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Campler M, Cheng T-Y, Angulo J, et al

Efficacy of ivermectin administration to growing pigs after a PRRSV 1-4-4 L1C challenge
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(taken at University of Missouri).

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JSHAP SPOTLIGHT

Hunter Everett

2023 AASV Board of Directors Student Delegate
North Carolina State University

Hunter Everett earned his BS ('20) and DVM ('24) degrees from North Carolina State University. After graduation, Hunter plans to stay in North Carolina to pursue a career as a production swine veterinarian. When asked about the benefits of being an AASV student member, Hunter said "Serving as the student delegate has allowed me to see behind the curtain of the association and to experience first-hand how much the association and its members truly support and value students and their success. The concern for future swine veterinarians is evident at every meeting with discussions of ways to continuously improve support and gain student involvement within the industry. On behalf of all students, I would like to thank AASV, its members, the AASV Foundation, and industry partners for everything they do to ensure student success."

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A legacy of animal care

In the wake of Dr Angela Baysinger's recent passing, I was asked to serve as acting president of AASV. One of our members recently asked me about continued service as acting president. I was quick to respond, "Of course I would, and you would too!" One responsibility that continues as acting president is writing this JSHAP message to share with AASV members how the leadership of the association is addressing relevant topics. Fortunately, the other executive committee members, Drs Locke Karriker and Rebecca Robbins, have agreed to share in writing this message over the coming months. We welcome your input on topics you strongly feel we should address.

As we continue to celebrate the life and leadership of Dr Baysinger, we recognize her focus on and contributions to the welfare of the pig. She was serving as the chairperson of the American Veterinary Medical Association's Animal Welfare Committee at the time of her passing. Dr Baysinger understood the needs of the pig and welcomed debate around education and operations of the livestock farmer. She also had a great sense of humor. She was easy to talk with and sincere in every conversation. We should continue to build on the momentum she created for a lifelong respect for the sanctity of life, both our own and the animals we care for.

Few have as much nervous optimism about animal care as a 10-year-old 4-H member getting ready for the fair. This time of year, we are particularly familiar with animal welfare as we watch young people and their families share hours and hours preparing their favorite show animals in the hopes of being recognized as the ideal representative for their breed. Most of these show animals seem to like the attention as well! However, not every minute of livestock shows is rainbows and butterflies. I personally remember nervous optimism leading to a few family arguments.

My hope in recognizing the show season as we talk welfare, is to rekindle the fires for good showmanship in many of our friends and families that started our interest in animal care in the first place. For those who have never raised a show animal, you can certainly appreciate the human-animal bond that is created, even when the result is high-quality bacon and pork chops. The farm staff we interact with also experience this bond every day. As the herd veterinarian, we need to encourage the appreciation of high-quality animal care. We need to call out the animals' needs and address shortcomings quickly.

"Veterinarians in the AASV are the ideal advocate for the welfare of the pig."

Veterinarians in the AASV are the ideal advocates for the welfare of the pig. We have the training to understand the biological and physical needs of the pig. We have the responsibility to regularly evaluate the facilities, medical products and procedures, and individual pig and population health for the clients we serve. It is up to us to educate caregivers, to think ahead of seasonal changes and risks, and even sharp corners or cold nights should catch our attention as we continue to advocate for the welfare of the pig.

Please keep animal welfare front and center, Dr Baysinger would have called for it. We should gladly accept that responsibility. We are excellent at animal observation and often hired for staff education. Let's show the world how we can advocate for and improve the lives of the animals we care for.

William L Hollis, DVM
AASV President

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* Pharmgate Animal Health, Smithfield Hog Production-North Region, Iowa State University; Smith, C.; Chamba, F.; Pittman, J.; Rawal, G.; Zhang, J.; Francisco, C.; Evaluation of the response to PRRSGard® administration in weaned pigs. March 2020.

** Pharmgate Animal Health, Veterinary Resources Inc.; Chamba, F.; Sui, J.; Conarchy, B.; Zhang, X.; Kesl, L.; Ma, S.; Ruth, D.; Venegoni, A.; Experimental safety and efficacy of a unique MLV PRRSV vaccine: PRRSGard®; July 2019.

*** Swine Vet Center, Pharmgate Animal Health; Kettelkamp, E.; Betlach, A.; Yeske, P.; McCuiston, L.; Okones, J.; Evaluation of airborne shedding and production setback post-weaning from Pharmgate PRRSGard® vaccine in commercial conditions. March 2023.

Honky-tonks to streetcars

Well, I have pretty much wrapped up the 2024 AASV Annual Meeting. I would judge the 55th Annual Meeting in Nashville, Tennessee to have been a success. Although the venue was large, a frequent comment we heard during the meeting, I think it met our needs. Every venue has its quirks, though. Some rooms could have used a few more chairs (the number of attendees is always a guessing game), and some rooms were more like the Cumberland Caverns making audio-visual a challenge. Hopefully, though, we were able to accomplish the key goal of providing a high-quality continuing education experience with a little fun thrown in.

The value and relevance of the scientific portion of the meeting goes to the vision of Dr Angela Baysinger and the interpretation of that vision by her Program Planning Committee members, moderators, and speakers. The successful coordination and implementation of the meeting is thanks to the hard work of the AASV staff (Sue, Abbey, and Sherrie) and friends (Lee, Dave, Joel, Miranda, Karen, Emily, and Rhea) who gave up their personal time to come out and work long hours for little pay. I hope everyone found value in the meeting. If there was something you think did not work or you have suggestions for how we can make future meetings better, I hope you completed the meeting survey and returned that to the office. We really do look at each of those. Total attendance in Nashville was 1040. Meeting attendance continues to improve but is still lagging the pre-COVID record of 1237 attendees in Orlando during 2019.

As I stop hearing the twang of guitars and finish off the last of the Tennessee bourbon I brought home, I start thinking there might be a little downtime before gearing up for 2025. But alas, it is not to be. By the time you read this, we will have already held the 2025 AASV Program Planning Committee meeting in preparation for the 56th Annual Meeting in San Francisco March 1-4. I am certain Dr Locke Karriker and his committee will put together another fabulous program!

I know a few of you have expressed some consternation with attending a meeting in California, and specifically San Francisco. You have expressed concerns about crime rates and the West Coast's attitude towards pork production. I hear you but let me give you a couple of things to think about.

First, from a logistical standpoint, remember that the contracts for our meeting locations are signed years in advance – back in 2017 for San Francisco. We were supposed to have gone there for our 2021 meeting, but COVID changed that. In 2020, I was able to renegotiate the contract to move the meeting to 2025 in exchange for some additional concessions on the part of the hotel. Cancelling the contract at that time would have cost the Association more than $650,000.

Second, if you are thinking about not attending the meeting in San Franciso to protest their regulations on pork production, understand that your absence only negatively impacts our association. The AASV is still responsible for the guaranteed minimums agreed to in the contract and the association must pay the difference. That could amount to tens of thousands of dollars. In addition, we rely on the profit from the Annual Meeting to support the AASV operations for the year. As far as the crime rate goes, it is a consideration in most cities – big and small. The tragic school shooting in Perry, Iowa in January reminds us that senseless violence can happen anywhere. No matter where the meeting is held, I would always encourage you to be smart about safety.

"I am ready to trade in the noise of Broadway honky-tonks for the clanging of streetcar bells, and I hope you make plans to join me."

Personally, I have been to San Francisco several times for meetings. Once or twice even at this same hotel, the Marriott Marquis. It is a great hotel with lots of things to do and places to eat within walking distance. However, the real reason we are there is for continuing education, camaraderie, and networking. I am sure those will all be superb even if you never leave the hotel!

In my mind, the best way you can respond to the challenges San Francisco presents are to show up and let them see the dedication and energy you put into ensuring the health and well-being of the animals under our care and the importance you place on the safety and wholesomeness of the pork our clients produce.

So, I am ready to trade in the noise of Broadway honky-tonks for the clanging of streetcar bells, and I hope you make plans to join me.

Harry Snelson, DVM
Executive Director

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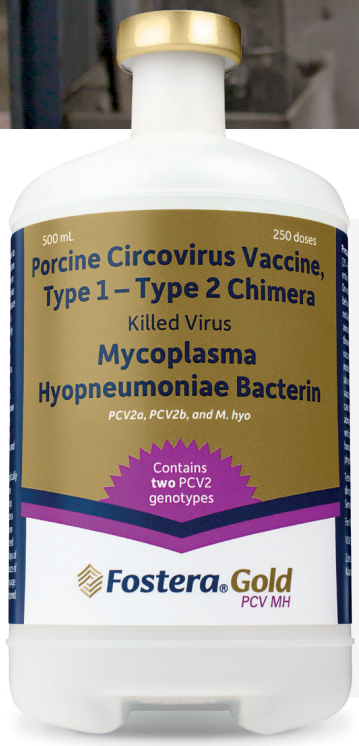

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[1]Data on file, Study Report No. B822R-US-14-325, Zoetis Inc.
[2]Data on file, Study Report No. B822R-US-16-582, Zoetis Inc.
[3]Data on file, Study Report No. B825R-US-16-667, Zoetis Inc.
[4]Data on file, Study Report No. B822R-US-15-557, Zoetis Inc.
[5]Data on file, Study Report No. B824R-US-15-451, Zoetis Inc.
[6]Data on file, Study Report No. B824R-US-13-118, Zoetis Inc.
[7]Data on file, Study Report No. B822R-US-15-544, Zoetis Inc.
[8]Data on file, Study Report No. B822R-US-16-622, Zoetis Inc.
[9]Data on file, Study Report No. B824R-US-15-505, Zoetis Inc.
[10]Data on file, Study Report No. B921R-US-20-992, Zoetis Inc.

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AASV committees plan work for 2024

The AASV Board of Directors establishes committees to address specific issues associated with swine veterinary medicine and provide recommendations for action to the AASV leadership. The AASV committees are a critical part of the leadership structure within AASV, and they also serve as a great way for members to participate in developing positions for the association, learn about important issues, network with other members, and develop their own leadership skills. The AASV members, leaders, and staff greatly appreciate the efforts of more than 300 volunteer members who serve on at least one committee.

The AASV's issue- and membership-based committees meet virtually during the summer and winter months and in-person at the AASV Annual Meeting. During their in-person meetings in Nashville, Tennessee in February, they planned work for the upcoming year. The following are some highlights from the Nashville committee meetings:

The **Boar Stud Committee** revised the *Boar Stud Health, Hygiene, and Sanitation Guidelines*. The committee plans to hold a preconference session during the 2025 AASV Annual Meeting in San Francisco.

The **Collegiate Activities Committee** has been investigating swine medicine curriculum and resources in US and Canadian schools of veterinary medicine. They will conduct a survey of the swine faculty workforce in the United States, Canada, and the Caribbean.

The **Committee on Transboundary and Emerging Diseases** heard updates from the newly established Porcine Epidemic Diarrhea (PED) Elimination Task Force. Goals of the task force are to 1) determine how to measure PED virus prevalence, 2) debate modified-live virus vaccine use, 3) debate biosecurity gaps, 4) outline PED virus control and elimination strategies, and 5) determine how the plans fit within a body such as the US Swine Health Improvement Plan. The committee also recommended the AASV Board of Directors reaffirm the position statements on permanent identification of swine and a North American program is needed to manage the risk of foreign animal disease introduction through feed ingredients. They recommended the board adopt a new position on traceability. The PED Task Force recommended a new position statement on PED virus elimination.

During the upcoming year, the **Communications Committee** is looking forward to the release of an updated AASV website. They established an outreach subcommittee to create a document listing speakers for schools or other entities looking for a swine medicine speaker.

The **Diversity, Equity, and Inclusion Committee** discussed plans to attend the Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS) conference to highlight careers in swine veterinary medicine.

The **Early Career Committee** heard updates about the US Department of Agriculture National Institute of Food and Agriculture Veterinary Services Grant Program funded AASV Participant-Led Early-Career Swine Veterinarian Development Program. The program has been extremely well received, and the committee plans to apply for funding again in 2025. The committee discussed how to best distribute results from the veterinarian attrition survey and is supporting the Student Engagement Committee as they work to develop a similar survey for fourth year veterinary students who were interested in joining the swine industry but chose another career path.

"The AASV members, leaders, and staff greatly appreciate the efforts of more than 300 volunteer members who serve on at least one committee."

The **Human Health, Safety, and Well-being Committee** hosted a well-attended hearing screening during the 2024 Annual Meeting. They recommend AASV offer this service again in the future.

The **Influenza Committee** continues to consider how breeding herds may be classified by influenza status. They established two working groups to focus on vaccines and surveillance. The committee recommended revisions to the influenza A position statement.

In addition to preparing for the 2024 AASV Annual Meeting preconference seminar, the **Nutrition Committee** discussed the best way to offer educational resources and learning opportunities in nutrition to veterinarians and how to grow nutrition PhD graduate student membership in the association.

After careful review and consideration of the name and mission of the group, the Pharmaceutical Issues Committee updated its name to the **Pharmaceutical and Biologics Committee**. The committee is now responsible for all pharmaceutical and biological topics. The committee heard a progress report on their international withdrawal interval project, formed a subcommittee to update the swine section of the American Veterinary Medical Association's

Advocacy continued on page 155

The American Association of Swine Veterinarians is committed to providing members with resources to promote and enhance well-being - the state of being comfortable, healthy, and happy.

The nine dimensions

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Being able to identify and manage your full range of emotions, and seeking help when necessary.

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Taking care of your body (e.g., getting enough sleep, eating a well-balanced diet, exercising regularly).

Financial
Being aware of your personal finances and adhering to a budget that enables you to meet your financial goals.

Creative
Participating in diverse cultural and artistic experiences.

Occupational
Being engaged in work that gives you personal satisfaction, and aligns with your values, goals, and lifestyle.

Spiritual
Having a sense of inner harmony and balance.

aasv.org/resources/wellbeing

Advocacy continued from page 153

Antimicrobial Resistance and Stewardship in Pathogens Affecting Animal Health in the US report, and planned for the incorporation of biologics into their work.

In cooperation with the Boar Stud Committee, the **Pig Welfare Committee** recommended a lameness preconference seminar for the 2025 AASV Annual Meeting. The committee recommended the board reaffirm the position statements on castration of swine, pig welfare, and anti-abuse policy and revise the position statements on sow housing and tail docking and teeth clipping in swine.

The **Porcine Reproductive and Respiratory Syndrome (PRRS) Committee** has finalized two factsheets prepared by the committee on PRRS virus next-generation sequencing and PRRS virus recombination. These have been published and are available on the AASV website at **aasv.org/documents/NGS-Factsheet.pdf** and **aasv.org/documents/Replication-Recombination-Factsheet.pdf**.

The **Pork Safety Committee** continues to monitor the US Department of Agriculture Food Safety and Inspection Service actions toward the 2022 proposed performance standards for *Salmonella* in raw pork. The committee recommended a preconference seminar at the 2025 AASV Annual Meeting.

The **Student Engagement Committee** will continue to host *The Swine Medicine Talks: An AASV Series for Veterinary Students*. The committee discussed updating the student recruitment brochure and opportunities to reach pre-veterinary students, such as the National FFA Convention, the Student American Veterinary Medical Association Convention, and the American Pre-Veterinary Medical Association Symposium. They plan to expand the current work the Early Career Committee has done in recruitment and retention.

See **aasv.org/aasv/positions** for all current position statements.

Almost all committees need additional members who are swine veterinary practitioners. If you are interested in learning more about the committee activities, visit the committee web pages on the AASV web site (**aasv.org/members/only/committee**). Contact a committee chair or the AASV office to join a committee.

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

Detection of *Lawsonia intracellularis* by oral fluids and fecal samples in Canadian swine

Magnus R. Campler, PhD; Ting-Yu Cheng, DVM, PHD; José Angulo, DVM; Leanne Van De Weyer, DVM; Andréia Gonçalves Arruda, DVM, PHD

Summary

Objectives: The study objectives were to 1) describe the proportion of *Lawsonia intracellularis*-positive samples in unvaccinated and vaccinated Canadian swine herds during the mid- and late-finishing phases; 2) compare the probability of detecting *L intracellularis* by quantitative polymerase chain reaction using fecal samples (FS) and oral fluids (OF); and 3) investigate risk factors of *L intracellularis* detection using FS and OF.

Material and methods: Site demographics and vaccination protocols were obtained from 40 Canadian swine sites via questionnaire. Three OF and 3 FS were collected per site once during the mid-finisher (15-17 wk of age) and once during the late-finisher (20-22 wk of age) production stages.

Results: Half of all investigated production sites were positive for *L intracellularis.* A 2-fold increase in *L intracellularis* detection rate was observed for OF compared to FS (odds ratio = 2.36; 95% CI, 1.24-4.49; *P* = .009). The presence of porcine circovirus type 2 (PCV2) had a 5-fold increased risk of *L intracellularis* positivity compared to sites without PCV2 (incidence rate ratio [IRR] = 4.99; 95% CI, 1.29-20.23; *P* = .02). A higher positive rate was found for sites with *L intracellularis* outbreaks within the last 2 years (IRR = 3.08; 95% CI, 1.51-6.37; *P* = .002).

Implications: This study presents evidence that OF may have a higher detection rate compared to FS for *L intracellularis.* Herds with PCV2 or exposure to recent *L intracellularis* outbreaks may be at increased risk of harboring *L intracellularis* and warrant additional investigation.

Keywords: swine, proliferative enteropathy, ileitis, vaccination, detection

Received: September 13, 2023
Accepted: February 8, 2024

Resumen - Detección de *Lawsonia intracellularis* por fluidos orales y muestras fecales en cerdos canadienses

Objetivos: Los objetivos del estudio fueron 1) describir la proporción de muestras positivas para *Lawsonia intracellularis* en piaras porcinas canadienses vacunadas y no vacunadas durante las fases de engorde medio y tardío; 2) comparar la probabilidad de detectar *L intracellularis* mediante la reacción en cadena de la polimerasa cuantitativa utilizando muestras fecales (MF) y fluidos orales (FO); y 3) investigar los factores de riesgo de la detección de *L intracelular* mediante MF y FO.

Material y métodos: Mediante un cuestionario se obtuvieron datos demográficos y protocolos de vacunación de 40 sitios porcinos canadienses. Se recolectaron tres FO y 3 MF por sitio, una vez durante las etapas de producción de engorde medio (15-17 semanas de edad), y una vez durante las etapas de producción de engorde tardío (20-22 semanas de edad).

Resultados: La mitad de todos los sitios de producción investigados fueron positivos a *L intracellularis.* Se observó un aumento de 2 veces en la tasa de detección de *L intracelular* para la FO en comparación con la MF (coeficiente de correlación = 2.36; IC 95%, 1.24-4.49; *P* = .009). La presencia de circovirus porcino tipo 2 (PCV2) tuvo un riesgo 5 veces mayor de positividad para *L intracellularis* en comparación con los sitios sin PCV2 (cociente de tasa de incidencia [CTI] = 4.99; IC 95%, 1.29-20.23; *P* = .02). Se encontró una tasa positiva más alta en los sitios con brotes de *L intracellularis* en los últimos 2 años (CTI = 3.08; IC 95%, 1.51-6.37; *P* = .002).

Implicaciones: Este estudio presenta evidencia de que la FO puede tener una tasa de detección más alta en comparación con la MF para *L intracellularis*. Las piaras con PCV2 o exposición a brotes recientes de *L intracellularis* pueden tener un mayor riesgo de albergar *L intracellularis* y justificar una investigación adicional.

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Supplementary material available at **https://doi.org/10.54846/jshap/1388suppl**

Campler M, Cheng T-Y, Angulo J, Van De Weyer L, Arruda AG. Detection of *Lawsonia intracellularis* by oral fluids and fecal samples in Canadian swine. *J Swine Health Prod*. 2024;32(4):156-163. **https://doi.org/10.54846/jshap/1388**

Résumé - Détection de *Lawsonia intracellularis* par échantillonnage de fluides oraux et échantillons fécaux chez des porcs canadiens

Objectifs: Les objectifs de l'étude étaient de 1) décrire la proportion d'échantillons positifs à *Lawsonia intracellularis* dans des troupeaux de porcs canadiens vaccinés et non-vaccinés au milieu et à la fin de la phase de finition; 2) comparer la probabilité de détecter *L intracellularis* par réaction d'amplification en chaîne par la polymérase quantitative en utilisant des échantillons fécaux (FS) et des fluides oraux (OF); et 3) étudier les facteurs de risques de la détection de *L intracellularis* en utilisant des FS et des OF.

Matériels et méthodes: Les données démographiques des sites et les protocoles de vaccination ont été obtenus de 40 sites porcins via un questionnaire. Trois OF et 3 FS ont été prélevés par site, une fois vers le milieu de la période de finition (15-17 semaines d'âge) et une fois vers la fin de la période de finition (20-22 semaines d'âge).

Résultats: La moitié des sites de production étudiés étaient positifs pour la présence de *L intracellularis*. Une augmentation du double dans les taux de détection était observée pour OF comparativement à FS (rapport de cotes = 2.36; IC 95%, 1.24-4.49; *P* = .009). La présence de circovirus porcin type 2 (PCV2) multipliait par 5 l'augmentation du risque de positivité à *L intracellularis* comparativement aux sites sans PCV2 (rapport du taux d'incidence [IRR] = 4.99; IC 95%, 1.29-20.23; *P* = .02). Un taux de positivité plus élevé a été trouvé pour les sites avec des poussées de cas de *L intracellularis* au cours des 2 dernières années (IRR = 3.08; IC 95%, 1.51-6.37; *P* = .002).

Implications: Cette étude présente des preuves que les OF pourraient avoir un taux de détection plus élevé comparativement au FS pour *L intracellularis*. Les troupeaux avec PCV2 ou des poussées de cas récentes de *L intracellularis* pourraient être plus à risque d'être positifs pour *L intracellularis* et le tout mérite des études additionnelles.

Porcine proliferative enteropathy, or ileitis, associated with the gram-negative obligate intracellular bacterium *Lawsonia intracellularis* remains a challenge for swine producers globally.[1,2] The 2012 National Animal Health Monitoring System reported that 28.7% of US growing-finishing swine production sites had confirmed cases of ileitis.[3] Ileitis is characterized by the thickening of the ileum mucosa with proliferated crypt epithelial cells, resulting in diarrhea, intestinal hemorrhaging, and weight loss.[4] Disease severity varies, with increased mortality mainly seen in acute cases, while chronic and subclinical cases are mainly associated in high morbidity and poor growth performance.[5] Although pigs often recover without intervention within a few weeks,[4] the shedding and transmission of *L intracellularis* between infected and susceptible animals via feces are likely, causing additional costs due to hindered feed conversion and extra care from the producer.[6,7] In addition, the cost of preventive management ranges from $0.18 to $1.00 per pig depending on vaccination strategy.[8]

The prevalence of *L intracellularis* in US and Canadian swine herds has been previously reported to be 75.0% to 96.0% and 16.7% to 100%, respectively.[1,9,10] However, *L intracellularis* prevalence may differ significantly among geographical regions, production sites, and production phases within sites. For instance, within-herd prevalence variability has been reported to be up to 90.0% for sows, 11.0% to 92.0% for growing pigs, and 16.7% to 100% for finishing pigs.[9,11,12] Thus, it has been suggested that approximately one-third of all grower and finisher pigs will be subjected to *L intracellularis* infection during their lifespan.[10] Additionally, prevalence estimates may be influenced by local intervention approaches, sampling techniques, diagnostic tools used, and the sampling time post infection.[13]

Because of the difficulty in culturing *L intracellularis*, diagnosis has been widely accomplished by detecting *L intracellularis* DNA in fecal and intestinal tissue samples using polymerase chain reactions (PCR).[14] However, quantifying *L intracellularis* DNA using fecal samples (FS) may yield inconsistent results with varied diagnostic performance due to differences in sample quality, herd prevalence, subclinical or clinical infection, the occurrence of lesions, and the number of samples analyzed.[15]

Alternatively, swine oral fluids (OF) have been successfully used as a diagnostic sample type for the detection of various swine pathogens (eg, porcine reproductive and respiratory syndrome virus (PRRSV), influenza A virus, and pseudorabies virus).[16,17] Oral fluid collection reduces sample collection-associated animal stress and personnel labor cost and time. More recently, OF has also been used for *L intracellularis* antibody detection with a reported 100% specificity and 84.6% to 88.5% sensitivity for immunoglobulin A and immunoglobulin G, respectively, when compared to serum samples using an immunoperoxidase monolayer assay.[18]

The use of live attenuated oral and intramuscular inactivated vaccines against *L intracellularis* is one of the prevention tools available for swine veterinarians and producers. Even though their use has shown a reduction in intestinal lesion manifestation and mortality, the data is still controversial about reducing fecal shedding of *L intracellularis*.[19-21] Protective effects have also been reported to be dependent on the vaccine dose by showing dose-dependent increases in humoral and cell-mediated immunities for the live-attenuated ileitis vaccine, Enterisol.[19]

To date, there is limited knowledge on the association between *L intracellularis* vaccination, sample type, and grower pig production phase and *L intracellularis* detection using quantitative PCR (qPCR). Additionally, investigation on how vaccination protocols and other farm-level risk factors (eg, detection of other pathogens, historical detection and clinical observation of *L intracellularis* cases, and historical use of *L intracellularis* vaccine) may be associated with *L intracellularis* detection in herds has not been fully reported in the literature. Thus, the objectives of this study were to 1) describe the proportion of *L intracellularis*-positive samples in unvaccinated and vaccinated Canadian swine herds during the mid- and late-finishing phases; 2) compare the probability of detecting *L intracellularis* by qPCR using FS and OF; and 3) investigate risk factors of *L intracellularis* detection using FS and OF.

Animal care and use

Animal ethics review and approval were not required for the current study as all samples and data were collected by the herd veterinarians as part of their routine professional duties and existing veterinarian-client-patient relationship. All animals were housed and cared for under commercial swine conditions according to the Canadian National Farm Animal Care Council's Code of Practice for the care and handling of farm animals.

Materials and methods

A prospective cohort study design was implemented during June to October 2021 by enrolling 40 wean-to-finish swine production sites in the Canadian provinces of Ontario (ON = 18), Manitoba (MB = 20), and Quebec (QC = 2). The mean (SD) herd size was 3140 (2566) and pigs were conveniently enrolled through clients of 2 veterinary clinics in ON and MB. Recruitment was conducted based on veterinarian communication with clients through their professional network. Half of the enrolled sites (ON = 10; MB = 10) were actively vaccinated with an *L intracellularis* vaccine (Porcilis Ileitis, Merck Animal Health) before and during the study, whereas the remaining 20 sites (ON = 8; MB = 10, QC = 2) were unvaccinated.

Throughout the study period, each site was visited twice, once during the mid-finisher (15-17 weeks of age) phase and once during the late-finisher (20-22 weeks of age) phase. During these visits, 3 pens were conveniently selected at each site by the herd veterinarian, and 1 OF and 1 FS were collected from each pen per visit. The location of each sampled pen was spatially fixed between the 2 sampling events, ie, the same pens were sampled for the mid-finisher and late-finisher phases. Thus, 12 samples were collected per site ([1 OF + 1 FS] × 3 pens × 2 visits), culminating in a total of 480 samples for the study. Each sampling method included samples obtained from multiple individuals. Multiple fresh fecal samples were collected from the floor of pig pens and conveniently selected by the herd veterinarian aiming for a representative sample. Oral fluid samples were obtained from cotton ropes attached to each pen for 20 to 30 minutes on each sampling day. Each cotton rope was removed from the pen and placed inside a plastic bag and manually squeezed by hand to extract the oral fluids, which were then centrifuged at 100*g* for 5 minutes and stored at -20°C until qPCR screening for *L intracellularis* DNA.

Fecal samples were prepared by diluting 2 g of feces in 10 mL of phosphate-buffered saline. Then, suspensions were homogenized by vigorous vortexing and later decanted. Nucleic acids were extracted directly from FS and OF supernatants using a nucleic acids purification kit (MagMAX Pathogen RNA/DNA Kit, Thermo-Fisher) on an automated KingFisher Flex Purification System (Thermo-Fisher) according to the manufacturer's instructions and eluted with 90 µL of nuclease-free water.

Samples were examined for 4 important bacteria known to cause diarrhea in fattening pigs using in-house Biovet finisher pig diarrhea multiplex qPCR (Biovet). The 4 bacteria were *Brachyspira hyodysenteriae*, *Brachyspira hampsonii*, *L intracellularis*, and *Salmonella*. Testing was performed according to the manufacturer's instructions.

A short questionnaire (see Supplementary Materials) was created to obtain site demographics including province, the detection and diagnosis of *L intracellularis* in the past 2 years, the use of *L intracellularis* vaccines before 2021, the strategy of ongoing *L intracellularis* vaccination, the presence of clinical signs of enteric disease, or common endemic diseases (eg, PRRSV, porcine circovirus type 2 [PCV2], and *Mycoplasma hyopneumoniae*). The questionnaire was distributed to herd veterinarians of enrolled sites at the beginning of the study via Microsoft Teams (Microsoft Corporation), completed by the veterinarian at the time of sampling, and returned to investigators over the course of the study. Questions with a response rate < 80% (ie, > 20% missing responses) were excluded from the data analysis.

Statistical analysis

Statistical analyses were performed using R (version 4.2.2).[22] Given sample size was based on logistical and budget-related aspects, *post hoc* chi-squared power analysis was conducted based on the number of collected samples (sample size) and the effect size calculated from the probability of detection using G*Power (version 3.1.9.7).[23] The probability of committing a type I error (α) was set at .05. For the power estimation on detecting the effect of sample type (sample-level analysis), FS were used as the proportions of *L intracellularis* DNA positive and negative under the null hypothesis ($p(H_0)$ in G*power) while OF samples were used under the alternative hypothesis ($p(H_1)$ in G*power). Likewise, for the detection of *L intracellularis* vaccination effects, the detection of *L intracellularis* in unvaccinated and vaccinated sites (site-level analysis) was used for determining the $p(H_0)$ and $p(H_1)$, respectively.

Of the total 480 projected samples, 440 (85.7%) were used in the final analysis. Regarding the omitted samples, 29 OF samples collected from the mid-finisher phase did not meet the minimum sample quality (ie, contaminated by feces, insufficient amount of obtained fluids, or failed internal control after retesting) for *L intracellularis* qPCR (vaccinated sites = 24; unvaccinated sites = 5). In addition, 5 FS samples (vaccinated sites = 2; unvaccinated sites = 3), and 6 OF samples (vaccinated sites = 1; unvaccinated sites = 5) from the late-finisher phase had inconclusive qPCR results and were omitted from the analysis. Statistical power was estimated to be 99.96% at the sample level (total number of samples, n = 440) using the contingency table (Table 1) formed by the detection of *L intracellularis* and the specimen type (OF/FS). Similarly, the site-level power (total number of samples, n = 40) was estimated to be 93.13% using the contingency table (Table 1) consisting of the detection of *L intracellularis* and the *L intracellularis* vaccination status among sites.

Descriptive statistics are reported as the number of qPCR *L intracellularis*-positive and -negative sites, and proportions of positive and negative samples by sample type and vaccination status including vaccine dosage used and production phase. The *L intracellularis* positivity measured by qPCR was compared between vaccinated and unvaccinated herds by specimen type and sampling phases using Fisher exact test.

Association between specimen type and *L intracellularis* detection

The effect of specimen type (OF and FS) on the detection of *L intracellularis* was investigated by building a multivariable logistic mixed regression model at the sample level using the binomial distribution. The model (Figure 1) consisted of the binary *L intracellularis* detection of each sample as the outcome variable (positive/negative), specimen type (OF/FS) as the fixed effect of interest, and potential confounders (eg, production phase (mid-/late-finisher), *L intracellularis* vaccination status (yes/no), detection of other endemic diseases (yes/no for each disease), detection/clinical observation of *L intracellularis* in the past two years (yes/no), use of *L intracellularis* vaccine prior to 2021 (yes/no), number of pigs in the sample barn (continuous).

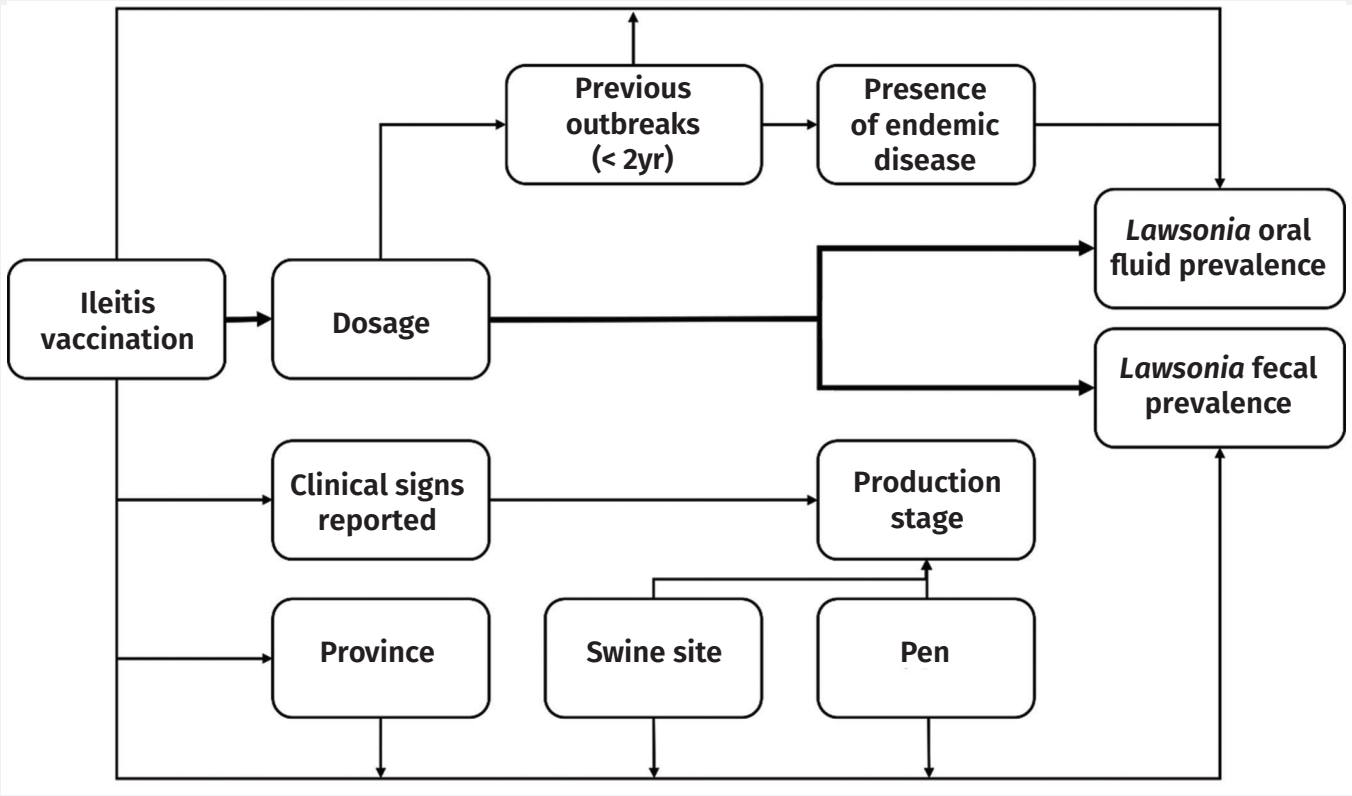
Prior to statistical modeling, potential confounding variables were screened based on pairwise correlation and unconditioned effects on the outcome, ie, the detection of *L intracellularis* DNA, by reporting Cramér's V and constructing univariable models, respectively.

Table 1: Contingency tables for the estimation of statistical power for detecting the effect of sample type (sample-level analysis) and site vaccination status (site-level analysis) on *Lawsonia intracellularis* positivity

Level of effects		*L intracellularis* DNA detection status		
		Positive, No. (%)	Negative, No. (%)	Statistical power (1-β)*
Sample type	Oral fluids (n = 205)	47 (22.9)	158 (77.1)	99.96%
	Fecal (n = 235)	34 (14.5)	201 (85.5)	
Site *L intracellularis* vaccination status	Vaccinated (n = 235)	13 (65.0)	7 (35.0)	93.13%
	Unvaccinated (n = 20)	7 (35.0)	13 (65.0)	

* Statistical power estimation was performed using G*Power (version 3.1.9.7).[23]

Figure 1: Causal diagram displaying the investigation of relationships between ileitis vaccination protocols, selected random and fixed effects, and oral fluid and fecal sampling prevalence outcomes for *Lawsonia intracellularis* in vaccinated and unvaccinated swine sites. Thicker arrows represent the strongest expected relationship.



Variables with a *P* value ≥ .2 in the univariable models were excluded from the multivariable analysis. In addition, for each pair of strongly correlated variables (Cramér's V > .25) with significant univariable effects, the one(s) with highest *P* value in the univariable models were excluded from the multivariable models.

To account for multi-level clustering effects within the dataset, the sampled pen identification, site, and province were included in the model as a nested random effect (pen ⊂ site ⊂ province).

Biologically relevant interactions between variables retained in the models were considered. Significance was declared at $P < .05$ and a trend at $.05 \leq P < .10$. The effect of each variable was reported as an odds ratio (OR) with a profile likelihood 95% CI, indicating the fold change of the odds of samples being *L intracellularis* positive. In addition, the intraclass correlation coefficient (ICC) was reported to show the proportion of data variation explained by the random effect term.

Risk factor analysis for *L intracellularis* detection

Potential risk factors associated with the detection of *L intracellularis* in vaccinated and unvaccinated sites were separately assessed at the site level using two Poisson logistic regression models. In particular, the detection risk of *L intracellularis* was estimated as the proportion of positive samples, ie, positive rate, of each site regardless of the specimen type, and was included in both models by assigning the count of positive samples as the outcome and the

total number of collected samples as the offset. The overall detection risk based on all samples was used to increase the sample size at the farm level. Thus, the models were constructed to estimate the proportion of positive OF or FS samples from a farm. Risk factors listed in Figure 1 were screened using the same procedure as described in the previous section. For vaccinated sites, dosage (full, half, and quarter doses) and the use of a booster (yes/no) were included to investigate the effect of vaccination strategy (Table 2). Likewise, the effect of each variable was reported as an incidence rate ratio (IRR) with a profile likelihood of 95% CI, indicating the fold change of sites' *L intracellularis*-positive rates and significant effects were declared as previously described.

Results

For sites actively vaccinating against *L intracellularis*, we found a range of different self-imposed vaccination strategies from the questionnaire, ie, quarter dose with a booster (0.5 mL + 0.5 mL), half dose with no booster (1.0 mL), half dose with a booster (1.0 mL + 1.0 mL), full dose with no booster (2.0 mL), and full dose with a booster (2.0 mL + 2.0 mL). Additional descriptives of vaccinated sites are found in Table 2.

Overall, 20 of 40 sites (50%) tested positive for *L intracellularis,* of which 65.0% were vaccinated (13 of 20) and 35.0% were unvaccinated (7 of 20; Table 3). Regardless of sampling method, 81 of 440 samples were considered positive (OF: 47 of 205 [22.9%]; FS: 34 of 235 [14.5%]), yielding a mean *L intracellularis* detection risk of 18.7% (Table 3). For mid-finisher pigs, a higher proportion of positive FS was detected in unvaccinated (9 of 57 [15.8%]) compared to vaccinated herds (6 of 59 [10.2%]), whereas a higher proportion of positive OF samples were detected in vaccinated (13 of 38 [34.2%]) compared to unvaccinated herds (10 of 52 [19.2%]; Table 3). For late-finisher pigs, a larger number of positive samples were found for both specimen types in vaccinated (FS: 12 of 60 [20.0%]; OF: 16 of 58 [27.6%]) compared to unvaccinated sites (FS: 8 of 57 [14.0%]; OF: 7 of 59 [11.9%]; Table 3). In addition, only 22.5% (9 of 40) and 52.5% (21 of 40) of producers responded to the questions regarding use of water (Question 25; Supplementary Materials) and feed medication (Question 27; Supplementary Materials) and were therefore excluded from the data analysis.

For the sample-level model investigating the effect of specimen type on *L intracelluaris* DNA detection, the production phase, *L intracellularis* vaccination status, and number of pigs in the sampled barn were screened and accounted for in the Poisson logistic regression model as confounders. Overall, the use of OF sampling yielded a two-fold increase in the odds of detecting *L intracelluaris* DNA when compared to FS (OR = 2.36; 95% CI, 1.24-4.49; $P < .01$). In contrast, no significant effects of animal production phase, site vaccination status, and the number of pigs in the sampled pens were found. According to the ICC analysis on the nested random effect, site identification nested within province explained 59% of the data variation whereas the pen identification (nested within site identification and province) and province explained less than 0.01%. Among unvaccinated sites,

Table 2: Demographics and vaccination protocols of *Lawsonia intracellularis* vaccinated swine sites in Canada

Vaccination protocol (dose + booster)	No. of sites	Mean herd size (SD)	Dose structure, mL	Total dosage, mL	Age at administration, d	Age at booster, d	Gastrointestinal signs*	No. sites with ileitis < 2 yr†
All vaccinated sites (n = 20)								
1/1 + 1/1	3	3212 (2435)	2.0 + 2.0	4	3	21-42	No	2
1/1	1	102	2.0	2	28	n/a	No	1
1/2 + 1/2	8	2470 (1099)	1.0 + 1.0	2	21-35	42-50	No	1
1/2	3	2520 (3217)	1.0	1	21-35	56	No	1
1/4 + 1/4	5	3162 (1712)	0.5 + 0.5	1	21	42	Yes (1 site)	1
Vaccinated sites positive for *L intracellularis* (n = 13)								
1/1 + 1/1	2	163 (138)	2.0 + 2.0	4	21	28-42	No	2
1/1	1	34	2.0	2	28	n/a	No	1
1/2 + 1/2	5	323 (241)	1.0 + 1.0	2	21-35	42-50	No	1
1/2	2	334 (250)	1.0	1	24-35	56	No	1
1/4 + 1/4	3	49 (18)	0.5 + 0.5	1	21	21-42	Yes (1 site)	1

* Visible gastrointestinal signs at the time of vaccination.

† Sites with previous outbreaks of Ileitis within the last two years.

Table 3: Number of positive and negative *Lawsonia intracellularis* sites and samples per Canadian province, sampling type, vaccination status, and production phase across 20 swine sites and 440 collected samples

***L intracellularis* positive sites per province**

Province	n	Vaccinated, No. (%)	Unvaccinated, No. (%)
MB	11	8 (72.7)	3 (27.3)
ON	8	5 (62.5)	3 (37.5)
QC	1	0 (0.0)	1 (100.0)
Total		13 (65.0)	7 (35.0)

Sample distribution per province

Province	n	Positive, No. (%)	Negative, No. (%)
MB	237	45 (19.0)	192 (81.0)
ON	180	33 (18.3)	147 (81.7)
QC	23	3 (13.0)	20 (87.0)
Total	440	81 (18.4)	359 (81.6)

Distribution per sampling type

	Vaccinated, No. (%)		Unvaccinated, No. (%)		*P* value*
Sample type	Positive	Negative	Positive	Negative	
Mid-finisher phase					
OF	13 (34.2)[a]	25 (65.8)	10 (19.2)[a]	42 (80.8)	.14[a]
FS	6 (10.2)[b]	53 (89.8)	9 (15.8)[b]	48 (84.2)	.42[b]
Total	19 (19.6)	78 (80.4)	19 (17.4)	90 (82.6)	
Late-finisher phase					
OF	16 (27.6)[c]	42 (72.4)	8 (14.0)[c]	49 (86.0)	.11[c]
FS	12 (20.0)[d]	48 (80.0)	7 (11.9)[d]	52 (88.1)	.32[d]
Total	28 (23.7)	90 (76.3)	15 (12.9)	101 (87.1)	

* A Fisher's Exact test was used to determine statistical differences between positive samples in vaccinated and unvaccinated herds by sampling type and production phases. Statistical difference was determined at $P < .05$.

[a-d] Superscripts specify Fisher's Exact comparison between the number of positive samples from vaccinated or unvaccinated sites.

OF = oral fluids; FS = fecal sample.

the detection of PCV2 and the presence of gastrointestinal (GI) signs at the time of sampling showed significant effects on the *L intracellularis*-positive rate, regardless of sample types. Sites positive for PCV2 were estimated to have 4.99 times higher odds of also being positive for *L intracellularis* than PCV2-negative sites (IRR = 4.99; 95% CI, 1.29-20.23; $P = .02$). No effect of PRRSV was observed. Additionally, herds without GI signs at the time of vaccination had 9 times lower odds of also being positive for *L intracellularis* as compared to those herds showing GI signs at the time of sampling (IRR = 0.1; 95% CI, 0.02-0.42; $P < .01$).

A significantly lower positive rate was found in those vaccinating using a full dose with a booster compared to those using a half dose with no booster (IRR = 0.22; 95% CI, 0.06-0.83; $P = .03$). Furthermore, a higher positive rate was estimated for sites that had *L intracellularis* cases diagnosed in the past 2 years (IRR = 3.08; 95% CI, 1.51-6.37; $P < .01$), administering *L intracellularis* vaccines before 2021 (IRR = 9.85; 95% CI, 1.95-179.55; $P = .03$), or for herds positive for *M hyopneumonae* during the study period (IRR = 4.41; 95% CI, 2.00-10.75; $P < .001$). Province was not included in both models as a random effect due to the overfitting issue. Interaction terms were not included in both models due to the singular fit issue.

Discussion

This study found *L intracellularis* present in 50% of the investigated wean-to-finish swine sites during the mid- to late-finisher phases of which 65.0% of the sites were vaccinated with an inactivated intramuscular vaccine while 35.0% were not. Previously reported prevalence and seroprevalence of *L intracellularis* have varied greatly in herds in both Europe and North America.[9,12,24,25] However, and in contrast to our study, none of the sites enrolled in those studies were actively administrating an *L intracellularis* vaccine. As our study was designed to incorporate vaccinated and unvaccinated swine sites, it is likely that the observed

detection risk will differ from the general swine population. Furthermore, in regard to sample positivity based on sampling methodology, OF yielded a higher risk of *L intracellularis* infection detection compared to FS in vaccinated sites while the opposite was observed in unvaccinated sites. However, a higher proportion of positive samples occurred in vaccinated sites compared to unvaccinated sites during the late-finisher phase regardless of sampling type. It is possible that swine in the late-finisher phase had more opportunities to come in contact with the pathogen, thus enabling a more advanced disease progression to occur compared to younger swine. In addition, circumstantial factors that may have impacted the accuracy of the sampling techniques should not be underestimated or disregarded,[13] although sampling accuracy was not controlled for in our study. Given the investigative nature and behavior of swine, they could have had the opportunity to interact with both fecal matter present in the pen as well as ropes used for OF sampling, which could act as a vector between the 2 sampling sources as *L intracellularis* naturally transmits between pigs via the oral-fecal route.[26]

Our models showed that OF sampling had approximately twice the chance of detecting *L intracellularis* compared to FS after accounting for vaccination status and the number of pigs in the sampled herd. These results are in line with previous studies comparing the sensitivity for OF and FS in other infections such as PCV2, PRRSV, porcine parvovirus 3, 5, and 6, and porcine deltacoronavirus.[27-29] There are also indications for higher sensitivity of OF compared to FS over time for detecting porcine epidemic diarrhea virus.[16] Although the generalized assumption that OF has a higher sensitivity compared to FS can be made from these examples and the results of our study, this may in fact be attributed to specific disease pathogeneses affecting the level of virus shedding. In turn, this may influence detection risks for different sampling techniques and time of sampling and therefore, our results should be interpreted cautiously and on a case-by-case basis. The current study was not designed to make specific inferences about sensitivity and specificity, as we lacked the presence of a validated robust gold standard applied to individual subjects.

Our study found that swine sites without GI signs at the time of sample collection had a 90% decrease in the odds of being *L intracellularis* positive. Being an agent of porcine proliferative enteropathy and one of most common causes of diarrhea in swine,[30] it is not surprising that sites lacking clinical GI signs in their pigs showed lower odds of harboring swine infected with *L intracellularis.* It has previously been reported that natural gut microbiota changes during weaning may cause younger pigs to be increasingly susceptible to enteric infections and for weaned pigs to be more commonly infected with *L intracellularis* compared to older pigs.[31] In our study, we found that unvaccinated herds with the presence of a clinical PCV2 diagnosis at the time of sampling increased the odds of detecting *L intracellularis* five-fold compared to herds absent of PCV2. Similarly, herds with a clinical diagnosis of *M hyopneumonae* increased the odds of being *L intracellularis* positive by more than four-fold.

This study also had important limitations. The sample size may have impacted the study representation and power detecting effects of associated risk factors, especially on a site-level analysis. Additionally, the number of animals that contributed to pooled OF and FS samples was unknown and likely varied, and this could impact the probability of *L intracellularis* detection. Furthermore, missing *L intracellularis* testing results and questionnaire responses may have biased the model estimates and affected study findings, as all clinical diagnoses were self-reported by the herd veterinarians and not independently verified by the research group. Finally, to increase understanding between the associated risk factors of *L intracellularis* detection, a more comprehensive model including movements of pigs, staff, and feed, production data, and long-term health data, and density of commercial swine farms in the region should be implemented in future studies.

The results of this study indicate that the use of OF may have a better *L intracellularis* detection rate when compared to FS. Based on the results of this study, the observed site positivity for *L intracellularis* may be linked to the use of lower amounts than the recommended vaccine dose and pre-existing GI pathogens on site, such as porcine circovirus and mycoplasmal pneumonia. Additional research is recommended to determine sample methodology efficacies and risk factors associated with positive detection of *L intracellularis.*

Implications

Under the conditions of this study:

- Oral fluids may be a useful method for detecting *L intracellularis* in swine.
- Previous health status may impact risks of *L intracellularis* infection.
- Time of sampling may affect OF and FS detection rates.

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Conflict of interest

Drs Van De Weyer and Angulo are currently employed by Zoetis. This project was funded by Zoetis. Zoetis is a global animal health company with a portfolio that includes vaccine development and manufacturing for pets and livestock, including swine.

Disclaimer

Dr Arruda, a member of this journal's editorial board, was not involved in the editorial review of or decision to publish this article.

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Efficacy of ivermectin administration to growing pigs after a virulent porcine reproductive and respiratory syndrome virus 1-4-4 L1C challenge

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Summary

Objective: To conduct a pilot study, under noncommercial conditions, to assess the potential efficacy of ivermectin administered subcutaneously to pigs following a porcine reproductive and respiratory syndrome virus (PRRSV) 1-4-4 L1C challenge.

Materials and methods: A total of 50 feeder pigs were enrolled and allocated into 2 groups. On day 0, all pigs were challenged with PRRSV 1-4-4 L1C. Animals in group 1 received an ivermectin dose of approximately 500 µg/kg administered subcutaneously at 1 and 3 days post challenge (DPC). Group 2 animals remained untreated. Serum was collected from each animal on DPC 1, 3, 5, 7, 10, and 14 and tested individually to assess PRRSV viremia levels via quantitative polymerase chain reaction (qPCR). On DPC 14, pigs were weighed, euthanized, necropsied, and lungs were scored for lung lesions. Bronchoalveolar lavage (BAL) was performed on each set of lungs and the corresponding level of viremia was measured via qPCR. Any animal that died prior to necropsy was weighed, received a lung score, and BAL collected.

Results: There was no significant difference in viremia levels between treatment groups. There was a trend toward significance between treatment groups in lung lesion scores with the ivermectin-treated pigs exhibiting less lung pathology compared to the control group ($P = .05$).

Implications: Ivermectin administered to pigs post virulent PRRS 1-4-4 L1C challenge did not reduce the level of viremia in serum or BAL fluid but may have reduced lung lesions.

Keywords: swine, ivermectin, porcine reproductive and respiratory syndrome

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Resumen - Eficacia de la administración de ivermectina a cerdos en crecimiento después de un reto del virus virulento del síndrome reproductivo y respiratorio porcino 1-4-4 L1C

Objetivo: Realizar un estudio piloto, en condiciones no comerciales, para evaluar la eficacia potencial de la ivermectina administrada por vía subcutánea a cerdos después del reto con la cepa 1-4-4 L1C del virus del síndrome reproductivo y respiratorio porcino (PRRSV).

Materiales y métodos: Se incluyeron un total de 50 cerdos de engorda y se distribuyeron en 2 grupos. En el día 0, todos los cerdos fueron desafiados con PRRSV 1-4-4 L1C. Los animales del grupo 1 recibieron una dosis de ivermectina de aproximadamente 500 µg kg administrada por vía subcutánea los días 1 y 3 días post reto (DPR). Los animales del grupo 2 no recibieron tratamiento. Se recolectó suero de cada animal en DPR 1, 3, 5, 7, 10, y 14 y se analizó individualmente para evaluar los niveles de viremia del PRRSV mediante la reacción en cadena de la polimerasa cuantitativa (qPCR). En el DPR 14, los cerdos fueron pesados, sacrificados, se hizo la necropsia, y los pulmones fueron evaluados para detectar lesiones pulmonares. Se realizó lavado broncoalveolar (LBA) en cada conjunto de pulmones y se midió el nivel correspondiente de viremia mediante qPCR. Todos los animales que murieron antes de la necropsia fueron pesados, recibieron una puntuación pulmonar y se recolectó el LBA.

Resultados: No hubo diferencias significativas en los niveles de viremia entre los grupos de tratamiento. Hubo una tendencia a la significación entre los grupos de tratamiento en las puntuaciones de las lesiones pulmonares, ya que los cerdos tratados con ivermectina mostraron menos patología pulmonar en comparación con el grupo control ($P = .05$).

Implicaciones: La ivermectina administrada a cerdos después de una exposición virulenta con PRRS 1-4-4 L1C no redujo el nivel de viremia en el suero o en el líquido LBA, pero puede haber reducido las lesiones pulmonares.

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Crawford K, Saltzman R, Ellingson J, Thomas P, Rademacher C, Karriker L. Efficacy of ivermectin administration to growing pigs after a virulent porcine reproductive and respiratory syndrome virus 1-4-4 L1C challenge. *J Swine Health Prod*. 2024;32(4):164-172. **https://doi.org/10.54846/jshap/1368**

Résumé - Efficacité de l'administration d'ivermectin à des porcs en croissance après une infection défi avec le virus virulent 1-4-4 L1C du syndrome reproducteur et respiratoire porcin

Objectif: Mener une étude pilote, dans des conditions non-commerciales, pour évaluer l'efficacité potentielle de l'administration d'ivermectin par voie sous-cutanée à des porcs à la suite d'une infection défi avec le virus du syndrome reproducteur et respiratoire porcin (VSRRP) 1-4-4 L1C.

Matériels et méthodes: Cinquante porcs a été sélectionnés et répartis en 2 groupes. Au jour 0, tous les porcs ont été infectés avec le VSRRP 1-4-4 L1C. Les animaux du groupe 1 ont reçu une dose d'ivermectin d'environ 500 µg/kg par voie sous-cutanée aux jours 1 et 3 post-infection (JPI). Les animaux du groupe 2 sont demeurés non-traités. Du sérum a été prélevé de chaque animal aux JPI 1, 3, 5, 7, 10, et 14 et testé individuellement pour évaluer le degré de virémie VSRRP par réaction d'amplification en chaîne par la polymérase quantitative (qPCR). À 14 JPI, les porcs ont été pesés, euthanasiés et soumis à une nécropsie, et les poumons ont été notés pour les lésions pulmonaires. Un lavage bronchoalvéolaire (LBA) a été réalisé sur chaque paire de poumons et les niveaux de virémie correspondants mesurés par qPCR. Tout animal qui mourait avant la date prévue de nécropsie était pesé, recevait un pointage des lésions pulmonaires, et du LBA prélevé.

Résultats: Il n'y avait pas de différence significative dans les degrés de virémie entre les groupes de traitement. Il y avait une tendance vers un seuil significatif entre les groupes de traitement dans les pointages de lésions pulmonaires chez les porcs traités avec de l'ivermectin, ceux-ci montrant moins de pathologies pulmonaires que le groupe témoin ($P = .05$).

Implications: L'ivermectin administré à des porcs à la suite d'une infection défi avec la souche virulente du VSRRP 1-4-4 L1C n'a pas réduit la virémie dans le sérum ou un LBA, mais pourrait avoir réduit les lésions pulmonaires.

Porcine reproductive and respiratory syndrome virus (PRRSV) continues to devastate the US swine industry, costing producers millions of dollars of lost revenue annually due to high mortality rates and decreased production performance.[1,2] Although several vaccines exist for PRRSV, none provide sterilizing immunity. The combination of the ever-changing nature of the virus and the lack of understanding of what elicits specific immunity to PRRSV make it difficult to create a cross-protective vaccine.[3-5] There are no antiviral treatments labelled for use in swine to treat common viral diseases found in the US swine industry, including PRRSV. Field reports suggest the use of nonsteroidal anti-inflammatory drugs to reduce morbidity, however their efficacy remains questionable and may lead to gastrointestinal ulceration.[6]

Ivermectin (IVM), derived from avermectin, a macrocyclic lactone, is a parasiticide labelled for the treatment of several parasitic infections in both veterinary and human medicine. The antiparasitic labelled dose of IVM in swine is 300 µg/kg administered subcutaneously. The antiparasitic properties of IVM are generated by its apparent agonism of the gamma-aminobutyric acid receptor resulting in cell hyperpolarization and ultimately cell paralysis and death.[7] In addition to antiparasitic properties, IVM has also shown to have anticancer, antiviral, antifungal, and antibacterial effects in biological systems.[8] The antiviral effects of IVM were measured against several human flaviviruses such as West Nile and yellow fever virus. The antiviral mechanism of action is suggested to inhibit viral replication by targeting the nonstructural protein 3 helicase domain.[9] Lee and Lee[10] showed the ability of IVM to significantly reduce the viral replication of PRRSV in porcine alveolar macrophages *in vitro*. Furthermore, a 2021 case report suggested that the administration of IVM to sows and gilts in the face of a concurrent PRRSV outbreak may have reduced the severity of the outbreak, allowing production parameters to return to baseline more quickly.[11] The pharmacokinetic profile of IVM in swine suggests that, when delivered at a dose of 300 µg/kg, it can be detected in plasma for up to 20 days post administration.[12] The combination of the proposed mechanism of action and relatively slow clearance of IVM in pigs may make this molecule a suitable antiviral candidate. It is critical for the swine industry to understand if there are potential antiviral capabilities of IVM against PRRSV.

Animal care and use

This study was conducted at VRI and was reviewed and approved by VRI's Institutional Animal Care and Use Committee.

Materials and methods

Experimental design

All pigs were sourced from colostrum-deprived caesarean-derived (CDCD) dams inseminated with commercial Duroc boar semen, housed in a biosafety level-1 barn during gestation. Prior to transport to the biosafety level-2 isolation facility, PRRSV-naïve status was confirmed via enzyme-linked immunosorbent assay and quantitative polymerase chain reaction (qPCR). At arrival, pigs were weighed, blocked by litter, and randomly allocated into 2 treatment groups, each containing 25 pigs. The animals were allowed to acclimate for 2 days prior to challenge. At 0 days post challenge (DPC), study animals were approximately 8 weeks of age and the mean weight was 24.9 kgs (range, 14.9-34.4 kgs). Beginning on DPC-1 through the end of the study (DPC 14), all pigs were observed for clinical signs associated with PRRSV infection or IVM toxicity. A numerical value was assigned to each pig for a respiratory, depression, and body condition score (normal = 0, mild = 1, moderate = 2, severe = 3). On DPC 0, all pigs were challenged with PRRSV restriction fragment length polymorphism (RFLP) 1-4-4 L1C variant isolate ISU21-1775 with a target dose of 4-5 log median tissue culture infectious dose/mL.[13] Challenge material was delivered intranasally (1 mL/nare) followed by a 1 mL intramuscular injection for a total of 3 mL of challenge material administered to each animal. On DPC 1, using the mean weight of the group 1 animals, IVM (Boehringer Ingelheim) was administered subcutaneously to each animal at a dose of approximately 500 µg/kg (1.2 mL). The group 2 pigs remained untreated. The group 1 pigs were retreated on DPC 3 at the same dose, while the group 2 pigs remained untreated. Blood was collected from each pig via jugular venipuncture using individual needles (20 gauge × 3.8 cm) and vacutainers on DPC 0, 1, 3, 5, 7, 10, and 14. Blood was centrifuged at 3000*g* for approximately 10 minutes; the serum

was harvested and submitted to the Iowa State University Veterinary Diagnostic Laboratory (ISU VDL) to determine PRRSV viremia levels by qPCR. Any pig that died prior to the end of study was weighed, a lung lesion score was recorded, and a bronchoalveolar lavage (BAL) was performed. Fourteen days post challenge, body weights were recorded for all remaining pigs and necropsies performed to determine percentage of observed lung lesions. Total lung lesions for each pig were scored by the primary investigator and calculated using the following formula[14]: Total lung lesions = Right apical % × 0.11 + right cardiac% × 0.10 + right diaphragmatic% × 0.34 + left apical% × 0.05 + left cardiac% × 0.06 + left diaphragmatic% × 0.29 + intermediate% × 0.05. Bronchoalveolar lavage fluid was collected from each set of lungs and the corresponding level of viremia was measured via PRRSV qPCR by the ISU VDL.

Dose determination

The IVM dose regimen used in this study was arbitrarily selected to reflect the *in vitro* exposures presented to various viral targets in studies previously described and represents an off-label dose.[10] It was selected at a higher range within the dose spectrum to maximize the potential to detect dose dependent effects on PRRSV. Additional studies requiring dose refinement and establishment of a sufficient withdrawal period to protect food safety would be warranted prior to implementation as a routine practice. These components were deemed premature, especially considering the ethical obligation to minimize animals impacted with research, considering that no *in vivo* evidence of efficacy at any level has been discovered in the peer-reviewed literature. The potential side effects of IVM toxicity have been described to be neurologic in several species, including pigs and humans.[15,16] Presence or absence of clinical neurologic signs of IVM toxicity were included in daily observations. The pigs in this study were excluded from the human and animal food supply.

Statistical analysis

The primary outcome variable was the level of viremia (copies of target DNA per mililiter) in serum and BAL. These outcomes were evaluated using a generalized linear mixed model as appropriate (the MIXED procedure in SAS [SAS Institute; version 9.4]). The BAL viremia values were subject to analysis of variance (ANOVA), with treatment group as a fixed effect and litter as a random effect. Serum viremia values were evaluated using repeated measures ANOVA, with treatment group, day post challenge, and day × group interaction as fixed effects and litter as a random effect. A compound symmetric structure was assumed for the covariance matrix. The PRRSV copy numbers were $\log_{10}$ transformed prior to statistical analysis.

Secondary outcome variables included average daily gain and lung scores. These outcomes were subject to ANOVA as previously described. Lung lesion scores were arcsine transformed prior to statistical analysis.

Clinical scores associated with body condition, depression, and respiratory observations were subject to analysis using the Kruskal-Wallis test (the NPAR1WAY procedure in SAS) for each day.

Results

There was not a statistically significant difference detected between treatment groups in the viremia level in BAL or serum (Tables 1 and 2). In addition to the primary outcome variables, there was no significant difference noted in average daily gain between treatment groups (Table 3). Only 3 animals gained weight over the course of the 14-day study. All 3 animals belonged to the IVM-treated group (data not shown). On DPC 14, the percentage of lung lesions in the IVM-treated group was less than the control group, although not statistically significant ($P = .05$; Table 3).

Body condition scores were more likely to be lower in the IVM-treated pigs as compared to the control pigs at 8 and 9 DPC (Table 4). Depression scores were more likely to be lower in IVM-treated pigs as compared to the control pigs at 6, 8, 12, and 13 DPC (Table 5). Respiratory scores were more likely to be lower in IVM-treated pigs as compared to control pigs at 6 DPC; at 9 DPC, scores were more likely to be higher in IVM-treated pigs as compared to the control pigs (Table 6).

At scheduled necropsy (14 DPC), 16 of 25 animals (64%) in the IVM-group and 14 of 25 animals (56%) in the control group completed the study (Table 7).

Discussion

The results of this study suggest that IVM, when administered subcutaneously to pigs at a dose of approximately 500 µg/kg at 24 and 72 hours post virulent PRRSV RFLP 1-4-4 L1C variant strain challenge, does not reduce the level of viremia in serum or BAL. However, IVM administered at this dose and time may reduce the presence of lung lesions and may lessen the clinical impact post challenge. Several factors could contribute to this conclusion including overall study design, PRRSV strain virulence, IVM dosage, timing of administration relative to challenge, the effect of an immunosuppressive virus on the pharmacokinetic profile and bioavailability of IVM, and genetic susceptibility of the experimental pigs used in this study.

During October 2020, the PRRSV 1-4-4 L1C variant strain emerged in the United States and devastated the swine industry with unprecedented production losses.[17] A presentation at the 2022 Iowa State University James D. McKean Swine Disease Conference showed that the challenge virus used in this study has potentially higher transmissibility and pathogenicity compared to other PRRSV strains, even of the same lineage.[13] Although IVM did not appear to mitigate the infectivity and shedding of PRRSV in this study, it may show efficacy when challenged with a less virulent PRRSV strain. Further studies are needed to explore this hypothesis.

A label claim for IVM as an antiviral therapeutic has not been approved by the US Food and Drug Administration, therefore the dosing regimen used in this study was estimated based on the *in vitro* PRRSV work done by Lee and Lee[10] and the limited information known about the pharmacokinetic behavior of IVM in swine.[12] Although IVM's half-life is relatively long, the level of active ingredient may not have reached therapeutic levels to have an antiviral effect on the PRRSV challenge used in this study.[12] Ivermectin's proposed antiviral mechanism of action as a viral helicase inhibitor prevents viral replication by altering the trafficking of viral proteins between the cytoplasm and nucleus of the host cell.[7] A study by Mastrangelo et al,[9] assessed the efficacy of IVM *in vitro* against the flavivirus yellow fever virus. Like PRRSV, the yellow fever virus is a single-stranded RNA virus that relies on

Table 1: Summary of BAL viremia outcomes

Variable	LSMeans (SEM)		*P* value*
	Group 1	Group 2	
PRRSV Ct	19.04 (.039)	19.57 (.39)	.25
PRRSV copies/mL†	8.29 (.12)	8.13 (.12)	.26

* The BAL viremia values were subject to ANOVA, with treatment group as a fixed effect and litter as a random effect.

† PRRS copies/mL were log10 transformed prior to analysis to stabilize the residuals. Log10 LSMeans are presented.

BAL = bronchoalveolar lavage; PRRSV = porcine reproductive and respiratory syndrome virus; Ct = cycle threshold.

Table 2: Summary of serum viremia outcomes

Variable	Days post challenge	LSMeans (SEM)		*P* values*		
		Group 1	Group 2	Group	Day	Group × Day
PRRSV Ct†	0	36.9894 (.4586)	36.9787 (.4599)	.96	< .001	.85
	1	20.2094 (.4586)	20.8147 (.4599)			
	3	18.5734 (.4586)	18.8547 (.4599)			
	5	17.4694 (.4586)	17.3947 (.4599)			
	7	17.5934 (.4586)	17.3747 (.4599)			
	10	17.3141 (.4702)	17.1766 (.4712)			
	14	20.3964 (.5267)	20.0854 (.5527)			
PRRSV copies/mL‡	0	0.0032 (.1397)	0.0064 (.1401)	.96	< .001	.83
	1	7.9376 (.1397)	7.7516 (.1401)			
	3	8.4387 (.1397)	8.3470 (.1401)			
	5	8.7707 (.1397)	8.7930 (.1401)			
	7	8.7327 (.1397)	8.8026 (.1401)			
	10	8.8193 (.1433)	8.8606 (.1436)			
	14	7.8766 (.1605)	7.9750 (.1684)			

* Serum viremia values were evaluated using repeated measures ANOVA, with treatment group, day post challenge, and day × group interaction as fixed effects and litter as a random effect.

† Where Ct values were > 37 a value of 37 was reported.

‡ PRRSV copies/mL were $\log_{10}$ (copy + 1) transformed prior to analysis to stabilize the residuals. Log_{10} LSMeans are presented.

PRRSV = porcine reproductive and respiratory syndrome virus; Ct = cycle threshold.

Table 3: Summary of average daily gain and lung lesion scores outcomes

Variable	LSMeans (SEM)		*P* value*
	Group 1	Group 2	
Lung lesion scores†	36.06%	57.76%	.05
Average daily gain	-0.47 (.075)	-0.50 (.079)	.82

* These outcomes were subject to ANOVA, with treatment group as a fixed effect and litter as a random effect.

† Lung lesion scores were arcsine transformed prior to analysis to stabilize the residuals. Back transformed LSMeans are presented.

Table 4: Summary of body condition scores

Day post challenge	Group	Body condition score					
		0		1		2	
		n	%	n	%	n	%
0	1	25	100.00	0	0	0	0
	2	25	100.00	0	0	0	0
1	1	25	100.00	0	0	0	0
	2	25	100.00	0	0	0	0
2	1	25	100.00	0	0	0	0
	2	25	100.00	0	0	0	0
3	1	25	100.00	0	0	0	0
	2	25	100.00	0	0	0	0
4	1	24	96.00	1	4.00	0	0
	2	21	84.00	4	16.00	0	0
5	1	20	80.00	5	20.00	0	0
	2	21	84.00	4	16.00	0	0
6	1	15	60.00	10	40.00	0	0
	2	19	76.00	6	24.00	0	0
7	1	19	76.00	6	24.00	0	0
	2	15	60.00	10	40.00	0	0
8	1	12	48.00	13	52.00	0	0
	2*	5	20.00	13	52.00	7	28.00
9	1	10	40.00	14	56.00	1	4.00
	2*	5	20.83	13	54.17	6	25.00
10	1	4	17.39	19	82.61	0	0
	2	7	30.43	13	56.52	3	13.04
11	1	2	9.09	20	90.91	0	0
	2	0	0	21	100.00	0	0
12	1	1	5.26	18	94.74	0	0
	2	0	0	18	85.71	3	14.29
13	1	0	0	18	100.00	0	0
	2	0	0	15	93.75	1	6.25
14	1	0	0	15	93.75	1	6.25
	2	0	0	12	85.71	2	14.29

* Group 1 significantly different from group 2 at $P < .05$.

Table 5: Summary of depression scores

Day post challenge	Group	Depression scores							
		0		1		2		3	
		n	%	n	%	n	%	n	%
0	1	25	100.00	0	0	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
1	1	25	100.00	0	0	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
2	1	25	100.00	0	0	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
3	1	25	100.00	0	0	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
4	1	24	96.00	1	4.00	0	0	0	0
	2	24	96.00	1	4.00	0	0	0	0
5	1	22	88.00	3	12.00	0	0	0	0
	2	18	72.00	7	28.00	0	0	0	0
6	1	22	88.00	3	12.00	0	0	0	0
	2*	16	64.00	9	36.00	0	0	0	0
7	1	22	88.00	3	12.00	0	0	0	0
	2	17	68.00	6	24.00	2	8.00	0	0
8	1	19	76.00	6	24.00	0	0	0	0
	2*	1	4.00	17	68.00	7	28.00	0	0
9	1	1	4.00	23	92.00	0	0	1	4.00
	2	0	0	19	79.17	5	20.83	0	0
10	1	2	8.70	21	91.30	0	0	0	0
	2	2	8.70	19	82.61	0	0	2	8.70
11	1	0	0	20	90.91	0	0	2	9.09
	2	0	0	21	100.00	0	0	0	0
12	1	0	0	18	94.74	1	5.26	0	0
	2*	0	0	8	38.10	13	61.90	0	0
13	1	0	0	18	100.00	0	0	0	0
	2*	0	0	6	37.50	10	62.50	0	0
14	1	0	0	15	93.75	0	0	1	6.25
	2	0	0	14	100.00	0	0	0	0

* Group 1 significantly different from group 2 at $P < .05$.

Table 6: Summary of respiratory scores

Day post challenge	Group	Respiratory scores							
		0		1		2		3	
		n	%	n	%	n	%	n	%
0	1	25	100.00	0	0	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
1	1	25	100.00	0	0	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
2	1	24	96.00	1	4.00	0	0	0	0
	2	25	100.00	0	0	0	0	0	0
3	1	25	100.00	0	0	0	0	0	0
	2	24	96.00	1	4.00	0	0	0	0
4	1	23	92.00	2	8.00	0	0	0	0
	2	19	76.00	6	24.00	0	0	0	0
5	1	22	88.00	3	12.00	0	0	0	0
	2	18	72.00	7	28.00	0	0	0	0
6	1	23	92.00	2	8.00	0	0	0	0
	2*	17	68.00	8	32.00	0	0	0	0
7	1	15	60.00	5	20.00	5	20.00	0	0
	2	17	68.00	6	24.00	2	8.00	0	0
8	1	4	16.00	12	48.00	9	36.00	0	0
	2	4	16.00	15	60.00	5	20.00	1	4.00
9	1	2	8.00	8	32.00	15	60.00	0	0
	2*	0	0	19	79.17	5	20.83	0	0
10	1	0	0	2	8.70	21	91.30	0	0
	2	0	0	8	34.78	14	60.87	1	4.35
11	1	0	0	0	0	22	100.00	0	0
	2	0	0	2	9.52	19	90.48	0	0
12	1	0	0	0	0	18	94.74	1	5.26
	2	0	0	2	9.52	19	90.48	0	0
13	1	0	0	2	11.11	16	88.89	0	0
	2	0	0	2	12.50	14	87.50	0	0
14	1	0	0	1	6.25	15	93.75	0	0
	2	0	0	3	21.43	9	64.29	2	14.29

* Group 1 significantly different from group 2 at $P < .05$.

Table 7: Summary of mortalities occurring prior to study completion*

Group 1			Group 2		
Pig ID	**Mortality**	**Euthanasia date**	**Pig ID**	**Mortality**	**Euthanasia date**
493	Euthanized	9 DPC	485	Found dead	14 DPC
512	Found dead	12 DPC	506	Found dead	13 DPC
525	Euthanized	11 DPC	521	Found dead	9 DPC
536	Found dead	10 DPC	534	Found dead	10 DPC
541	Found dead	13 DPC	540	Found dead	13 DPC
563	Euthanized	11 DPC	557	Found dead	13 DPC
571	Found dead	11 DPC	562	Found dead	13 DPC
575	Found dead	14 DPC	566	Euthanized	10 DPC
592	Found dead	14 DPC	568	Found dead	14 DPC
			570	Euthanized	10 DPC
			572	Found dead	13 DPC

* At study completion (14 DPC), 16 of 25 animals in group 1 and 14 of 25 animals in group 2 were euthanized and necropsied as scheduled.

a nonstructural protein for viral replication. The authors concluded that IVM exerted antiviral activity only when administered during the first 14 hours after viral cell entry. Therefore, IVM appears to be effective exclusively during the replication cycle when viral helicase is active.[8] Future studies assessing IVM efficacy on PRRSV should include a prechallenge or immediate postchallenge dosing protocol.

It has been well documented that the immunosuppressive nature of disease, specifically PRRSV, impacts the pharmacokinetic profile of parenterally administered pharmaceuticals. Pigs infected with PRRSV had a lower overall plasma concentration of intramuscularly injected ceftiofur hydrochloride.[18,19] It is unknown, however, if a PRRSV infection changes the bioavailability of IVM in swine.

The pigs used in this study were derived from CDCD dams inseminated with commercial boar semen. The genetic background of the animals used in this study may not represent the robust immunologic profile of a pig derived in a commercial setting. Future studies should include pigs sourced from a commercial setting.

Implication

Under the conditions of this study, ivermectin did not reduce the level of PRRSV 1-4-4 variant L1C in serum or BAL.

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Conflict of interest

None reported.

Disclaimer

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* Non-refereed references.

Conversion tables

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28.35
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
Mature sow or boar	300	136
	661	300
	794	360
	800	363

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

NPB learns from EU swine health and industry practices on international trip

National Pork Board (NPB) staff, board members, and a state pork association executive traveled across Denmark and the Netherlands April 5-13, 2024 to understand their swine industry firsthand.

During the trip, the group traveled to Padborg, Denmark, which is on the border of Denmark and Germany. During 2019, Danish producers cofunded the construction of a fence along the border and a truck safety wash as preventative measures to keep African swine fever (ASF) and wild boar out of the country. This fence stretches approximately 62 km (42 mi), 1.5 m tall, and 0.5 m below the surface. So far, ASF has not been detected in Denmark. The fence construction and truck wash are a product of collaboration between the swine industry and the government, which impressed the trip attendees. "When consensus is reached on an issue and the appropriate knowledge is available," said Gordon Spronk, NPB board member, "leadership can make real change for the good of everyone, the entire industry."

The group toured and met with professionals at Danish Crown, an internationally oriented Danish food company with butchery operations, processing, and sales of pork and beef. Danish Crown is a large importer of US pork and must pay the Pork Checkoff $0.35 per $100 value of each pig. The group was impressed by the Danish Crown's business model and attention to value instead of volume while targeting profitable segments within their market.

They also toured the Danish Agriculture & Food Council and SEGES Innovation, an independent company focused on sustainable food production. Attendees heard from multiple experts on current topics of interest at SEGES Innovation, including research and development, strategy for the Danish pig sector, and DanBred genetic and breeding goals. The group was influenced by Denmark's commitment to sustainability and science-based research to make business decisions.

Trip attendees touring the fence on the border of Denmark and Germany. Photo courtesy of Dr Dustin Oedekoven.

The next stop was at Biogas Horsens, a bio-digestion plant that produces biogas from manure provided by local farmers and organic waste from the food industry. The biogas is upgraded to natural gas onsite. The group was fascinated by this modern approach to manure management and sustainable practices.

The last stop in Denmark was to Go'Gris sow farm, a self-sufficient hog farm that grows all necessary grain and forage to feed the 1000 sows that produce about 32,000 slaughter pigs annually. The group noted the high body condition of sows at this farm and their ability to farrow an average of 20 liveborn piglets per litter.

National Pork Board members browsing pork products in the Netherlands. Photo courtesy of Dr Dustin Oedekoven.

The group then traveled to Utrecht, Netherlands where they visited the US Department of Agriculture Foreign Agricultural Service, learning more about EU and German pig production from experts, and met with the Pig Improvement Company based in Germany. They also met with a swine research farm and Nutreco, a leading animal nutrition company with an emphasis on sustainability with several brands in their portfolio that are world leaders in their respective fields.

On their last stop, the group toured Westfort Plant, a family-owned processing plant that specializes in pork. Four different locations in the Netherlands process approximately 1200 tons of pork products per day and up to 300,000 tons annually. The group toured the newest processing plant in IJsselstein, which is the most modern and innovative using the newest software and technology to streamline the process.

"There is a convergence occurring in software with the result combining on-farm production data, performance data, management tools, and traceability solutions in a data warehouse," Spronk said. "This software roll-up meets not only consumer and regulatory demands but helps everyone in the supply chain make better decisions for continuous improvement to achieve a sustainable, world-class pork chain."

National Pork Board Members in Denmark. Photo courtesy of Dr Dustin Oedekoven.

We believe that pork is an important part of a healthy, balanced, nutritious diet, pig and crop farming are sustainable, and the ethical treatment of our people and animals is key to a resilient food system. This international trip was an important touchpoint for many attendees to continue promoting our mission of building trust with consumers and adding value to US-raised pork. The lessons and key takeaways will be used by each attendee on their own farm and in their leadership position at NPB and state associations, representing more than 60,000 US pig farmers and making decisions using Pork Checkoff dollars.


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Call for papers – AASV 2025 Student Seminar Veterinary Student Scholarships

The American Association of Swine Veterinarians announces an opportunity for veterinary students to make a scientific presentation at the AASV Annual Meeting in San Francisco, California on Sunday, March 2, 2025. Interested students are invited to submit a one-page abstract of a research paper, clinical case study, or literature review for consideration. The submitting student must be a current (2024-25) student member of the AASV at the time of submission and must not have graduated from veterinary school prior to March 2, 2025. Submissions are limited to one abstract per student.

Abstracts and supporting information must be submitted online at **cmt3.research.microsoft.com/AASV2025**. Submissions must be completed before **11:59 PM Central Daylight Time** on **Wednesday, September 11, 2024** (firm deadline). Late submissions will not be considered. Students will receive an email confirmation of their submission. If they do not receive the confirmation email, they must contact Dr Justin Brown (**brownjt@iastate.edu**) by Friday, September 13 with supporting evidence that the submission was made in time; otherwise the abstract will not be considered for judging.

The abstracts will be reviewed by an unbiased, professional panel consisting of private practitioners, academicians, and industry veterinarians. Fifteen abstracts will be selected for oral presentation in the Student Seminar at the AASV Annual Meeting. Students will be notified of the review results by October 15, 2024, and those selected to participate will be expected to provide the complete paper or abstract reformatted for publication in the conference proceedings by November 15, 2024.

Student Seminar

Student participants will receive presentation awards and compete for scholarships awarded through the AASV Foundation. The oral presentations will be judged to determine the scholarship amount.

The **Zoetis Foundation** has provided a $26,250 grant to the AASV Foundation to support awards and the top student presenter scholarship. This includes a $750 award for the student presenter of each paper selected for oral presentation at the meeting. Through the Zoetis Foundation's grant, the AASV Foundation will also award a $5000 scholarship to the student whose project and oral presentation are judged best overall.

Elanco Animal Health provides $20,000 in additional funding, enabling the AASV Foundation to award scholarships of $2500 each for 2nd through 5th place, $1500 each for 6th through 10th place, and $500 each for 11th through 15th place.

Student Poster Session

Abstracts that are not selected for oral presentation in the Student Seminar will be considered for presentation in a poster session at the Annual Meeting. Those who participate in the poster session will receive a $500 presentation stipend funded by the AASV Foundation through a grant from the **Zoetis Foundation**. All students selected to make a poster presentation will be expected to supply a brief paper formatted for publication in the conference proceedings by November 15. The guidelines for preparing posters for the display are available at **aasv.org/annmtg/2025/posters.php**.

Veterinary Student Poster Competition

The presenters of the top fifteen poster abstracts compete for scholarship awards ranging from $200 to $500 in the Veterinary Student Poster Competition, sponsored by **United Animal Health**. See **aasv.org/annmtg/2025/postercomp** for poster judging details.

In all cases, the student presenter is required to attend the meeting in person to make the presentation. Recorded/virtual presentations will not be accepted unless the meeting converts to an entirely virtual event.

Complete information for preparing and submitting abstracts is available at **aasv.org/annmtg/2025/studentseminar**. The rules for submission should be followed carefully. For more information, contact the AASV office by phone, 515-465-5255, or email, **aasv@aasv.org**.

Call for Submissions – Industrial Partners

The American Association of Swine Veterinarians invites submissions for the Industrial Partners oral and poster sessions at the 56th AASV Annual Meeting. This is an opportunity for commercial companies to make brief presentations of a technical, educational nature to members of the AASV. The conference will be held March 1-4, 2025 in San Francisco, California.

The oral sessions consist of a series of 15-minute presentations scheduled from 1:00 to 5:00 PM on Sunday, March 2. A poster session takes place the same day. Poster authors will be required to be stationed with their poster from noon until 1:00 PM, and the posters will remain on display throughout the afternoon and the following day for viewing.

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

SUBMISSION LIMIT: Restricted program space necessitates a limit on the number of presentations per company. Companies that are a member of the *Journal of Swine Health and Production* Industry Support Council **and** sponsor the AASV e-Letter may submit three topics for oral presentation. Companies that are **either** a member of the JSHAP Industry Support Council **or** sponsor the AASV e-Letter may submit up to two topics. All other companies may submit one topic for oral presentation. In addition, every company may submit one topic for poster presentation, but the topic must not duplicate the oral presentation. **All topics must represent information not previously presented at the AASV Annual Meeting or published in the meeting proceedings.**

To participate, send the following information to aasv@aasv.org by October 1, 2024:

1. Company name
2. Presentation title
3. Brief description of the presentation content
4. Presenter name (one only) and contact details (mailing address, telephone number, and email address)
5. Whether the submission is intended for oral or poster presentation

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

The presenting author is required to register* for and attend the meeting in person to make the presentation. Recorded/virtual presentations will not be accepted unless the meeting converts to an entirely virtual event.

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

Call for Abstracts – Research Topics

Plans are underway for the 56th Annual Meeting of the American Association of Swine Veterinarians (AASV) to take place March 1-4, 2025 in San Francisco, California.

As part of the meeting, there will be a session highlighting research projects related to swine health and production (virology, bacteriology, parasitology, environment, food safety, odor, welfare, etc.). Abstracts are now being accepted to be considered for presentation during the Research Topics session, which will be held Sunday, March 2.

Those interested in making a 15-minute oral presentation of **previously unpublished, applied research** must submit 2 copies of a one-sided, one-page abstract. One copy (for review purposes) should contain the abstract title but must omit the authors' names and affiliations. Use 1-inch margins and 12 pt Times New Roman font. Tables and figures may be included but must fit on the page with the text. The submitted abstracts will be used for review purposes only.

Submit abstracts to **aasv@aasv.org** no later than **August 15, 2024**. Provide the presenting author's name, mailing address, phone number, and email address within the email message accompanying each submission.

Abstracts not selected for oral presentation will be considered for poster presentation. All presenting authors will be notified of the selection results in September. Authors of abstracts selected for oral or poster presentation must provide a paper reformatted for publication in the conference proceedings by November 15, 2024.

PLEASE NOTE: It is not necessary to be an AASV member to submit an abstract or participate if selected. Participation in the Research Topics oral and poster session is at the presenter's expense. No speaking stipend or travel expense reimbursement is paid by the AASV.

The presenting author is required to register for and attend the meeting in person to make the presentation. Recorded or virtual presentations will not be accepted unless the meeting converts to an entirely virtual event.

Non-AASV member presenters may register for the meeting at the AASV regular member rate. Qualifying full-time graduate students must join AASV if they wish to register at the lower graduate student member rate.

AASV Board of Directors, committee leaders meet

The AASV Board of Directors met in West Des Moines, Iowa on April 24 and 25. On Wednesday, the board gathered with the AASV committee leaders to learn about recent committee activities and requests for board action, followed by a review of board member roles and responsibilities. The board convened for official business on Thursday. A summary of actions taken follows.

Swine Medicine Talks: The board approved the Student Engagement Committee's motion for $2500 to fund the Swine Medicine Talks in 2024-25.

Swine Housing Decisions: The board voted to form a task force to prepare a letter addressing swine housing decisions. Members will include Drs Sara Hough, Maryn Ptaschinski, Bill Hollis, and a member of the AASV Pig Welfare Committee.

Boar Stud Health, Hygiene, and Sanitation Guidelines: The board approved revisions to the guidelines requested by the Boar Stud Committee.

Swine Faculty Workforce Survey: The board approved the Collegiate Activities Committee's request to conduct a survey of the swine faculty workforce in the United States, Canada, and the Caribbean.

Porcine Reproductive and Respiratory Syndrome (PRRS) Virus Fact Sheets: The board voted to approve publication of two factsheets prepared by the PRRS Committee on PRRS virus next-generation sequencing and PRRS virus recombination.

Swine Health Improvement Plan (SHIP) Resolution: As requested by the Porcine Epidemic Diarrhea (PED) Elimination Task Force, the board voted to approve a resolution on PED virus health status certification for submission to the US SHIP House of Delegates.

Committee mission and name changes

Pharmaceutical Issues Committee Name and Mission Change: The board passed a motion to change the committee's name to Pharmaceutical and Biologics Committee and approved a revised mission statement, available at **aasv.org/members/only/committee/PharmaceuticalIssuesCommittee.php**.

Student Engagement Committee Mission Change: The board approved revising the committee's mission statement to include promotion of activities to support student development within the swine medicine profession. See **aasv.org/members/only/committee/StudentRecruitmentCommittee.php**.

Position statements

Position statements undergo review every 3 years on a rotating basis. See **aasv.org/aasv/positions** for all current positions.

The board voted to **reaffirm** the following AASV positions:

- Anti-Abuse Policy
- A North American program is needed to manage the risk of foreign animal disease introduction through feed ingredients
- Castration of Swine
- Permanent Identification of Swine
- Pig Welfare
- Swine Health Information Technology

The board voted to **revise** the following AASV positions:

- Influenza A Viruses
- Sow Housing
- Tail Docking and Teeth Clipping of Swine

The board voted to **approve new** AASV positions:

- PEDV Elimination
- Traceability

The board created a task force to prepare a new position statement on gene-editing technology.

Members of AASV can read complete AASV Board of Directors and Executive Committee meeting minutes at **aasv.org/aasv/board**.

Interested in joining a committee? Contact the AASV office by email, **aasv@aasv.org**, or phone, 515-465-5255.

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AASV news continued from page 179

AASV attends student career events

Several members volunteered to represent AASV at two spring student career events.

The American Pre-Veterinary Medical Association (APVMA) Symposium is an event that brings together pre-veterinary students from across the country to attend lectures, hands-on laboratories, and networking events. The 2024 symposium expo, which was held Saturday, March 9 at North Carolina State University, showcased the diversity of the profession. Attendees included 495 students and 29 advisors from 29 liberal arts colleges and universities. Attendees were able to choose from 30 lectures and 18 hands-on labs and visit 71 exhibitors at 40 different tables. The AASV sponsored the swine necropsy wet-lab.

Please thank the following members who volunteered their time to distribute student recruitment resources and represent the swine veterinary profession:

Drs Wesley Lyons and Heather Fowler represent AASV at the 2024 MANNRS Conference and Training Expo.

Drs Lisa Becton, Kayla Castevens, Mary Battrell, Jenna Scott, Daniel Boykin, Daniel Carreno, Brian Cerrito, Glen Almond, and Sara Hough. One volunteer commented, "We had a few students stop by that I think might be interested in swine production, but equally as important, we had a chance to share with those who are not."

Learn more about the APVMA at **apvma.org** and the AASV Student Recruitment Committee at **aasv.org/members/only/committee/StudentRecruitmentCommittee.php**.

The mission of Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS) is to promote academic and professional advancement by empowering minorities in agriculture, natural resources, and related sciences.

The annual training conference and career expo was held March 20-24, 2024 in Chicago, Illinois. More than 5000 high school, undergraduate, and graduate students from around the United States had the opportunity to attend lectures and workshops, network, and explore careers. More than 100 companies representing crops, food processing, academia, agrifinance, government, and animal agriculture attended the career expo.

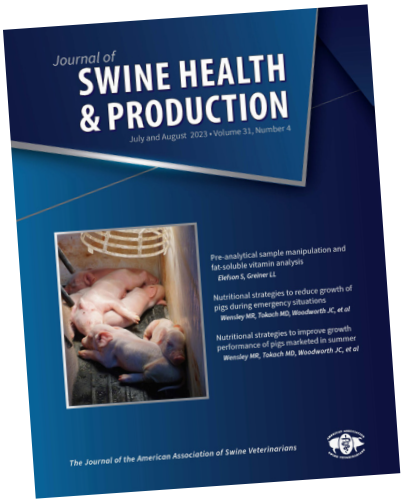
Please thank Drs Wesley Lyons and Heather Fowler for representing AASV and the swine veterinary profession. They reported that more than 200 highly engaged students visited the booth.

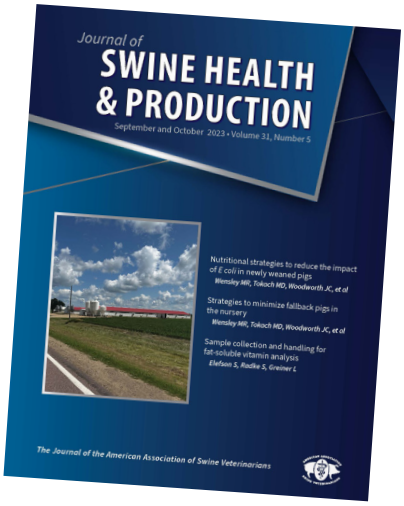
Learn more about MANRRS at **manrrs.org** and the AASV Diversity, Equity, and Inclusion Committee at **aasv.org/members/only/committee/DEI.php**.

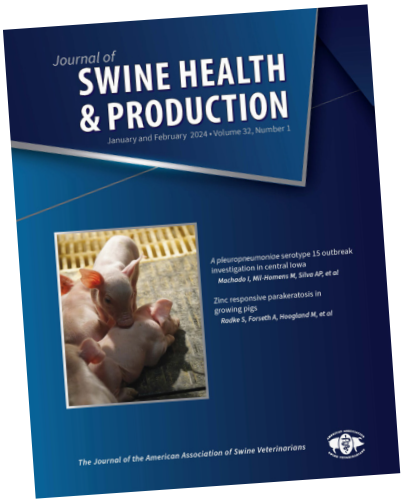
Drs Lisa Becton and Kayla Castevens represent AASV at the 2024 American Pre-Veterinary Medical Association Symposium.

AASV news continued on page 183

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**.

AASV news continued from page 181

Scholarships available for MentorVet Leap; apply by August 2

The American Association of Swine Veterinarians and MentorVet collaborated in spring 2023 to offer 5 scholarships to swine veterinarians early in their careers. After a successful pilot, AASV has again approved funding for scholarships for early-career swine veterinarians to participate in the 2024 MentorVet Leap program. Four additional scholarships are available for the fall 2024 MentorVet Leap program.

The MentorVet Leap program is a 6-month, entirely virtual, evidence-based mentorship and professional development program that aims to promote well-being and decrease burnout in the transition into veterinary practice. The mentorship program has been adapted to meet the needs of early-career swine veterinarians including swine-specific case examples and paired mentorship with a more experienced swine veterinarian.

In addition to paired mentorship, the program provides holistic support to veterinarians through a combination of professional skills training, financial and mental health coaching, and peer mentorship. Mentees engage in a self-paced online curriculum and then meet monthly with other early-career veterinarians to discuss shared challenges and share perspectives on how to create a sustainable career path.

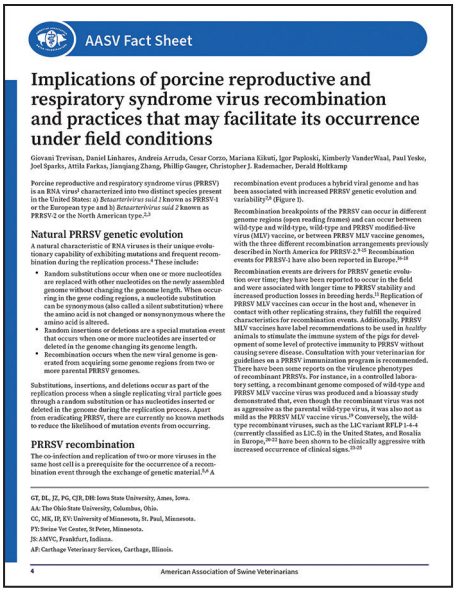
Jenna Scott, DVM, a 2023 AASV MentorVet Leap scholarship recipient, shared, "MentorVet Leap is a great way to gain knowledge and learn skills to better navigate early-career veterinary practice. Through the MentorVet Leap program, I have also been paired with an excellent mentor whom I plan to stay in communication with after the program ends. I have found it very helpful to have a supportive person to talk to about goals and stresses associated with work."

During the 2023 pilot, small-group discussions were facilitated by a MentorVet team member allowing early-career swine veterinarians to connect with one another and share experiences. After participating in the program in spring 2023, swine veterinarian Jordan Buchan shared, "Being able to discuss topics such as self-care, professional boundary setting, and conflict resolution, amongst many others, with colleagues in the same discipline of veterinary medicine, was life changing. In addition, being assigned an external professional mentor in the industry continues to be a great asset. I actively use the lessons learned during my participation in MentorVet every day in my career. I am very grateful to AASV for funding my enrollment in the program and know it will continue to be transformative for many young swine veterinarians in the future."

The fall 2024 Leap program will take place August 11, 2024 to January 31, 2025. The deadline to apply for the fall 2024 scholarship is August 2, 2024. AASV members who have received their veterinary degree in the past 5 years (Classes of 2020-2024) can apply for a scholarship to participate in the MentorVet Leap Program by visiting **mentorvet.net/scholarships**.

AASV PRRS Committee publishes factsheets

The Porcine Reproductive and Respiratory Syndrome (PRRS) Committee identified the need for educational materials on the use and interpretation of whole genome sequencing in the field and understanding recombination of the PRRS virus. The PRRS Committee published two factsheets to address this need. "When to use next-generation sequencing for clinical and epidemiological decisions related to porcine reproductive and respiratory syndrome virus," and "Implications of porcine reproductive and respiratory syndrome virus recombination and practices that may facilitate its occurrence under field conditions" are available on the AASV website at **aasv.org/documents/NGS-Factsheet.pdf** and **aasv.org/documents/Replication-Recombination-Factsheet.pdf**.



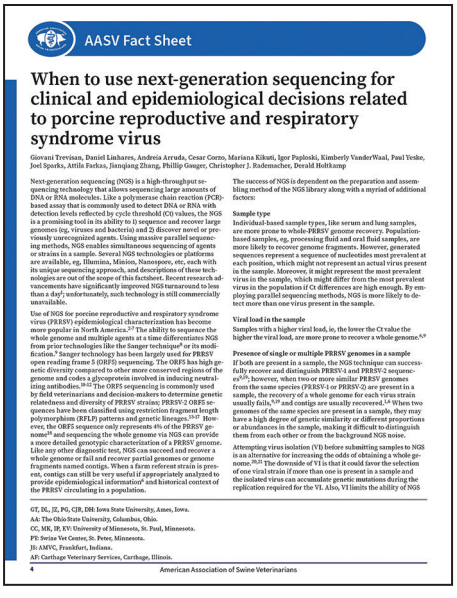
AASV Fact Sheet

Implications of porcine reproductive and respiratory syndrome virus recombination and practices that may facilitate its occurrence under field conditions

Giovani Trevisan, Daniel Linhares, Andreia Arruda, Cesar Corzo, Mariana Kikuti, Igor Paploski, Kimberly VanderWaal, Paul Yeske, Joel Sparks, Attila Farkas, Jianqiang Zhang, Phillip Gauger, Christopher J. Rademacher, Derald Holtkamp

Natural PRRSV genetic evolution

PRRSV recombination



AASV Fact Sheet

When to use next-generation sequencing for clinical and epidemiological decisions related to porcine reproductive and respiratory syndrome virus

Giovani Trevisan, Daniel Linhares, Andreia Arruda, Cesar Corzo, Mariana Kikuti, Igor Paploski, Kimberly VanderWaal, Paul Yeske, Joel Sparks, Attila Farkas, Jianqiang Zhang, Phillip Gauger, Christopher J. Rademacher, Derald Holtkamp

AASV Foundation GOLF OUTING

veenkergolf.com

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Tuesday, September 10th

11 AM – 6 PM

Veenker Memorial Golf Course

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REGISTRATION FORM

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(per person - includes 18 holes of best-ball golf, cart rental, beverages, lunch, and pork dinner)

☐ **TEAM registration - $500.00**
(group of four - list names below)

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2. _____
3. _____
4. _____

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Address_____
City, State, Zip _____
Email _____

REGISTER BY AUGUST 27

Return this form with payment to
AASV Foundation, 830 26th Street, Perry, IA 50220
or register online at **aasv.org/foundation/golf**.

aasv.org/foundation/golf

Let's golf!

Golfers, it is time to recruit and register your golf team to support the AASV Foundation! Registration is now open at **aasv.org/foundation/golf**.

Preregister by August 27 to join your colleagues in support of the AASV Foundation at Veenker Memorial Golf Course on **Tuesday, September 10**. We hope to repeat the experience of golfers at last year's September event, who enjoyed picture-perfect weather as they made their way around the scenic course in Ames, Iowa.

Everyone is welcome! AASV members, industry stakeholders, clients, staff, family, and friends are all invited to register a 4-person team for this 18-hole, best-ball tournament. Individual golfers and pairs are also welcome and will be assigned to a team. The registration fee ($125 per golfer or $500 per team) includes 18 holes of best-ball golf, cart, lunch, beverages, awards dinner, and prizes.

Golfer check-in and warm-up on the driving range begins at 11:00 AM, followed by a shotgun start at noon. Golfers compete as a foursome in addition to participating in individual games and contests hosted by sponsors at various holes across the course.

Lunch, sponsored by **Merck Animal Health**, is provided to golfers before they tee off and beverage tickets supplied by **Zoetis** will help golfers stay hydrated

throughout the afternoon. At the conclusion of the afternoon, scores will be tallied, ties will be broken, and the team and individual contest winners will be announced by event coordinator Dr Josh Ellingson during the pork dinner sponsored by **Boehringer Ingelheim Animal Health**.

Funds raised by the event support AASV Foundation programs, including research grants, travel stipends for students attending the AASV Annual Meeting, swine externship grants, scholarships for veterinarians pursuing board certification in the American College of Animal Welfare and the American Board of Veterinary Practitioners, student debt relief scholarships, AASV heritage videos, and more.

For a sneak peek at the golf course, visit **veenkergolf.com**. For more information or to register, see **aasv.org/foundation/golf**, or contact AASV by phone, 515-465-5255, or email, **foundation@aasv.org**.

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UPCOMING MEETINGS

ISU James D. McKean Swine Conference

July 23 - 24, 2024 (Tue-Wed)
Scheman Building
Iowa State University
Ames, Iowa

For more information:
Tel: 515-294-6222
Email: **registrations@iastate.edu**
Web: **regcytes.extension.iastate.edu/swinedisease**

International Conference on Boar Semen Preservation

August 19 - 22, 2024 (Mon-Thu)
Vic, Barcelona, Spain

For more information:
Email: **info@boarsemen2024.com**
Web: **boarsemen2024.com**

Carthage Veterinary Service 34th Annual Swine Conference

August 27, 2024 (Tue)
Oakley-Lindsay Center
Quincy, Illinois

For more information:
Web: **hogvet.com**

Allen D. Leman Swine Conference

September 21 - 24, 2024 (Sat-Tue)
St Paul River Center
Saint Paul, Minnesota

For more information:
Web: **lemanconference.umn.edu**

US Animal Health Association 128th Annual Meeting

October 10 - 16, 2024 (Thu-Wed)
Gaylord Opryland Hotel
Nashville, Tennessee

For more information:
Web: **usaha.org/meetings**

13th Leman China Swine Conference & World Swine Industry Expo

October 25 - 27, 2024 (Fri-Sun)
Western China International Expo City
Chengdu city, Sichuan province, China

For more information:
Tel: +86 010 60600195
Email: **andyzhang@shixin-expo.com**
Web: **lemanchina.com**

AVMA Diversity, Equity, Inclusion, and Wellbeing Summit

November 7 - 9, 2024 (Thu-Sat)
Atlanta, Georgia

For more information:
Web: **avma.org/events**

Pig Research Summit 2024

November 20 - 21, 2024 (Wed-Thu)
Crowne Plaza Copenhagen Towers
Copenhagen, Denmark

For more information:
Web: **pigresearchsummit.com**

2025 AVMA Veterinary Leadership Conference

January 9 - 11, 2025 (Thu-Sat)
Chicago, Illinois

For more information:
Web: **avma.org/events/veterinary-leadership-conference**

American Association of Swine Veterinarians 56th Annual Meeting

March 1 - 4, 2025 (Sat-Tue)
San Francisco Marriott Marquis
San Francisco, California

For more information:
American association of Swine Veterinarians
830 26th Street
Perry, Iowa

Tel: 515-465-5255
Email: **aasv@aasv.org**
Web: **aasv.org/annmtg**

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

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