to confront career development challenges with a focus on the pearls, possibilities, and opportunities of the swine industry.

Listserv

The Early Career Committee created a forum (**early.aasv.org**) for swine veterinarians to exchange dialogue unique to those early in their careers. The forum is intended to offer peer-to-peer support as veterinarians navigate through the first several years in swine medicine, no matter what their careers looks like!

COMING SOON

Mentor Directory

The Early Career Committee is creating a mentor directory program to better connect early career AASV members with established members to serve in a mentorship role. Early career mentees will be AASV members less than 10 years post graduation or those new to swine medicine. Mentors should be AASV members at least 3 years post graduation. Tips for success in developing a lasting mentor-mentee relationship will be provided on the committee webpage.

Resource Directory

The Early Career Committee is compiling a list of veterinarians who may be able to offer expertise, knowledge, or serve as a resource for early career veterinarians should they have questions about a specific topic. Example topics include diseases, diagnostics, finances, and leadership. This resource directory will be housed in the members-only section of the AASV website.

Podcasts

The committee has been developing a podcast series highlighting topics for early career swine veterinarians. The first three podcasts are expected to be released before the end of 2021.

Early Career Committee leaders, subcommittee volunteers, and committee members have accomplished many of their goals generated during their very first committee meeting in 2020.

I interacted with many of these committee volunteers when they were students, and I am so proud to see them emerge as leaders in the organization. The future looks bright with these amazing swine veterinarians early in their careers!

Abbey Canon, DVM, MPH, DACVPM
Director of Public Health and Communications

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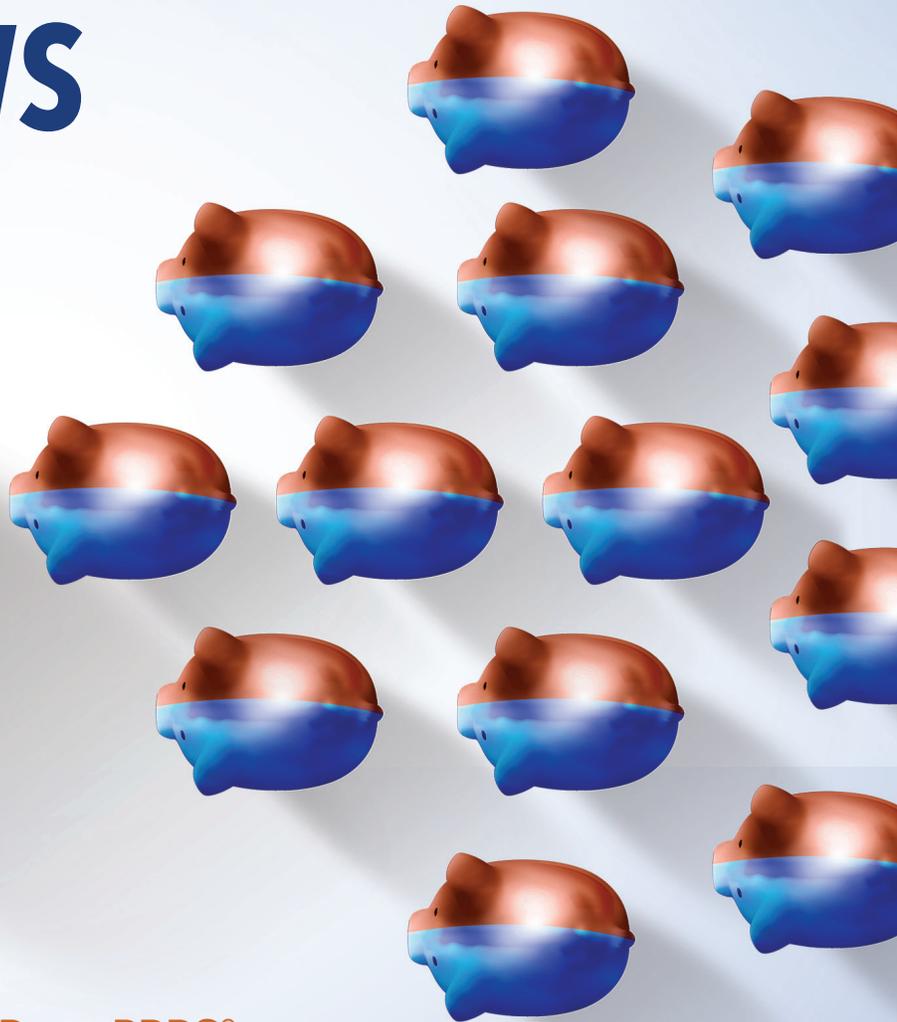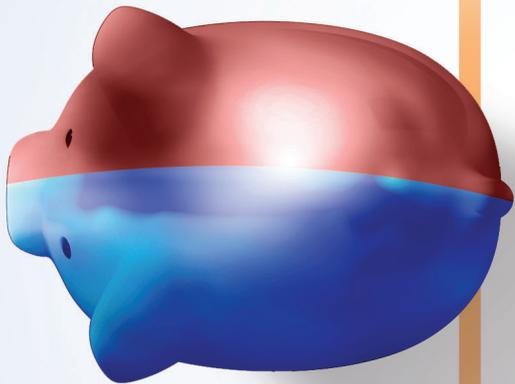
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Cumulative index

The *Journal of Swine Health and Production* cumulative index is updated online throughout the year as issues go to press. Articles can be accessed via the "Search" function and from the Abstracts page, **www.aasv.org/shap/abstracts/**.

Index by Title 2021

Comparison of intradermal and intramuscular porcine circovirus type 2 vaccination methods concerning labor, production parameters, and antimicrobial treatments: A randomized field study in a Danish finishing herd. Ellegaard B, Korsgarrd J, Nielsen GB. *J Swine Health Prod*. 2021;29(3):129-132.

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Establishing *Mycoplasma hyopneumoniae* herd status classification criteria for breeding herds. Clavijo MJ, Galina Pantoja L, Holtkamp DJ, Yeske P, Johnson C, Sprague M, Fano E, Main R, McDowell E, Painter T, Becton L, Baumert D, Glowzenski L, Snelson H, Maschhoff A. *J Swine Health Prod*. 2021;29(6):319-326.

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Field evaluation of a new single-dose *Mycoplasma hyopneumoniae* bacterin effects on growth performance. Kim S, Oh T, Yang S, Park KH, Cho H, Chae C. *J Swine Health Prod*. 2021;29(4):180-188.

Increasing creep pellet size improves creep feed disappearance of gilt and sow progeny in lactation and enhances pig production after weaning. Craig JR, Kim JC, Brewster CJ, Smits RJ, Braden C, Pluske JR. *J Swine Health Prod*. 2021;29(1):10-18.

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Thank you, reviewers

for working together and creating a journal to be proud of!

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We apologize if we have inadvertently left a reviewer's name off the list.

Stress happens to us all.

Your corn is no different.

You can't control the weather,
but you can control mycotoxins.

Humidity & Rain
Increases the risk of fungal growth and mycotoxin production

Heat
Creates the perfect environment for molds to grow

Drought
Causes grain damage and facilitates fungal spores' entrance

TAKE THE STRESS OUT OF MYCOTOXIN MANAGEMENT.
UnitedAnH.com/Stress

ISU James D. McKean Swine Conference

November 4 - 5, 2021 (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
Email: **registrations@iastate.edu**
Web: **regcytes.extension.iastate.edu/swinedisease/**

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

AASV Early Career Swine Veterinarian Conference

November 5, 2021 (Fri)
Scheman Building
Iowa State University
Ames, Iowa

For more information:
Email: **aasv@aasv.org**
Web: **aasv.org/earlycareer/**

Passion for Pigs Seminar and Trade Show

December 1, 2021 (Wed)
Mathewson Exhibition Center
Missouri State Fairgrounds
Sedalia, Missouri

For more information:
Julie Lolli
Passion for Pigs
6674 Highway 15
Shelbina, MO 63468
Tel: 573-588-6110
Email: **julie@passionforpigs.com**
Web: **passionforpigs.com**

North American PRRS Symposium

December 4, 2021 (Sat)
Chicago Marriott Downtown
Magnificent Mile Hotel
540 N Michigan Ave
Chicago, Illinois

For more information or to register:
Web: **vetmed.illinois.edu/education/continuing-education/north-american-prrs-symposium/**

2022 Pig Ski Conference

February 9 - 11, 2022 (Wed-Fri)
Copper Mountain, Colorado

For more information or to register:
Lori Yeske
Pig Group
39109 375th Ave
Saint Peter, MN 56082
Tel: 507-381-1647
Email: **pyeske@swinevetcenter.com**
Web: **pigski.com**

American Association of Swine Veterinarians 53rd Annual Meeting

February 26 - March 1, 2022 (Sat-Tue)
Reserve lodging now:
JW Marriott Indianapolis
10 S West Street
Indianapolis, Indiana
866-704-6162
aasv.org/annmtg/2022/lodging.php

For more information:
American Association of Swine Veterinarians
830 26th Street
Perry, Iowa 50220 USA
Tel: 515-465-5255
Email: **aasv@aasv.org**
Web: **aasv.org/annmtg**

7th International Symposium on Animal Mortality Management

June 13 - 16, 2022 (Mon-Thu)
Raleigh, North Carolina
Web: **animalmortmgmt.org/**

26th International Pig Veterinary Society Congress

June 21 - 24, 2022 (Tue-Fri)
A hybrid conference
Riocentro Convention and Event Center
Rio de Janeiro, Brazil

For more information:
Rua Guaicuí 26, 10º andar
Coração de Jesus
Belo Horizonte, MG 30380.380
BRAZIL
Tel: +55 31 3360 3663
Email: **ipvs2022@ipvs2022.com**
Web: **ipvs2022.com**

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

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