

Journal of

SWINE HEALTH & PRODUCTION

November and December 2023 • Volume 31, Number 6



Evaluating efficacy of ammunition for the euthanasia of market-weight pigs

Stahl CA, Fangman TJ, Fangman JT

First detection of SVA in pigs from Mexico

Navarro-López R, Perez-de la Rosa JD, Rocha-Martínez MK, et al

Salt toxicosis management

Rademacher CJ, Greiner LL, Radke SL

The Journal of the American Association of Swine Veterinarians





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

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

The *Journal of Swine Health and Production* is a refereed publication and is a benefit of membership in the American Association of Swine Veterinarians. For inquiries regarding membership or subscriptions, please contact:

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

Editorial questions, comments, and inquiries should be addressed to Rhea Schirm, Publications Manager:
Email: jshap@aasv.org.

DISCLAIMER

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

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

JOURNAL OF SWINE HEALTH AND PRODUCTION

(ISSN 1537-209X) Volume 31, Number 6; November and December
Copyright © 2023 American Association of Swine Veterinarians

AASV STAFF

Harry Snelson
Executive Director,
snelson@aasv.org

Sue Schulteis
Associate Director,
aasv@aasv.org

Abbey Canon
Director of Public Health
and Communications,
canon@aasv.org

Dave Brown
Webmaster/IT Specialist,
dave@aasv.org

AASV OFFICERS

William Hollis
President,
hollis@hogvet.com

Angela Baysinger
President-elect,
angela.baysinger@merck.com

Locke Karriker
Vice President,
karriker@iastate.edu

Michael Senn
Immediate Past President,
senn-hpvc@cox.net

JSHAP STAFF

Terri O'Sullivan
Executive Editor,
jshap@aasv.org

Sherrie Webb
Associate Editor,
webb@aasv.org

Rhea Schirm
Publications Manager,
Advertising Coordinator,
jshap@aasv.org

Emily Hanna
Proofreader

Tina Smith
Graphic Designer,
tina@aasv.org

Laura Batista
Spanish translator

Serge Messier
French translator

Zvonimir Poljak
Consulting Epidemiologist

EDITORIAL BOARD

Glen Almond
North Carolina,
glen_almond@ncsu.edu

Andréia G. Arruda
Ohio, arruda.13@osu.edu

Marie Culhane
Minnesota, grame003@umn.edu

Russ Daly
South Dakota,
Russell.Daly@sdstate.edu

Phil Gauger
Iowa, pcgauger@iastate.edu

Jordan Gebhardt
Kansas, jgebhardt@vet.k-state.edu

Daniel Linhares
Iowa, linhares@iastate.edu

Meghann Pierdon
Pennsylvania,
mpierdon@upenn.edu

Alex Ramirez
Arizona,
alexramirez@arizona.edu

Mike Tokach
Kansas, mtokach@ksu.edu

Beth Young
Sweden,
byoung.dvm@gmail.com

TABLE OF CONTENTS

President’s message	273
Executive Director’s message	275
From the Editorial Office	277
Evaluating the efficacy and safety of differing gun caliber and ammunition combinations for the euthanasia or depopulation of market-weight pigs	278
<i>Stahl CA, Fangman TJ, Fangman JT</i>	
Conversion tables	288
First detection and genetic characterization of Senecavirus A in pigs from Mexico	289
<i>Navarro-López R, Perez-de la Rosa JD, Rocha-Martínez MK, et al</i>	
Management of sodium ion toxicosis – water deprivation syndrome	295
<i>Rademacher CJ, Greiner LL, Radke SL</i>	
News from the National Pork Board	299
AASV news	301
AASV Annual Meeting Program	305
AASV Foundation news	309
Advocacy in action	314
Thank you, reviewers.....	319
Cumulative index	320
Upcoming meetings	323

Cover photo is courtesy of
Tina Smith
(taken at University of Missouri).

Download this issue at [www.aasv.org/shap/
issues/v31n6/v31n6jshap.pdf](http://www.aasv.org/shap/issues/v31n6/v31n6jshap.pdf)



JSHAP SPOTLIGHT

Dr Laura Greiner

Iowa State University

Dr Laura Greiner earned a BS ('96), MS ('99), and PhD ('01) from Iowa State University (ISU). Dr Greiner currently serves as the Director of the Iowa Pork Industry Center where she works to educate Iowa swine producers about new production information and research while also teaching pork production to ISU undergraduate students. Dr Greiner serves as a JSHAP reviewer and encourages contributors to “provide as much detail as possible to help all readers understand what was conducted and evaluated. The more you share concerning the research or case study, the better our readers can draw their own conclusions and enrich their understanding.”

BACKED BY DATA. PROVEN IN PIGS.

SAFE + EFFECTIVE

NO DRAG

1.17lb
per day ADG

1.19lb
per day ADG

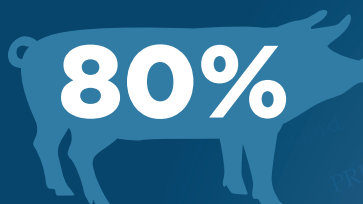
PRRSgard*

Control

No statistical difference in average daily gain between vaccinates and control pigs D0-42.**

0%
**DIFFERENCE
IN NURSERY
LIVABILITY**

No difference in livability between vaccinates and control pigs.*



80%

of naïve pen-mates
tested PRRS
negative after
6 WEEKS

At 41 days post-vaccination, 80% of the control pigs (57/71) tested negative for PRRSGard RT-PCR compared to 20% (14/71) of the control pigs that tested positive.



82%
less time viremic

1.10 weeks in vaccinates and 2.0 weeks in control group.***



75%
fewer viremic pigs

Mean TCID of 3.0 for placebo pigs compared to mean TCID of 0.75 for vaccinates at 14 days post-vaccination.***



zero VIRUS DETECTION IN AIR FOR 35 DAYS

There was no PRRSV detected in aerosol samples at any of the three test locations up to 35 days post-vaccination, when aerosol testing concluded.***

See for yourself at [PRRSGard.com](https://www.prrsgard.com)



Pharmgate
ANIMAL HEALTH

* 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.

California dreaming

It seems our hog producers and the state of California have shared the news reels all year with regards to sow gestation housing and animal welfare regulation. There is more than enough political fodder on this subject for even the largest consumer of the evening news. My parents fall into that category, by the way. I am concerned that the media shift to narrow-focused political agenda shaping may have created less of what we are looking for and removed all sense of original thinking. Even so, we find ourselves in the news and on the debate floor.

Debate regarding the AASV Annual Meeting at the recent fall AASV Board of Directors meeting leads me to raise this topic. Seven years ago, the AASV Board of Directors voted to hold the Annual Meeting in San Francisco in 2021. Due to COVID-19, the San Francisco meeting venue had to be rescheduled and now in 2025, we are locked and loaded for a California AASV Annual Meeting.

Many of you know the AASV Annual Meeting is not only a large financial obligation of the organization, but it is also our collective single largest means of

membership outreach. We are known for excellent scientific rigor and challenging debate. The AASV Annual Meeting is where relationships are strengthened, personal development goals are discussed, and much animal health business planning is outlined for the new year.

Debate around the San Francisco meeting leads me to encourage our membership to start California dreaming! California is a very diverse state with a great deal to offer. One of my most interesting production consulting clients is a northern California pasture farmer. His spring photos are beautiful. His customers love his product. We were fortunate that he called with some simple herd management questions.

We need to start planning today for San Francisco – AASV personal development activities for our businesses. If you are responsible for the development of veterinarians or the talent of veterinary teams, start planning today to host events and meaningful activities guaranteed to draw a crowd! If you are a student, start seeking fund raising sources today. It is amazing to me the resources available from the AASV Foundation and the various

“The AASV Annual Meeting is where relationships are strengthened, personal development goals are discussed, and much animal health business planning is outlined for the new year.”

university groups with the specific mission to support student development. As Dr Locke Karriker shared at our recent board meeting, “If you have an axe to grind with California – get to the meeting.” Holding healthy debate is the only way to have your experiences heard. You are the only expert on your specific professional experiences. Plan now to come to the California meeting and share in what is certain to be lively debate.

In the meantime, the 2024 Annual Meeting will be held in Nashville, Tennessee and is anticipated to be very well attended. Nashville is centrally located, easy to get to, and has lots of entertainment opportunities. Check out the 2024 Annual Meeting program in this issue of JSHAP or online at aasv.org/annmtg. Get your hotel room reserved and proceedings papers started!

William L Hollis, DVM
AASV President





Boehringer
Ingelheim

COMPLETE
CONFIDENCE

ARE YOUR PIGS COUGHING BEHIND YOUR BACK?



Start listening to your pigs to get
the best ROI.

SoundTalks® is a listening device that can detect respiratory disease up to five days earlier than conventional methods.¹ This gives producers valuable health data and proven ROI through early intervention and increased pig performance.

To learn how you can hear when you're not there, go to bi-animalhealth.com/swine.

HEAR TO PROTECT

¹ A. Spronk, D. Polson, S. Playter. Field application of cough monitor technology: A swine practitioner's perspective.

SoundTalks® is a registered trademark of SoundTalks NV, used under license.
©2022 Boehringer Ingelheim Animal Health USA Inc., Duluth, GA. All Rights Reserved.
US-POR-0265-2022



Cow docs have challenges, too

I just returned from attending the American Association of Bovine Practitioners' (AABP) 56th Annual Convention. The meeting was held in Milwaukee, Wisconsin. By all accounts, the meeting was well-attended with just over 1100 attendees. This was a nice recovery following a disappointing turnout last year in Long Beach, California (which I am told resulted in a significant loss in revenue for the association). Overall, the practitioners I spoke with seemed positive and the general tone of the meeting was upbeat. I think everyone was happy to be coming together again and getting back to "normal." It occurred to me that our two organizations have really grown up together.

I had the opportunity to sit in on their Board of Directors meeting on Wednesday. As I listened to them work their way through the issues on the agenda, I was struck by how similar their challenges are to ours. One of the main concerns for AABP members is the employment of recent graduates. The board discussed the results of a recent senior student survey conducted by the association. The results mirror many of the challenges the swine veterinary profession is facing as well.

The survey was distributed to 273 AABP student members with graduation dates in 2023, of which 161 responded. The gender breakdown was approximately 24% male, 75% female, and 1% nonbinary. When asked what they plan to do post graduation, 117 respondents planned to enter a mixed-animal practice while 27 were going into a bovine-exclusive private practice. Five individuals reported planning to work with bovine but not in private practice and 12 were not planning to work with bovine going forward. The overall breakdown indicated that 148 respondents would be working in private practice, 7 completing internships, 1 in industry, and 5 reported "other."

In an effort to evaluate the employment opportunities available to this year's graduates, the survey asked how many job offers each individual had received. Survey results indicated that 102 respondents had received 3 or more offers, 36 had received 2 offers, 18 had received one offer, and 4 reported receiving no job offers. Starting salary ranges offered were < \$69,999 (18 respondents), \$70,000 - \$84,999 (56 respondents), \$85,000 - \$99,999 (44 respondents), and >\$100,000 (42 respondents).

The starting salary ranges were interesting considering the reported levels of student debt. Seventeen students reported having no educational debt, 45 students had <\$100,000, 72 students had \$100,000 - \$200,000, and 26 students found themselves saddled with over \$200,000 of educational debt. Obviously, the amount of educational debt made starting salary a significant consideration when evaluating employment opportunities (46 respondents included salary/compensation as an obstacle to employment). Salary, however, was not the only consideration respondents noted. Nine listed biases of various types as an obstacle to employment and 95 expressed concerns over the hours of work required.

"One of the main concerns for AABP members is the employment of recent graduates."

As you are hopefully aware, AASV is exploring the issue of attracting veterinarians and recent graduates to the swine veterinary profession, as well as how to retain those currently practicing. We have funded a study to engage with a sample of our members that have decided to either move away from swine practice or out of swine medicine altogether. The goal of this study is to help us understand what issues are driving this migration with the hope of shifting that tide. In addition, the AASV Foundation is also considering ways they might contribute to encouraging students to pursue a career in swine veterinary medicine.

The 2023 AASV Salary Survey provides some insight into the current status of employment within the swine veterinary profession as expressed by AASV members. I hope you were one of the 43% of our eligible members that took the time to participate in the survey.

When you have the chance, take the time to encourage a student that might be interested in swine medicine or an existing member who might be considering a move away from swine. You are the best ambassador for our profession.

Harry Snelson, DVM
Executive Director





WE MOMS

Systemwide performance starts with the sow.



Strong sow research can change your system.

UnitedAnH.com/Mother

Terri's favorites

In my January-February 2023 message¹ I introduced the JSHAP editorial series “Behind the scenes in 2023.” At the heart of the series, the goal was to have JSHAP team members share their contributions to the journal. The messages were entertaining from learning about wearing other people’s underwear to putting together the pieces of the journal puzzle including managing, editing, proofreading, graphics, publishing and more.²⁻⁵

My favorite aspect of the behind-the-scenes series is that members of the JSHAP team brought their own stories, backgrounds, and unique voices to the series. This really highlighted the wide variation in our expertise ranging from scientific background, editorial editing, managing, proofreading, and digital production, and really underscores the effort and teamwork involved in putting the journal together. If you have not read the series, I encourage you to go back and have a peek throughout the 2023 issues.

The November-December issue is also a favorite of mine because it is the issue where we thank our reviewers. I am always impressed and thankful to continually receive comprehensive and

high-quality reviews from our reviewers. If you have not been a reviewer for JSHAP in the past, we are always looking for reviewers so do not hesitate to contact Rhea Schirm (jshap@asav.org) or complete our new reviewer survey (uoguelph.eu.qualtrics.com/jfe/form/SV_416D52bMubewq7c). The journal would not be successful without the support of our editorial board members, staff members, and the AASV Industry Support Council.

Another of my favorite sections of the journal is the JSHAP Spotlight piece that we introduced in 2021.⁶ This is the section of the journal that provides a short bio on different people who have contributed to the journal, including our editorial board members and a few of our many reviewers. Our 2024 Spotlight feature will highlight a different demographic, but I will not say any more and spoil the surprise! Be sure to keep an eye on that section in the 2024 issues.

And, of course, another of my favorite aspects is the core of the journal, the scientific manuscripts. The journal continues to receive and review high-quality contributions to the scientific literature.

Thank you to everyone who has contributed, and continues to contribute, to the success of the journal and for being part of the JSHAP team!

I hope you enjoy this issue of the journal.

Terri O’Sullivan, DVM, PhD
Executive Editor

“My favorite aspect of the behind-the-scenes series is that members of the JSHAP team brought their own stories, backgrounds, and unique voices to the series.”

References

- *1. O’Sullivan T. Behind the scenes in 2023 [editorial]. *J Swine Health Prod.* 2023;31(1):9.
 - *2. Webb S. Refining and polishing a manuscript [editorial]. *J Swine Health Prod.* 2023;31(2):71.
 - *3. Smith T. What are your thoughts on wearing other people’s underwear? [editorial]. *J Swine Health Prod.* 2023;31(3):117.
 - *4. Schirm R. The JSHAP publication manager and advertising coordinator roles [editorial]. *J Swine Health Prod.* 2023;31(4):185.
 - *5. Hanna E. Emily’s role as proofreader [editorial]. *J Swine Health Prod.* 2023;31(5):229.
 - *6. O’Sullivan T. Introducing JSHAP Spotlight [editorial]. *J Swine Health Prod.* 2021;29(1):9.
- * Non-refereed references.



Evaluating the efficacy and safety of differing gun caliber and ammunition combinations for the euthanasia or depopulation of market-weight pigs

Chad A. Stahl, PhD; Thomas J. Fangman, DVM, MS, DABVP; John T. Fangman, PE

Summary

Objective: Evaluate the effectiveness and safety of firearm caliber and ammunition combinations that could be used on farm for euthanasia of market-weight pigs.

Materials and methods: Heads from 64 market-age pigs (32 barrows and 32 gilts) were collected from a federally inspected slaughter facility. Heads were randomly assigned to one of 4 caliber and ammunition combinations: .22 long rifle (LR), .22 Magnum (Mag), .38 Special, and 9 mm. The fully jacketed ammunition was discharged from each of the 4 unique firearms (each with a 16-in barrel length) while ensuring a consistent muzzle to forehead distance of 12.7 cm.

Results: The 9 mm bullets traveled further through the head and into the ballistic gel ($P < .001$) and the furthest total distance ($P < .001$). Bullets from the .38 Special traveled further into the ballistic gel and a further total distance than both the .22 LR and .22 Mag ($P < .001$). The trauma area of the brain was greater for the 9 mm and the .38 Special bullets when compared to .22 LR or .22 Mag, respectively ($P < .001$). There was no difference in the trauma area of the brain for the .22 LR bullets compared to .22 Mag bullets ($P = .12$).

Implications: This proof-of-concept study generated data to define efficacy and safety considerations when using a firearm to euthanize market-weight pigs and demonstrated that the .22 LR full metal jacket bullet could provide predictable euthanasia in market-weight pigs with minimal risk of contralateral emergence.

Keywords: swine, depopulation, euthanasia, gunshot, ammunition

Received: November 7, 2022

Accepted: May 9, 2023

Resumen - Evaluación de la eficacia y seguridad de diferentes combinaciones de calibre de arma y municiones para la eutanasia o despoblación de cerdos de peso de mercado

Objetivo: Evaluar la efectividad y seguridad de las combinaciones de calibre de arma de fuego y municiones que podrían usarse en una granja para la eutanasia de cerdos de peso de mercado.

Materiales y métodos: Se utilizaron 64 cerdos en edad de mercado (32 machos castrados y 32 hembras) de un rastro inspeccionado por el gobierno federal. Los animales fueron asignados aleatoriamente a una de las combinaciones de calibre 4 y municiones: .22 rifle largo (LR),

.22 Magnum (Mag), .38 Especial, y 9 mm. La munición completamente encamisada se descargó de cada una de las 4 armas de fuego (cada una con una longitud de cañón de 16 pulgadas) al mismo tiempo que se aseguraba una distancia constante del cañón a la frente de 12.7 cm.

Resultados: Las balas de 9 mm viajaron más lejos a través de la cabeza y en el gel balístico ($P < .001$) y la distancia total más lejana ($P < .001$). Las balas del .38 Especial viajaron más lejos en el gel balístico y a una distancia total mayor que el .22 LR y el .22 Mag ($P < .001$). El área de trauma del cerebro fue mayor para las balas 9 mm y .38 Especial en comparación con .22 LR o .22 Mag,

respectivamente ($P < .001$). No hubo diferencia en el área de trauma del cerebro para las balas .22 LR en comparación con las balas .22 Mag ($P = .12$).

Implicaciones: Este estudio de prueba de concepto generó datos para definir las consideraciones de eficacia y seguridad al usar un arma de fuego para sacrificar cerdos de peso de mercado y demostró que la bala con cubierta metálica completa .22 LR podría proporcionar una eutanasia predecible en cerdos de peso de mercado con un riesgo mínimo de emergencia contralateral.

CAS: Food Animal Consultation & Testing Services, Des Moines, Iowa.

TJF: Huvepharma Inc, Peach Tree City, Georgia.

JTF: Independent Consultant, Kansas City, Missouri.

Corresponding author: Dr Thomas J Fangman, 17919 Country Club Rd, Atchison, KS 66002; Tel: 660-621-1272; Email: thomasfangman59@gmail.com

Stahl CA, Fangman TJ, Fangman JT. Evaluating the efficacy and safety of differing gun caliber and ammunition combinations for the euthanasia or depopulation of market-weight pigs. *J Swine Health Prod.* 2023;31(6):278-288. <https://doi.org/10.54846/jshap/1342>

Résumé - Évaluation de l'efficacité et de la sécurité de différentes combinaisons de calibres d'armes à feu et de munitions pour l'euthanasie ou le dépeuplement de porcs de poids de marché

Objectif: Évaluer l'efficacité et la sécurité des combinaisons de calibres d'armes à feu et de munitions qui pourraient être utilisées à la ferme pour l'euthanasie des porcs de poids de marché.

Matériels et méthodes: Des têtes de 64 porcs d'âge commercial (32 castrats et 32 cochettes) ont été prélevées dans un abattoir inspecté par le gouvernement fédéral. Les têtes ont été assignées au hasard à l'une des quatre combinaisons de calibre et de munitions: .22 long rifle

(LR), .22 Magnum (Mag), .38 Special, et 9 mm. Les munitions entièrement gainées ont été déchargées de chacune des quatre armes à feu uniques (chacune avec une longueur de canon de 16 pouces) tout en garantissant une distance constante entre le museau et le front de 12.7 cm.

Résultats: Les balles de 9 mm ont voyagé plus loin à travers la tête et dans le gel balistique ($P < .001$) et la distance totale la plus éloignée ($P < .001$). Les balles du .38 Special ont voyagé plus loin dans le gel balistique et une distance totale plus longue que les .22 LR et .22 Mag ($P < .001$). La zone traumatique du cerveau était plus grande pour les balles 9 mm et .38 Special par rapport à .22 LR ou .22 Mag,

respectivement ($P < .001$). Il n'y avait aucune différence dans la zone traumatique du cerveau pour les balles .22 LR par rapport aux balles .22 Mag ($P = .12$).

Implications: Cette étude de preuve de concept a généré des données pour définir les considérations d'efficacité et de sécurité lors de l'utilisation d'une arme à feu pour euthanasier des porcs de poids commercial et a démontré que la balle à enveloppe métallique .22 LR pouvait fournir une euthanasie prévisible chez les porcs de poids commercial avec un risque minimal d'émergence controlatérale.

Euthanasia of livestock is sometimes necessary, and it is important that it be conducted skillfully to quickly render the animal unconscious and insensible to pain while being mindful of personal safety. Important considerations when determining the most appropriate method of euthanasia include human safety, animal welfare, practicality, cost limitations, aesthetics, and technical skill requirements.¹ A gunshot to the head is an effective method of euthanasia of swine if conducted correctly.¹ The impact caused by the penetrating bullet causes concussion and damage to vital areas of the market-weight pig brain. When faced with on-farm depopulation of market-weight pigs, many producers use a firearm as an approved method of depopulation.² There is an abundance of historical information on the general considerations of euthanasia, human safety, and proper firearm placement.^{1,3} More recently, scientific data has been generated to further define proper caliber and ammunition selection to achieve a minimum energy of 300 foot-pounds (ft-lb) for a predictable, humane death by gunshot for animals weighing up to 400 pounds.⁴ Nevertheless, there is little to no information illustrating both the efficacy and safety of firearms when using the multiple caliber and ammunition combinations currently available: .22 long rifle (LR), .22 Magnum (Mag), .38 Special, or 9 mm. Nor is there a definitive methodology for assessing said efficacy and safety concerns. This lack of information was exacerbated by an unpredictable increase in consumer demand for lead round-nose and jacketed hollow-point bullets, leaving the full metal jacket (FMJ) bullet as the only readily available option in each of the

mentioned calibers during the summer of 2020. Hence, a proof-of-concept exercise predicated upon the ability to conceptualize and evaluate the effectiveness and safety of multiple caliber and ammunition combinations is warranted and of need to the swine industry now and in the event of a foreign animal disease outbreak.

Animal care and use

This proof-of-concept study is exempt from animal care and use approval as no live animals were used. Heads from market-weight pigs were obtained from a federally inspected slaughter facility subject to the US Humane Methods of Slaughter Act.

Materials and methods

Raw material acquisition, transport, and preparation

Heads ($N = 64$) from an equal number of market-weight barrows and gilts were collected from the harvest floor of a federally inspected slaughter facility, wrapped in plastic, placed within cardboard boxes, transported for 7 hours at ambient temperature, and delivered to a ballistic range located in central Missouri over the course of 2 collection days. Upon arrival, heads were removed from their packaging and randomly assigned to one of 4 caliber and ammunition combinations consisting of the .22 LR, .22 Mag, .38 Special, and 9 mm. All bullets were fired from rifles with a 16-in barrel length. Once the caliber and ammunition combinations were randomly assigned, heads were placed upon a table fitted with a wooden reinforcement bracket that provided support

to the left and right temporal regions. The table height was adjusted so that the forehead height was 76.2 cm from the ground, which closely approximates the head height of a market-weight pig. A rubber tarp strap was positioned over the snout and securely fastened to each side of the table to ensure further stability of the target. Two ballistic gel blocks (40.6 cm long \times 15.2 cm high \times 15.2 cm wide) were placed directly posterior to the head and stacked with a 5.0-cm offset with the top block closest to the head so that the total ballistics gel distance of the stack was 50.8 cm from top diagonal to bottom diagonal (Figure 1). These stacked ballistic gel blocks also provided support for the head.

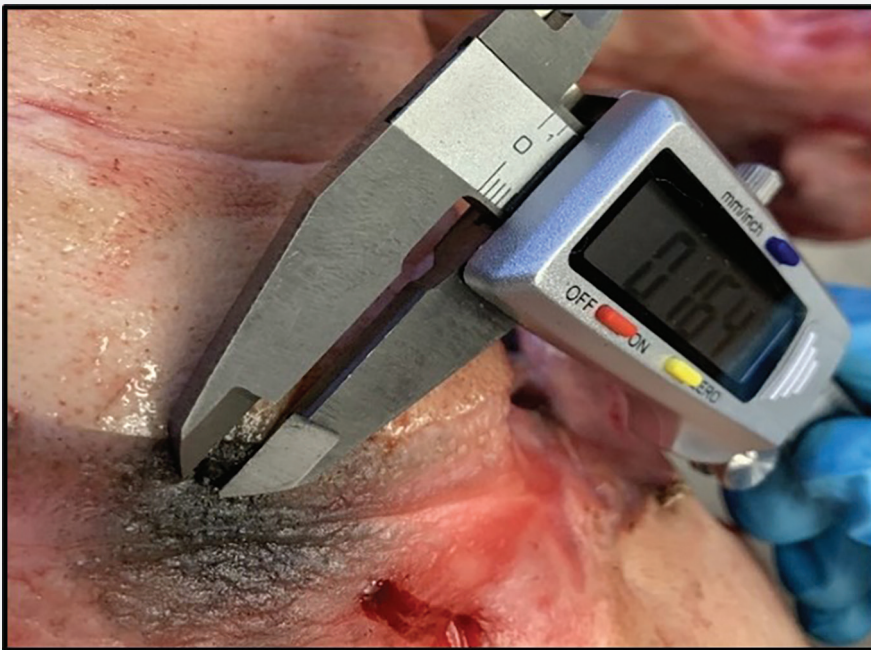
Firearm placement and ammunition discharge

Professionals trained as ballistic experts from Rooster Industries LLC (Columbia, Missouri) provided the firearms and fired the rounds into the skulls. Firearm placement and proper distance from the target was determined using a 12.7-cm jig mounted to the end of the barrel that served to position the barrel of each firearm in a fixed distance from the head when fired (Figure 1). Each caliber/ammunition combination accounted for sex (8 barrow and 8 gilt heads). Further head variability occurred as a portion of the heads obtained from the federally inspected slaughter facility were skinned. Because of this, an effort was made to include presence or absence of skin (0, 1) as a variable equally within each caliber/ammunition combination and between both sexes. Immediately following firearm discharge, penetration depth into the ballistic gel was determined for each

Figure 1: Stabilization of head and demonstration of 12.7-cm jig used for positioning muzzle distance. A rubber tarp strap was positioned over the snout and securely fastened to each side of the table to ensure further stability of the target. Two ballistic gel blocks (40.64 cm long × 15.24 cm high × 15.2 cm wide) were placed directly posterior to the head and stacked with a 5.08-cm offset with the top block closest to head so that the total ballistic gel distance of the stack was 50.80 cm from top diagonal to bottom diagonal. These stacked ballistic gel blocks also provided support for the head.



Figure 2: Measurement of entrance wounds were taken from the furthest margin on the skin to account for skin contraction after bullet penetration using a digital caliper.



bullet that remained after leaving the skull (not all bullets were contained by the gel and some bullets fragmented). Each head was identified with a unique animal identification number (1-64) and letter indicating the caliber utilized (A = .22 LR, B = .22 Mag, C = .38 Special, D = 9 mm).

Skull and brain evaluation

Heads were chilled at approximately 39°F for 12 hours following bullet placement and prior to dissection and assessment of both the skull and brain. Chilling of the heads prior to dissection was conducted to solidify brain tissue and allow for accurate grid measurements of brain tissue following ballistic trauma. Approximately 12 hours after chilling, heads were weighed to the nearest .05 kg and the lower portion of the jaw was removed to better facilitate the longitudinal sawing of heads into equal halves from tip of the snout to back of the skull. Prior to bifurcation of the skull, the diameter of the bullet entry wound was measured with a digital caliper (Work-Zone). Entry wound measurements were taken from the furthest margin on the skin to account for skin contraction after bullet penetration (Figure 2). If skin was not present, entry wound diameter was determined by measuring the inside margin of exposed bone. Heads were marked with a chalk line from the center of the snout to the center of the head behind the ears using a straight classic chalk reel (Irwin). A Sawzall reciprocating saw (Milwaukee Tool) with a 20.3-cm all-purpose blade was used to cut the heads into equal halves by following the chalked line (Figure 3). Once the skulls were bifurcated, the thickness of the skull was measured from the point of bullet entry to the dorsal margin of the brain cavity (Figure 4). Skull penetration depth was measured with a probe following the path of the bullet from the point of entry to the point of exit or to the location where the bullet or fragments were identified (Figure 4). Penetration depth into the ballistics gel was also measured if it occurred and reported as a combined penetration depth of skull and ballistics gel. Not all bullets exited the skull and not all bullets that exited the skull could be retrieved as some went beyond the gel and some fragmented.

Figure 3: A Sawzall saw (Milwaukee Tool) with a 20.32-cm all-purpose blade was used to cut the heads into equal halves.

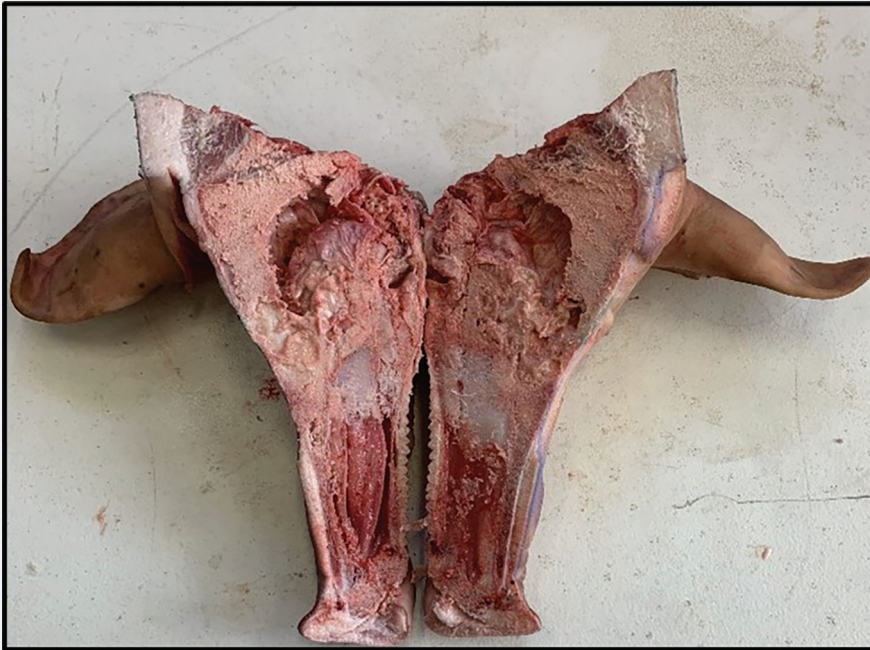


Figure 4: Skull thickness was measured from the point of bullet entry to the dorsal margin of the brain cavity. Skull penetration depth was measured with a probe following the path of the bullet from the point of entry to the point of exit or to the location where the bullet or fragments were identified.



A plastic loin eye area grid (Ames, Iowa) was used to obtain measurements of the exposed brain (both halves) by placing this grid over each section and counting the number of dots covering the brain surface (Figure 5). The mean grid dot score was divided by 20 to determine the surface area (in²) of the exposed brain. The surface area value was then converted to cm². The percentage of damaged brain tissue was also measured with the grid. Each half of the brain was carefully dissected from the skull and weighed to the nearest gram to determine brain weight.

When possible, bullets were retrieved from the head or ballistic gel with a 60% (36 of 60 bullets) retrieval rate. For the bullets and fragments retrieved, bullet weight (grains) and diameter (cm) were recorded. These values were compared to manufactured weights and premeasured diameters to calculate bullet expansion and weight loss following skull penetration and ballistic gel when applicable.

Chronograph data acquisition

A ballistic precision chronograph (Cladwell Shooting Supply) was used to determine the actual velocity of 5 bullets in each caliber fired from a 16-in barrel. The mean of the 5 chronograph velocity values was used to determine the bullet energies with the following formula³: (velocity² × bullet weight)/450240.

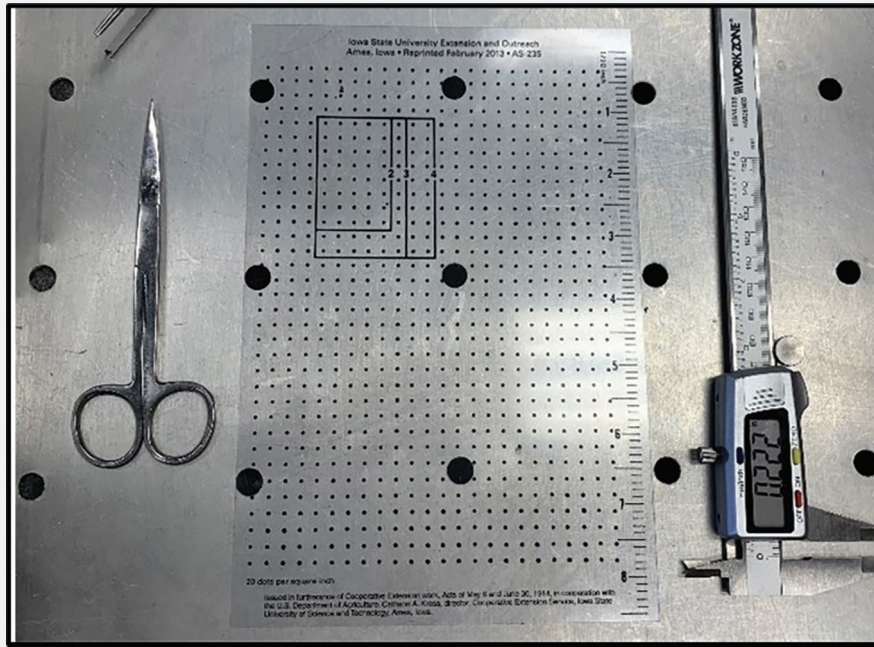
Bullet data

When possible, bullets were recovered from the back of the skull or the ballistics gel. The recovered FMJ bullets were evaluated for conformational changes following passage through the skull and ballistic gel. These conformational changes in the bullet were then compared to a non-fired bullet from each caliber. The lead portion (bullet) of each cartridge was removed from nonfired intact cartridges to determine prefiring weights, lengths, and diameters of all calibers. These prefiring measurements were used to compare post-firing bullet changes.

Statistical analysis

The MIXED procedure of SAS (SAS Institute Inc) was used to test the fixed effects of sex (barrow, gilt), caliber (.22 LR, .22 Mag, .38 Special, 9 mm), and the presence or absence of skin at the point of bullet placement (0, 1). The DIFF option was used to separate differences in LSMEANS. Differences in least squares means were deemed significant at $P < .05$.

Figure 5: Brain trauma was assessed using a plastic loin eye area grid (Ames, IA) to measure both halves of the exposed brain by placing this grid over each section and counting the number of dots covering the brain surface.



Results

Chronograph data, firearm placement, and ammunition discharge

The mean chronograph velocity findings and calculated energy values are reported in Table 1 along with the manufacturer reported energy values. For each individual caliber, the summary statistics are reported in Table 2. Measured parameters for each caliber included skull thickness (cm), head weight (kg), entrance wound diameter (cm), bullet distance head (cm), bullet distance gel (cm), total bullet distance (cm), trauma area (cm²), and recovered brain weight (g). Table 3 provides a summary of measured parameters for all calibers.

Head weight

Random selection of heads from a federally inspected slaughter facility resulted in a significant difference in head weight between barrows and gilts (6.49 kg vs 6.84 kg; $P < .05$). No significant sex \times skin interaction existed further supporting the difference in head weight was independent of the presence of skin. Randomization of allocation to caliber/ammunition combination eliminated this difference in head weight between barrows and gilts when assessing safety

and efficacy ($P = .28$). A summary of the least squares means for all calibers is reported in Table 4.

Forehead skin

Other than head weight ($P = .003$), the fixed effect of skin at bullet placement (0, 1) was not significant ($P > .05$) among any of the variables measured within each of the 4 caliber/ammunition combinations (Table 4). Nevertheless, future research in this area should include only heads with forehead skin intact if possible.

Entrance wound diameter

There was no difference in entrance wound diameter between the .38 Special and the 9 mm ($P = .15$). As expected, the entrance wound diameter of the .38 Special and 9 mm was significantly larger than both the .22 LR or .22 Mag ($P < .001$) while the entrance wound diameter of the .22 Mag was larger than the .22 LR ($P < .05$; Table 4).

Skull thickness

There was no difference in skull thickness among any of the 4 caliber/ammunition combinations evaluated ($P = .34$) nor was there a significant difference in skull thickness between barrows and gilts ($P = .32$; Table 4).

Penetration depth of skull and ballistic gel

Stacked ballistic gel blocks were used to capture bullets emerging from the contralateral side of the skull (Figure 1). Bullets emerging in this gel could be dangerous to a technician, employee, or other animals within proximity to the euthanasia procedure. Ballistic gelatin closely simulates the density and viscosity of human and animal muscle tissue and is used as a standardized medium for testing the terminal performance of firearms ammunition.

The stacked ballistic gel blocks captured many, but not all, bullets that penetrated the contralateral side of the skull. There was no difference in the distance the bullet traveled into the head for any caliber/ammunition combination ($P = .91$) as all bullets remaining in the head were found at the base of the skull (Table 4). The 9 mm bullets traveled the furthest into the ballistic gel ($P < .001$) and the furthest total distance ($P < .001$). The 323 ft-lb energy of the Cascade Cartridge Inc (CCI) Blazer Brass 9 mm Luger 115 grain FMJ bullet and the 321 ft-lb energy of the Winchester .38 Special FMJ 130 grain bullet appeared to be an excessive energy level resulting in contralateral emergence of the bullet (Table 4). At a bullet energy greater than 300 ft-lb, 100% of the .38 Special bullets exited the skull and penetrated the ballistic gel 5.0 to 35.6 cm and 100% of the 9 mm bullets exited the skull (9 of these bullets penetrated the entire 50.8 cm of available ballistic gel). Those 9 mm bullets that remained in the gel penetrated the gel 23.5 to 50.8 cm, with 50.8 cm being the maximum measurable distance traveled through the gel. Bullets from the .38 Special traveled further into the ballistic gel and a further total distance than both the .22 LR and .22 Mag ($P < .001$). There was no difference in the distance traveled into the ballistic gel ($P = .68$) or total distance traveled for the .22 LR compared to .22 Mag ($P = .61$; Table 4).

Brain surface area and measurable brain trauma

There was no difference in the surface area (cm²) of the bifurcated brains ($P > .10$) nor was there a significant difference in the trauma area of the brain for the 9 mm bullets compared to .38 Special bullets ($P = .83$; Table 4). The trauma area of the brain was greater for the 9 mm bullets and the .38 Special bullets than the .22 LR or .22 Mag ($P < .001$). There was no difference in the trauma area of the brain for

Table 1: Full metal jacket bullet mean energy values reported by the manufacturer and determined by chronograph

Ammunition type, FMJ	Barrel length, in	Manufacturer			Chronograph	
		Weight, grain	Velocity, ft/s	Energy, ft-lb	Calculated energy, ft-lb	Velocity*, mean, ft/s
Aguila .22 super extra: copper plated	16	40	1255	139	138.95	1250.60
CCI maxi mag 22 WMR	16	40	1875	312	311.14	1871.40
Winchester .38 Special	16	130	NA	NA	321.49	1055.20
Winchester .38 Special	4	130	800	185	197.21	826.10
CCI blazer brass 9 mm luger	16	115	1145	323	380.91	1221.20

* Mean of 5 fired FMJ bullets for each caliber firearm.

FMJ = Full Metal Jacket; CCI = Cascade Cartridge Inc; WMR = Winchester Magnum Rimfire; ft-lb = foot-pound; NA = not applicable.

the .22 LR bullets compared to .22 Mag bullets ($P = .12$). The trauma area of the brain was greater in males than females ($P = .03$; Table 4).

Recovered brain weight

There was no difference in recovered brain weight between barrows and gilts ($P = .10$) yet differences were observed in recovered brain weight between caliber/ammunition combinations tested ($P = .001$; Table 4).

Bullet data

The bullet recovery rate was 56.3% (9 of 16 bullets) for the .22 LR, 62.5% (10 of 16 bullets) for the .22 Mag, 90.9% (10 of 11 bullets) for the .38 Special, and 43.8% (7 of 16 bullets) for the 9 mm. Bullets were recovered from either the skull or ballistic gel (Table 5).

Bullet weight loss was determined when an identifiable bullet was retrieved. Bullet weight retention was a measurement intended to capture bullet conformation and reflect the degree of fragmentation for all calibers when not completely fragmented, especially in .22 LR and .22 Mag calibers. Bullets from both .22 calibers fragmented resulting in a mean weight loss of 29.5% (11.8 of 40 grains) for the .22 LR and 31.3% (12.5 of 40 grains) for the .22 Mag. The mean bullet weight loss for the .38 Special was 1.0% (128.7 of 130 grains) and no fragmentation was observed while the mean bullet weight loss for the 9 mm was 0.0% (115.5 of 115.5 grains; Table 6).

Bullet expansion of .22 LR was increased by 62.9% (from 0.56 to .091 cm) and .22 Mag increased by 58.3% (from 0.56 to 0.96 cm) when fragmentation was not complete. Bullet expansion of the .38 Special was 8% (from 0.88 to 0.96 cm). Bullet expansion of 9 mm was 2% (from 0.89 to 0.91 cm; Table 7).

Bullet length compression was measured and is reported here as the percentage of original conformation. For the .22 LR, caliber conformation was 48.4% (0.61 of 1.26 cm) and 42.7% (0.49 of 1.15 cm) for the .22 Mag. Bullet length conformation of the .38 Special was 94.8% (1.28 of 1.35 cm). Bullet length conformation of the 9 mm was 93.9% (1.39 of 1.48 cm; Table 8).

Discussion

This proof-of-concept study was initiated in response to an urgent need to obtain scientific information on firearm and ammunition selection for the humane and safe depopulation of market-weight pigs. It was the desire of the authors to advance the science of euthanasia when using a firearm in market-weight pigs and demonstrate a novel methodology for quantifying efficacy while concomitantly addressing safety concerns in multiple caliber/ammunition combinations.

The application of the described methods generated valid data to define efficacy and safety considerations when using firearms in market-weight pigs for the calibers chosen in this study (.22 LR, .22 Mag, .38 Special, and 9 mm). The calibers studied here were selected due to their published energy data and relative availability. The manufacturer's bullet energy data for the .22 Mag, .38 Special, and 9 mm is approximately 300 ft-lb, which is considered appropriate for the efficacious euthanasia of market-weight pigs³ while the .22 LR served as a low-energy control firearm (139 ft-lb) with an expectation that it would not penetrate as deeply as the aforementioned cartridges.

Generalized summaries of the literature³ involving the .22 caliber suggests that if used for euthanasia, it is best fired from a rifle. The findings of this study

would suggest that the .22 LR in a FMJ fired from a rifle was effective at penetrating the skull and brain with 31 of the 32 bullets effectively passing through the brain tissue. The energy of the .22 LR Aguila .22 Super Extra 40 grain copper plated bullet used in this study is reported to be 139 ft-lb. This reported energy value is much less than the proposed 300 ft-lb required for euthanasia,³ yet these findings suggest that 300 ft-lb is not required for market-weight pigs if using a FMJ ammunition type. The energy of the .22 Mag CCI Maxi Mag 22 MWR 40 grain FMJ bullet used in this study is reported to be 312 ft-lb. The data collected on the .22 Mag did not demonstrate superior differences from the .22 LR. Fragments from 4 of the .22 LR FMJ bullets exited the contralateral side of the head and fragments from 8 of the .22 Mag FMJ bullets exited the contralateral side of the head. Those .22 bullet fragments that exited the head penetrated the ballistic gel < 6.35 cm. All .22 caliber bullets fragmented to some degree in the skull creating greater opportunity for energy transfer and brain damage. The apparent performance similarity of the two .22 caliber FMJ bullet types would not necessitate the use of .22 Mag bullets for euthanasia of market-weight pigs. Of note, the single .22 Mag bullet that did not penetrate the brain tissue resulted from an improper angle toward the lower jaw causing it to pass through the skull rostral to the brain.

The manufacturer reported energy for the Winchester .38 Special 130 grain FMJ bullet was 185 ft-lb when fired from a 4-in barrel. The chronograph calculated energy value of the Winchester .38 Special bullet fired from a 4-in barrel was determined to be 197 ft-lb versus 321 ft-lb when this same bullet was fired from a

Table 2: Simple statistics summary of variables measured for each caliber of firearm

Variable	.22 Long rifle			.22 Magnum			.38 Special			9 mm		
	N	Mean (SD)	Min Max	N	Mean (SD)	Min Max	N	Mean (SD)	Min Max	N	Mean (SD)	Min Max
Skull thickness, cm	16	2.46 (0.89)	1.02 4.32	17	2.41 (0.92)	1.27 5.59	11	1.94 (0.30)	1.52 2.29	16	2.35 (0.55)	1.52 3.30
Head wt, kg	16	6.82 (0.85)	5.35 7.98	17	7.06 (0.69)	6.17 8.62	11	6.52 (0.59)	5.81 7.35	16	6.75 (0.83)	5.35 7.80
Entrance wound diameter, cm	16	0.49 (0.76)	0.40 0.63	17	0.57 (0.13)	0.11 0.69	11	.93 (0.16)	0.68 1.20	16	0.85 (0.11)	0.67 1.05
Bullet distance head, cm	14	12.11 (2.18)	8.13 14.99	16	12.24 (2.09)	5.59 15.24	11	12.22 (0.80)	10.92 13.97	16	11.82 (1.03)	10.41 13.97
Total bullet distance, cm	13	12.41 (2.74)	8.13 14.99	16	13.77 (3.39)	5.59 19.25	10	36.35 (9.68)	17.78 47.63	15	54.82 (11.09)	34.16 64.77
Brain surface area, cm ²	16	28.83 (2.92)	24.19 33.55	17	27.59 (5.14)	19.03 40.65	11	28.83 (3.77)	20.65 34.52	16	30.00 (4.32)	21.61 36.45
Trauma area, cm ²	16	0.00 (0.00)	0.00 0.00	17	0.44 (0.91)	0.00 3.55	8	2.02 (0.89)	0.00 2.90	14	1.80 (0.99)	0.65 3.55
Recovered brain wt, g	16	88.88 (9.92)	70.00 108.00	17	78.82 (14.75)	53.00 106.00	11	90.82 (9.66)	75.00 104.00	16	95.50 (9.92)	80.00 116.00
Original bullet wt*, gr	16	40.00 (0.00)	40.00 40.00	15	40.00 (0.00)	40.00 40.00	11	130.00 (0.00)	130.00 130.00	15	115.00 (0.00)	115.00 115.00
Retrieved bullet wt, gr	5	28.93 (9.32)	15.00 37.30	5	32.14 (5.16)	23.10 36.00	7	128.60 (0.65)	127.90 129.90	3	115.23 (0.15)	115.10 115.40
Δ bullet wt, gr	5	11.07 (9.32)	2.70 25.00	5	7.86 (5.16)	4.00 16.90	7	1.40 (0.60)	0.10 2.10	3	0.23 (0.15)	0.10 0.40

* Original weight as reported by the ammunition manufacturer.

wt = weight; gr = grain.

Table 3: Simple statistics of variables measured for all firearm calibers

Variable	N	Mean (SD)	Min	Max
Skull thickness, cm	60	2.32 (0.75)	1.02	5.59
Head wt, kg	60	6.82 (.76)	5.35	8.62
Entrance wound diameter, cm	60	0.69 (0.22)	0.11	1.20
Head bullet distance, cm	57	12.09 (1.64)	5.59	15.24
Gel bullet distance*, cm	55	16.66 (19.71)	0.00	50.80
Total bullet distance, cm	54	29.03 (19.74)	5.59	64.77
Brain surface area, cm ²	60	28.79 (4.16)	19.03	40.65
Trauma area, cm ²	55	0.88 (1.14)	0.00	3.55
Recovered brain wt, g	60	88.15 (12.89)	53.00	116.00

* Maximum measurable distance into the ballistics gel was 50.80 cm.

wt = weight; gr = grain.

Table 4: Least squares means of variables measured for caliber and sex

Variable	N	Caliber				Sex		P	
		.22 LR	.22 Mag	.38 Special	9 mm	Barrow	Gilt	Caliber	Sex
Skull thickness, cm	60	2.39	2.34	1.88	2.29	2.31	2.13	.34	.32
Head wt, kg	60	6.67	6.94	6.45	6.60	6.49 ^d	6.84 ^e	.28	.05
Entrance wound diameter, cm	60	0.51 ^a	0.58 ^b	0.94 ^c	0.86 ^c	0.71	0.71	< .001	.86
Head bullet distance, cm	57	12.14	12.27	12.24	11.86	12.14	12.12	.91	.98
Gel bullet distance, cm	55	1.04 ^a	2.13 ^a	24.77 ^b	43.74 ^c	18.24	17.60	< .001	.75
Total bullet distance, cm	54	12.98 ^a	14.43 ^a	37.03 ^b	55.60 ^c	30.40	29.64	< .001	.71
Brain surface area, cm ²	60	28.71	27.48	28.71	29.87	29.35	28.06	.44	.25
Trauma area, cm ²	55	0.06 ^a	0.45 ^a	1.94 ^b	1.87 ^b	1.29 ^d	0.84 ^e	< .001	.03
Recovered brain wt, g	60	87.90 ^a	78.16 ^b	90.51 ^a	94.52 ^a	85.34	90.20	.001	.10

^{a,b,c} Numbers with differing superscripts within rows are statistically significant for caliber.

^{d,e} Numbers with differing superscripts within rows are statistically significant for sex.

LR = long rifle; Mag = Magnum; wt = weight.

Table 5: Description of full metal jacket bullets recovered from either the skull or ballistic gel

Caliber	Recovered bullets		Exited skull		Fragmented bullets	
	Number	%	Number	%	Number	%
.22 Long rifle	9 of 16	56.30	4 of 16	25	16 of 16	100
.22 Magnum	10 of 16	62.50	8 of 16	50	16 of 16	100
.38 Special	10 of 11	90.90	11 of 11	100	0 of 16	0
9 mm*	7 of 16	43.80	16 of 16	100	0 of 16	0

* 100% of bullets penetrated the skull and 9 of 16 bullets penetrated both the skull and 50.80 cm of ballistic gel.

Table 6: Mean full metal jacket bullet weight change and fragmentation*

Caliber	Weight decrease [†]		Weight differences, grains		
	Number	%	Beginning	Ending	Difference
.22 Long rifle	9 of 9	100	40.00	28.24	-11.76
.22 Magnum	10 of 10	100	40.00	27.51	-12.49
.38 Special	0 of 10	0	130.00	128.69	-1.31
9 mm	0 of 7	0	115.50	115.46	-0.04

* Bullet weight loss was determined when an identifiable bullet was retrieved. Bullet weight retention was a measurement intended to capture bullet conformation and reflect the degree of fragmentation for all calibers.

† Weight decrease > 3 grains.

Table 7: Mean full metal jacket bullet diameter of recovered bullets

Caliber	Bullets with expansion > 10%		Bullet diameter, cm		
	Number	%	Starting	Ending	Difference
.22 Long rifle	9 of 9	100	0.56	0.91	0.35
.22 Magnum	10 of 10	100	0.56	0.96	0.40
.38 Special	1 of 10	10	0.88	0.96	0.08
9 mm	0 of 7	0	0.89	0.91	0.02

Table 8: Full metal jacket bullet compression and mean length of recovered bullets

Caliber	Bullet compression > 45%		Bullet length, cm		
	Number	%	Starting	Ending	Difference
.22 Long rifle	9 of 9	100	1.26	0.61	-0.65
.22 Magnum	10 of 10	100	1.15	0.48	-0.67
.38 Special	0 of 10	0	1.35	1.28	-0.07
9 mm	0 of 7	0	1.48	1.39	-0.09

16-in barrel. These bullet energy findings are consistent with the contralateral emergence of the bullets we observed in this proof-of-concept study. Furthermore, a 130 grain FMJ bullet fired from a 4-in barrel of a .38 Special will provide an energy of approximately 185 ft-lb. However, this same bullet and caliber fired from a 16-in barrel would demonstrate an increased energy of 321 ft-lb.

The reported energy of 323 ft-lb for the CCI Blazer Brass 9 mm Luger 115 grain FMJ bullet and the 321 ft-lb of the Winchester .38 Special FMJ 130 grain bullet appeared to be an excessive energy level

resulting in contralateral emergence of the bullet. These results suggest that a bullet energy greater than 300 ft-lb is excessive for the safe application of firearms for euthanizing market-weight pigs.

Brain weight differences were observed in the general population of 60 pigs. However, sex or trauma caused by ammunition caliber did not impact the brain weight difference. The authors suggest that a larger number of heads is required to assess the impact of sex or trauma caused by ammunition caliber on brain tissue given the natural variation that exists within individual brains.

An unexpected hammer block malfunction occurred in the rifle firing the .38 Special bullet resulting in less total heads available for assessment with this caliber and reducing the total head count from 64 to 60. This event lends credence to the need for a backup firearm when performing these evaluations and when conducting euthanasia or depopulation in the field.

It was determined during head dissection that 2 bullets (one .22 Mag caliber and one 9 mm caliber) did not contact the brain due to operator error. The .22 Mag bullet was placed between the eyes but at an improper angle directed toward the lower jaw rather than the back of the head causing the bullet to pass through the skull rostral to the brain. The 9 mm bullet was placed 3.6 cm above the line between the eyes and passed caudal to the brain due to inadvertent operator error. Notably, an additional 9 mm bullet missed the brain entirely due to an anatomical malformation of the brain cavity. Figure 6A demonstrates the proper placement of the firearm and bullet entry into the skull. Figure 6B demonstrates the path of the bullet above the brain cavity and demonstrates the anatomical anomaly of the location of the brain lower in the skull. The authors are uncertain of the incidence of anatomical malformations of brain placement that could occur within a population of pigs. This specific finding is of interest not only to the producer but also the slaughter facility as it suggests that operator error is not necessarily the singular reason for a failed attempt to render an animal unconscious and insensible to pain. When considering proper firearm placement, the variation of skull conformation within species can be as important as the variation between species. Under the conditions of this study, success or failure to penetrate brain tissue did not appear to be related to firearm or bullet characteristics but more to the selection of the ideal anatomical site and bullet placement. Three of 60 shots missed the brain and would suggest a 5% failure rate under relatively ideal conditions.

The information obtained from this proof-of-concept study illustrates the ability to consistently evaluate and subsequently quantify the effectiveness of a FMJ bullet fired into the forehead of a market-weight pig using each of 4 caliber rifles (.22 LR, .22 Mag, .38 Special, 9 mm). Moreover, these findings demonstrate the variation in penetrative depth and bullet conformational

Figure 6: One pig had an anatomical malformation of the brain cavity resulting in the bullet missing the brain entirely. **A)** The proper placement of the firearm and 9 mm bullet entry into the skull. **B)** The path of the bullet was above the brain cavity due to an anatomical anomaly of the brain being lower in the skull.



change both among and within a given caliber/ammunition combination and the relative safety or lack thereof when using firearms as a means of euthanasia or depopulation. The .22 LR FMJ bullet (energy at approximately 140 ft-lb) can provide predictable euthanasia by gunshot in market-weight pigs with minimal risk of contralateral emergence. The .38 Special and 9 mm FMJ bullets (energy at 300 ft-lb) created safety concerns of bullets emerging from the contralateral side of the head. Albeit each of the selected caliber/ammunition combinations were effective in this instance, there is little doubt that 300 ft-lb is not required for predictable euthanasia of market-weight pigs. Under ideal conditions, firearm placement and observed anatomical anomalies (brain size and location) resulted in a 95% success rate of brain penetration. Additional research is required to better understand and measure the effects of firearm placement in live animals.

The intended purpose of this research is to provide reference materials that trained professionals can use when selecting the proper caliber/ammunition combination needed to properly euthanize market-weight pigs on an individual basis or during depopulation events. Given the lack of information illustrating both the efficacy and safety of using one or more caliber/ammunition combinations when euthanizing market-weight pigs, further work is needed to ascertain differences in efficacy and safety when using FMJ, lead round-nose, and jacketed hollow-point bullets fired from the .22 LR, .22 Mag, .38 Special, and 9 mm firearms. In addition, the pork industry would benefit from broadening the size and scope of this research to include market pigs at heavier live weights (> 350 lb), sex (gilts, barrows, sows, and boars), and genotype.

Implications

Under the conditions of this study:

- A .22 LR FMJ bullet (139 ft-lb) penetrated the skull with low risk of passthrough.
- The .38 Special and 9 mm FMJ bullets (> 300 ft-lb) created human safety concerns.
- Head anomalies and bullet placement reduced successful brain penetration to 95%.

Acknowledgments

The authors would like to acknowledge the National Pork Board for funding this project. The authors would like to thank Dr Jessica Davenport and Katie Tapper for assistance with head dissection and data collection. The authors would also like to thank the University of Missouri for the use of their meats lab for head dissection.

Conflict of interest

None reported.

Disclaimer

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

References

*1. National Pork Board. *On-farm euthanasia of swine: Recommendations for the producer*. 2016. Accessed April 11, 2023. <https://www.aasv.org/documents/2016EuthRec-EN.pdf>

*2. American Veterinary Medical Association. *AVMA guidelines for the depopulation of animals: 2019 edition*. 2019. Accessed August 25, 2023. <https://www.avma.org/sites/default/files/resources/AVMA-Guidelines-for-the-Depopulation-of-Animals.pdf>

*3. American Veterinary Medical Association. *AVMA guidelines for the euthanasia of animals: 2020 edition*. 2020. Accessed April 11, 2023. <https://www.avma.org/sites/default/files/2020-02/Guidelines-on-Euthanasia-2020.pdf>

*4. Fangman T, Stahl C, Fangman J. Understanding muzzle energy (energy) when selecting an appropriate firearm for humane euthanasia. National Pork Board. 2020. Accessed April 11, 2023. <https://library.pork.org/account/dashboard/?mediaId=5D5F3841-799C-4D1D-A91E089912FF8BA7>

* 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

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$$

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$$

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

Conversion chart, kg to lb (approx)

Pig size	Lb	Kg
Birth	3.3-4.4	1.5-2.0
Weaning	7.7	3.5
	11	5
	22	10
Nursery	33	15
	44	20
	55	25
	66	30
Grower	99	45
	110	50
	132	60
Finisher	198	90
	220	100
	231	105
	242	110
	253	115
Sow	300	136
	661	300
Boar	794	360
	800	363

1 tonne = 1000 kg

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

1 ppm = 1 mg/L

First detection and genetic characterization of Senecavirus A in pigs from Mexico

Roberto Navarro-López, DVM; Juan Diego Perez-de la Rosa, DVM, MSc; Marisol Karina Rocha-Martínez, MSc; Gabino Galván Hernández, DVM; Marcela Villarreal-Silva, PhD; Mario Solís-Hernández, DVM; Eric Rojas-Torres, DVM; Ninnet Gomez-Romero, DVM, MSc

Summary

Senecavirus A (SVA) is a member of the *Senecavirus* genus within the Picornaviridae family. An SVA infection causes ulcerative lesions indistinguishable from other vesicular diseases. We describe the genetic characterization of the first SVA detected in Mexico on 2 swine farms. Phylogenetic analyses demonstrated a genetically close relationship with SVA isolates from the United States detected in 2017, sharing a 98.3% to 98.4% nucleotide identity. Nevertheless, genetic differences were found. In Mexico, SVA is considered an exotic virus. Although the introduction source could not be determined, further studies are needed to understand the molecular epidemiology of SVA detected in Mexico.

Keywords: swine, Senecavirus A, reverse transcriptase-polymerase chain reaction, sequencing, Mexico

Received: February 10, 2023

Accepted: July 10, 2023

Resumen - Primera detección y caracterización genética del Senecavirus A en cerdos de México

El Senecavirus A (SVA) es un miembro del género *Senecavirus* dentro de la familia Picornaviridae. La infección por SVA causa lesiones ulcerosas indistinguibles de las otras enfermedades vesiculares. En este reporte, describimos la caracterización genética del primer SVA detectado en México en 2 granjas porcinas. Los análisis filogenéticos demostraron una relación genéticamente cercana con los aislados de SVA de los Estados Unidos detectados en 2017, que comparten una identidad de nucleótidos entre 98.3% al 98.4%. Sin embargo, se encontraron diferencias genéticas. En México, el SVA es considerado un virus exótico. Aunque no se pudo determinar la fuente de introducción, se requieren más estudios para comprender la epidemiología molecular del SVA detectado en México.

Résumé - Première détection et caractérisation génétique de Senecavirus A chez des porcs au Mexique

Le Senecavirus A (SVA) est un membre du genre *Senecavirus* au sein de la famille des Picornaviridae. L'infection par le SVA cause des lésions ulcéraires indistinguibles des autres maladies vésiculaires. Nous décrivons la caractérisation génétique du premier SVA détecté au Mexique dans deux fermes porcines. Les analyses phylogénétiques ont démontré une relation apparentée avec des isolats de SVA des États-Unis détectés en 2017, partageant une identité de nucléotides de 98.3% à 98.4%. Malgré tout, des différences génétiques ont été trouvées. Au Mexique, le SVA est considéré comme un virus exotique. Bien que la source d'introduction n'a pu être déterminée, des études additionnelles sont requises pour comprendre l'épidémiologie moléculaire du SVA détecté au Mexique.

Senecavirus A (SVA) is a single-stranded, positive sense, nonenveloped RNA virus classified as the only species in the genus *Senecavirus* within the Picornaviridae family.¹ The SVA genome is approximately 7300 bases in length containing an open reading frame encoding a polyprotein of 2181 amino acids, encoding 12 proteins²: L-VP4-VP2-VP3-VP1-2A-2B-2C-3A-3B-3C-3D. The viral genome has the viral genome-linked protein at its 5' end; the 5' untranslated

region contains a type IV internal ribosome entry site, and the 3' untranslated region end is polyadenylated.¹

An SVA infection can cause porcine idiopathic vesicular disease (PIVD), characterized by coronary band hyperemia, lameness, erosions, and vesicles in the oral skin mucosa, snout, interdigital space, and along the coronary bands.² Lesions are clinically indistinguishable from other vesicular diseases including foot-and-mouth disease (FMD), vesicular

stomatitis (VS), and vesicular exanthema of swine (VES). Based on previous studies of experimental infections, lesions appear between 3 to 5 days post inoculation (dpi) and resolve by day 14 to 21 dpi.³ A survey by Fernandes et al⁴ comparing pathogenicity of the historical SVA strain SVV-001 to the contemporary SVA strain SD15-26 showed that the historic isolate presents low virulence in finishing pigs. In contrast, a similar study conducted by Buckley et al⁵ showed growing

RN-L, GGH, MV-S, MS-H, ER-T, NG-R: Comisión México-Estados Unidos para la Prevención de Fiebre Aftosa y Otras Enfermedades Exóticas de los Animales, Mexico City, Mexico.

JDP-R, MKR-M: Centro Nacional de Servicios de Constatación en Salud Animal, Morelos, Mexico.

Corresponding author: Dr Ninnet Gomez-Romero. Comisión México-Estados Unidos para la prevención de fiebre Aftosa y otras enfermedades exóticas de los animales, Carretera Mexico-Toluca Km 15.5 Piso 4 Col. Palo Alto. Cuajimalpa de Morelos. C.P. 05110. Mexico City, Mexico; Tel: +52 551359 7651; Email: ninnet.gomez.i@senasica.gob.mx

Navarro-López R, Perez-de la Rosa JD, Rocha-Martínez MK, Galván Hernández G, Villarreal-Silva M, Solís-Hernández M, Rojas-Torres E, Gomez-Romero N. First detection and genetic characterization of Senecavirus A in pigs from Mexico. *J Swine Health Prod.* 2023;31(6):289-294. <https://doi.org/10.54846/jshap/1358>

pigs developed vesicular lesions when inoculated with either a historical or contemporary SVA isolate despite the difference in infection kinetics. However, these contrasting results of clinical presentation in pigs after infection with historical or contemporary SVA strains indicate that additional research is required to better understand host and viral factors involved in the pathogenicity of SVA strains.

Senecavirus A was first isolated by the US Department of Agriculture National Veterinary Service Laboratory in 1988 from stillborn piglets and piglets showing diarrhea.⁶ Subsequently, SVA was detected in 2002 as an adventitious virus in cell line culture PER.C6. This first viral isolate was named SVV-001, and the complete genome sequence was published in 2008.⁷ Since the initial detection, subsequent analyses of samples from pigs with vesicular disease-like clinical signs revealed the circulation of SVA in different regions worldwide.

Senecavirus A has been present in US swine populations since 1988, with a significant increase in cases in late 2014.⁶ In addition, SVA was isolated from sows displaying PIVD-like clinical signs in 2007 in Canada.⁸ Furthermore, vesicular disease outbreaks caused by SVA were reported in 2015 in the United States, Brazil, and China.⁹⁻¹¹ The SVA detected in China was similar to SVA described in the United States and Brazil; however, after progressive dissemination among several Chinese provinces, current SVA strains were segregated into at least 5 phylogenetic clades.¹² In early 2016, SVA-related vesicular disease was described

in swine from Colombia, where the detected strains shared homology with previously recognized SVA strains in the United States.¹³ In the same year, Thailand reported the detection of SVA, which was closely related to the SVA strain initially identified in Canada.¹⁴ Vietnam detected SVA isolates in 2018 with high genetic identity with SVA strains from China.¹⁵ Recently, SVA was confirmed to be the cause of vesicular disease in swine from Chile, allegedly originating from SVA strains circulating in the United States.¹⁶

In Mexico, SVA is considered an exotic virus by the National Secretary of Agriculture and Rural Development; thus, disease caused by SVA mandates immediate notification to the National System of Epidemiological Surveillance.¹⁷ No official information or scientific reports of SVA in the swine population within the Mexican national territory have been previously reported. In this case report, we describe the genetic characterization of SVA collected from 2 related clinical cases of SVA infection in pigs from 2 regions in Mexico in 2021.

Animal care and use

This study was conducted at the Mexico-United States Commission for Prevention of Foot-and-Mouth Disease and Other Exotic Animal Diseases (CPA) according to good production practices in the pig farm manual implemented by the Ministry of Agriculture and Rural Development.

Case descriptions

Case 1

On December 21, 2021, a farm in the Valladolid municipality in Yucatán reported the sudden onset of vesicular lesions in 30 gilts at 20 weeks of age. These 30 gilts belonged to a 365-head group of replacement gilts ranging in age from 7 to 20 weeks old and were obtained from a farm in the state of Sonora in northern Mexico. Before the clinical manifestations, the gilts were transported and placed in quarantine at the destination farm in Yucatán. During arrival, lameness and fever were detected warranting further examination. Vesicles on the snouts and ulcerative lesions in the dewclaw, sole, heel, and coronary bands were detected (Figure 1). Sick animals were removed upon the onset of clinical signs and isolated from the quarantined gilts in separate pens off-site. Previous evidence of similar clinical manifestations on the farm or in neighboring areas was not reported. Due to the vesicular lesions resembling those of vesicular exotic diseases, drag swabs from the vesicular lesions of 6 affected animals and 1 epithelium tissue sample from the gilt with severe lesions were collected and submitted for diagnosis to the Immunology, Cellular, and Molecular Biology Laboratory from the CPA and identified as case number CPA-21738-21 (case 1).

Case 2

On December 22, 2021, the farm where the gilts from case 1 were obtained in Sonora state, reported ulcerative lesions on the snouts and mouths of 13 pigs. Due to the trade relationship and similar

Figure 1: Lesions (red arrows) caused by Senecavirus A infection in gilts. A) Vesicle on the snout. B) Ulcerative lesions on the foot. C) Ulcerative lesion on the coronary band.



clinical manifestations with case 1, drag swabs, whole blood, and serum samples were collected from the 13 pigs with lesions and 2 epithelium samples were collected from pigs displaying severe lesions. Additionally, 2 whole blood and 2 serum samples were collected from clinically healthy pigs. All samples were submitted for diagnosis to the Immunology, Cellular, and Molecular Biology Laboratory from CPA under the case number CPA-21748-21 (case 2). Prior to the disease event, no evidence of vesicular lesions in the animal population was reported on this or neighboring farms.

Diagnosis and laboratory findings

Conventional differential diagnosis was completed by CPA to exclude diseases with related clinical presentations. The samples from case 1 were evaluated by real-time quantitative reverse transcriptase-polymerase chain reaction (qRT-PCR) for molecular screening of viruses associated with vesicular diseases including foot-and-mouth disease virus (FMDV), swine vesicular disease virus (SVDV), vesicular stomatitis virus (VSV), and SVA. No positive results were obtained for FMDV, SVDV, and VSV. Conversely, SVA was detected in 4 drag swab samples and 1 epithelium sample displaying positive cycle threshold values ranging from 22 to 33. In addition, viral isolation of SVA was attempted; however, no positive results were obtained.

Likewise, the qRT-PCR assay was used for FMDV, SVDV, VSV, and SVA detection in samples from case 2. Results indicated 2 epithelium and 1 whole blood sample were positive for SVA with positive cycle threshold values ranging from 28 to 34. Moreover, a competitive enzyme-linked immunosorbent assay was performed, and SVA antibodies were detected in all serum samples from case 2. In addition, a neutralization test and viral isolation for FMDV and VSV were performed with no positive results.

Genome sequencing of SVA detected in epithelium samples from both cases was conducted at the National Center for Diagnostic Services in Animal Health. The 2 SVA sequences, partial and whole genome, were deposited in GenBank under the accession numbers ON369393 and ON369394, respectively. The phylogeny based on the comparison of whole genome sequences of reference SVA strains has led to the segregation of SVA sequences into 3 main clades

represented by prototype strains, historical strains, and contemporary strains. Similar to previous studies,¹⁸ there is a display of temporal and geographic clustering of SVA sequences. The clade of contemporary strains is particularly diverse as it includes circulating SVA identified between 2011 and 2021 and grouped by country of origin including strains from the United States, Canada, Colombia, Vietnam, China, Brazil, Thailand, and Mexico. The phylogenetic analysis clustered the SVA sequences from Mexico within the contemporary strains detected in the United States in 2017 (Figure 2). Furthermore, the genetic analysis revealed that SVA sequences from cases 1 and 2 presented a 99.9% nucleotide identity to each other and displayed a 92.7% identity with the SVV-01 SVA prototype strain and 98.2% with SVA strains detected in pigs from Canada and the United States. Specifically, based on the full-length genome sequence, the SVA identified in Mexico shared a 98.3% to 98.4% nucleotide identity and a 99.3% to 99.4% similarity at the amino acid level with an SVA detected in 2017 from swine in California named USA/MI17-011956/2017 (GenBank accession number MN812959.1).

The SVA amino acid sequences were deduced and analyzed for the presence of substitutions. Despite sharing a high genetic similarity, the amino acid substitution analysis showed differences between the SVA sequences from case 1 and case 2, revealed by 12 and 14 amino acid substitutions in the polyprotein sequence compared with the USA/MI17-011956/2017 strain, respectively (Table 1). The two Mexican SVA sequences exhibited more substitutions in the 3D gene, with 3 and 4 substitutions, respectively, followed by VP1, 2B, and 3A genes. Conversely, no mutations were found in L, VP4, VP2, 2A, and 3B genes.

Due to positive cases of SVA, both farms were quarantined, and control measures were conducted, including depopulation, farm disinfection, and surveillance.

Discussion

Since late 2014, a global increase in the occurrence of SVA infection cases in the United States, Brazil, Colombia, China, Thailand, Vietnam, and Chile has been reported.¹¹⁻¹⁶ Phylogenetic analyses has shown the evolutionary divergence between SVA historical and contemporary strains and most SVA strains are grouped in separate phylogenetic clusters based on their geographic location.

With a few exceptions, most contemporary clustered SVA strains are evolving independently within the swine population of an affected country. Therefore, transmission among nations can be inferred.¹⁹ Analysis of global SVA genomes revealed 3 major evolutionary clusters based on complete genome sequences or the VP1 gene sequence used. Hence, further investigation is needed for a definitive designation on SVA isolates emerging worldwide over time.^{20, 21}

Mexico has been considered free of FMD since 1955, and other vesicular diseases like VS and VES are considered exotic diseases. Therefore, it is mandatory to rule out infectious diseases with clinical signs resembling these diseases. In late 2021, the detection of SVA was confirmed in 2 pig farms from northern and southwest Mexico, which were linked by pig movements. The affected animals displayed lameness, fever, vesicles on the snout, and ulcerative lesions in the interdigital region and coronary band. Senecavirus A was identified in different sample types including drag swabs from vesicular lesions, epithelium, and whole blood samples from the affected animals in case 1. Antibodies against SVA were detected in all serum samples collected from animals from case 2. In addition, the presence of other exotic vesicular diseases was ruled out.

In the present study, 1 full-length genome and 1 near-full-length genome (6071bp) of Mexican SVA, identified as CPA-21738-21 (case 1) and CPA-21748-21 (case 2), were obtained. Genetic characterization was performed to determine the phylogenetic relationship with previously reported SVA. Analysis of the genome sequences from both cases demonstrated that the Mexican SVA shared high genomic identity with each other (99.9%) at the nucleotide and amino acid levels. These SVA strains were grouped into the contemporary SVA strain cluster sharing a common ancestor with the 2017 and 2020 isolates from the United States because of the high genetic identity and similarity (Figure 2). Furthermore, the close genetic relationship between cases 1 and 2 suggests that they originated from the same ancestor but underwent different substitutions. Hence, SVA strains from Mexico have endured genetic changes in several regions including amino acid substitutions occurring in the 3D, VP1, and 3A genes compared with the USA/MI17-011956/2017 strain.

Figure 2: Phylogenetic tree based on complete Senecavirus A sequence. Phylogenetic inference was conducted using the maximum likelihood method. Distances were computed using the Tamura-Nei parameter model. Reference sequences are identified by GenBank accession numbers. Sequences obtained in this study are in bold.

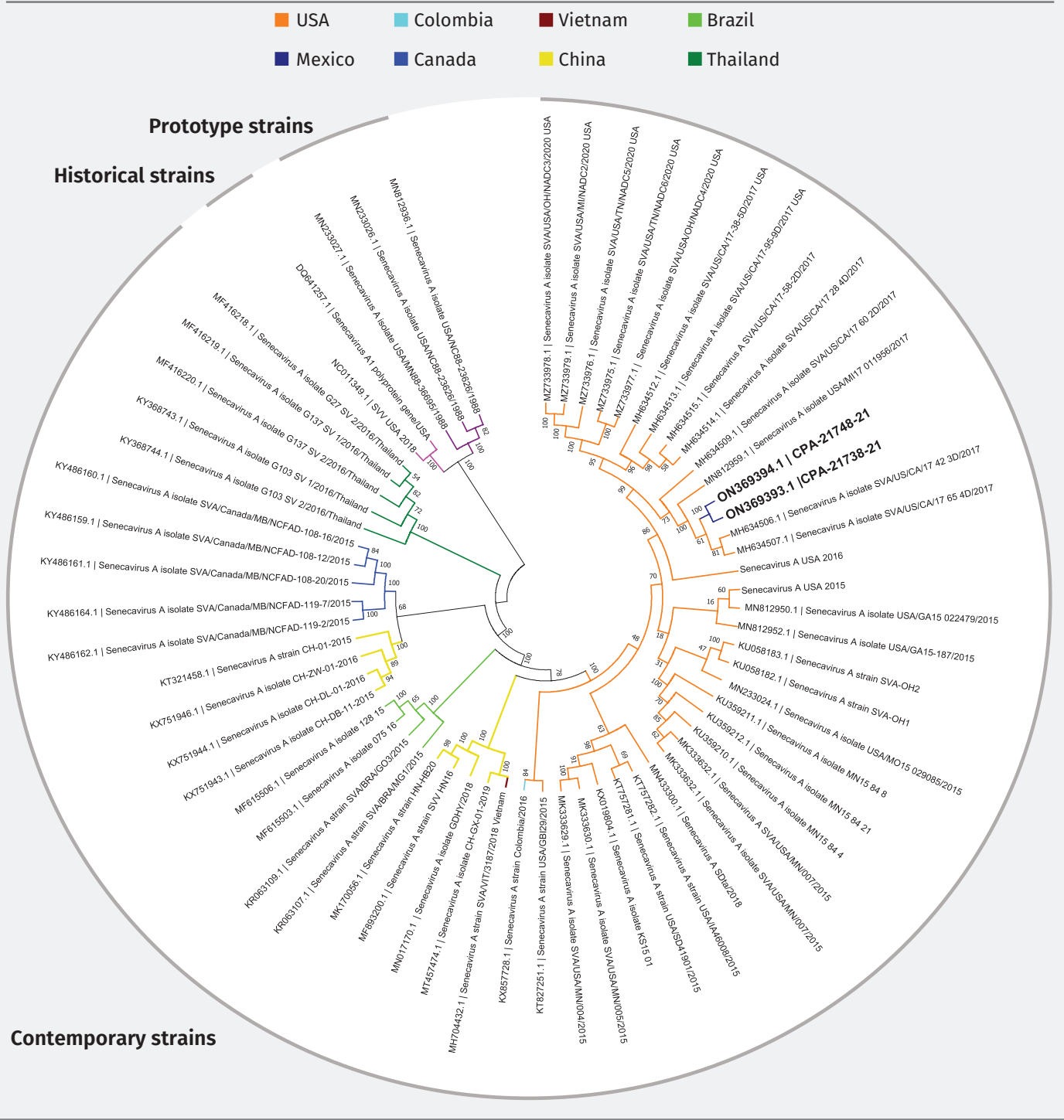


Table 1: Amino acid substitutions in Senecavirus A detected in Mexico in December 2021*

Gene	Range	Case 1		Case 2	
		Substitutions, No.	Amino acids	Substitutions, No.	Amino acids
L	1-79	0	–	0	–
VP4	80-150	0	–	0	–
VP2	151-434	0	–	0	–
VP3	435-673	1	Q492R	1	Q492R
VP1	674-937	2	V766A, I894V	2	V766A, I894V
2A	938-946	0	.	0	.
2B	947-1074	2	S1043R, K1060S	2	S1043R, K1060S
2C	1075-1396	1	T1317A	1	T1317A
3A	1397-1486	2	T1469A, E1472D	2	T1469A, E1472D
3B	1487-1508	0	.	0	.
3C	1509-1719	1	K1610R	2	A1519V, K1610R
3D	1720-2180	3	D1767G, A1850V, M1860V	4	D1767G, A1850V, M1860V, V1874A

* The number and the amino acid substitution are indicated in comparison to the USA/MI17-011956/2017 Senecavirus A isolate.

Similar to the SVA strains we identified, Bennett et al¹⁶ described that the SVA detected in Chile showed a close relationship with SVA detected in swine from California in 2017. Furthermore, the low homology in genetic identity of the SVA strains from Mexico in comparison with SVA strains from Colombia (96.9%), Brazil (95.7%), Vietnam (95.5%), Canada (95.2%), China (94.9%-95.1%), and Thailand (93.7%) demonstrated the isolates are distantly related.

In Mexico, SVA is classified as an exotic pathogen; therefore, outbreaks of vesicular disease caused by SVA have not been reported. Moreover, no SVA serosurveys have been conducted in the past. Nonetheless, SVA antibodies were detected in pigs with clinical signs from case 2. This suggests that SVA could have been circulating previously in the farm's pig population for some period but was undetected due to the lack of detectable clinical presentation. Previous studies have shown that pigs infected with SVA might appear clinically healthy and remain asymptomatic.^{22,23} However, the development of vesicular lesions can be associated with immunosuppressive factors, like stress. Thus, activities like mobilization and transportation could

potentially trigger the clinical presentation in SVA-infected animals.²³ Likewise, the differences in nucleotide and amino acid levels between SVA strains identified in this study suggest continuous evolutionary events, possibly while discreetly spreading in the Mexican swine population before this first detection.

In countries with exotic vesicular diseases, finding SVA in swine has important implications and can lead to confusion in differentiating SVA from an exotic disease outbreak because they share similar clinical signs. Therefore, accurate SVA diagnosis by molecular screening and confirmation using serological assays are suggested as a more effective diagnostic method.¹¹ Here, we have described the first detection of SVA in Mexico. The affected pigs were infected with a unique SVA isolate described herein, sharing homology with those SVA isolates identified in the United States in 2017.

Nonetheless, further studies of more cases need to be conducted to understand the source of SVA's introduction to Mexico, its risk factors, prevalence, or detection of possible future outbreaks. Moreover, it is necessary to evaluate the transmission routes within pig

populations and through mechanical vectors like flies.²⁴ In addition, retrospective serological studies from symptomatic and asymptomatic pigs will help determine the timing of SVA introduction in Mexico. These results will increase the knowledge regarding SVA epidemiology and highlight the significant SVA surveillance role in Mexican swine populations to prevent SVA reintroduction and further spread. Although control measures were applied in affected farms, SVA is now a growing concern for swine producers from Mexico. Thus, this case report will increase awareness that the prompt notification of the vesicular disease caused by SVA helps prevent and control SVA infection.

Implications

Under the conditions of this study:

- Evidence of SVA infection in pigs from Mexico was detected for the first time.
- Lesions and clinical signs of SVA can be misleading for diagnosis.
- Introduction of SVA in Mexico is a high-risk factor for swine producers.

Acknowledgments

Conflict of interest

None reported.

Disclaimer

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

References

- Zell R, Delwart E, Gorbalenya AE, Hovi T, King AMQ, Knowles NJ, Lindberg AM, Palansch MA, Palmenberg AC, Reuter G, Simmonds P, Skern T, Stanway G, Yamashita T, ICTV Report Consortium. ICTV virus taxonomy profile: Picornaviridae. *J Gen Virol*. 2017;98:2421-2422. <https://doi.org/10.1099/jgv.0.000911>
- Cameron R. Diseases of skin. In: Straw BE, Zimmerman JJ, D'Allaire S, Taylor DJ, eds. *Diseases of Swine*. 9th ed. Blackwell; 2006:179-198.
- Joshi LR, Fernandes MHV, Clement T, Lawson S, Pillatzki A, Resende TP, Vannucci FA, Kutish GF, Nelson EA, Diel DG. Pathogenesis of Senecavirus A infection in finishing pigs. *J Gen Virol*. 2016;97(12):3267-3279. <https://doi.org/10.1099/jgv.0.000631>
- Fernandes MHV, Maggioli MF, Joshi LR, Clement T, Faccin TC, Rauh R, Bauermann FV, Diel DG. Pathogenicity and cross-reactive immune responses of a historical and a contemporary Senecavirus A strains in pigs. *Virology*. 2018;522:147-157. <https://doi.org/10.1016/j.virol.2018.06.003>
- Buckley AC, Michael DD, Faaberg KS, Guo B, Yoon K-J, Lager KM. Comparison of historical and contemporary isolates of Senecavirus A. *Vet Microbiol*. 2021;253:108946. <https://doi.org/10.1016/j.vetmic.2020.108946>
- Knowles NJ, Hales LM, Jones BH, Landgraf JG, House JA, Skele KL, Burroughs KD, Hallenbeck PL. Epidemiology of Seneca Valley virus: Identification and characterization of isolates from pigs in the United States. In: *XIVth Meeting of the European Study Group on the Molecular Biology of Picornaviruses*. 2006;G2.
- Hales LM, Knowles NJ, Reddy PS, Xu L, Hay C, Hallenbeck PL. Complete genome sequence analysis of Seneca Valley virus-001, a novel oncolytic picornavirus. *J Gen Virol*. 2008;89(Pt 5):1265-1275. <https://doi.org/10.1099/vir.0.83570-0>
- Pasma T, Davidson S, Shaw SL. Idiopathic vesicular disease in swine in Manitoba. *Can Vet J*. 2008;49:84-85.
- Vannucci FA, Linhares DC, Barcellos DE, Lam HC, Collins J, Marthaler D. Identification and complete genome of Seneca Valley virus in vesicular fluid and sera of pigs affected with idiopathic vesicular disease, Brazil. *Transbound Emerg Dis*. 2015;62(6):589-593. <https://doi.org/10.1111/tbed.12410>
- Wu Q, Zhao X, Chen Y, He X, Zhang G, Ma J. Complete genome sequence of Seneca Valley virus CH-01-2015 identified in China. *Genome Announc*. 2016;4(1):e01509-15. <https://doi.org/10.1128/genomeA.01509-15>
- Gimenez-Lirola LG, Rademacher C, Linhares D, Harmon K, Rotolo M, Sun Y, Baum DH, Zimmerman J, Piñeyro P. Serological and molecular detection of Senecavirus A associated with an outbreak of swine idiopathic vesicular disease and neonatal mortality. *J Clin Microbiol*. 2016;54(8):2082-2089. <https://doi.org/10.1128/JCM.00710-16>
- Wang M, Chen L, Pan S, Mou C, Shi K, Chen Z. Molecular evolution and characterization of novel Seneca Valley virus (SVV) strains in South China. *Infect Genet Evol*. 2019;69:1-7. <https://doi.org/10.1016/j.meegid.2019.01.004>
- Sun D, Vannucci F, Knutson TP, Corzo C, Marthaler DG. Emergence and whole-genome sequence of Senecavirus A in Colombia. *Transbound Emerg Dis*. 2017;64(5):1346-1349. <https://doi.org/10.1111/tbed.12669>
- Saeng-Chuto K, Rodtian P, Temeeyasen G, Wegner M, Nilubol D. The first detection of Senecavirus A in pigs in Thailand, 2016. *Transbound Emerg Dis*. 2018;65(1):285-288. <https://doi.org/10.1111/tbed.12654>
- Arzt J, Bertram MR, Vu LT, Pauszek SJ, Hartwig EJ, Smoliga GR, Palinski R, Stenfeldt C, Fish IH, Hoang BH, Phuong NT, Hung VV, Vu PP, Dung NK, Dong PV, Tien NN, Dung DH. First detection and genome sequence of Senecavirus A in Vietnam. *Microbiol Resour Announc*. 2019;8(3):e01247-18. <https://doi.org/10.1128/MRA.01247-18>
- Bennett B, Urzúa-Encina C, Pardo-Roa C, Ariyama N, Lecocq C, Rivera C, Badía C, Suárez P, Agredo M, Aguayo C, Ávila C, Araya H, Pérez P, Berríos F, Agüero B, Mendieta V, Pituco EM, de Almeida IG, Medina R, Brito B, Johow M, Ramirez VN. First report and genetic characterization of Seneca Valley virus (SVV) in Chile. *Transbound Emerg Dis*. 2022;69:e3462-e3468. <https://doi.org/10.1111/tbed.14747>
- SEGOB. Secretaría de Gobernación. Diario oficial de la nación. Acuerdamediante el cual se dan a conocer en los Estados Unidos Mexicanos la enfermedad y plagas exóticas y endémicas de notificación obligatoria de los animales terrestres y acuáticos [Agreement through which mandatory notification of exotic and endemic diseases and pests of terrestrial and aquatic animals are made known in the United Mexican States]. Published November 29, 2018. Accessed December 22, 2022. https://dof.gob.mx/nota_detalle.php?codigo=5545304&fecha=29/11/2018#gsc.tab=0
- Leme RA, Alfieri AF, Alfieri AA. Update on Senecavirus infection in pigs. *Viruses*. 2017;9(7):170. <https://doi.org/10.3390/v9070170>
- Joshi LR, Mohr KA, Gava D, Kutish G, Buysse AS, Vannucci FA, Piñeyro PE, Crossley BM, Schiltz JJ, Jenkins-Moore M, Koster L, Tell R, Schaefer R, Marthaler D, Diel DG. Genetic diversity and evolution of the emerging picornavirus Senecavirus A. *J Gen Virol*. 2020;101(2):175-187. <https://doi.org/10.1099/jgv.0.001360>
- Liu F, Wang Q, Huang Y, Wang N, Shan H. A 5-year review of Senecavirus A in China since its emergence in 2015. *Front Vet Sci*. 2020;7:567792. <https://doi.org/10.3389/fvets.2020.567792>
- Segalés J, Barcellos D, Alfieri A, Burroughs E, Marthaler D. Senecavirus A. *Vet Pathol*. 2017;54(1):11-21. <https://doi.org/10.1177/0300985816653990>
- Hause B, Myers O, Duff J, Hesse RA. Senecavirus A in pigs, United States, 2015. *Emerg Infect Dis*. 2016;22(7):1323-1325. <https://doi.org/10.3201/eid2207.151591>
- Maggioli MF, Fernandes MHV, Joshi LR, Sharma B, Tweet MM, Noll JCG, Bauermann FV, Diel DG. Persistent infection and transmission of Senecavirus A from carrier sows to contact piglets. *J Virol*. 2019;93(21):e00819-19. <https://doi.org/10.1128/JVI.00819-19>
- Turner JH, Paim WP, Maggioli MF, Peter CM, Miknis R, Talley J, Bauermann FV. Prolonged viability of Senecavirus A in exposed house flies (*Musca domestica*). *Viruses*. 2022; 14(1):127. <https://doi.org/10.3390/v14010127>

* Non-refereed references.



Management of sodium ion toxicosis – water deprivation syndrome

Christopher J. Rademacher, DVM; Laura L. Greiner, MS, PhD; Scott L. Radke, MS, DVM, DABVT

Summary

If a pig is exposed to prolonged periods without water or excessive salt intake, the sodium content of the brain increases. The most severe problems occur when a pig is rehydrated with unfettered water access. The high concentration of sodium in the brain draws water in and the brain swells inside the rigid calvarium causing neurologic clinical signs and ultimately, death. Rehydration must occur as a slow process over a period of many hours to prevent brain swelling. Water introduction must occur over a period of hours with slow water introduction to allow for the sodium ion exchange.

Keywords: swine, sodium toxicosis, dehydration, water deprivation

Received: January 6, 2023

Accepted: June 15, 2023

Resumen - Manejo de la toxicosis por iones de sodio – síndrome de privación de agua

Si un cerdo es expuesto a períodos prolongados sin agua o ingesta excesiva de sal, el contenido de sodio del cerebro aumenta. Los problemas más graves ocurren cuando un cerdo se rehidrata con acceso al agua sin restricciones. La alta concentración de sodio en el cerebro atrae agua y el cerebro se inflama dentro del calvario rígido causando signos clínicos neurológicos y, en última instancia, la muerte. La rehidratación debe ocurrir como un proceso lento durante un período de muchas horas para prevenir la inflamación del cerebro. La introducción de agua debe ocurrir durante un período de horas con una introducción lenta de agua para permitir el intercambio de iones de sodio.

Résumé - Prise en charge de la toxicose des ions sodium – syndrome de privation d'eau

Si un porc est exposé à des périodes prolongées sans eau ou à une consommation excessive de sel, la teneur en sodium du cerveau augmente. Les problèmes les plus graves surviennent lorsqu'un porc est réhydraté avec un accès illimité à l'eau. La forte concentration de sodium dans le cerveau attire l'eau et le cerveau gonfle à l'intérieur du calvarium rigide, provoquant des signes cliniques neurologiques et finalement la mort. La réhydratation doit se produire comme un processus lent sur une période de plusieurs heures pour prévenir le gonflement du cerveau. L'introduction d'eau doit se produire sur une période de plusieurs heures avec une introduction d'eau lente pour permettre l'échange d'ions sodium.

Sodium ion toxicosis (salt toxicity or salt poisoning) is a condition that occurs when animals are without water for a time and then consume high volumes of water in a short period. Although rare, intoxication through the consumption of excessive concentrations of sodium within feed can occur. Excess sodium intake during a period of water deprivation may exacerbate and expedite complications. Ingestion of brackish or salt water may also result in sodium ion intoxication. Following an extended period without water, sodium increases within the brain through passive diffusion. As a result, glycolysis is inhibited and the production of adenosine triphosphate (ATP), a source of energy, is halted. With ATP production diminished, sodium-potassium dependent ATPase pumps, can no longer actively transport sodium out of the neural

tissue.¹ Clinical complications occur when unrestricted access to water is provided. The abrupt and rapid increase of water consumption results in a sudden osmotic shift within the brain by the influx of water leading to swelling of the brain, neurologic deficits, and eventual death. Returning animals to normal levels of water consumption to prevent sodium ion intoxication requires time and gradual re-introduction to water.² This practice tip provides procedures for re-introducing animals experiencing sodium ion toxicosis to water in a controlled manner.

Clinical signs

Initial signs of sodium ion intoxication due to water deprivation may include thirst, anorexia, and constipation characterized by firm feces, and then

usually followed by central nervous system signs. Severe cases of sodium ion intoxication result from extended periods without water (> 24 hours) and are exacerbated upon rapid rehydration. The amount of time that animals are deprived of water resulting in sodium ion intoxication is dependent on the environment and may be less than 24 hours. Severe cases often result in pigs exhibiting intermittent convulsive seizures with opisthotonos, often starting from a “dog-sitting” position.¹⁻³ As they are centrally unaware, affected animals may appear to wander aimlessly, exhibit head pressing, head jerking, jaw chomping, and appear to be blind and deaf. Moribund pigs become comatose, often lying on their sides with continuous paddling. Most moribund animals will die within a few hours and up to 48 hours after they begin displaying these clinical signs.

CJR, SLR: Department of Veterinary Diagnostics and Preventive Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

LLG: Department of Animal Science, College of Agriculture, Iowa State University, Ames, Iowa.

Corresponding author: Dr Christopher Rademacher, 2225 Lloyd, Ames, IA, 50011; Tel: 515-294-8792; Email: cjrdvm@iastate.edu

Rademacher CJ, Greiner LL, Radke SL. Management of sodium ion toxicosis - water deprivation syndrome. *J Swine Health Prod.* 2023;31(6):295-297. <https://doi.org/10.54846/jshap/1353>

Diagnosis

Diagnosis is initially established based on clinical signs coupled with a history of prolonged water deprivation, excessive sodium intake, or both. Confirmation of the initial diagnosis is recommended and can be confirmed by submitting fresh and formalin-fixed brain tissue from affected animals to a veterinary diagnostic laboratory.^{1,2,4} In addition, a thorough history should be collected to rule out other potential agents, such as organophosphate and carbamate pesticides, that may cause similar clinical symptoms.⁴ An assessment of how long pigs may have been deprived of water or exposed to excessive concentrations of sodium should be performed. Facilities, equipment, and water flow and availability should also be evaluated.¹

Histologic examination of the cerebrum often shows a pathognomonic eosinophilic meningoencephalitis characterized by cuffing of meningeal and cerebral vessels (Figure 1) with eosinophils in acutely affected pigs (< 12 hours from unrestricted access to water following deprivation). In addition to the eosinophilic perivascular cuffing, necrosis of neurons and laminar cortical necrosis, also known as polioencephalomalacia, may be observed.^{1,2} A definitive diagnosis of sodium ion intoxication should

not be solely dependent on formalin-fixed brain and presence of eosinophilic perivascular cuffing. Animals that have been treated, have started to recover, or sampled 24 hours following initial complications are likely to exhibit few eosinophils as they are typically replaced by macrophages. When examining fixed tissue microscopically, only a single cell layer can be observed. There is a possibility that the aforementioned pathognomonic lesions may not be observed. Therefore, multiple sections should be submitted for evaluation.² Analysis of brain sodium concentrations is an additional method for diagnosing sodium ion intoxication due to water deprivation. A brain sodium concentration greater than 1800 ppm in fresh brain (wet) is an indicator of salt toxicity.¹ In such situations, it is not uncommon that brain sodium concentrations exceed 2000 ppm.² In treated or recovering individuals, brain sodium concentrations may be normal (< 1800 ppm).³ Analysis of brain sodium can only be performed on fresh tissue as buffered and nonbuffered formalin can falsely elevate or lower brain sodium, respectively.⁵ Serum, ocular fluid, and cerebral spinal fluid (CSF) can also be used to evaluate sodium concentrations. Other than a spinal tap, serum serves as the only ante-mortem sample to aid in diagnosing dehydration and sodium ion intoxication. Evaluation of serum at

a clinic may be performed to offer evidence of dehydration and hypernatremia in living affected animals. Sodium within serum and CSF > 160 mEq/L are supportive of a diagnosis. The cleanliness of a CSF sample must be taken into consideration as contamination by blood and other material may occur during the collection process.²

Causes of dehydration

Dehydration is an event in which an organism releases more water than it consumes. Water release from an organism can be in forms of excretions (urinary, fecal, and sweat) and breath. Water deprivation can occur at various times throughout an animal's life. For example, disease can cause a fever which reduces the animal's intake of water. Facility issues such as broken, frozen, or clogged water lines or medicators can also create periods of water absence. Long transportation times and producer error when switching water lines during times of mass water medication can result in pigs going without water for an extended time. High air temperatures in which the body must compensate for temperature regulation can result in significant water loss. For example, the deprivation time would be shorter in animals during hot summer months than those in cooler environments. Animals may have water available to them at all times, but that does not mean that they drink it. In situations where water has always been available, an evaluation of water meters to monitor usage should be performed. Although water may have been available, there are circumstances in which water consumption may have been stagnant or decreased. These include unpalatable water due to either additives such as medications or water sourced from a new well in which a salt vein was struck and no quality testing was performed. The height of the waterers and familiarity of the watering system to animals should also be considered. Animals not familiar with new sources of water, ie, cup vs nipple waterer, may not approach or use the waterer.¹⁻⁴

Interventions

More severe dehydration results in a longer period of rehydration. Any supplementary water interventions should be continued until the pigs quit fighting for water or lose interest in the water source. When serum sodium levels cannot be actively monitored, individuals should assume that pigs should be

Figure 1: Histologic image of eosinophilic meningoencephalitis that could indicate salt toxicosis (hematoxylin and eosin, original magnification × 40).

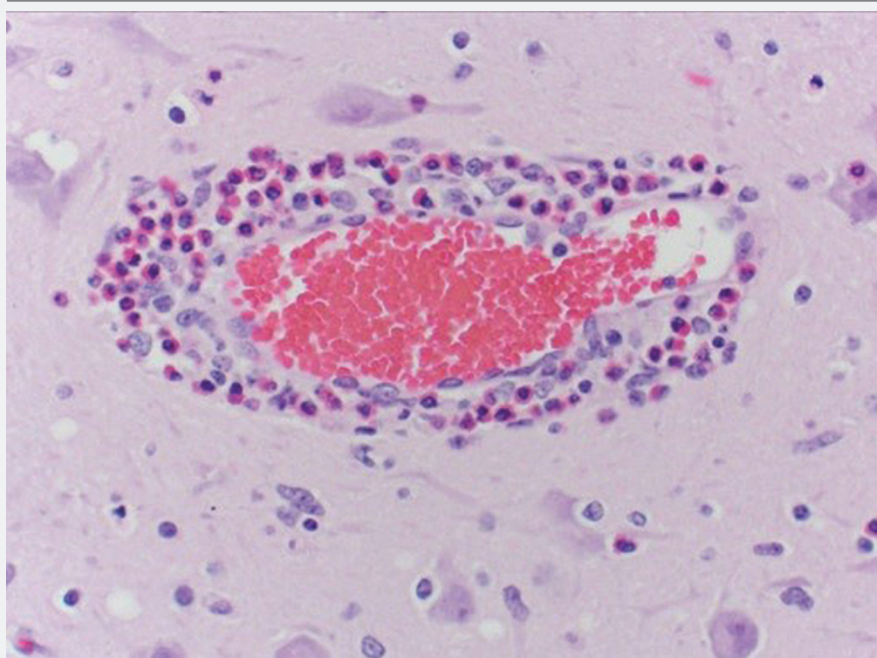


Photo credit: Drs Steve Ensley and Scott Radke.

rehydrated at a rate of 0.5% of body weight each hour.³ However, when serum sodium levels can be measured, the goal would be to replace 50% of the free water deficit (FWD) within the first 24 hours.² The remaining deficit should be replaced within the following 48 hours.³ Liters of FWD is calculated as $FWD = 0.6 \times BW \times (\text{current Na}^+) / (\text{desired Na}^+ - 1)$ where BW is pig body weight in kilograms and Na^+ is serum sodium concentration in milliequivalents per liter.¹⁻³

When reintroducing water, methods need to be conducted over multiple hours until the pigs lose interest in the water source to successfully reduce the risk of sodium toxicosis. An anti-inflammatory protocol based on veterinarian input should be included as an intervention for pigs that are severely impacted. Pigs should never be given electrolytes in the water during a rehydration event.

To generate a list of interventions used in the field, members of the American Association of Swine Veterinarians (AASV) were asked via the AASV-L Email Discussion List⁶ how they have brought water deprived pigs back onto water. The following is a compilation of suggestions from veterinary practitioners (N = 15) for the various methods they have used to minimize the clinical signs of salt toxicity while slowly re-introducing the pigs to water. The methods listed are not all inclusive and, in some scenarios, the producer may choose to use multiple methods of rehydration based upon pen stocking density and access to the water supply.

Turning the water on and off

Water can be turned on and off for a variety of timeframes. Some of the suggested water intake patterns were 1) on for 5 to 10 minutes within each 30 minute period; 2) on for 3 to 5 minutes and off for 5 to 10 minutes; 3) 15 minutes on and 2 hours off; and 4) fill water cups and repeat in 10-minute increments. If the stocking density within the pen is high or the number of functional drinkers available is reduced, it is possible that the most aggressive pigs in the pen will get more than their share of the available water in the limited time the water is turned on. Less aggressive pigs may drink the spillage from other pigs. In this situation, an additional water supply may be needed to increase the odds that rehydration starts in the greatest percentage of pigs possible.

Use of floor space

When a large number of pigs are affected, as an adjunct to turning on and off water as previously described, producers can use the floor to create water access. Methods to employ could include 1) running water on slatted or partially slatted floors by using either a garden hose or buckets; 2) placing snow on the floors or slats; and 3) removing feed from feeders, pouring in small amounts of water, and periodically refilling the water once the feeders have been emptied.

Misters

If functional spray misting or drip cooling systems are available in the facility, they can be used to slowly rehydrate the pigs. It should be kept in mind that when misters are used, feed could get wet and so covers over the feeders should be considered. Misters can be run at intervals of 15 minutes on and then 15 minutes off.

Creep feeders

Creep feeders or capped PVC tubing cut in half to create troughs can be placed into pens to quickly allow water access to a large group of pigs. Small amounts of water would need to be added over time.

Veterinary intervention

A veterinarian, veterinary technician, or a trained caretaker under direct veterinary supervision may employ other techniques to restore fluid, such as rectum infusion or intraperitoneal injection.

Acknowledgments

The authors would like to thank the swine veterinary community that responded via the AASV listserv for their suggestions and practice tips for this publication.

Conflict of interest

None reported

Disclaimer

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

References

1. Niles G. Metals and Minerals: Sodium. In: Plumlee KH. *Clinical Veterinary Toxicology*. Mosby; 2004:218-221.
2. Osweiler GD. Water Related Toxicoses. In: Osweiler GD. *Toxicology*. Wiley-Blackwell; 1996:355-357.
3. Ensley SM, Radke SL. Toxic Minerals, Chemicals, Plants, and Gases. In: Zimmerman J, Karriker L, Ramirez A, Schwartz K, Stevenson G. *Diseases of Swine*. 11th Ed. Wiley-Blackwell; 2019:1082-1083. <https://doi.org/10.1002/9781119350927.ch70>
4. Thompson LJ. Salt toxicosis in animals. In: *Merck Manual Veterinary Manual*. Revised May 2022. Modified November 2022. Accessed April 9, 2023. <https://www.merckvetmanual.com/toxicology/salt-toxicosis/salt-toxicosis-in-animals>
- *5. Schunk D, Ensley S, Radke S, Magstadt D. The effects of formalin fixing on trace mineral status. In: *Proceedings of the AAVLD Annual Meeting*. American Association of Veterinary Laboratory Diagnosticians. 2017. San Diego, CA.
- *6. Recovery from Water Deprivation. AASV-L Email Discussion List. October 19, 2022.

* Non-refereed references.





YOUR NEW WEAPON
AGAINST
FLU

NEW SEQUIVITY IAV-S NA vaccine works differently than past influenza A vaccines. Because it was built differently.

This one-of-a-kind influenza A vaccine for growing pigs utilizes revolutionary RNA particle technology to cut down flu with serious power. It's safe and effective - and the proven Microsol Diluvac Forte® adjuvant provides optimal immune response to help keep pigs on track.

Scan the QR code to learn more,
or visit [SEQUIVITY.COM/IAVS-NA](https://sequivity.com/iavs-na).



TALK TO YOUR VETERINARIAN TODAY.



Emphasizing the importance of traceability for the swine industry

Foreign animal diseases (FADs), especially African swine fever, are always an important topic to animal health officials, pig farmers, and those who represent the swine industry. Keeping FADs out of the United States and ensuring business continuity for pig farmers are key priorities to the National Pork Board (NPB) and the swine industry. It is imperative the industry works together to control the spread of diseases, as exposure to an FAD would close export markets for US pork and have a negative effect on the farm economy.

The NPB, the National Pork Producers Council (NPPC), and the US Swine Health Improvement Plan (US SHIP) initiative, have been collaborating to identify industry-driven opportunities to improve preharvest traceability in the swine industry. The key areas of focus include movements to slaughter, including cull channels; intrastate movements; speed at which movement data is available; and premises identification numbers across all segments of the industry. To aid in this effort, the industry assembled the Swine Traceability Task Force. They are tasked with reviewing and revising a set of Swine Traceability Standards. Producers had the opportunity to provide feedback on the standards to NPPC in October. The final draft of the Swine Traceability Standards will be presented during the 2024 National Pork Industry Forum in March, an event held jointly by NPB and NPPC.



The goal of the Swine Traceability Standards is to arm animal health officials with additional information they will need to trace live swine. It is a priority of the industry to ensure state animal health officials have the traceability information they need on day one of an FAD incident to support disease control, regionalization, and resumption of commerce and trade. In 2022, the United States exported over \$7.6 billion in pork and pork products to over 100 countries – nearly a quarter of US pork production (Source: 2022 Year-end data from USDA Foreign Agricultural Service and USMEF). A closure in the export market would be detrimental to the US swine industry.

The NPB has dedicated resources to help producers share traceability information with animal health officials, including a free, opt-in technology solution called AgView. This promotes business continuity for US pig farmers by uniquely making disease traceback and

pig movement data available to the US Department of Agriculture (USDA) and state animal health officials on day one of an FAD outbreak. The future of AgView includes serving as the approved swine movement repository for US SHIP and as the database of record for a potential mandatory preharvest traceability system.

To ensure collaboration and success, the industry is working closely with USDA on a complementary project to improve preharvest traceability in cull markets using the most up-to-date technology. Veterinarians serve an important role in this process and will be essential in working with producers to ensure herd health and help them understand the importance of traceability in the swine industry. For more information about these efforts to improve preharvest traceability in the swine industry, please visit usswinehealthimprovementplan.com.





WHAT IF ALL THE LITTLE PIGS DON'T MAKE IT TO MARKET?

SPONSORED CONTENT

Dr. Pat Hoffmann, DVM and technical consultant for Elanco Animal Health, recognizes the importance of a proactive approach to swine respiratory disease (SRD) to stave off resulting economic impacts.

“What we forget sometimes is that impacts early on in the nursery will flow all the way to the finisher and to the packer,” Hoffmann said. SRD is responsible for 44.2% of nursery mortalities, which equates to fewer pigs reaching finishing.¹ Pigs that do survive SRD can have lasting effects on their average daily gain (ADG) and overall finishing weight.² For every 10% of lung area affected, ADG decreases by 37.4 grams.³ Mortality loss and decreased ADG cause an economic loss for producers in the nursery through to finish.² Attached lungs at the packer impact bottom lines, as well.⁴

SRD in the nursery is prevalent due to the stress of weaning, transportation, and co-mingling.⁵ Hoffmann stated that, “One of the earliest, objective signs of SRD that I like to watch for is a drop in 24 hour water consumption. Many times that will indicate something is wrong before clinical symptoms become apparent.”

Those clinical symptoms may include lethargy, coughing, sneezing, nasal and ocular discharge, thumping, fever and reduced feed intake.

According to Hoffmann, the prevalence of SRD means we must be alert. “The first thing I want to understand are any issues with air, water and feed and get that addressed. If the pigs experience stress, they will be more susceptible to pathogens as they move through the barn.”

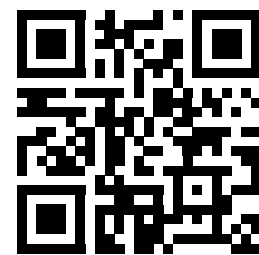
Even with minimal stress, some level of SRD challenge is still likely to appear. When deciding which treatment option is best, Hoffmann recommended looking at the disease situation. “In my experience as a veterinarian, I rely on differential diagnoses that match my clinical experience, the diagnostic history of the flow, and sensitivities to the pathogens that I am addressing.” Depending on the clinical signs, incidence rates, and overall sense of urgency, first choice will be injectables for individual pig treatment and then water solubles or feed additives for whole herd treatment.

“An early response to SRD is not only key to minimize morbidity and mortality, but also maximize growth performance

and feed conversion of the group all the way to the packer,” Hoffmann said.

“Getting ahead of a challenge and making sure you’re choosing the right treatment solution is critical. Use every resource at your disposal to get the Full Value out of every pig.”

Read more about SRD impacts at swineweb.com/life-is-hard-a-nursery-pig/



¹USDA 2007. Swine 2006 Part I: Reference of Swine Health and Management in the United States, 2006. Fort Collins, CO: USDA APHIS: VS, CEAH. Publication N475.1007. ²Qin, S., et al. Viral communities associated with porcine respiratory disease complex in intensive commercial farms in Sichuan province, China. *Sci Rep* 8, 13341 (2018). ³Straw B., et al. Estimation of the cost of pneumonia in swine herds. *Jour of Amer Vet Med Assoc.* 1989. 195(12):1702-1706. ⁴Keenlside, J. 2005. Preventing carcass losses. *The Pig Site.* Retrieved from: www.thepigsite.com/articles/preventing-carcass-losses. Accessed on Sept 20, 2019. ⁵Brockmeier, S., et al. *Porcine Respiratory Disease Complex. Polymicrobial Diseases.* Washington (DC): ASM Press; 2002. Chapter 13. Accessed on January 19, 2021.

YOUR PRRS ARSENAL JUST GOT BIGGER



The labels contain complete use information, including cautions and warnings. Always read, understand and follow the label and use directions.

Prevacent, Swine Awake, the Full Value Pork logo, Elanco and the diagonal bar logo are trademarks of Elanco or its affiliates. Barricade is a trademark of Aptimmune Biologics, Inc. ©2023 Elanco or its affiliates. PM-US-23-1700 | 1176781714



Students: Apply for Alternate Student Delegate position by November 17

The AASV Student Engagement Committee is accepting applications from veterinary students interested in serving as the alternate student delegate on the AASV Board of Directors. This student will represent student interests and serve as a non-voting member of the AASV board. This experience will provide the student with a unique perspective of the inner workings of the AASV. The term of service is 2 years: the first year as alternate student delegate, and the second year as the student delegate.

The alternate student delegate and student delegate are required to attend the AASV Board of Directors' fall and spring meetings each year, as well as the 2 AASV Annual Meetings held during their term. The spring board of directors meeting is usually held in early April and the fall board meeting is generally held in late September or early October. Recent board meetings have been held in central Iowa, but the date and location can vary, as determined by the board. The 2 delegates work with AASV staff to prepare for student activities (ie, Vet Hunt, Speed Networking, etc) conducted during the AASV Annual Meeting. During the student breakfast at the Annual Meeting, the student delegate is encouraged to present a summary of board activities and describe student opportunities in AASV to the students in

attendance. In addition, the delegate and alternate delegate serve as voting members of the AASV Student Engagement Committee and are invited to participate in committee conference calls and meetings.

Both delegates receive reimbursement of their travel and lodging expenses to attend board meetings as well as both AASV Annual Meetings held during their term of office.

Interested students must be members of AASV in their freshman or sophomore year. The Student Engagement Committee does take notice of repeat applicants in the selection process. Applicants are required to submit the following documentation to the AASV (aasv@aasv.org):

1. An introductory letter, not to exceed one page, describing why they want to serve as the alternate student delegate for AASV, their level of interest/background in swine medicine, and their future career goals.
2. A one- or two-page resume featuring the student's interest and experience in production medicine, particularly swine medicine.
3. A statement of recommendation from a faculty member.

The deadline for submission of necessary documentation is **Friday, November 17, 2023**. The delegate will be chosen by members of the AASV Student Engagement Committee following review of the submitted materials.

The term of service is 2 years, beginning at the AASV Annual Meeting. During the first year, the student will serve as the alternate student delegate. The alternate delegate will automatically succeed as student delegate, beginning at the Annual Meeting the following year. The alternate delegate will serve in the capacity of delegate if the student delegate is unable to carry out their duties. Each year, a new alternate delegate is selected by the AASV Student Engagement Committee.

Questions may be directed to the chair of the AASV Student Engagement Committee, Dr Jamie Madigan, jamiemm@pillenfamilyfarms.com.

AASV award nominations due December 11

When considering who to nominate for the AASV awards to be presented at the 2024 Annual Meeting, it seems especially appropriate to keep the meeting theme - *Leading AASV into the Future* - in mind. Do you know a member who has demonstrated exemplary leadership and vision as they carry out their role in practice, technical services, academia, research, or another area? Someone whose actions are benefiting and leading AASV and the swine veterinary profession into the future? Nominate them for one of the following 6 awards to be presented in Nashville, Tennessee!

Howard Dunne Memorial Award –

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

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

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

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

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

Young Swine Veterinarian of the Year – Given annually to a swine veterinarian who is an AASV member, 5 years or less post graduation, who has demonstrated the ideals of exemplary service and proficiency early in their career. Those AASV members who received their veterinary degree in 2018 through 2022 are eligible to be considered for the 2024 award.

Are you wondering who has been recognized in the past? See aasv.org/aasv/awards for a list of the previous recipients of each award.

Nominations are due December 11. The nomination letter should specify the award and cite the qualifications of the candidate for the award. Submit nominations to AASV by mail, 830 26th Street, Perry, Iowa 50220, or email: aasv@aasv.org.

AASV meets with AVMA leadership

The American Veterinary Medical Association (AVMA) Board of Directors and staff visited the National Animal Disease Center and the Iowa State University Veterinary Diagnostic Laboratory in Ames, Iowa in September. The AASV leadership took advantage of the opportunity to discuss swine medicine with AVMA leadership during their visit to Iowa.

An overview of US pork production and the swine industry was provided by AASV Executive Director Dr Harry Snelson, and AASV Director of Public Health and Communications

Dr Abbey Canon described AASV and its membership. Dr Liz Wagstrom introduced the National Pork Board and National Pork Producers Council, and Dr Paul Sundberg described the Swine Health Information Center. Drs Deb Murray and Aaron Lower, AASV representatives to the AVMA House of Delegates, and AASV President Dr Bill Hollis provided accounts of current swine veterinary practice and workforce challenges. Dr Canon highlighted some of AASV's efforts to examine swine veterinary attrition and address retention. Dr Mike Senn, AASV past president, explained the

current and recent challenges facing swine veterinarians and pork producers, including Proposition 12, depopulation, and vaccine technology. Dr Locke Karriker, AASV vice-president, further described obstacles in swine veterinary education.

AASV Board of Directors conducted business in August

The AASV Board of Directors met August 30-31 in Manhattan, Kansas where they took several actions during the business portion of the meeting.

Antimicrobial stewardship course

reimbursements: The board approved a motion from the Pharmaceutical Issues Committee to reimburse 20 AASV-member practitioners upon completion of the Swine Medicine Education Center's course on antimicrobial stewardship.

International withdrawal database:

The board passed a motion to provide \$10,000 for a gap analysis to be completed as Phase 1 of a larger, 3-phase project to prepare an evidence-based international withdrawal interval database.

MentorVet scholarships: The board reviewed available evaluations from participants who completed the AASV-funded MentorVet program in July 2023, along with data from the MentorVet program itself. The board approved \$2995 to fund scholarships for 5 AASV-member, early-career veterinarians (2019-2023 veterinary graduates) to participate in the spring 2024 cohort of the MentorVet Leap program.

Swine faculty survey: The board approved a request from the Collegiate Activities Committee to conduct a survey to identify recruitment and retention issues for swine faculty at veterinary institutions.

Collegiate Activities Committee mission change: The board approved a revised committee mission statement, available at aasv.org/members/only/committee/CollegiateActivitiesCommittee.php.

Position statements: Two position statements were approved by the board. AASV position statements undergo review every three years on a rotating basis. See aasv.org/aasv/positions.htm for all current positions.

- **Basic Guidelines of the Judicious Therapeutic Use of Antimicrobials in Swine:** The board approved the Pharmaceutical Issues Committee's motion to revise the previous position.
- **Vaccine Technology:** The board approved a new position on vaccine technology.

Complete Board of Directors and Executive Committee meeting minutes are available to AASV members at aasv.org/aasv/board.



55th AASV Annual Meeting

February 24-27, 2024
Nashville, Tennessee

*Leading
AASV*

*into the
Future*



aasv.org/annmtg

* Photo courtesy of the National Pork Board, Des Moines, Iowa, USA

2024 Annual Meeting Program

SATURDAY, FEBRUARY 24

Preconference seminars

1:00 PM – 5:00 PM

- Seminar #1 Max Rodibaugh Memorial Practice Tips Seminar
Melissa Billing, chair
- Seminar #2 Maximizing the Value of Big Diagnostic Data
Daniel Linhares and Giovanni Trevisan, co-chairs
- Seminar #3 Disease Preparedness: Lessons and Updates
Andreia Arruda and Marie Culhane, co-chairs
- Seminar #4 Swine Savvy: Mastering the Art of Swine Business
Amber Stricker, chair
- Seminar #5 Pig Livability: What Works, What Doesn't
Jordan Gebhardt, chair

SUNDAY, FEBRUARY 25

Preconference seminars

8:00 AM – 12:00 PM

- Seminar #6 Biosecurity
Derald Holtkamp, chair
- Seminar #7 Much Ado about Flu
Micah Jansen, chair
- Seminar #8 Case Reports, Case Studies, and Field Trials – Oh My!
Michelle Sprague, chair
- Seminar #9 Swine Health through Nutrition: Modulating the Microbiome and Enhancing Productivity and Performance through the Feed
Alex Hintz, chair
- Seminar #10 Swine Medicine for Students
Angie Supple and Jeremy Pittman, co-chairs

Research Topics

8:00 AM – 12:00 PM

Session chair: **Chris Rademacher**

- 8:00 AM FFN titers in sows and piglets following homologous inactivated PRRSV administration to sows
Lindsey Britton
- 8:15 AM Field experiences with a novel PRRS live virus vaccine based on the naturally nonpathogenic G16X strain from 2021 to 2023 in Mexico
Jesus Horacio Lara Puente
- 8:30 AM What is behind tongue tip sampling and other welfare-friendly postmortem samples for accurately detecting PRRSV?
Mariana Kikuti
- 8:45 AM Evaluation of PRRSV vertical transmission using stillborn tongue tip fluids sampling
Isadora Machado
- 9:00 AM Have we seen this PRRSV before? Where? When? SDRS PRRSV BLAST: An informative tool to support swine veterinarians and producers
Srijita Chandra
- 9:15 AM Early detect PRRSV outbreaks in breeding herds by monitoring operational data using univariate and multivariate statistical process control charts
Mafalda Pedro Mil-Homens
- 9:30 AM Ear-vein blood swabs, oral swabs, and nasal swabs can be used with precision for PRRSV surveillance in weaning-age pigs
Onyekachukwu Henry Osemeke
- 9:45 AM REFRESHMENT BREAK
- 10:15 AM Environmental viability of *Mycoplasma hyopneumoniae*
Cassidy Cordon

- 10:30 AM Confirming Day 0 in a *Mycoplasma hyopneumoniae* herd closure
Amanda Sponheim
- 10:45 AM Probability of influenza A virus RNA detection at different pooling levels for commonly used sample types in breeding herds
Daniel Moraes
- 11:00 am Comparison of fecal diagnostic tests for the detection of monophasic *Salmonella* and their association with clinical signs
Fernando Leite
- 11:15 AM Characterization of hemolytic *Escherichia coli* cases and antimicrobial susceptibility from ISU VDL cases from 2010 to 2022
Rodrigo Paiva
- 11:30 AM Paper sampling for passive environmental surveillance for swine pathogens
Betsy Armenta-Leyva
- 11:45 AM Evaluation of oral meloxicam to reduce signs of OCD-associated lameness in developing boars
Megan Hood
- 12:00 PM Session concludes

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

12:00 PM – 5:00 PM

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

Concurrent sessions

1:00 PM – 5:30 PM

- Session #1 **Student Seminar**
Andrew Bowman and Justin Brown, co-chairs
- Session #2 **Industrial Partners**
McKenna Brinning-Henningson and Kim Crawford, co-chairs

- Session #3 **Industrial Partners**
Heather Fowler and Mike Senn, co-chairs
- Session #4 **Industrial Partners**
Attila Farkas and Matthew Turner, co-chairs

MONDAY, FEBRUARY 26

General Session

Leading AASV into the Future

8:00 AM – 12:30 PM

Program and Session chair: Angela Baysinger

- 8:00 AM **Howard Dunne Memorial Lecture**
Swine veterinarians: Who are we and where are we going?
Joel Nerem
- 9:00 AM **Alex Hogg Memorial Lecture**
Past, present, and future challenges for the swine veterinary profession
Chris Rademacher
- 10:00 AM REFRESHMENT BREAK
- 10:30 AM Successful disease eradication in the United States: What worked and why?
Jeff Zimmerman
- 11:00 AM *Mycoplasma* elimination from regional to national level (why aren't we there yet?)
Paul Yeske
- 11:30 AM PRRS: The never-ending story
Amy Maschhoff
- 12:00 PM The zombie apocalypse approach to biosecurity, biocontainment, and disease control and elimination
Luc Dufresne
- 12:30 PM AASV-AASV FOUNDATION LUNCHEON

Concurrent Session #1: Disease Elimination: Theory to Move us Forward

2:00 PM – 5:30 PM

Session chair: Claire LeFevre

- 2:00 PM *Mycoplasma* elimination success versus PRRSV elimination failure
Michael Rahe
- 2:30 PM Pseudorabies virus elimination versus porcine epidemic diarrhea virus elimination: We did it before, why not do it again?
Lisa Tokach and Megan Potter
- 3:00 PM Current trends in *Mycoplasma hyopneumoniae* elimination
Amanda Sponheim
- 3:30 PM REFRESHMENT BREAK
- 4:00 PM Practical experiences during PRRS eradication in Hungary 2012-2022
István Szabó
- 4:30 PM Experiences with influenza elimination in sow farms
Jorge Garrido Mantilla
- 5:00 PM Approaches to disease elimination: A cross-species comparison with poultry
Jessica Higgins
- 5:30 PM Session concludes

Concurrent Session #2: Sustaining the Farm in the Face of Evolution

2:00 PM – 5:30 PM

Session chair: Brian Payne

- 2:00 PM Introduction
Brian Payne
- 2:05 PM Implications of Proposition 12 compliance
Cara Haden
- 2:30 PM Our Proposition 12 journey: Production considerations and lessons we are learning
Carlos Roudergue
- 2:55 PM Passing or needing corrections: Proposition 12
Jason McCallister
- 3:20 PM Roundtable questions and answers
Haden, Roudergue, McCallister
- 3:30 PM REFRESHMENT BREAK
- 4:05 PM The future of farrowing
Tom Parsons
- 4:30 PM Staying alive: Protein market sustainability
Dan Thomson
- 4:55 PM The veterinarian's role in drug regulation: The views of the National Pork Board and the National Pork Producers Council
Heather Fowler and Ashley Johnson
- 5:20 PM Roundtable questions and answers
Parsons, Thomson, Fowler, Johnson
- 5:30 PM Session concludes

Concurrent Session #3: Immunology Toolbox: Today and Tomorrow

2:00 PM – 5:30 PM

Session co-chairs: Brent Pepin and Phil Gauger

2:00 PM	Vaccine platforms: What's currently available? <i>Geetha Srinivas</i>
2:20 PM	Vaccine development and off-label use <i>Mike Roof</i>
3:00 PM	Vaccines and maternal antibody <i>Pablo Pineyro</i>
3:30 PM	REFRESHMENT BREAK
4:00 PM	Vaccine immunology and expectations <i>Mike Rahe</i>
4:30 PM	Futuristic vaccines: mRNA <i>David Verhoeven</i>
4:45 PM	Futuristic vaccines: DNA vaccines <i>Hiep Vu</i>
5:15 PM	Next generation nanovaccine platforms for animal health <i>Balaji Narasimhan</i>
5:30 PM	Session concludes

TUESDAY, FEBRUARY 27

General Session

Driving Demand and Protecting the Product

8:00 AM – 12:00 PM

Session chair: Bill Hollis

8:00 AM	Driving demand worldwide: What are the economics? What can a veterinarian do? <i>Erin Borror</i>
9:00 AM	Driving demand: What we are doing with your money. What you need to do. <i>Bill Even</i>
10:00 AM	REFRESHMENT BREAK
10:30 AM	Protecting the product: Are your clients participating in price protection? <i>Dustin Baker</i>
11:00 AM	Protecting the product: How I work with my packer <i>Deb Murray</i>
11:30 AM	Protecting the product: What I need from veterinarians <i>Grace Houston</i>
12:00 PM	Session and meeting conclude



Researchers: Submit your proposals for funding

The AASV Foundation plans to award up to \$100,000 in 2024 to support research with direct application to the swine veterinary profession and is now receiving proposals to be considered for funding.

Proposals are due by 12:00 PM Central Time on **December 15, 2023**, and may request a maximum of \$30,000 per project. The announcement of projects selected for funding will occur during the 2024 AASV Annual Meeting on Monday, February 26.

Proposed research should fit one of the 5 action areas stated in the AASV Foundation mission statement (see sidebar). The instructions for submitting proposals are available on the AASV Foundation website at aasv.org/foundation/2024/research.php.

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

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

A summary of the research previously funded by the foundation is available at aasv.org/foundation/research.htm.

For more information, or to submit a proposal, contact the AASV Foundation: 515-465-5255; foundation@aasv.org.

AASV Foundation Mission Statement

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

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

Let's have a grand ole auction, y'all!

Yee haw! AASV is headed to Nashville, Tennessee, the home of country music, Honky Tonk Highway, and the Grand Ole Opry! As you dig those cowboy boots out of the closet and start practicing your line dance moves, take a few minutes to think about how you can “step up” to support the AASV Foundation fundraising auction!

For starters, “scoot” over to the AASV Foundation website to download the donation form at aasv.org/foundation/2024/auctioninfo.php. Need ideas for your donation? Just “weave” through the list of last year’s donations at aasv.org/foundation/2023/auctionlist.php. Please don’t “brush” us off – we would not want that to get on the “grapevine.” We hope you will “kick” it up a notch with your unique and creative donation! But you had better “hustle” because donations are due **December 1!**

To donate, submit the donation form with a photo of your item. Your contribution will be recognized in the auction catalog as well as on the auction website, and your name will appear in the full-page JSHAP spread recognizing our auction item donors.

As in recent years, the silent auction will be conducted virtually via ClickBid, and auction donors are asked to hold onto their donation for shipment to the winning bidder after the auction. The live auction will be held immediately following the Monday evening awards reception at the 2024 AASV Annual Meeting in Nashville.

Whether you choose to donate cash or an auction item, this annual fundraiser is essential for providing immediate and ongoing support for the many scholarships and grants awarded by the

foundation each year, including scholarships, travel stipends, and externship grants for veterinary students as well as research grants, debt relief, and scholarships for graduate veterinarians. See aasv.org/foundation for details about these and additional programs supported by the foundation.

Questions about the auction or what to donate? Contact a member of the Auction Committee (listed at aasv.org/foundation/2024/auctioninfo.php) or send a message to foundation@aasv.org.

Questions about line dancing? See YouTube!

We'll see y'all in Nashville for the AASV Foundation's grand ole auction!

IT ISN'T HOW MUCH A SECOND
DOSE OF UNIFERON[®] COSTS.

IT'S HOW MUCH IT RETURNS.

Research proves that investing in a second dose of Uniferon[®] for your baby pigs provides ROI that can't be denied.

6.56 LBS

IMPROVEMENT AT WEAN TO MARKET

4%

INCREASE IN AVERAGE DAILY GAIN

2.5%

IMPROVEMENT IN HOT AND COLD CARCASS WEIGHTS

1.5 LBS

ADDITIONAL TRIMMED LOIN

To learn more about what two doses of Uniferon[®] can do for your baby pigs and your operation, call 908-769-7045 or email us at uniferon.us@pharmacosmos.com.

Hogg Scholarship available to practitioners seeking MS or PhD

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

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

Applications for the scholarship will be accepted until **December 1, 2023**. The scholarship recipient will be announced Monday, February 26 during the AASV Annual Meeting.

Dr Alex Hogg's career serves as the ideal model for successful applicants. After 20 years in mixed animal practice, Dr Hogg pursued a master's degree in veterinary

pathology. He subsequently became the Nebraska swine extension veterinarian and professor at the University of Nebraska. Upon "retirement," Dr Hogg capped off his career with his work for MVP Laboratories. Always an enthusiastic learner, at age 75 he graduated from the Executive Veterinary Program offered at the University of Illinois.

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

Hogg Scholarship application requirements

An applicant for the Hogg Scholarship shall have:

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

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

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

Applications and requests for information may be emailed to foundation@aasv.org or mailed to:

AASV Foundation
830 26th Street
Perry, IA 50220

Veterinary students invited to apply for \$5000 scholarship by December 31

To assist future swine veterinarians with their educational expenses, the AASV Foundation and Merck Animal Health are pleased to offer the AASVF-Merck Animal Health Veterinary Student Scholarships. Ten \$5000 scholarships will be awarded to sophomore and junior veterinary students in 2024. Applications are due **December 31, 2023** for scholarships that will be announced during the 2024 AASV Annual Meeting.

Second- and third-year veterinary students enrolled in AVMA-accredited or -recognized colleges of veterinary medicine in the United States, Canada, Mexico, South America, or the Caribbean Islands are eligible to apply. All applicants must be current (2023-2024) student members of AASV. Students

who have previously been awarded one of these scholarships are not eligible to reapply. Previous scholarship recipients are recognized at aasv.org/foundation/scholarshipwinners.htm.

To apply, students must submit a resume and the name of a faculty member or AASV member to serve as a reference, along with written answers to 4 essay questions. The application and instructions are available at aasv.org/foundation/2024/AASVF-MerckScholarships.php.

A committee of 4 conducts the selection process. Two AASV Foundation board members and 2 AASV members-at-large rank the applicants by scoring their past and current activities, level of interest in

swine veterinary medicine, future career plans, and financial need. The scholarship recipients will be announced during the luncheon on Monday, February 26 at the 2024 AASV Annual Meeting in Nashville, Tennessee (attendance not required). The scholarship funds will be disbursed after the conference.

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

Perfect weather graces golfers at rescheduled event

Due to the extreme heat that blanketed the country in late August, the annual AASV Foundation Golf Outing originally scheduled for August 23 was postponed until September 27. The decision to postpone turned out to be a good one, as participants enjoyed a lovely fall day with temperatures in the 70°F range instead of suffering through August's 110°F + heat index.

Thirty-one golfers competed in the best-ball team contest over Veenker Memorial's challenging golf course in Ames, Iowa. The AMVC team of Josh Ellingson, Trey Kellner, Shelby Ramirez, and Nick Weihs took top honors with a score of eleven under par. The Fairmont Vet Clinic team (Justin Borchardt, Javen Holm, Brian Roggow, and Steve Sumej) came in a close second at ten under, despite missing their usual teammate and not-so-secret weapon, Deb Roggow. At five under par, a tiebreaker was needed to determine the third-place winner: Aurora Pharmaceutical's team of Mark Brinkman, David Knock, Roger Rathjen, and Grant Weaver.

Additionally, contests and games were offered at several of the holes to test and reward individual skills. All the teams and contest winners are recognized here, except for the team composed of Marcus Kehrl, Kent Schwartz, Steve Sornsen, Ron White, and Jeff Zimmerman. While these golfers did not make it into the traditional placings, they declared themselves winners in the "over 65 division" (being the only team with all players over the age of 65).

The overall success of this fundraising event is due in large part to the generous support of sponsors. For several years, **Boehringer Ingelheim** has sponsored the awards dinner and **Zoetis** has hosted the beverages for the day. **Merck Animal Health** stepped up to provide the golfers' lunches this year and seven golf-hole sponsors provided on-course giveaways, games, and contests for the golfers to enjoy. Please join the foundation in thanking **Agri-King**, **APC**, **Aurora Pharmaceutical**, **Huvepharma**, **Insight Wealth Group**, **Kemin Animal Nutrition and Health**, and **National Pork Producers Council** for their support!



From left to right, the AMVC team of Trey Kellner, Josh Ellingson, Nick Weihs, and Shelby Ramirez took first place honors in the best-ball team contest with a score of eleven under par. Photo by Martina Valline, courtesy of Andrew Kleis, Insight Wealth Group.

The funds raised by the event help support a variety of AASV Foundation activities, including scholarships for students and graduate veterinarians, research grants, student debt relief, swine externship grants, travel stipends for students attending the AASV Annual Meeting, Heritage videos, and more.

Dr Josh Ellingson coordinated the event for the foundation and announced the following team and individual contest winners during the concluding awards dinner:

First flight

First place, hosted by AMVC: Josh Ellingson, Trey Kellner, Shelby Ramirez, and Nick Weihs

Second place, hosted by Fairmont Vet Clinic: Justin Borchardt, Javen Holm, Brian Roggow, and Steve Sumej

Third place, hosted by Aurora Pharmaceutical: Mark Brinkman, David Knock, Roger Rathjen, and Grant Weaver

Second flight

First place, hosted by VRI: Ben Crawford, Travis Harrison, Brian Martinson, and Mike Roof

Second place, hosted by Phibro Animal Health: Dennis Dwyer and Mark Rooney

Third place, Jeb Gent, Chelcee Hindman, Jim Lovin, and Anna McGeehan

Fourth place, hosted by Merck Animal Health: Mike Bauer, Darran Miller, Michelle Sprague, and Steve Sprague

Individual contests

Hole #2, **Chipping contest**, sponsored by Kemin Animal Nutrition and Health: Brian Martinson and Darran Miller

Hole #4, **Closest to the pin - second shot**: Anna McGeehan

Hole #7, **Closest drive to the target**: Mark Rooney

Hole #11, **Closest to the pin - tee shot**, sponsored by Huvepharma: Jim Lovin (1st), Brian Roggow (2nd)

Hole #15, **Random club challenge**, sponsored by National Pork Producers Council: Justin Borchardt

Hole #16, **Closest to the pin - third shot**: Ron White

Hole #18, **Longest putt**, sponsored by Aurora Pharmaceutical: Mark Brinkman

Early-career swine veterinarians: Opportunity to apply for debt relief - twelve \$7500 grants to be awarded!

The AASV Foundation is pleased to announce 2 opportunities for AASV members to apply for debt relief. **Applications are due December 1** for a total of twelve \$7500 grants to be awarded at the 2024 AASV Annual Meeting. While the application process is the same for both opportunities, the eligibility requirements are different, as described below and at aasv.org/foundation/debtrelief.php.

Dr Conrad and Judy Schmidt Family Student Debt Relief Scholarships

The foundation will award two \$7500 scholarships to AASV members 2- to 5-years post graduation from veterinary school (2019, 2020, or 2021 graduates) who are engaged in **private veterinary practice** devoted 50% or more to swine, providing on-farm service directly to

independent pork producers. The recipient must have maintained continuous AASV membership since joining as a student and must also have attended the AASV Annual Meeting while in veterinary school.

AASVF/Zoetis Foundation Student Debt Relief Grant Program

New this year - the AASV Foundation has partnered with the Zoetis Foundation to award ten \$7500 grants to swine veterinarians to help relieve their student debt burden. In addition to private practitioners, AASV members who work for production companies, universities, or pharmaceutical companies are encouraged to apply. Any member who graduated from an AVMA-accredited college of veterinary medicine in the years 2014

through 2021, joined AASV as a student member, and whose career since graduation has been 50% or more devoted to swine is eligible to apply.

Those who meet eligibility requirements for the Schmidt scholarship also qualify for the AASVF/Zoetis Foundation grant and will automatically be considered for both opportunities from the same application. Previous recipients of either award are not eligible to reapply.

To apply, complete and submit the application available at aasv.org/foundation/debtrelief.php to foundation@aasv.org by **December 1**. The scholarship recipients will be announced during the 2024 AASV Annual Meeting in Nashville, Tennessee.

For more information, contact foundation@aasv.org.

AASV Foundation to fund ABVP candidate

The AASV Foundation Board of Directors has established the Swine Health Management Scholarship Program to annually support one AASV member interested in pursuing board certification through the American Board of Veterinary Practitioners (ABVP). As part of its mission to support the development and scholarship of students and veterinarians, the board's goal with this program is to relieve some of the financial burden associated with achieving board certification.

If you are interested in pursuing board certification, additional information can be found on the ABVP website (abvp.com).

Scholarship applicants must have either a DVM or VMD with at least 5 years of continuous membership in the AASV prior to sitting for the certification entrance examination administered during the AASV Annual Meeting.

The applicant must provide a letter of application including a curriculum vitae, a brief description of the applicant's background, interest in swine health and reasons for pursuing board certification in Swine Health Management, and how the applicant anticipates serving the swine industry and AASV as a result of becoming board certified. A selection committee designated by the Foundation will review the applications and select one awardee annually to be notified during the first week of January.

Submit applications **no later than December 15** to the AASV Foundation by email (foundation@aasv.org) or mail to:

AASV Foundation
830 26th Street
Perry, IA 50220

The scholarship will provide reimbursements for Swine Health Management Certification-related expenses incurred within the first 2 years following the scholarship award date. Eligible expenses include such things as travel, course fees, and textbooks. Reimbursement will not cover lost income. Maximum amount of reimbursement will be \$10,000. An additional incentive payment of \$10,000 will be paid upon successful and timely completion of the Swine Health Management Board Certification.

For more information regarding the scholarship program, contact the AASV Foundation by phone, 515-465-5255, or email, foundation@aasv.org.



AASV leaders tour the National Bio and Agro-Defense Facility

What happens at the National Bio and Agro-Defense Facility (NBAF) in Manhattan, Kansas is not classified and is not secret. In fact, staff at NBAF are excited to share their vision, mission, impressive facility, and plans for the near future. A forward-thinking communications team developed messaging for animal and public health stakeholders, policy decision makers, and the public long before the site was selected in 2009 and construction began on the \$1.25 billion, 574,000-ft² facility. They also have essential information that all swine veterinarians should know (USDA NBAF Communications, email, September 2023).

Top 10 things all swine veterinarians should know about NBAF

1. The US Department of Agriculture (USDA) NBAF is a technologically advanced facility in Manhattan, Kansas that will safely and securely support USDA's mission to protect livestock from foreign, emerging, and zoonotic diseases.
2. While scientists at the Plum Island Animal Disease Center in New York have been successful in their role of protecting the swine industry, the center is more than 68 years old and does not have the capacity to expand the mission to cover emerging and zoonotic diseases.
3. The NBAF has biosafety level (BSL)-2 and -3 containment laboratories and is the first facility in the United States with BSL-4 containment capable of housing large livestock. The containment laboratories at NBAF require the highest level of safety protocols and equipment so scientists can safely study and diagnose a variety of high-consequence animal pathogens.
4. The NBAF will be home to the Animal and Plant Health Inspection Agency's Foreign Animal Disease Diagnostic Laboratory (FADDL) which conducts 24/7 diagnostic testing, emergency response, training for state and federal veterinarians, and manages two vaccine banks. Surrounded by the industry NBAF seeks to protect, FADDL's ability to receive diagnostic samples and conduct timely confirmatory diagnostic testing is critical to mitigating a foreign animal disease outbreak.
5. Manhattan, Kansas was selected as the site for the NBAF after an extensive 3-year site selection process. This location allows scientists to leverage proximity to academic researchers and the highest concentration of animal health companies in the nation, known as the Animal Health Corridor, for potential key collaborations.
6. The expanded training facilities at NBAF will allow USDA to increase the number of state and federal veterinarians trained by the FADDL team every year as part of the Foreign Animal Disease Diagnostician Course. This training helps veterinarians learn to recognize foreign animal diseases in swine and collect diagnostic samples that would then be sent to FADDL for confirmatory testing should an outbreak occur.
7. The NBAF will be home to 3 Agricultural Research Service units, 2 of which are new to USDA, to continue research on foot-and-mouth disease, African swine fever, and classical swine fever as well as research on arthropod-transmitted diseases and diseases that can transfer between animals and people such as Japanese encephalitis virus and Nipah virus.
8. The unique capabilities of NBAF, such as the size and number of animal rooms within containment, will allow scientists to fill knowledge gaps related to animal pathogens



OUR VISION

A safer and more resilient America through a world-class science facility for large animal agricultural research, training, and diagnostics.



OUR MISSION

To protect the United States against transboundary, emerging, and zoonotic animal diseases that threaten our food supply, agricultural economy, and public health.

not previously possible in the United States or even across the world. For example, scientists will seek to understand swine diseases at various life stages and test vaccines, antivirals, and other veterinary medical products.

9. The Biologics Development Module is a unique proof-of-concept production facility inside NBAF's secure campus. It is designed to enhance and expedite the transition of innovations from research to commercially-viable medical products such as vaccines and diagnostics.
10. It will still be a couple of years before the full mission is transferred from Plum Island to NBAF as USDA staff work to ensure a safe and secure transfer and standup of NBAF's science programs through a phased approach of crawl, walk, jog, and run.

AASV leader impressions of NBAF

In late August, AASV leaders were invited to tour NBAF. Here, they share observations they considered of particular importance for swine veterinarians.

"NBAF is government money very well spent. I was impressed with motivated, intelligent staff putting forward an ultra-high end facility advancement sufficient to study very real, clear, and present danger in animal health. I felt I was walking in a live "Disney-Marvel Movie." Our guide was an engineer with a Bachelor's degree in physics who started on the maintenance team. He knew every bolt, monitoring device, and service purpose of the building." – **Dr Bill Hollis, AASV President**

"There is four times the amount of space and four times the number of employees to fully operate the laboratories (ie, there are 400 support staff for every 100 laboratory employees). There are three floors of air handling, HVAC, and waste handling for one laboratory floor." – **Dr Melissa Billing, AASV District 1**

"Biocontainment is the biggest priority, especially being in town across from the veterinary medical school and in food-animal country. They have a community engagement group to help with the social messaging. The staff who gave tours were very engaged and understood the importance of the work being done for our industry. I was impressed by the caliber of people already at the facility." – **Dr Sara Hough, AASV District 2**

"The mission of NBAF is important to all of us - veterinarians, livestock producers, and the general public." – **Dr Stephen Patterson, AASV District 3**

"I was pleasantly surprised that all of the different groups seem to be working together at NBAF, instead of independently." – **Dr Megan Inskeep, AASV District 4**

"Although it is located in the middle of the United States, this facility is equipped with state-of-the-art safety and lockdown mechanisms that will withstand natural disasters and other potential threats to safely contain the pathogens that are studied in the BSL-2, -3, and -4 laboratories." – **Dr Attila Farkas, AASV District 5**

"I was most impressed by the presence of the Biologics Development Module (BDM) which is a unique proof-of-concept production facility within NBAF. This module is designed to enhance and expedite the transition of innovations from research to commercially viable vaccines and diagnostics. In my conversation with the director of the BDM, it was refreshing to hear their deep understanding of the process and need for the commercialization of innovations created at NBAF." – **Dr Mike Senn, AASV Past-President**

"The redundancies in place for biosafety to safeguard all working with BSL-3 and -4 agents is impressive." – **Dr Chris Rademacher, AASV District 6**

"Each suit required to enter the BSL-4 costs about \$10,000." – **Dr Maryn Ptaschinski, AASV District 7**

"I was impressed with the approach taken by the team at NBAF to ensure safety and security. There was an all-encompassing monitoring system surrounding a sophisticated design of negative pressure and filtration to contain aerosolized risk. Additionally, there were multiple systems in place to handle fomite contamination, waste management, and carcass management that were more than sufficient to ensure biocontainment. I appreciated the approach of putting the processes in place before actually starting up the facility in order to make sure everyone is trained, and the equipment and technology are functioning properly. The facility engineering accounts for severe weather threats, backup systems in the case of equipment or power failure, and has automated timed processes for people entering and exiting the containment facility." – **Dr Christine Mainquist-Whigham, AASV District 8**

"I was impressed with the overall security and culture of the NBAF team. There were several thoughts and actions in place to ensure that the security (especially from a biocontainment standpoint) of the building, data, and processes were of the highest importance to the team. The steps to ensure employee, national, and international security for food, human, and agricultural safety were taken and well thought through. In addition, I appreciated the culture of the NBAF team and demonstrating that transparency with the community and external stakeholders is critical." – **Dr Alyssa Betlach, AASV District 9**



AASV leadership toured the new National Bio and Agro-Defense Facility in Manhattan, Kansas.

Shaping the future of piglet care

Prepare, protect, and support resilience in your piglets.
As your partner, we provide local swine expertise and complete,
tailor-made solutions to help you achieve your goals.
Together, we can create a new future for piglet care.

If not us, who? If not now, when?

We Make It Possible

Learn more
at dsm.com/pigletcare



dsm-firmenich 

“This impressive BSL-4 laboratory is the only one in the nation capable of housing large animals.” – **Dr Angela Baysinger, AASV President-Elect**

“The tornado and high-wind sensors are state of the art and automatically activate the built in defenses to protect the people, animals, and research inside. The building windows are designed to take a hit from a flying pickup truck and the vents seal automatically. They can last 2 weeks in the winter on the generators.” – **Dr Susan Detmer, AASV District II**

“I was amazed at the amount of forethought and planning that went into everything, the number of fail-safes that had been put into place, and the amount of training and planning that has gone into potential emergency situations. My favorite part was that the laboratories had windows and that they found a way to make them secure and still provide that aspect for their laboratory employees.” – **Dr Hunter Everett, AASV Student Delegate**

“Overall, I came away with confidence that the facility is safe and provides vital, unique research support for American animal agriculture. It is an asset that furthers America’s global leadership in safe food production.” – **Dr Locke Karriker, AASV Vice-President**

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



Are you and your clients prepared to respond to a Foreign Animal Disease?



Get ready with the
**CERTIFIED SWINE
SAMPLE COLLECTOR**
training program

- 1. Contact the State Animal Health Official (SAHO) in the state(s) in which you plan to train or use Certified Swine Sample Collectors (CSSCs) to confirm participation eligibility prior to participating in the program.**
- 2. Review the CSSC Program Standards.**
- 3. Identify individuals who could be trained to collect and submit samples on your behalf.**
- 4. Access CSSC training materials at securepork.org/cssc.**
- 5. Conduct classroom and hands-on training.**
- 6. Submit a list of trained individuals to SAHO(s) in state(s) trainees will be collecting samples.**

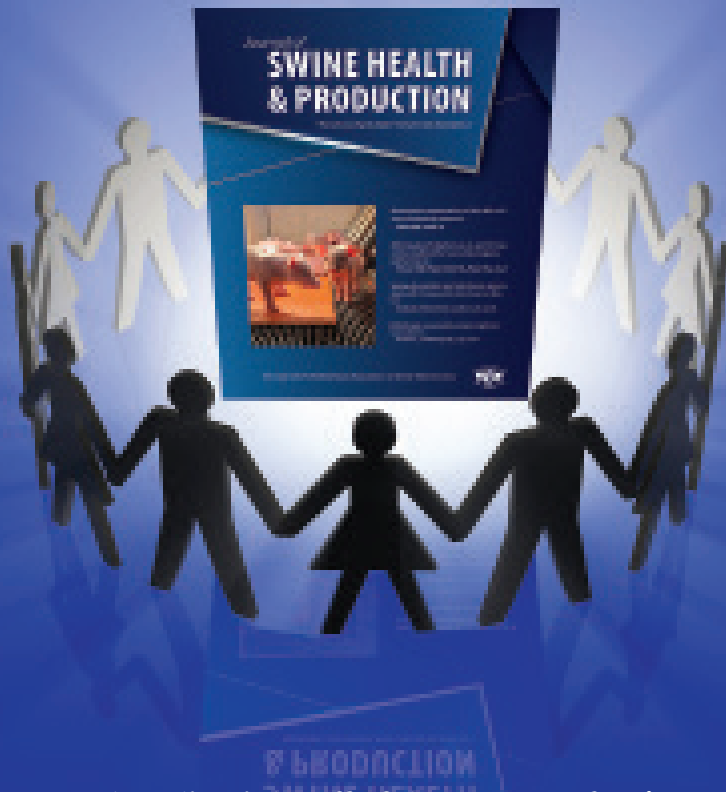


For more information on the training program



If you are ready to start training, contact the state animal health officials in the state in which you wish to train individuals





Thank you, reviewers

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

The editorial staff of the *Journal of Swine Health and Production* acknowledges the invaluable assistance of the following individuals for their service as referees for the manuscripts that were reviewed between September 13, 2022, and September 19, 2023.

Marcelo Almeida

Glen Almond

Gary Althouse

Andreia Arruda

Brittany Backus

Lisa Becton

Jon Bergstrom

James Bradford

George Charbonneau

Robert Charette

Jane Christopher-
Hennings

Cesar Corzo

Paula Fedorka Cray

Tom Crenshaw

Marie Culhane

Russ Daly

Don Davidson

Anne Deckert

Pablo Valdes Donoso

Tim Evans

Jamil Faccin

Juliana Bonin Ferreira

William Flowers

Robert Friendship

Aaron Gaines

Phillip Gauger

Jordan Gebhardt

Marika Genzow

Laura Greiner

Marlin Hoogland

Lee Johnston

Mariana Kikuti

Robert Knox

Evan Koep

Kelly Lager

Daniel Linhares

James Lowe

Gustavo Machado

Darin Madson

Dominiek Maes

Edison Magalhaes

Steven McOrist

Mariana Boscato
Menegat

Steven Moeller

Annette O'Connor

Carissa Odland

Onyekachukwu
Osemeke

Meghann Pierdon

Maria Pieters

Pablo Pineyro-Pineiro

Michael Rahe

Alex Ramirez

Gaurav Rawal

David Rosero

Ryan Samuel

Jan Sargeant

Marcia Carlson Shannon

Ana Paula Serafini Poeta
Silva

Elise Tatone

Lisa Tokach

Montserrat Torremorell

Jerry Torrison

Carles Vilalta

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

CUMULATIVE INDEX

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

Index by Title 2023

A sounder of swine: The importance of clustering in the design, analysis, and interpretation of clinical trials. Sargeant JM, O'Connor AM, O'Sullivan TL, Ramirez A, Wang C. *J Swine Health Prod.* 2023;31(3):120-127. <https://doi.org/10.54846/jshap/1315>

Air filtration to prevent porcine reproductive and respiratory syndrome virus infection. Desrosiers R, Cousin V. *J Swine Health Prod.* 2023;31(2):77-81. <https://doi.org/10.54846/jshap/1303>

An assessment of rope sampling methodologies on pen-level oral fluid samples for detection of PRRSV infection. Crum W, Bartels M, Drum G, Kayser R, Skoglund L, Munger L, Honkola K, Rotolo M, Pepin B, Havas KA. *J Swine Health Prod.* 2023;31(3):128-132. <https://doi.org/10.54846/jshap/1308>

Biological sample collection and handling methods for fat-soluble vitamin and trace mineral analysis. Elefson S, Radke S, Greiner L. *J Swine Health Prod.* 2023;31(5):242-245. <https://doi.org/10.54846/jshap/1349>

Evaluating natural planned exposure protocols on rotavirus shedding patterns in gilts and the impact on their suckling pigs. Anderson AV, Shepherd F, Dominguez F, Pittman JS, Marthaler D, Karriker LA. *J Swine Health Prod.* 2023;31(1):10-19. <https://doi.org/10.54846/jshap/1294>

Evaluating the efficacy and safety of differing gun caliber and ammunition combinations for the euthanasia or depopulation of market-weight pigs. Stahl CA, Fangman TJ, Fangman JT. *J Swine Health Prod.* 2023;31(6):278-288. <https://doi.org/10.54846/jshap/1342>

Evaluating the impact of organic matter and sample processing techniques on RNA detection using environmental samples. Houston GE, Blommer AK, Harrison OL, Bai J, Woodworth JC, Jones CK, Poulson-Porter EG, Paulk CB, Gebhardt JT. *J Swine Health Prod.* 2023;31(2):87-91. <https://doi.org/10.54846/jshap/1311>

Feeding strategies to improve sow satiety in pen gestation housing. Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. *J Swine Health Prod.* 2023;31(3):137-140. <https://doi.org/10.54846/jshap/1323>

Feeding strategies to increase sow colostrum quality and yield. Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. *J Swine Health Prod.* 2023;31(3):133-136. <https://doi.org/10.54846/jshap/1322>

First detection and genetic characterization of Senecavirus A in pigs from Mexico. Navarro-López R, Perez-de la Rosa JD, Rocha-Martínez MK, Galván-Hernández G, Villarreal-Silva M, Solís-Hernández M, Rojas-Torres E, Gomez-Romero N. *J Swine Health Prod.* 2023;31(6):289-294. <https://doi.org/10.54846/jshap/1358>

Identification of border disease virus in naturally infected pigs in Mexico. Navarro-López R, Perez-de la Rosa JD, Villarreal-Silva M, Solís-Hernández M, Rojas-Torres E, Lemus y Sanchez J, Gomez-Romero N. *J Swine Health Prod.* 2023;31(2):72-76. <https://doi.org/10.54846/jshap/1296>

Influence of biological sample pre-analytical manipulation for fat-soluble vitamin analysis. Elefson S, Greiner LL. *J Swine Health Prod.* 2023;31(4):186-192. <https://doi.org/10.54846/jshap/1348>

Management of sodium ion toxicosis - water deprivation syndrome. Rademacher CJ, Greiner LL, Radke SL. *J Swine Health Prod.* 2023;31(6):295-297. <https://doi.org/10.54846/jshap/1353>

Maximizing value and minimizing waste in clinical trial research in swine: Design features to minimize bias. Sargeant JM, O'Connor AM, O'Sullivan TL, Ramirez A. *J Swine Health Prod.* 2023;31(2):82-86. <https://doi.org/10.54846/jshap/1313>

Maximizing value and minimizing waste in clinical trials in swine: Selecting outcomes to build an evidence base. Sargeant JM, O'Connor AM, O'Sullivan TL, Ramirez A. *J Swine Health Prod.* 2023;31(1):29-35. <https://doi.org/10.54846/jshap/1300>

Nutritional strategies to improve the growth performance of pigs marketed in summer. Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. *J Swine Health Prod.* 2023;31(4):197-200. <https://doi.org/10.54846/jshap/1321>

Nutritional strategies to reduce growth of pigs during emergency situations. Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. *J Swine Health Prod.* 2023;31(4):193-196. <https://doi.org/10.54846/jshap/1320>

Nutritional strategies to reduce the impact of *Escherichia coli* in newly weaned pigs. Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. *J Swine Health Prod.* 2023;31(5):230-235. <https://doi.org/10.54846/jshap/1318>

Strategies to minimize fallback pigs in the nursery. Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. *J Swine Health Prod.* 2023;31(5):237-241. <https://doi.org/10.54846/jshap/1319>

Water use patterns within each day: Variation between batches of growing pigs in commercial production systems. Little SB, Woodward AP, Browning GF, Billman-Jacobe H. *J Swine Health Prod.* 2023;31(1):20-28. <https://doi.org/10.54846/jshap/1297>

Index by Author 2023

Anderson AV, Shepherd F, Dominguez F, Pittman JS, Marthaler D, Karriker LA. Evaluating natural planned exposure protocols on rotavirus shedding patterns in gilts and the impact on their suckling pigs. *J Swine Health Prod.* 2023;31(1):10-19. <https://doi.org/10.54846/jshap/1294>

Crum W, Bartels M, Drum G, Kayser R, Skoglund L, Munger L, Honkola K, Rotolo M, Pepin B, Havas KA. An assessment of rope sampling methodologies on pen-level oral fluid samples for detection of PRRSV infection. *J Swine Health Prod.* 2023;31(3):128-132. <https://doi.org/10.54846/jshap/1308>

Desrosiers R, Cousin V. Air filtration to prevent porcine reproductive and respiratory syndrome virus infection. *J Swine Health Prod.* 2023;31(2):77-81. <https://doi.org/10.54846/jshap/1303>

Elefson S, Greiner LL. Influence of biological sample pre-analytical manipulation for fat-soluble vitamin analysis. *J Swine Health Prod.* 2023;31(4):186-192. <https://doi.org/10.54846/jshap/1348>

Elefson S, Radke S, Greiner L. Biological sample collection and handling methods for fat-soluble vitamin and trace mineral analysis. *J Swine Health Prod.* 2023;31(5):242-245. <https://doi.org/10.54846/jshap/1349>

Houston GE, Blommer AK, Harrison OL, Bai J, Woodworth JC, Jones CK, Poulson-Porter EG, Paulk CB, Gebhardt JT. Evaluating the impact of organic matter and sample processing techniques on RNA detection using environmental samples. *J Swine Health Prod.* 2023;31(2):87-91. <https://doi.org/10.54846/jshap/1311>

Little SB, Woodward AP, Browning GF, Billman-Jacobe H. Water use patterns within each day: Variation between batches of growing pigs in commercial production systems. *J Swine Health Prod.* 2023;31(1):20-28. <https://doi.org/10.54846/jshap/1297>

Navarro-López R, Perez-de la Rosa JD, Rocha-Martínez MK, Galván-Hernández G, Villarreal-Silva M, Solís-Hernández M, Rojas-Torres E, Gomez-Romero N. First detection and genetic characterization of Senecavirus A in pigs from Mexico. *J Swine Health Prod.* 2023;31(6):289-294. <https://doi.org/10.54846/jshap/1358>

Navarro-López R, Perez-de la Rosa JD, Villarreal-Silva M, Solís-Hernández M, Rojas-Torres E, Lemus y Sanchez J, Gomez-Romero N. Identification of border disease virus in naturally infected pigs in Mexico. *J Swine Health Prod.* 2023;31(2):72-76. <https://doi.org/10.54846/jshap/1296>

Rademacher CJ, Greiner LL, Radke SL. Management of sodium ion toxicosis - water deprivation syndrome. *J Swine Health Prod.* 2023;31(6):295-297. <https://doi.org/10.54846/jshap/1353>

Sargeant JM, O'Connor AM, O'Sullivan TL, Ramirez A. Maximizing value and minimizing waste in clinical trials in swine: Selecting outcomes to build an evidence base. *J Swine Health Prod.* 2023;31(1):29-35. <https://doi.org/10.54846/jshap/1300>

Sargeant JM, O'Connor AM, O'Sullivan TL, Ramirez A. Maximizing value and minimizing waste in clinical trial research in swine: Design features to minimize bias. *J Swine Health Prod.* 2023;31(2):82-86. <https://doi.org/10.54846/jshap/1313>

Sargeant JM, O'Connor AM, O'Sullivan TL, Ramirez A, Wang C. A sounder of swine: The importance of clustering in the design, analysis, and interpretation of clinical trials. *J Swine Health Prod.* 2023;31(3):120-127. <https://doi.org/10.54846/jshap/1315>

Stahl CA, Fangman TJ, Fangman JT. Evaluating the efficacy and safety of differing gun caliber and ammunition combinations for the euthanasia or depopulation of market-weight pigs. *J Swine Health Prod.* 2023;31(6):278-288. <https://doi.org/10.54846/jshap/1342>

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Feeding strategies to increase sow colostrum quality and yield. *J Swine Health Prod.* 2023;31(3):133-136. <https://doi.org/10.54846/jshap/1322>

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Feeding strategies to improve sow satiety in pen gestation housing. *J Swine Health Prod.* 2023;31(3):137-140. <https://doi.org/10.54846/jshap/1323>

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Nutritional strategies to reduce growth of pigs during emergency situations. *J Swine Health Prod.* 2023;31(4):193-196. <https://doi.org/10.54846/jshap/1320>

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Nutritional strategies to improve the growth performance of pigs marketed in summer. *J Swine Health Prod.* 2023;31(4):197-200. <https://doi.org/10.54846/jshap/1321>

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Nutritional strategies to reduce the impact of *Escherichia coli* in newly weaned pigs. *J Swine Health Prod.* 2023;31(5):230-235. <https://doi.org/10.54846/jshap/1318>

Wensley MR, Tokach MD, Woodworth JC, Goodband RD, DeRouchey JM, Gebhardt JT. Strategies to minimize fallback pigs in the nursery. *J Swine Health Prod.* 2023;31(5):237-241. <https://doi.org/10.54846/jshap/1319>



AFRICAN SWINE FEVER? NOT ON MY WATCH.



A single case of African swine fever could wipe out America's swine population. Help farmers defend their herds by sharing vital information on biosecurity safeguards, signs of infection and reporting protocols. Get materials to spread the word – and stop the virus.
www.aphis.usda.gov/ProtectOurPigs



UPCOMING MEETINGS

Iowa Pork Industry Center Sow Summit

November 1, 2023 (Wed)
Gateway Hotel and Conference Center
Ames, Iowa

For more information:
Stacie Matchan
109 Kildee Hall
806 Stange Rd
Ames, Iowa 50011
Email: sgould@iastate.edu
Web: ipicsowsummit.org

Passion for Pigs Seminar & Trade Show

November 29, 2023 (Wed)
Sedalia, Missouri

For more information:
Julie Lolli
Tel: 660-651-0570
Email: julie@passionforpigs.com
Web: passionforpigs.com

2023 NAPRRS/NC229: International Conference of Swine Viral Diseases

December 1 - 2, 2023 (Fri-Sat)
Intercontinental: Chicago
Magnificent Mile
505 N. Michigan Avenue
Chicago, Illinois

For more information:
University of Illinois
Office of Public Engagement
Tel: 217-333-2907
Email: ICSVD@vetmed.illinois.edu
Web: [vetmed.illinois.edu/
education/continuing-education/
north-american-prrs-symposium](http://vetmed.illinois.edu/education/continuing-education/north-american-prrs-symposium)

AVMA Veterinary Leadership Conference 2024

January 4 - 6, 2024 (Thu-Sat)
Chicago, Illinois

For more information:
Web: [avma.org/events/
veterinary-leadership-conference](http://avma.org/events/veterinary-leadership-conference)

Banff Pork Seminar

January 9 - 11, 2024 (Tue-Thu)
Banff, Alberta, Canada

For more information:
Tel: 780-492-3651
Email: pork@ualberta.ca
Web: banffpork.ca

2024 Pig-Group Ski Seminar

January 31 - February 2, 2024 (Wed-Fri)
Copper Mountain, Colorado

For more information:
Dr Paul and Lori Yeske
Tel: 507-381-1647
Web: pigski.com

American Association of Swine Veterinarians 55th Annual Meeting

February 24 - 27, 2024 (Sat-Tue)
Gaylord Opryland Resort and
Convention Center
Nashville, Tennessee

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

International Symposium on One Health Research: Improving Food Security and Resilience

April 21 - 23, 2024 (Sun-Tue)
Moody Gardens Resort and
Convention Center
One Hope Boulevard
Galveston, Texas

For more information:
Email: UTMBOneHealth@utmb.edu
Web: [utmb.edu/one-health/events/
international-one-health-symposium/
welcome-symposium](http://utmb.edu/one-health/events/international-one-health-symposium/welcome-symposium)

27th International Pig Veterinary Society Congress & 15th European Symposium of Porcine Health Management

June 4 - 7, 2024 (Tue-Fri)
Congress Centre Leipzig
Leipzig, Germany

For more information:
Web: ipvs2024.com

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

AASV Industry Support Council

*The Journal of Swine Health and Production is made possible
by the generous support of these Industry Support Council members:*



**Boehringer
Ingelheim**



DSM

BRIGHT SCIENCE. BRIGHTER LIVING.



ENDOVAC
Animal Health



MERCK

Animal Health

PHARMACOSMOS
Committed to Quality



Pharmgate
ANIMAL HEALTH



UNITED
ANIMAL HEALTH



VIROX
ANIMAL HEALTH

zoetis

JSHAP Resources

AASV resources _____ aasv.org

Author guidelines _____ aasv.org/shap/guidelines

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

Membership information _____ aasv.org/aasv/membership

Subscription information _____ ecom.aasv.org/journal

Upcoming meetings _____ aasv.org/meetings

Industry Support Council member info _____ aasv.org/shap/advertising.php