January and February 2014 • Volume 22, Number 1

Journal of Swine Health & Production

Effects of post-farrowing meloxicam on sow and piglet parameters
Tenbergen R, Friendship R, Cassar G, et al

Yohimbine reversal of xylazine-ketamine-telazol in sows
Pairis-Garcia MD, Johnson AK, Millman ST, et al

Estimated prevalence and impact of PFTS
O'Sullivan TL, Harding JCS, Friendship R, et al

C difficile antitoxin in piglets
Ramirez A, Rowe EW, Arruda PH, et al

The Journal of the American Association of Swine Veterinarians

Journal of Swine Health and Production

(**ISSN 1537-209X**) Volume 22, Number 1; January and February 2014

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

The *Journal of Swine Health and Production* is a refereed publication and is a benefit of membership in the American Association of Swine Veterinarians. Subscriptions ($US) are available to nonmembers at $140.00 per year (six issues) for United States, Canada, and Mexico. The cost is $175.00 for all countries outside North America. For inquiries regarding membership or subscriptions, please contact:

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

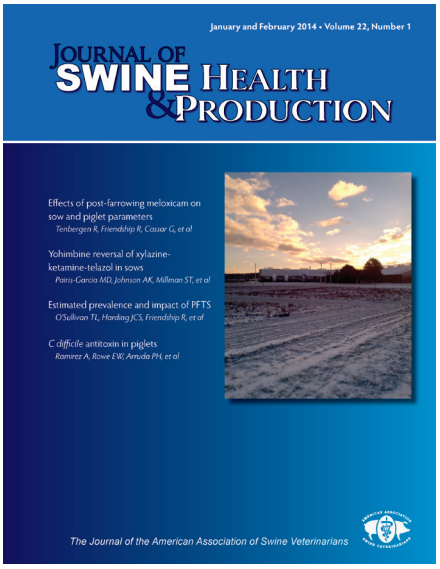
Editorial questions, comments, and inquiries should be addressed to:

Karen Richardson
Publications Manager
Journal of Swine Health and Production
Department of Population Medicine
University of Guelph
Guelph, Ontario
Canada N1G 2W1
Tel: 519-856-2089; Fax: 519-763-3117
E-mail: pub_mgr@aasv.org

Note: extra postage required for mail to Canada.

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

About the cover…



Cold Canadian morning

Photo courtesy of Dr Terri O'Sullivan

AASV Resources online at https://www.aasv.org

Author guidelines
https://www.aasv.org/shap/guidelines.pdf

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

Membership information
https://www.aasv.org/aasv/membership.html

Subscription information
http://ecom.aasv.org/journal

Upcoming meetings
https://www.aasv.org/meetings

Table of contents

"The strength and character of the AASV lie in the commitment and in the engagement of its members. Get engaged!"

quoted from the President's message, page 5

NURSERY

GROWER

FINISHER

Used in seven out of every 10 nursery pig treatments in the U.S.[1], Denagard® (tiamulin hydrogen fumarate) is the trusted source for broad-spectrum control of respiratory and enteric challenges[**], especially when fed along with CTC.

But the benefits of using Denagard don't stop in the nursery. When fed into the grower phase and through to finish, Denagard + CTC leads to healthier pigs with heavier finishing weights, up to 5.7 lbs heavier![2] Research shows pigs fed Denagard + CTC in all production phases have better health and growth performance than pigs not medicated or fed Pulmotil®, CTC or OTC treatments alone.[2,3]

Contact your local Novartis Animal Health representative, call 800-843-3386 or visit www.us.denagard.com for additional details on the usage of Denagard in all phases of your operation.

Warning: Observe label withdrawal times. Keep out of reach of children. Avoid contact with skin. Direct contact with skin or mucous membranes may cause irritation.

Caution: Do not feed undiluted. Do not use in feeds for animals other than swine. The effects of tiamulin on swine reproductive performance, pregnancy and lactation have not been determined. Swine being treated with Denagard should not have access to feeds containing polyether ionophores (e.g., lasalocid, monensin, narasin, salinomycin and semduramicin) as adverse reactions may occur. If signs of toxicity occur, discontinue use.

Take pride

*Brumm MC, Yeske P, Loula TJ. Impact of in-feed antibiotic regimens on pig performance and expression of clinical and subclinical diseases. Paper presented at: 2012 AASV Annual Meeting; March 10 – 13; Denver, Colo.

**Johnson RW. The Energy Cost of Illness in Swine. Paper presented at: Swine Energetics, University of Illinois Pork Industry Conference; December 4 – 5, 1996; Urbana-Champaign, Ill.

1 Document Q2 2011 GfK Kynetek Data

2 Erlandson K, et al. Impact of Denagard® plus chlortetracycline in pigs on improving disease control as measured by improved growth performance. Paper presented at: 2012 AASV Annual Meeting; March 10 – 13; Denver, Colo.

3 Mechler D, Hammer JM, Jacela JY. A comparison of Denagard®/CTC and Pulmotil® on nursery pig growth performance and economic return. Paper presented at: 2011 AASV Annual Meeting; March 5 – 8; Phoenix, Ariz.

The label contains complete use information including cautions and warning. Always read and follow the label and use directions.

The strength and character of an association

The American Association of Swine Veterinarians (AASV) is now a 45-year-old association of veterinarians with a rich tradition of fellowship and cohesiveness, and I would say, success, despite its tenure occurring throughout the greatest period of evolution the swine industry has yet seen. The industry we serve today is more global and more concentrated. Our patients are found on larger farms where often they represent the only species present. We talk in terms of biosecurity and preventive medicine. We spend more time on animal welfare and advocacy and less time on "procedures." Whom we serve and how we serve them have both changed a great deal over the last several decades. And yet I believe the AASV remains both strong and vital. There are any number of professional associations, some weak, some strong. What is it that accounts for the difference?

In leadership meetings we have spent a fair amount of time discussing the difference between member-driven organizations and staff-driven organizations. The AASV is blessed with an excellent staff that is both committed and thoroughly competent. They are awesome, and yet, to a person, they would all tell you that the strength and character of any organization lie in the commitment and engagement of its members. Simply put, YOU can take the credit for our past success. Members make the difference. The strength and future success of our association also depend upon you.

We are not a large organization in terms of our number of members. However, we are a large organization in terms of what our industry expects of us. We are expected to provide the voice of science and the voice of reason. More and more, we are expected to be advocates for our patients, our clients, and our industry. As an organization, our mission should both keep us focused on these expectations and provide knowledge and education to help our members fulfill these expectations. As members and as a leadership team, it is important for us to stay grounded in and focused on our mission.

"My challenge to every new graduate is to find a committee representing an area that you have special interest in and get involved."

It is the mission of the AASV "to increase the knowledge of swine veterinarians by promoting the development and availability of the resources that enhance the effectiveness of professional activities; creating opportunities that inspire personal and professional growth; advocating science-based approaches to industry issues; encouraging personal and professional interaction; and mentoring students, encouraging life-long careers as swine veterinarians."

The strength and character of the AASV lie in the commitment and in the engagement of its members. As a small organization, from a membership perspective, it is very important for all members to be involved. My goal for our members is for you to get inspired, get engaged, and then get involved. We are surrounded in the AASV by past leaders who provide a wonderful example of what commitment and engagement at a high level look like. If I were to mention them all here, this would become a lengthy article. We all know them and appreciate them for what they do. At the leadership level, there continue to be opportunities to serve. I would encourage each of our members to explore the idea of serving on our executive team at some time. Additionally, there are 11 districts in the AASV's geographic footprint, and they each call for an elected director. There is an opportunity to be a delegate to the AVMA House of Delegates. There are at least six standing AVMA committees that each require an AASV member to represent our association, that relate to animal agriculture, animal welfare, clinical practice, environmental issues, food safety, and legislative initiatives. There is also a collegiate member's opportunity to be an AASV student delegate.

A vital part of the AASV and its mission to increase the knowledge of veterinarians is our standing committee structure. Under the umbrella of health, nutrition, and research are the committees related to boar-stud biosecurity, foreign-animal disease, influenza, nutrition, Production Animal Disease Risk Assessment Program, porcine reproductive and respiratory syndrome, and swine health. Within the area of political and social issues are committees related to human health, Operation Main Street, pharmaceutical issues, pig welfare, and pork safety.

I strongly encourage all members to be engaged in one or more of our committees. My challenge to every new graduate is to find a committee representing an area that you have special interest in and get involved. Our committee leaders are always looking for new members with fresh ideas.

The strength and character of the AASV lie in the commitment and in the engagement of its members. Get engaged! Talking with one of our executive team members or staff is a great place to start.

Matt Anderson, DVM
AASV President

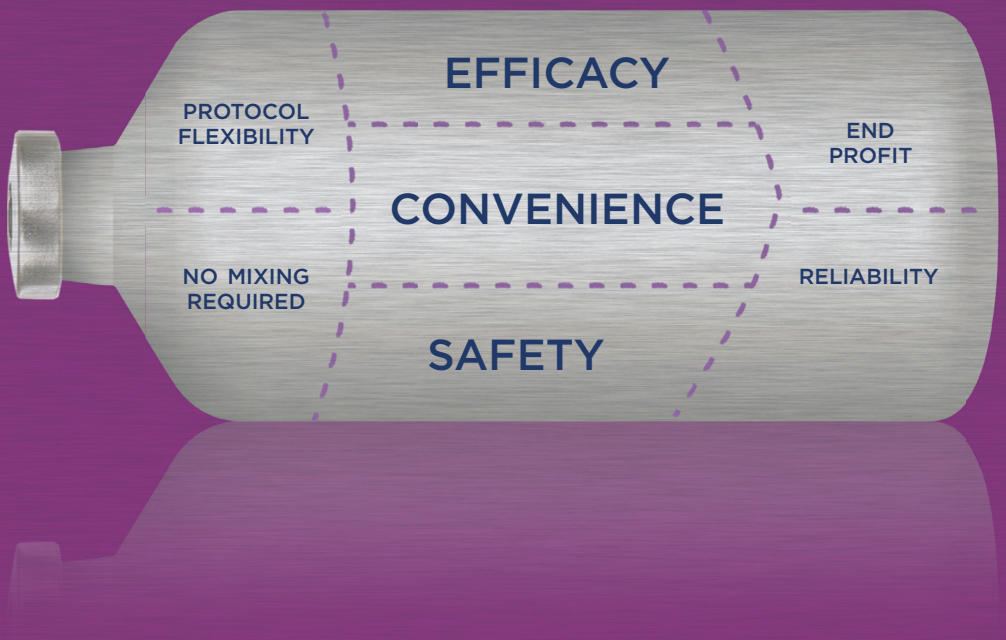
zoetis

A CUT ABOVE.

INTRODUCING

FOSTERA™ PCV MH

BUILT FROM THE GROUND UP TO HELP PROTECT YOUR PIGS



Fostera PCV MH helps provide safe, reliable protection against PCV and *Mycoplasma hyopneumoniae* diseases. It is a uniquely formulated vaccine, not just a combination of two existing vaccines.

Help protect your pigs with the first and only combination vaccine to offer one-bottle, one-dose convenience with the flexibility of two-dose administration.

Don't compromise safety, efficacy, or convenience when protecting your pigs.

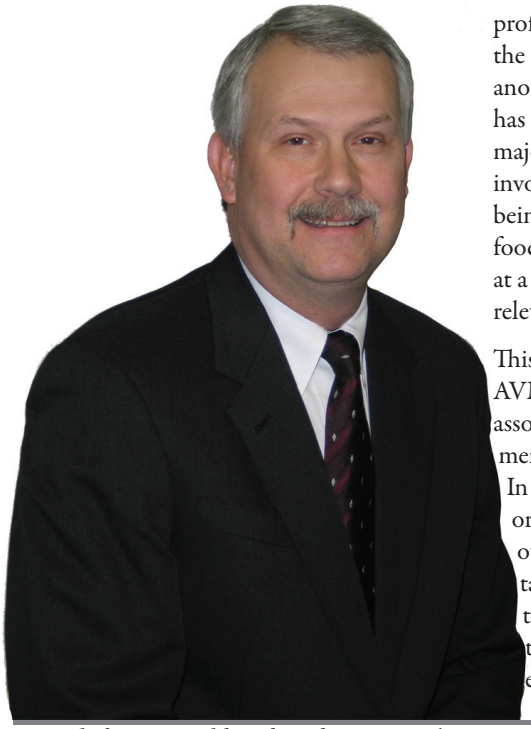
Learn more at zoetisUS.com/FosteraPCVMH

Fostera™ PCV MH

Relevancy

All organizations strive for relevancy. Without it, an organization will eventually have no reason to exist. A primary focus for the American Association of Swine Veterinarians (AASV) is how we remain relevant to our members. It is now, and always has been, our mission to educate swine veterinarians and to advocate for science-based approaches to industry issues. Our relevance is based upon those two critical purposes. Increasingly, the AASV finds itself in situations where our relevance to others outside of our membership, may be promoted or, conversely, questioned.

On one hand, the pork industry is tightly aligned with producers and veterinarians collaborating and communicating at multiple levels and in numerous settings. From an organizational standpoint, the relationships of the AASV with the National Pork Board (NPB) and the National Pork Producers Council (NPPC) have never been stronger. The synergy that has developed over the years is substantial. The ongoing challenges with porcine epidemic diarrhea (PED) virus have made me more fully appreciate the working relationships that have been built over time within the pork industry. The leaders and staff of NPB and NPPC have valued and promoted the relevance of the AASV and swine veterinarians.



As we continue to work through PED, the issue of relevancy has continued to badger me. Relevancy comes down to this: How does the AASV better prepare for the next emerging disease? Very simply, we need to prepare and execute an informed and flexible plan, take action, achieve goals, and move ahead. Our ability to get results will ultimately determine our relevancy to our members and others. The AASV needs to be a leader, not necessarily THE leader. Our success will depend on the synergy of partnering with a host of stakeholders within the pork industry. An emerging disease that affects the entire industry needs leadership, expertise and resources from the AASV, NPB, NPPC, and state and federal animal-health officials.

Shifting to the other end of the spectrum of relevancy with others, there is an exercise in relevancy taking place within the American Veterinary Medical Association (AVMA). The AVMA has a problem as they strive to represent all veterinarians within the profession. The struggle occurs because of the divergence of the members from one another. The brutal fact is that the AVMA has over 80,000 members and the vast majority (> 90%) of that membership is not involved in the day-to-day care of animals being raised for food. This separation leaves food-supply veterinarians outnumbered and at a distinct disadvantage when it comes to relevancy to the AVMA.

This disadvantage could intensify as the AVMA reorganizes from an "association of associations" to an association of individual members (remember the > 90% figure). In the current structure, the AASV has organizational representation on numerous AVMA councils, committees, and task forces. There is a substantial threat to representation in a re-organized structure where individual membership is emphasized rather than representation by allied species-related associations. The sheer numbers are against veterinarians engaged in animal agriculture. Our relevancy to the AVMA may be so diminished that we no longer find a role with the organization.

> *"We cannot stubbornly rely on what worked for us in the past."*

The other aspect of the AVMA that is reflecting the demographic changes in its membership is that it is increasingly staffed by veterinarians with no experience with food animal practice or production. I am a firm believer that practical experience with food animals is essential for those wishing to represent the veterinarians who practice food-animal medicine. This experience needs to be more than a day trip to a farm or a clinical rotation in college. It needs to be honed by the intensity of daily practice and interaction with food animals and their caretakers. Expertise and knowledge can't be simply gained from a book. If staff and leadership of an organization are lacking this experience, then they must recognize the shortcoming. The solution to this shortcoming is asking for and following the advice from those who do have the expertise. Otherwise, one must question the relevance of the AVMA to food-animal veterinarians.

The pursuit of relevancy is a continuum. An organization like the AASV cannot arrive at any given moment and declare that all is well because we are relevant to our members and others. As soon as we do, we may very well have begun the slow descent into irrelevancy. We cannot stubbornly rely on what worked for us in the past. New circumstances may demand consideration of a range of options, some of which we may have never even considered. I have two goals for the coming year. First, the AASV will become better prepared and equipped to respond to emerging diseases. Second, the AASV will effectively advocate for swine veterinarians in all pertinent situations, whether our relevancy is universally valued or not.

Circumvent® G2 PCV-M

Circumvent® G2 PCV

INTRODUCING THE ONLY

1-DOSE READY-TO-USE COMBO

WITH 5-MONTH PCV2 DURATION OF IMMUNITY

The Merck Circumvent® G2 family of vaccines lets you fight two costly diseases and improve herd health when you want, how you want.

- **Fights two costly diseases – PCV2 and mycoplasmal pneumonia – in 1 bottle**
- **Two dosing options available**
  - **1 dose at 3 weeks of age or older**
  - **2 doses as early as 3 days of age**

THE SCIENCE OF HEALTHIER ANIMALS

www.circumvent-g2.com

MERCK Animal Health

Welcome 2014

I am looking forward with great anticipation to the 2014 volume of *JSHAP*. We have an interesting line-up of manuscripts planned for the early issues, and the year promises to be filled with new ideas to move swine health and production forward in this fast-paced world of ours. The journal's success remains possible due to the continued support of authors, reviewers, the editorial board, the industry support council, the staff in the AASV office, and the journal staff. Thank you for all of your hard work in 2013.

To keep up with the electronic world, the journal is now available as a single PDF file to download for reading on your iPad or Android phone. It was with the support of the AASV Board of Directors and the hard work of our AASV Webmaster, David Brown, that this has been made possible. Future issues will be provided in this format, and we are interested in your comments and thoughts on the feature. But please don't "text-and-drive" or "*JSHAP*-and-drive." We hope you enjoy this accessibility.

In each issue we publish a photo of a commercial swine barn or pigs on the front cover, as well as on the back cover. We aim to use photos that are submitted by our readers. The photo on the cover of this issue is one that I took last winter almost exactly 1 year ago.

Tina Smith, our graphic artist, was asking for some nice cold winter photos for our stock supply. So I took it upon myself to get a picture of a wintery pig-barn scene. It may not be obvious in the photo, but it was certainly cold that morning when I got out of my truck to get in a better position for the shot. I looked at my truck thermometer, in fact, and it was -30°C (approximately -22°F, which is cold no matter what unit of measure you use). The student travelling with me thought I was a bit crazy...yes, perhaps..., but I felt committed to getting a photo for Tina. Our winter photo supply is still lean, and so this winter I encourage you to get out of your trucks and take some shots for the journal. It is actually kind of fun to see your own photo in print. And then you can tell the story of how you hiked through a snowbank to get that perfect image for *JSHAP*.

A few tips for a successful photo for the cover of *JSHAP*

Please ensure that the photos do not include people, and your digital images must be 300 dpi to accommodate the requirements of print media. You will need to set your digital camera or cell phone to take the largest image size available. This means that you will use the quality or compression setting which allows you to store the *smallest* number of images on the memory card. I actually have my cellphone settings *JSHAP*-photo ready! If the camera will save a TIF file, then select that option. Please do not be tempted to resize, crop, rotate, or color-correct the image prior to submission to the journal. Just send us the original image. Please send

"Get your cameras or cell phones out – we look forward to seeing your photos!"

the images by e-mail attachment to **tina@aasv.org**. Tina will also need to know your name, affiliation, and the approximate location of the image, or other details that you would like to submit which describe the image. Perhaps a description along the line of "The *JSHAP* editor asked us to take photos so I walked through howling wind in -40°F (exaggeration helps) up a hill (both ways) to take this photo of a pig barn." But don't despair if you are not hardy enough to tackle this cold winter task, as we also need spring, summer, and autumn images. Get your cameras or cell phones out – we look forward to seeing your photos!

Terri O'Sullivan, DVM, PhD
Executive Editor

ORIGINAL RESEARCH PEER REVIEWED

Investigation of the use of meloxicam post farrowing for improving sow performance and reducing pain

R. Tenbergen, MS; R. Friendship, DVM, MS, Diplomate ABVP; G. Cassar, DVM, PhD, Diplomate ABVP; M. R. Amezcua, DVM, MS, PhD; D. Haley, MS, PhD

Summary

Objectives: To determine the effects of meloxicam administered to sows shortly after parturition on nursing behaviour and piglet survival and growth.

Materials and methods: A total of 289 sows and their litters were used. Sows within 12 hours of farrowing were randomly allocated to receive either an intramuscular injection of meloxicam (extra-label) or a placebo. Researchers were blinded to treatment. All piglets were weighed within 12 hours of birth, at castration and tail-docking (5 to 7 days of age), and prior to weaning (19 to 21 days of age). Litters were categorized as small, medium, and large. Additional measurements involving the sow, including position changes, rectal temperatures, and feed-intake scores, were performed on a smaller number of the study sows.

Results: There were no significant treatment effects on piglet mortality or growth rate. However, growth rate of pigs in medium-sized litters (11 to 13 pigs) tended to be better for sows treated with meloxicam than for sows given a placebo ($P = .07$). Growth rate was positively correlated with weight at birth and at weaning ($P < .001$) and negatively correlated with sow parity and litter size at birth ($P < .001$). Piglet mortality was not associated with treatment, but was associated with large litter size and light birth weight ($P < .001$).

Implications: Meloxicam given to all sows post farrowing does not result in improved piglet survival and growth. Improved performance might be noted if only sows having difficult farrowings were treated. Further studies are required to confirm.

Keywords: swine, meloxicam, pain, parturition, neonatal mortality

Received: March 30, 2012
Accepted: May 16, 2013

Resumen - Investigación del uso del meloxicam post parto para mejorar el desempeño de la hembra y reducir el dolor

Objetivos: Determinar los efectos del meloxicam, administrado a hembras poco después del parto, en el comportamiento de lactancia y supervivencia y crecimiento del lechón.

Materiales y métodos: Se utilizó un total de 289 hembras y sus camadas. Las hembras se asignaron al azar, máximo de 12 horas después del parto, para recibir una inyección intramuscular de meloxicam (fuera de etiqueta) o un placebo. Los investigadores desconocían el tratamiento aplicado. Todos los lechones se pesaron máximo 12 horas después del nacimiento, al momento del castrado y corte de cola (5 a 7 días de edad), y antes del destete (19 a 21 días de edad). Las camadas se categorizaron como pequeña, mediana, y grande. Se realizaron medidas adicionales referentes a la hembra, incluyendo cambios de posición, temperaturas rectales, y evaluación de consumo de alimento en un número menor del total de hembras en el estudio.

Resultados: No hubo efectos de tratamiento significativos en el índice de crecimiento o mortalidad del lechón. Sin embargo, el índice de crecimiento de los cerdos en camadas de tamaño medio (11 a 13 cerdos) tendió a ser mejor en los cerdos tratados con meloxicam que en los cerdos que recibieron el placebo ($P = .07$). El índice de crecimiento se correlacionó positivamente con el peso al nacer y el peso al destete ($P < .001$) y se correlacionó negativamente con la paridad de la hembra y el tamaño de la camada al nacer ($P < .001$). La mortalidad del lechón no se asoció con el tratamiento, pero si se asoció con la camada de tamaño grande y el peso ligero al nacer ($P < .001$).

Implicaciones: El meloxicam administrado a todas las hembras después del parto no resulta en una mejora de crecimiento y supervivencia del lechón. Se podría notar una mejora en el desempeño si sólo se tratan a las hembras que tengan partos difíciles. Se requieren más estudios para confirmar estos hallazgos.

Résumé - Étude sur l'utilisation post-parturition du meloxicam pour améliorer les performances des truies et réduire la douleur

Objectifs: Déterminer les effets du meloxicam administré à des truies peu de temps après la parturition sur le comportement d'allaitement ainsi que sur la survie et la croissance des porcelets.

Matériels et méthodes: Un total de 289 truies et leur portée ont été étudiées. Des truies ayant mis-bas depuis moins de 12 heures étaient réparties de manière aléatoire pour recevoir une injection intramusculaire soit de meloxicam (utilisation hors-homologation) ou d'un placébo. Le traitement était inconnu des chercheurs. Tous les porcelets étaient pesés dans les 12 premières heures suivant la naissance, au moment de la castration et du coupage de queue (5 à 7 jours d'âge), et avant le sevrage (19 à 21 jours d'âge). Les portées étaient catégorisées en petite, moyenne, et

Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada.

Corresponding author: Dr R. Friendship, Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1 Canada; Tel: 519-824-4120 ext 54022; Fax: 519-763-3117; E-mail: rfriends@uoguelph.ca.

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

Tenbergen R, Friendship R, Cassar G, et al. Investigation of the use of meloxicam post farrowing for improving sow performance and reducing pain. *J Swine Health Prod.* 2014;22(1):10–15.

large. Des mesures additionnelles relatives à la truie, incluant les changements de position, les températures rectales, et les pointages d'ingestion de nourriture, ont été réalisées sur un nombre restreint des truies de l'étude.

Résultats: Aucun effet significatif du traitement n'a été noté sur la mortalité ou le taux de croissance des porcelets. Toutefois, le taux de croissance des porcelets dans les portées de taille moyenne (11 à 13 porcelets) avait tendance à être meilleur pour les truies traitées avec du meloxicam comparativement aux truies recevant le placébo ($P = .07$). Le taux de croissance était corrélé positivement avec le poids à la naissance et au sevrage ($P < .001$) et négativement avec la parité de la truie et la taille de la portée à la naissance ($P < .001$). La mortalité des porcelets n'était pas associée avec le traitement, mais était associée avec des portées de large taille et un poids léger à la naissance ($P < .001$).

Implications: Le meloxicam administré à toutes les truies post-parturition n'améliore pas le taux de survie et la croissance des porcelets. Une amélioration des performances pourrait être notée si seulement les truies ayant une parturition difficile étaient traitées. Des études supplémentaires sont nécessaires afin de confirmer le tout.

Pre-weaning mortality is an important issue in pig production, with more than 10% of live-born piglets dying before weaning and 80% of those in the first 3 days after birth.[1] Crushing of piglets by the dam is a major cause of this neonatal mortality, with losses estimated at 4.8% to 18% of all piglet mortality.[2] In addition to preventing accidental trauma, another important reason that the sow must quickly settle after parturition and begin to nurse is so that the piglets are able to consume colostrum for energy and immunity.

It is generally accepted that parturition in any species is a painful process, and even in species that give birth to litters of relatively small offspring there is potential for considerable pain to occur in the case of dystocia or small parity-1 sows farrowing large piglets.[3] Analgesics such as meloxicam, a relatively long-acting non-steroidal anti-inflammatory drug (NSAID), are licensed for food-producing animals in some countries, although at present use of meloxicam for sows is extra-label in Canada and in the United States. There is limited published research on the impact of analgesia after parturition in sows. In cattle, Richards et al[4] found that administration of ketoprofen (an NSAID) at parturition is clinically advantageous when fetal membranes are likely to be retained, but found no other production or reproductive advantage to using ketoprofen. However, these authors suggested its routine use at calving might be justified on welfare grounds. Administering analgesics to sows at farrowing may alleviate pain and allow them to lie more restfully, and thus provide piglets more opportunity for colostrum intake without the risk of being crushed.

The objective of this trial was to determine the effect of meloxicam, administered to sows shortly after parturition, on nursing behavior and piglet survival and growth.

Materials and methods

This study was approved by the University of Guelph Animal Care Committee in accordance with the Canadian Council of Animal Care Guidelines.

Herd and facilities

This study was carried out on a 600-sow commercial swine operation between May 2011 and November 2011. The sows were Landrace × Yorkshire crossbreds, and the sires of the piglets were Duroc × Pietrain. All sows and litters were housed in fully slatted, mechanically ventilated farrowing rooms (four rooms containing 24 farrowing crates and one containing 12 crates). Heat pads were provided in the creep area of each crate. Apart from nursing, no additional diet was offered to piglets. Piglets had unlimited access to water nipples. Teeth clipping of piglets was not practiced. Rooms were filled in an all-in, all-out manner and were cleaned and disinfected between groups.

Study design

This study involved 289 litters and 3006 piglets. Piglets received an injection of 200 mg of iron dextran and were ear notched within 12 hours of birth. Sows were alternately assigned to receive a single intramuscular (IM) injection of one of the following treatments within 12 hours of farrowing (time 0): 0.4 mg per kg of bodyweight of meloxicam (Metacam; Boehringer Ingelheim Ltd, Burlington, Ontario, Canada; extra-label use) or a similar volume of a placebo. The placebo contained 0.2 mg per mL propylparaben and 1.8 mg per mL methylparaben as preservatives. Treatment and placebo were in identical bottles identified as "A" or "B." The researchers were blinded to treatment during the trial. Piglets were individually weighed using a shipping scale (DYMO Pelouze; Rubbermaid Commercial Products, Winchester, Virginia) within 12 hours of birth, at 5 to 7 days of age, and prior to weaning (19 to 21 days of age). The scale had a capacity of 68 kg and a resolution of 0.1 kg.

Mortality data were collected daily. Cross-fostering was carried out by the herdsmen in a small number of litters prior to treatment, but was not permitted after treatment and weighing. The number of live piglets present at the time of an observation was referred to as litter size.

Additional measurements performed on a subset of sows

Twenty-four pairs of similarly aged sows that finished farrowing at about the same time, one treated and one control sow per pair, were chosen for a study to monitor posture. Small three-channel data loggers (HOBO Pendant G Acceleration Data Logger; Onset Computer Corporation, Pocasset, Massachusetts) were used to record posture for the first 24 hours after treatment, following the technique described by Ringgenberg et al.[5] Data loggers were attached to the right hind leg of the sow after treatment and set to record position at 5-second intervals. Each data logger was protected in a waterproof pocket and securely fastened with a self-adherent bandage and tape. Seven data loggers were dislodged, but complete records were obtained from 41 animals. For downloading the information, a coupler, an optical base station with USB interface, and the HOBOware Pro computer program (Onset Computer Corporation) were used. Each data point was converted into an acceleration unit (g) and a sow was recorded as "standing" when the X axis was ≥ 0.59g; otherwise, posture was recorded as "other." The outcomes calculated were the amount of standing time during the 24 hours and the mean duration of standing bouts (ie, the average number of minutes a sow remained standing during each standing bout in the 24-hour observation period).

Rectal temperatures were recorded for a total of 34 sows (approximately equal numbers of control and treatment sows) at time 0, 4 hours, and 24 hours. Temperatures were taken using a digital thermometer (MC-343HP; Omron, Lake Forest, Illinois). Feed intake of these 34 sows was recorded at 24 hours post treatment using a 1 to 3 scale (1 = ate nothing; 2 = feed partially consumed; 3 = all feed consumed).

Statistical analysis

Descriptive statistics and quantitative statistical analysis were performed in Statistix (Statistix 10, Version 10.1; College Station, Texas). Each continuous variable was plotted and tested for normality using the Shapiro-Wilk test. The correlation among continuous variables was tested using pair-wise correlations. The simple association between continuous variables with treatment was evaluated with a two-sample *t* test when the variables were normally distributed and with the Wilcoxon rank sum test when the variables were not normally distributed. The simple association of continuous variables with categorical variables was analyzed with a one-way analysis of variance when the variables were normally distributed and with a Kruskal-Wallis test when the variables were not normally distributed. A chi-square test was used to determine the simple association between treatment and dichotomous or categorical variables. Fisher's exact test was used in cases where the expected values in the 2 × 2 table were < 5 in at least one of the cells. A *P* value of < .05 was considered significant, and *P* values between .05 and .10 were considered indicative of a trend and reported for the rectal temperature and posture data.

The association of piglets' average daily gain (ADG) with treatment, parity, litter size and weight at birth, and litter identity (ID) were analyzed using a mixed linear regression model. The interactions of treatment and parity, litter size, and weight were evaluated to determine any effect on ADG of treatment by these variables. In this model, treatment, parity, litter size at treatment, and weight at birth were considered fixed effects, and litter ID was modeled as a random intercept. Models were compared using the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) value. Residuals were visualized after fitting the model to determine normality of residuals and the presence of unusual observations that would require further analysis.

The associations of pig mortality during the nursing period with treatment, parity, litter size and weight at birth, and litter ID were analyzed using a multilevel mixed effects logistic regression model. In this model, treatment, parity, litter size, and weight were considered fixed effects, and litter ID was modeled as a random intercept. The interactions of treatment and parity, litter size, and weight at birth were evaluated to determine any effect of treatment by these variables on pig mortality. The AIC and BIC were used to select the models.

The association of rectal temperatures, difference in rectal temperatures, time standing, and average duration of standing bouts of sows with treatment, parity, and the interaction of treatment and parity were analyzed using linear regression models. A square-root transformation was performed on posture behavior variables in order for the residuals to meet the model assumptions of normality and homoscedasticity.

Results

Pig performance

Treatment was not significantly associated with growth rate (ADG), weight at birth, or weight at weaning (Table 1). Litter size at weaning was higher for sows treated with meloxicam, but litter size at birth also tended to be larger for the meloxicam group (Table 1). Growth rate and weight at birth and at weaning were normally distributed. Growth rate was positively correlated with weight at birth and at weaning ($P < .001$) and negatively correlated with litter size ($P < .001$).

Parity and litter size at birth were not normally distributed and were positively correlated. Therefore, for analysis, parity and litter size at birth were categorized. Three parity categories were considered: Parity 1-2 (86 sows and 899 piglets), Parity 3-5 (72 sows and 758 piglets), and Parity > 5 (130 sows and 1349 piglets). Litter size at birth was categorized as follows: Score 1, < 11 pigs; Score 2, 11 to 13 pigs; and Score 3, > 13 pigs.

Parity was significantly associated with ADG. Piglets from sows within Parity 3-5 had better ADG (0.244 kg per day) than piglets from Parity 1-2 or Parity > 5 sows (0.228 and 0.230 kg per day, respectively; $P < .001$). In addition, ADG was significantly different among all the categories of litter size ($P < .001$). In general, ADG was lower in larger litters than in smaller litters. Because litter size and parity categories were highly associated, parity category and litter size were introduced into the model one at a time.

The multivariable mixed linear models were built using ADG or weight at weaning as dependent variables. The models with ADG had better AIC and BIC. The final mixed linear model included treatment, weight at birth, and the interaction of either treatment and parity or treatment and litter size. In both models, the interactions were not significant. However, the mixed model that included the interaction of treatment and litter size showed that piglets from the placebo group in litters of 11 to 13 pigs tended to gain less weight than pigs in that litter-size category in the meloxicam group ($P = .07$). In all ADG models, weight at birth was significant. In addition, the significant random intercept in the model indicated that ADG varied significantly by litter.

Mortality was not associated with treatment ($P = .36$). A total of 165 of 1565 pigs (10.54%) died in the meloxicam group and 167of 1441 pigs (11.58%) died in the

Table 1: Mean (standard deviation) of piglet weights, average daily gain, and litter size for sows receiving either meloxicam or a placebo shortly after farrowing*

	Meloxicam n = 1565	Placebo n = 1441	*P*
Initial piglet weight (kg)†	1.64 (0.37)	1.63 (0.35)	.24
Pig weight at weaning (kg)†	6.44 (1.50)	6.40 (1.52)	.50
ADG (kg)†	0.234 (0.06)	0.231 (0.07)	.23
Initial litter size‡	11.36 (1.94)	11.28 (2.20)	.09
Litter size at weaning‡	9.80 (1.89)	9.56 (1.85)	< .001

* Within 12 hours of farrowing, sows received an intramuscular injection of a placebo or meloxicam (Metacam; Boehringer Ingelheim Ltd, Burlington, Ontario, Canada; 0.4 mg/kg body weight; extra-label use). Piglets were weighed within 12 hours of birth, at 5-7 days of age, and prior to weaning (19-21 days of age).

† Two-sample *t* test.

‡ Wilcoxon rank sum.

placebo group. However, the number of pigs that died was significantly different in sows from different parities ($P < .001$). A total of 67 of 899 pigs (7.45%) died in litters of Parity 1-2 sows, 71 of 758 (9.36%) died in litters of Parity 3-5 sows, and 194 of 1349 (14.38%) died in litters of Parity > 5 sows. Mortality was also significantly associated with litter size at birth ($P < .001$). A total of 64 of 872 pigs (7.33%) died in litters with < 11 pigs, 221 of 1864 (11.85%) in litters with 11 to 13 pigs, and 47 of 270 (17.40%) in litters with > 13 pigs. The final mixed multilevel logistic model included treatment, weight at birth, and the interaction of treatment and parity or treatment and litter size. In all models, the interactions with treatment were not significant. Weight at birth was significantly associated with mortality. In general, pigs with light birth weights or pigs from large litters were more likely to die ($P < .001$). In addition, the significant random intercept in the model indicated that mortality varied significantly by litter.

No sows in the study showed clinical signs of illness such as mastitis or metritis, and no sows had a prolonged and difficult farrowing.

Sow temperature, feed intake, and standing behavior

Sow rectal temperatures and differences in temperature were normally distributed. Rectal temperatures and differences in rectal temperatures were not significantly associated with treatment (Table 2). In these data, parity categories and feed intake were not associated with treatment ($P = .44$ and $P = .98$, respectively).

The amount of time spent standing in the 24-hour observation period, as well as the average length of a standing bout in minutes, were not normally distributed and were significantly correlated ($P < .01$). Treatment was not associated with the amount of time spent standing or the average length of a standing bout (Table 2).

Posture behavior by treatment group and parity category is summarized in Table 3. The regression model for average standing time showed that in general, sows in Parity > 5 had longer average standing times than sows in Parity 1-2 ($P < .01$). No significant differences of treatment, parity group, or the interactions between treatment and parity were found in the regression model for average length of a standing bout.

Discussion

The sow must become comfortable and begin to nurse soon after farrowing is complete. Most piglet mortality occurs within the first day of life.[6] It is very important for piglets to obtain colostrum within the first 24 hours after birth in order to obtain sufficient energy and adequate immunological protection.[1] Starving piglets spend more time in close proximity to the sow in an attempt to increase their milk intake, but consequently are at a higher risk of being crushed.[6] Postpartum pain and inflammation might potentially interfere with a sow's ability to nurse, and so the administration of an NSAID like meloxicam might be expected to improve

Table 2: Mean values (standard deviation; SD) of rectal temperature and posture measurements for sows treated with either meloxicam or a placebo shortly after farrowing*

	Meloxicam (n = 18)	Placebo (n = 16)	*P*
Sow rectal temperature (SD) (°C)†			
At treatment (time 0)	38.80 (0.60)	38.76 (0.57)	0.80
4-6 hours post treatment	38.78 (0.53)	38.90 (0.43)	0.51
24 hours post treatment	38.83 (0.74)	38.65 (0.54)	0.42
Difference 0-4 hours	-0.01 (0.39)	0.13 (0.52)	0.35
Difference 0-24 hours	0.038 (0.61)	-0.106 (0.40)	0.42
	Meloxicam (n = 20)	**Placebo (n = 21)**	***P***
Posture behavior (SD)‡			
Time standing per 24-hour period (hours)	1.04 (0.63)	1.28 (1.12)	.88
Duration of standing bout (minutes)	10.32 (11.20)	10.23 (8.40)	.96

* Treatments described in Table 1. Matched pairs of sows were selected from a larger group on the basis of age similarity; researchers blinded to treatment. Posture behavior was recorded using small three-channel data loggers (HOBO Pendant G Acceleration Data Logger; Onset Computer Corporation, Pocasset, Massachusetts) attached to the hind leg of the sow, with position recorded at 5-second intervals.

† Two-sample *t* test.

‡ Wilcoxon rank sum.

Table 3: Mean (standard error) of posture behavior by treatment group (meloxicam or placebo post farrowing) and parity category effects*

Parity categories	Time standing per 24 hours (hours)	Length of a standing bout (minutes)
Meloxicam (n = 20)		
Parity 1-2 (n = 7)	0.44 (0.18)	5.42 (1.76)[a]
Parity 3-5 (n = 2)	1.05 (0.21)	12.61 (4.13)
Parity > 5 (n = 11)	1.40 (0.15)	12.82 (4.36)[b]
Placebo (n = 21)		
Parity 1-2 (n = 6)	1.27 (0.40)	5.75 (0.87)[a]
Parity 3-5 (n = 4)	1.33 (0.58)	12.91 (7.54)
Parity > 5 (n = 11)	1.24 (0.34)	11.31 (2.33)[b]

* Treatments described in Table 1. Posture behavior measurement described in Table 2.

[ab] Standing bouts were shorter in sows in Parity 1-2 than in sows in Parity > 5 ($P < .01$; regression model)

sow comfort and result in better milking performance. However, in the present study, there was no advantage with respect to piglet growth or survival if the sow was treated with meloxicam shortly after she finished farrowing or was injected with a placebo.

Mainau et al[7] performed a similar study using only 24 sows per treatment group and reported no overall differences in growth or mortality of piglets between sows given meloxicam and sows given a placebo, but they did note that low-birth-weight piglets from multiparous sows had a better ADG in the meloxicam group than in the placebo group. In the present study, the one subset of litters which did tend to grow better if the sow was given meloxicam was the medium-sized litters (11-13 pigs). The explanation for why meloxicam might improve performance in this litter group and not in others is unclear.

Although there may not be a difference in performance between treatment and controls overall, it is possible that some sows may find the farrowing experience more stressful than others. Primiparous gilts are believed to experience more painful parturitions than multiparous sows due to their lack of experience and a higher degree of effort than in multiparous females.[3] Keller[8] found that meloxicam treatment of sows post partum improved piglet survival, noting that the difference in piglet survival was primarily in the subset of sows requiring manual assistance. In addition, the use of meloxicam to treat mastitis-metritis-agalactia (MMA) syndrome in sows has been shown to increase piglet weight gain and decrease preweaning mortality.[9] It should be noted that in Canada and the United States, use of meloxicam to treat a postpartum sow would be extra-label use of the product.

Unfortunately, in the present study, information regarding ease of farrowing and duration of farrowing was not recorded, so that this aspect could not be evaluated. No sows in the present study appeared to suffer from MMA or other illness. The results of this study indicate that there is no benefit in improved production performance from routinely injecting all sows with meloxicam after farrowing, but further studies are warranted to determine if the use of analgesia under certain circumstances, such as a difficult farrowing, would result in improved productivity and improved animal welfare. An additional weakness of the current study was that it was conducted in a commercial setting, and researchers did not always have control of all aspects of management, for example some cross-fostering occurred prior to treatment and weighing, and this was not always recorded. It is possible that cross-fostering affected growth and survival and should have been prevented or at least controlled for in the analysis.

In the present study, sow rectal temperature, feed intake, and standing behavior were examined in a subset of sows to determine if there was evidence of improved animal comfort. In general, there were no significant differences between sows treated with meloxicam and those given a placebo. Unfortunately the sample sizes for these trials were small and possibly inadequate to determine a difference.

Mainau and Manteca[3] found that sows appear uneasy and restless during the 24 hours prior to parturition and spend most of their time (more than 82%) lying during the days around farrowing, with time spent lying increasing to at least 90% after farrowing. The present study found that sows spent 95% of their time lying whether or not they received meloxicam. In agreement with the present study, Haussman et al[2] reported that sows given an analgesic (butorphanol tartrate) every 6 hours until 3 days after farrowing had fewer position changes from 48 to 72 hours post partum, but not from farrowing to 48 hours, with no decrease in the rate of crushing over the 3 days.

Lying behaviour around farrowing may be affected by various factors that cannot be controlled with the administration of an analgesic. For example, Mainau et al[10] found that there are individual differences in activity levels between sows, with more marked variation from 1 day before until 1 day after farrowing. In addition, they found that human activity on the farm or environmental stress coincided with increased activity. This was not controlled for in the present study. In the present study, there was an interaction between parity and treatment, with the number of standing events or amount of time spent standing tending to be greater mainly in the third-parity group (oldest sows) among placebo-treated sows compared to the same parity group in the meloxicam-treated sows, suggesting that treated sows may have been more comfortable, but further work is needed to confirm this finding.

No ideal measurement of the effectiveness of pain control currently exists in pigs. Behavioural observations may be used in assessing pain, such as sow activity as discussed above, but measurements tend to be subjective and there is much individual variation. Physiological indicators of pain may include responses of the sympathetic-adrenomedullary system, such as changes in heart rate and rectal temperature, or responses of the hypothalamic-pituitary-adrenocortical system, which may result in changes in cortisol levels.[3] Blood cortisol concentrations may be used as an objective indicator of stress and pain, but they may also become elevated as a result of stresses such as handling. Irrespective of the parturition environment, parturition is associated with increased plasma cortisol concentrations,[11] suggesting that it is a stressful and painful process.

A reduction in feed intake is commonly seen in sows after parturition, especially in primiparous sows, and could be attributed to pain.[3] The present study did not find a difference in feed intake between treatment groups. This is in agreement with Mainau et al.[7] In cattle, Proudfoot et al[12] found that cows undergoing a difficult calving did not differ in their feed intake in the first 24 hours after calving, compared to cows undergoing a normal calving. Feed intake during lactation is affected by a variety of factors, including season, lactation length, and genetic variation among individual sows.[13] It is important to consider factors such as feed delivery practices, environmental conditions, and individual-sow health status when interpreting information on feed intake during lactation.[13] This was not recorded in the current study.

At present, there are few North American farms where pain control is considered for the post-farrowing sow. The present study has found that routine use of meloxicam did not improve productivity. It is possible that among farrowing sows, some experience more pain and have more need for pain control than others. Further research should concentrate on examining the benefits of analgesia on this particular subset of animals, both with respect to improved productivity and also to determine if meloxicam is effective in reducing postpartum pain in these sows.

Implications

- Under the conditions of this study, routine administration of meloxicam to all sows post farrowing does not result in improved piglet survival and growth.
- Further studies are warranted to determine if the use of analgesia under certain circumstances, such as a difficult farrowing, would result in improved productivity and improved animal welfare.

Acknowledgements

This work was financially supported by Boehringer Ingelheim Ltd Canada and Ontario Pork.

Conflict of interest

None reported.

References

1. Svendsen J. Perinatal mortality in pigs. *Anim Rep Sci*. 1992;28:59–67.

2. Haussman MF, Lay DC, Buchanan HS, Hopper JG. Butorphanol tartrate acts to decrease sow activity, which could lead to reduced pig crushing. *J Anim Sci*. 1999;77:2054–2059.

3. Mainau E, Manteca X. Pain and discomfort caused by parturition in cows and sows. *Appl Anim Behav Sci*. 2011;135:241–251.

4. Richards BD, Black DH, Chrisley RM, Royal MD, Smit RF, Dobson H. Effects of the administration of ketoprofen at parturition on the milk yield and fertility of Holstein-Friesian cattle. *Vet Rec*. 2009;165:102–106.

5. Ringgenberg N, Bergeron R, Devillers N. Validation of accelerometers to automatically record sow postures and stepping behaviour. *Appl Anim Behav Sci*. 2010;128:37–44.

6. Weary DM, Pajor EA, Thompson BK, Fraser D. Risky behaviour by piglets: a trade off between feeding and risk of mortality by maternal crushing? *Anim Behav*. 1996;51:619–624.

7. Mainau E, Ruiz-de-la-Torre JL, Dalmau A, Salleras JM, Manteca X. Effects of meloxicam (Metacam®) on post-farrowing sow behaviour and piglet performance. *Animal*. 2012;6:494–501.

*8. Keller F. Improved early piglet survival after Metacam® treatment of sows post farrowing. *Proc IPVS*. Jeju, South Korea. 2012; PO-177.

9. Hirsch AC, Philipp H, Kleemann R. Investigation on the efficacy of meloxicam in sows with mastitis-metritis-agalactia syndrome. *J Vet Pharmacol Therap*. 2003;26:355–360.

10. Mainau E, Dalmau A, Ruiz-de-la-Torre JL, Manteca X. Validation of an automatic system to detect position changes in puerperal sows. *Appl Anim Behav Sci*. 2009;121:96–102.

11. Meunier-Salaun MC, Gort F, Prunier A, Schouten WPG. Behavioural patterns and progesterone, cortisol and prolactin levels around parturition in European (Large-White) and Chinese (Meishan) sows. *Appl Anim Behav Sci*. 1991;31:43–59.

12. Proudfoot KL, Huzzey JM, von Keyserlingk MAG. The effect of dystocia on the dry matter intake and behaviour of Holstein cows. *J Dairy Sci*. 2009;92:4937–4944.

13. Lewis CRG, Bunter KL. Body development in sows, feed intake and maternal capacity. Part 1: performance, pre-breeding and lactation feed intake traits of primiparous sows. *Animal*. 2011;512:1843–1854.

* Non-refereed reference.

Conversion tables

Weights and measures conversions

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

Temperature equivalents (approx)

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

°F = (°C × 9/5) + 32

°C = (°F - 32) × 5/9

Conversion chart, kg to lb (approx)

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

1 tonne = 1000 kg

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

1 ppm = 1 mg/L

Effects of yohimbine, an alpha 2-antagonistic reversal agent, on physiological recovery parameters of anesthetized sows

Monique D. Pairis-Garcia, DVM; Anna K. Johnson, PhD; Suzanne T. Millman, PhD; Kenneth J. Stalder, PhD; Locke A. Karriker, DVM, MS, Diplomate ACVPM

Summary

Objective: To evaluate the efficacy of yohimbine as an anesthetic reversal agent for sows anesthetized with a combination of xylazine, ketamine, and telazol.

Materials and methods: Anesthesia was induced with xylazine, ketamine, and telazol in a single syringe, injected intramuscularly (IM). Following a 20-minute stabilization period, palpebral reflex was evaluated, and if absent, sows were injected IM with sterile saline (Control sows; n = 12) or yohimbine HCl (0.1 mg per kg; Yohimbine sows; n = 12). Data collected included insensibility measures (palpebral reflex, jaw tone, nose prick, alertness to human approach test, body posture) and physiologic measurements (heart rate, rectal temperature, respiratory rate, oxyhemoglobin saturation). Data was collected every 10 minutes until complete sensibility was attained.

Results: Yohimbine sows recovered from anesthesia 162 minutes earlier than Control sows ($P < .01$). For all insensibility measures, Yohimbine sows regained a normal response more quickly than Control sows ($P < .001$). In addition, Yohimbine sows maintained greater heart rate ($P < .05$) and rectal temperature ($P < .001$) between onset of anesthesia (the time anesthetic agents were injected) to completion of the trial (when sow attained complete return to sensibility). Respiratory rate and oxyhemoglobin saturation were maintained within normal physiological ranges throughout anesthesia, confirming that respiratory capability was not compromised under this anesthetic protocol.

Implications: Yohimbine is an effective reversal agent in sows anesthetized with xylazine, ketamine, and telazol administered simultaneously. This agent can be used by veterinarians to ensure a quicker recovery from anesthesia with minimal complications.

Keywords: swine, anesthesia, yohimbine, reversal agent

Received: February 12, 2013
Accepted: April 9, 2013

Resumen - Efectos de la yohimbina, un agente de inversión antagonista alpha 2, en los parámetros de recuperación fisiológica de hembras anestesiadas

Objetivo: Evaluar la eficacia de la yohimbina como un agente de inversión anestésica para hembras anestesiadas con una combinación de xilazina, ketamina, y telazol.

Materiales y métodos: La anestesia fue inducida con xilazina, ketamina, y telazol en una sola jeringa inyectada intramuscularmente (IM por sus siglas en inglés). Después de un periodo de estabilización de 20 minutos, se evaluó el reflejo palpebral y si estaba ausente, se inyectó a las hembras con solución IM de solución salina estéril (hembras Control; n = 12) o yohimbina HCl (0.1 mg por kg; hembras Yohimbina; n = 12). Los datos recopilados incluyeron medidas de insensibilidad (reflejo palpebral, respuesta de quijada, punción de nariz, prueba de alerta de cercanía humana, postura corporal) y medidas fisiológicas (ritmo cardiaco, temperatura rectal, ritmo respiratorio, saturación de oxihemoglobina). Los datos se recopilaron cada 10 minutos hasta que se logró sensibilidad completa.

Resultados: Las hembras yohimbina se recuperaron de la anestesia 162 minutos antes que las hembras control ($P < .01$). Para todas las medidas de insensibilidad, las hembras Yohimbina recobraron una respuesta normal más rápido que las hembras Control ($P < .001$). Además, las hembras Yohimbina mantuvieron un ritmo cardiaco mayor ($P < .05$) y temperatura rectal ($P < .001$) entre el inicio de la anestesia (el tiempo en que se inyectaron los agentes anestésicos) y el término de la prueba (cuando la hembra regresó a sensibilidad total). El ritmo respiratorio y la saturación de oxihemoglobina se mantuvieron dentro de los rangos fisiológicos normales durante la anestesia, confirmando que la capacidad respiratoria no se afectó bajo este protocolo anestésico.

Implicaciones: La yohimbina es un agente de inversión efectivo en hembras anestesiadas con xilazina, ketamina, y telazol administrados simultáneamente. Este agente puede ser utilizado por veterinarios para asegurar una recuperación más rápida de la anestesia con mínimas complicaciones.

MDPG, AKJ, KJS: Iowa State University, Department of Animal Science, Ames, Iowa.

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

LAK: Iowa State University, Swine Medicine Education Center, College of Veterinary Medicine, Ames, Iowa.

Corresponding author: Dr Locke Karriker, Swine Medicine Education Center, College of Veterinary Medicine, Ames, IA 50011; Tel: 515-294-2283; Fax: 515-294-1072; E-mail: karriker@iastate.edu.

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

Pairis-Garcia MD, Johnson AK, Millman ST, et al. Effects of yohimbine, an alpha 2-antagonistic reversal agent, on physiological recovery parameters of anesthetized sows. *J Swine Health Prod.* 2014;22(1):16-23.

Résumé - Effets de la yohimbine, un agent renversant l'action alpha-2 antagoniste, sur les paramètres de récupération physiologique de truies anesthésiées

Objectif: Évaluer l'efficacité de la yohimbine comme agent renversant l'anesthésie chez des truies anesthésiées avec une combinaison de xylazine, kétamine, et telazol.

Matériels et méthodes: L'anesthésie a été induite avec un mélange de xylazine, kétamine, et telazol dans une même seringue, et injecté par voie intramusculaire (IM). Suite à une période de stabilisation de 20 minutes, le réflexe palpébral a été évalué, et si absent, les truies étaient injectées IM avec de la saline stérile (truies Témoins; n = 12) ou de la yohimbine HCl (0,1 mg par kg; truies Yohimbine; n = 12). Les données accumulées incluaient des mesures d'insensibilité (réflexe palpébral, tonus de la mâchoire, piquage du groin, attention au test d'approche humaine, posture corporelle) et des mesures physiologiques (rythme cardiaque, température rectale, rythme respiratoire, saturation de l'oxyhémoglobine). Les données étaient prélevées toutes les 10 minutes jusqu'à ce que la sensibilité complète fut atteinte.

Résultats: Les truies Yohimbine ont récupéré de l'anesthésie 162 minutes plus tôt que les truies Témoins ($P < .01$). Pour toutes les mesures d'insensibilité, les truies Yohimbine ont retrouvé une réponse normale plus rapidement que les truies Témoins ($P < .001$). De plus, les truies Yohimbine ont maintenu un rythme cardiaque plus élevé ($P < .05$) et une température rectale plus élevée ($P < .001$) entre le début de l'anesthésie (moment de l'administration des agents anesthésiants) jusqu'à la complétion de l'essai (retour complet de la sensibilité). Le rythme respiratoire et la saturation de l'oxyhémoglobine se maintenaient à l'intérieur des valeurs physiologiques normales durant toute l'anesthésie, confirmant ainsi que la capacité respiratoire n'était pas compromise avec ce protocole d'anesthésie.

Implications: La yohimbine est un agent renversant efficace chez les truies anesthésiées avec un mélange de xylazine, kétamine, et telazol administré simultanément. Cet agent peut être utilisé par les vétérinaires afin d'assurer un retour plus rapide de l'anesthésie avec un minimum de complications.

Sows represent a unique population in the breeding herd, as physiological compromise (disease) and age can make anesthesia induction risky. According to the American Society of Anesthesiologists,[1] age (geriatric), weight,[2] disease status, and anatomical variation[3] contribute to a heightened anesthetic risk and can lead to prolonged recovery times and increase post-anesthetic complications.[4] In addition, studies evaluating natural on-farm sow deaths confirmed cardiovascular failure as one of the top three causes of mortality.[5-7] This increases sow anesthetic risk, as the cardiovascular system is a key system altered during anesthesia. Furthermore, direct observations in our laboratory revealed that anesthetized sows (anesthesia induced with xylazine, ketamine, and telazol injected simultaneously in a single syringe) exhibited prolonged recoveries, on average between 5 and 10 hours. Acknowledging inherent sow risk factors, it is critical to design a protocol that minimizes risks associated with anesthesia.

Swine may be anesthetized in order to complete routine production procedures or surgical operations.[8] Laboratory and on-farm anesthesia examples include, but are not limited to, coronary angiography, ischemia and reperfusion models for human disease,[9,10] tracheal culture and bronchoalveolar lavage for respiratory disease diagnosis,[11,12] and assistance with aggressive animals when performing reproductive procedures[13] or euthanasia.[14] A major disadvantage with anesthesia in swine is the unpredictable recovery time, which results in increased post-anesthetic risks and costs attributed to employee time spent monitoring the animal. Although utilization of on-farm anesthesia on a daily basis is not common, anesthesia combined with an effective reversal agent can provide an additional diagnostic tool for veterinarians. Sows are difficult to restrain due to their large size and can be easily stressed by physical restraint and handling. Anesthetic administration routes are limited in adult swine due to inaccessible superficial veins and thick subcutaneous fat layers.[15] In addition, responses and reactions of swine to anesthesia can vary, as noted by resistant responses to certain sedative drug combinations.[16,17] Xylazine, ketamine, and telazol are a common combination of drugs used for anesthesia of swine both on farm and under research conditions.[18] The choice to use all three drugs in combination in our laboratory was based on a toxicologically wide margin of safety in swine and prolonged analgesic properties attained using all three drugs, as compared to xylazine and ketamine administered together[19] and telazol administered alone.[20] Yohimbine is an alpha-2 adrenoceptor antagonist that has been reported to be effective in reversing xylazine effects in nursery-age swine and other food-producing animals.[21-23] In cats, yohimbine acts as a stimulant, shortening both ketamine-induced anesthesia and the effects of xylazine.[24] Providing a quicker recovery may decrease post-anesthetic complications in sows, providing a more efficient, cost-saving method for anesthesia to be applied on farms. Although yohimbine has proven effective in nursery-age swine, inherent anesthetic risk of sows makes it inappropriate to infer that sows will respond in the same manner as younger, healthier swine. The objective of this study was to determine yohimbine efficacy as an anesthetic reversal agent in sows anesthetized with xylazine, ketamine, and telazol injected simultaneously in a single syringe.

Materials and methods

The protocol for this study was approved by the Iowa State University Animal Care and Use Committee.

Animals and housing

Twelve multiparous, non-pregnant, cross-bred commercial maternal-line cull sows were used (mean bodyweight ± standard deviation = 233.6 ± 18.7 kg). All sows received a physical examination, which included lung and heart auscultation, rectal temperature, and reproductive tract ultrasonography. These sows were handled daily for research projects and were familiar with their environment and caretakers. The laboratory was located at Iowa State University, College of Veterinary Medicine, Ames, Iowa. To avoid confounding injury due to aggression, each sow was housed in an individual pen; however, sows could see, smell, hear, and have nose-to-nose contact with other cohorts. Sows were provided ad libitum access to water via one nipple drinker per pen (Model 65; Trojan Specialty Products, Dodge City, Kansas). Sows were fed twice daily on a single feed bunk with a diet designed to meet or exceed nutrient requirements for gestating sows.

Treatments

Sows were blocked by body weight and randomly allocated using a random number generator to two treatments. Treatments were as follows: Yohimbine, yohimbine HCl (0.1 mg per kg) administered intramuscularly (IM) into the neck muscle (n = 12) and Control, sterile saline administered IM at an equivalent volume (n = 12).

Experimental design

All sows were acclimated to the laboratory environment for 7 days prior to study commencement. All 12 sows received both treatments in a cross-over design with a 10-day washout period. This experimental design provided robust control of intra- and inter-animal variation and reduced the animal number required to find significant differences. Investigators were blinded to treatments to reduce the possibility of observer bias.

Anesthesia protocol

Sows were fasted overnight (16 hours), but were provided ad libitum access to water until 1 hour prior to anesthesia administration. Sows were restrained by a common pig snare in their home pen and anesthetized. Anesthetic agents were combined and injected at the doses indicated: xylazine (4.4 mg per kg; Anased, Lloyd Laboratories, Shenandoah, Iowa); ketamine HCl (2.2 mg per kg; Ketaset, Wyeth, Madison, New Jersey); and tiletamine HCl and zolazepam HCl in combination (4.4 mg per kg; Telazol, Wyeth).[18] Anesthesia onset began once anesthetic agents were injected. Ten minutes after anesthesia onset, sows were placed in lateral recumbency, and postural adjustments were made if involuntary movements resulted in compromised respiratory or circulatory capability. Twenty minutes after anesthesia onset, sows were evaluated for a palpebral reflex. This was determined by placing a finger on the medial canthus of the accessible eye and gently running the finger along the eyelashes. The presence or absence of the palpebral reflex was determined by attempting to elicit a blink response with three successive attempts. If a palpebral reflex was absent, one of the two treatments was administered. If a palpebral reflex was present, the sow was monitored every 10 minutes until the palpebral reflex was absent, and treatment was then administered. To prevent confounding effects of external stimuli such as human traffic and talking within and between the pens during anesthesia induction, these distractions were minimized. During anesthesia and recovery, electrical heating pads and blankets were utilized when the sow's rectal temperature dropped below 36°C.

Measures

Insensibility measures. Insensibility measures collected included the human approach test,[25] body posture, palpebral reflex, jaw tone, and nose prick test. Each measure was scored on a 0 to 2 scale, with score 0 representing a normal alert response, score 1 representing diminished response from normal, and score 2 representing no response (Table 1). Insensibility was measured immediately before anesthesia administration (Baseline), and every 10 minutes after anesthesia onset until sows reached a 0 score (Recovery). A sow was considered to have completed the trial once a 0 score for all measures was attained.

Physiologic measures. Physiologic measures were collected at the same time points as insensibility measures and included heart rate by auscultation (WLS5605-Cl Stethoscope; United Inc, India), rectal temperature (Jumbo Display Digital Thermometer; Graham Field Health Products Inc, Atlanta, Georgia), respiratory rate, and oxyhemoglobin saturation (SpO_2) collected from a pulse oximeter probe placed on the sow's lip or tongue (OxiMax N-65 Quick Guide; NellCor, Boulder, Colorado).

Statistical analysis

Data were analyzed using SAS software version 9.3 (SAS Institute Inc, Cary, North Carolina). Data were analyzed for normality by plotting a predicted residual plot and a quantile-quantile plot. Insensibility and physiologic measures were analyzed using a mixed model procedure utilizing polynomial regression in SAS. The insensibility statistical models included the fixed effect of treatment (Control versus Yohimbine), day (2 days), day-by-treatment interaction, and weight as a linear covariate. Sow was included as a random effect. The physiologic statistical models included the fixed effect of treatment (Control versus Yohimbine), day (2 days), day-by-treatment interaction, weight, and time (minutes) categories. Time categories were created starting at anesthesia onset. Sixty-minute timepoint interval blocks were included. All interactions were included in the model. A P value of < .05 was considered significant for the MIXED analysis of variance and when separating means. Fixed effect least squares (LS) means were separated using the PDIFF option in SAS, and data were expressed as LS means (95% confidence intervals) and mean (± SD).

Results

Insensibility measures

No difference was observed between treatments (Control versus Yohimbine) for time to administration, with all sows receiving either Yohimbine or saline on average between 23.5 minutes (95% CI, 17.6-29.4) and 27.0 minutes (95% CI, 21.4-32.6) post anesthesia administration. Yohimbine sows recovered from anesthesia 162 minutes earlier than Control sows (290 minutes, 95% CI, 195.4-384.6 versus 452 minutes, 95% CI, 364.2-559.7; P < .01). Time to return to sensibility for all measures (score 0) was shorter for Yohimbine sows than for Control sows (P < .01; Figure 1).

Physiologic measures

Heart rate. There was a treatment-by-time interaction, with Yohimbine sows demonstrating a greater heart rate over the anesthesia course than Control sows (P < .05; Figure 2). Within 3 hours post anesthesia administration, heart rate did not differ between treatments. During the following 4 hours, Yohimbine sows maintained greater heart rates (P < .01). When a 0 score was attained, mean heart rate in Yohimbine sows, 69.9 beats per minute (95% CI, 63.0-76.8), was greater than in Control sows, 49.1 beats per minute (95% CI, 42.7-55.5).

Rectal temperature. The interaction between treatment and time (P < .001) demonstrated greater rectal temperatures throughout anesthesia for Yohimbine sows than for Control sows (Figure 3). Within 3 hours post anesthesia administration, rectal temperature did not differ between treatments. During the following 7 hours, Yohimbine sows maintained greater rectal temperatures (P < .001). When a 0 score was attained, mean rectal temperature was greater in Yohimbine sows (34.8°C; 95% CI, 34.2°C-35.3°C) than in Control sows (32.2°C; 95% CI, 31.7°C-32.8°C).

Respiratory rate and SpO_2. Respiratory rate differed by treatment, time, treatment-by-time interaction, and body weight between Yohimbine sows (21.0 breaths per minute; 95% CI, 18.6-23.3) and Control sows (21.9 breaths per minute; 95% CI, 20.0-23.7): P < .01 (treatment); P < .001 (time); P < .001 (treatment-by-time interaction); P < .001 (weight) (Figure 4). For the first 3 hours following anesthesia induction, Control sows had greater respiratory rates than did Yohimbine sows. For the remaining 5 hours, respiratory rates in Control and Yohimbine sows did not differ. There was no difference in respiratory rate between treatments once sows attained a 0 score.

Table 1: Criteria and scoring system* used to assess insensibility throughout anesthesia† and recovery in sows treated with yohimbine (n = 12) or saline (n = 12)

Measure‡	Definition	Score	Observation
Palpebral reflex	Eye reaction to physical examination	2	No blink response when stimulated three times
		1	Blink reflex stimulated by two or fewer touches
		0	Normal blink response with one touch
Jaw tone	Jaw manipulation	2	Flaccid jaw tone: observer able to open jaw with no resistance
		1	Resistant jaw tone: observer able to open jaw, slight muscular resistance
		0	Normal jaw tone: sow does not allow jaw to be manipulated
Nose prick	Needle tip prick	2	No response: no movement associated with needle tip prick
		1	Diminished response: some movement associated with needle tip prick
		0	Normal response: movement associated with needle tip prick, sow is evasive
Human approach test	Response of sow to human	2	No response: no orientation towards stimulus.
		1	Diminished response: uncoordinated eye, ear, or head movement in response to stimulus
		0	Normal response: oriented eye, ear, or head movement toward and in response to stimulus
Sow body posture	Body posture	2	Lateral recumbency with no movement
		1	Lateral recumbency with spontaneous movement
		0	Standing on all four limbs

* Adapted from Kim et al[21] and Heinonen et al.[26]

† Sows were anesthetized with xylazine (4.4 mg/kg), ketamine HCl (2.2 mg/kg), and a combination of tiletamine HCl and zolazepam (4.4 mg/kg) administered simultaneously in a single intramuscular injection. Treatments administered following anesthesia onset were yohimbine (alpha-2 adrenoceptor antagonist) administered intramuscularly at 0.1 mg/kg (Yohimbine sows) or an equivalent volume of saline (Control sows). Insensibility measures were assessed every 10 minutes from injection of anesthetic agents until sows reached a 0 score.

‡ Measures are in order of return to sensibility for Yohimbine sows.

There were no treatment differences for SpO_2, but for both Yohimbine and Control sows, SpO_2 percentage increased with time under anesthesia (Figure 5).

Discussion

The objective of this study was to determine yohimbine's efficacy as an anesthetic reversal agent in sows. On the basis of previous work conducted on nursery pigs,[21,27,28] we expected treatment with yohimbine to decrease overall recovery time, decrease latency time to regain sensibility, and maintain physiologic parameters closer to normal homeostatic levels than treatment with saline.

When insensibility measures were evaluated, Yohimbine sows recovered sooner than Control sows, with Control sows taking over 7 hours to regain full sensibility. The results of this study are in agreement with previously published findings that yohimbine reduces overall time under anesthesia, but the anesthesia duration for mature sows was longer than for nursery-age swine. Kim and colleagues[21] reported that pigs receiving yohimbine 20 minutes after anesthesia induction regained sternal recumbency (52.2 ± 8.9 versus 76.2 ± 20.6 minutes) and the ability to stand (77.0 ± 9.8 versus 98.7 ± 15.8 minutes) and walk (81.3 ± 11.3 versus 110.8 ± 18.6 minutes) faster than did pigs that did not receive yohimbine. Overall, in the present study, recovery from anesthesia was three to five times longer in sows receiving the same anesthetic protocol at the same dose without administration of yohimbine. This may be explained by differences in body composition and repartitioning of drug in mature animals. However, further studies should be conducted. Regardless of prolonged anesthesia duration, yohimbine effectively reduced the time under anesthesia and in turn decreased the risk of post-anesthetic complications.[2,4,29]

During anesthesia recovery, Yohimbine sows maintained physiologic parameters more closely resembling a healthy sow at rest; however, Control sows had depressed physiological measures. In all species undergoing anesthesia, it is expected that the animal's physiologic state (ie, heart rate, temperature, respiratory rate, and oxygen exchange) will be altered from normal homeostatic levels.[30] This is due to effects on receptors in the heart, lungs, and peripheral veins by selected anesthetic agents such as xylazine.[31] Antagonistic agents like yohimbine may alter the impact that anesthetic agents like xylazine have on the sow's physiologic status.

Yohimbine sows had faster heart rates than did Control sows, with Yohimbine sows maintaining heart rates within a normal range[32] throughout anesthesia (60 to 90 beats per minute). Bradycardia is a common side effect noted in animals anesthetized

Figure 1: Latency to regain sensibility least squares means (± standard error) (minutes) for anesthetized sows administered yohimbine or saline to mitigate recovery effects ($P < .01$). Sows were anesthetized and treatments administered after anesthesia onset as described in Table 1. Statistical analysis was performed using a mixed model. Insensibility measures included palpebral reflex, nose prick test, jaw tone, human approach test (HAT), and body posture.

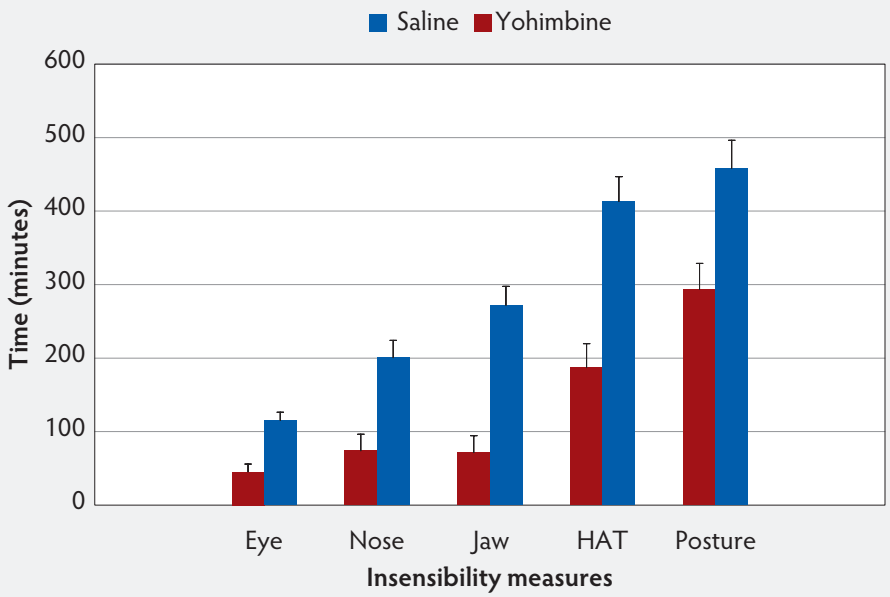
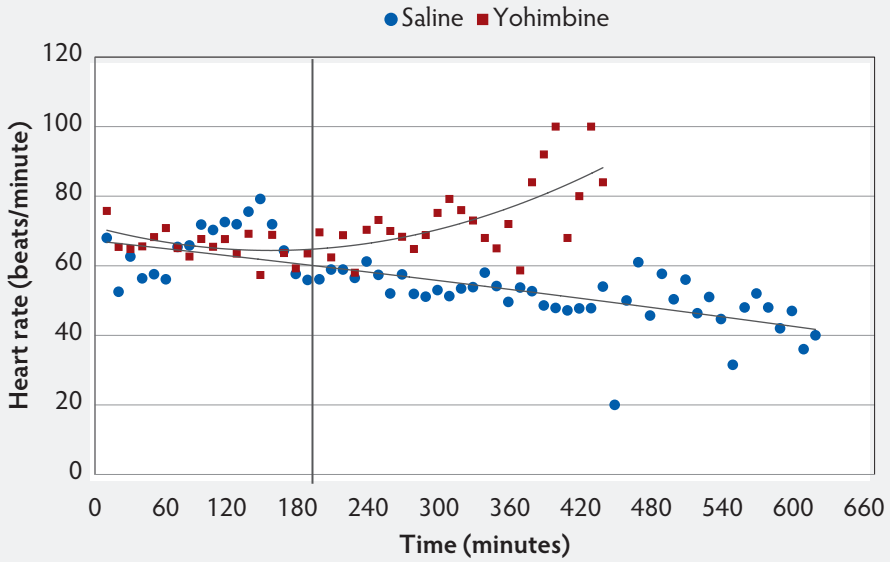


Figure 2: Heart rate least squares means by time for anesthetized sows administered yohimbine. Sows were anesthetized and treatments administered after anesthesia onset as described in Table 1. Statistical analysis was performed using a mixed model. Best fit lines for each treatment were fitted using a polynomial function. Black vertical line represents the first time that heart rate differed between Yohimbine and Control sows ($P < .05$).



with xylazine.[33] Xylazine is an alpha-2-adrenergic agonist that generates systemic vascular resistance by acting on the alpha-2 receptors located on peripheral veins.[31] This in turn produces hypertension and a short transient tachycardia, followed by a "compensatory baroreceptor-mediated reflex" resulting in bradycardia and decreased cardiac output.[31] This physiologic event can lead to inadequate oxygen-rich blood perfusion to vital organs and compromise basal metabolic requirements.[34] This may cause complications during recovery and may cause permanent organ-system damage. The Yohimbine treatment effectively antagonized xylazine effects on the sow's cardiovascular system, as was demonstrated in Yohimbine sows that did not become bradycardic during the anesthesia procedure and maintained a normal heart rate once a 0 insensibility score was attained.

During the anesthesia course, Yohimbine and Control sows reached subnormal body temperatures, but Yohimbine sows maintained higher overall temperatures within the last anesthetic hours. Rectal temperature in both treatment groups dropped approximately 1°C per hour within the first 2 hours after anesthesia. Between the third and fourth anesthesia hours, temperature dropped only 0.3°C per hour for Yohimbine sows, whereas the temperature of Control sows dropped 0.7°C per hour. Neither treatment group attained normal rectal temperature (38.0°C to 39.0°C) [30] when the sows reached a 0 insensibility score. However, Kim and colleagues[21] reported that nursery pigs had lower rectal temperatures when yohimbine was administered than did control pigs. In their study,[21] from the time pigs were anesthetized until recovery, rectal temperature dropped by 1°C. In the present study, rectal temperatures of both Yohimbine and Control sows dropped approximately 1°C within the first hour. However, temperature continued to drop in both treatment groups due to prolonged recovery times, which differs from previous work.[21]

Hypothermia in anesthetized companion animals is often overlooked, but can have severe consequences.[35] To date, to the authors' knowledge, there are no published studies evaluating hypothermia in swine. In companion animals, hypothermia has been defined as core body temperature dropping below 36°C,[36] and this was used in our study as a critical control point for thermal heat supplementation. Electrical heating pads and

Figure 3: Rectal temperature least squares means by time for anesthetized sows administered yohimbine or saline to mitigate recovery effects ($P < .001$). Sows were anesthetized and treatments administered after anesthesia onset as described in Table 1. Statistical analysis was performed using a mixed model. Best fit lines for each treatment were fitted using a polynomial function. Black vertical line represents the first time that rectal temperature differed between Yohimbine and Control sows ($P < .001$).

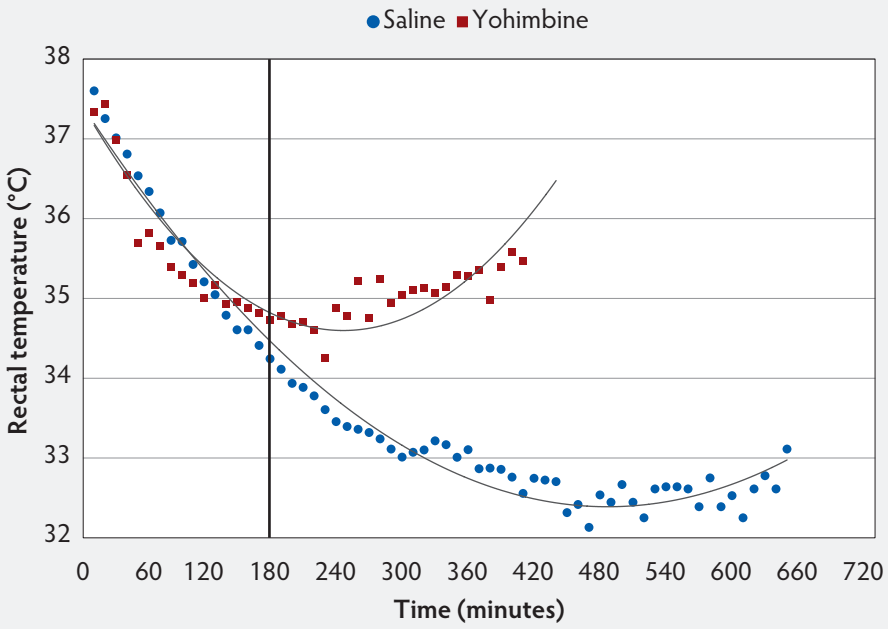
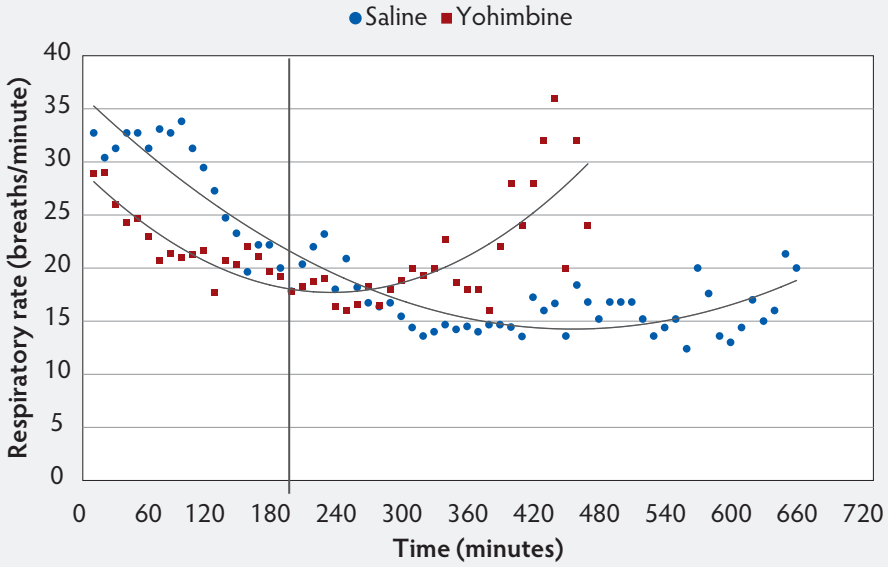


Figure 4: Respiratory rates least squares means by time for anesthetized sows administered yohimbine or saline to mitigate recovery effects ($P < .01$). Sows were anesthetized and treatments administered after anesthesia onset as described in Table 1. Statistical analysis was performed using a mixed model. Best fit lines for each treatment were fitted using a polynomial function.

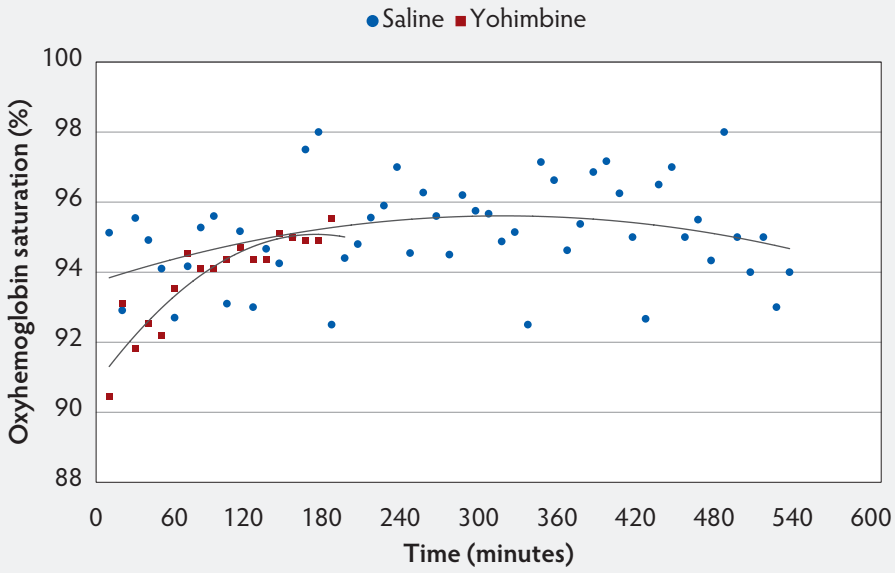


blankets were utilized when the sow's rectal temperature dropped below 36°C. Yohimbine sows maintained greater rectal temperatures and exhibited a slower rate of decline in rectal temperature over time. This is an advantage to the animal, as consequences of heat loss under anesthesia increase the risk of impaired immune-system function, impaired blood coagulation, cardiovascular depression, acidemia, and increased morbidity and mortality.[34]

Baseline respiratory rate was different between treatment groups, with Control sows having greater mean respiratory rate than Yohimbine sows. It is unclear why respiratory rate was greater in Control sows than in Yohimbine sows and why baseline respiratory rates in both groups were greater than reported normal respiratory rates (10 to 20 breaths per minutes)[32] in adult swine. Housing conditions were regulated to maintain a constant ambient temperature throughout the study and were unlikely to be the source for elevated respiratory rates. Behavioral excitability is a possible explanation for the increased baseline respiratory rate. Sows were not provided with a morning feed ration in order to minimize risk of aspiration or regurgitation while under anesthesia. It was noted that the sows exhibited increased vocalization and activity on trial day, compared to their typical behavior. This may have resulted from the sows not being fed that morning, which in turn elevated their respiratory rates. In addition, differences in baseline respiratory rate between treatments (Yohimbine versus Control) may have also been influenced by the sows' respiratory capability, which is influenced by lung development, maturation, and structural status. Previous sow history was not known, and therefore previous respiratory disease or compromised lung function may have influenced respiration under anesthesia.[37] It was noted that body weight had an effect on respiratory rate. However, because of the experimental design, weight or behavioral excitability would be unlikely to influence respiratory rate, as the same individual received both treatments.

Although Control sows did have greater mean respiratory rate during the first 2 hours, respiratory rate did not differ between treatment groups during the remaining time under anesthesia. A common side effect observed with xylazine administration includes respiratory depression.[31] Kim et al[21] reported that Yohimbine

Figure 5: Oxyhemoglobin saturation least squares means by time for anesthetized sows administered yohimbine or saline to mitigate recovery effects ($P > .05$). Sows were anesthetized and treatments administered after anesthesia onset as described in Table 1. Statistical analysis was performed using a mixed model. Best fit lines for each treatment were fitted using a polynomial function. Data points ended earlier in Yohimbine sows due to difficulty in continuous probe placement during recovery.



did not reverse respiratory depression in younger pigs until 5 minutes after administration. The results of our study and those of Kim et al[21] suggest that either yohimbine does not play a substantial role in controlling or regulating swine respiration under anesthesia, or the measurement methods (evaluating abdominal movements for 15 seconds) may not have been sufficiently sensitive to detect respiratory changes.

Treatment had no effect on SpO_2 concentrations in the present study, but all sows demonstrated a gradual increase in SpO_2 as time under anesthesia increased. No sows were provided with supplemental oxygen, therefore increased SpO_2 over time must be attributed to improved oxygen exchange by the sow. Gianotti and colleagues[38] determined that normal SpO_2 concentration in swine aged 60 to 90 days was 96% (± 2.10%). On the basis of data from this study, SpO_2 averages were within normal levels and did not fall below 90%. These data suggest that this anesthetic protocol did not compromise sow respiratory or oxygen exchange capability. However, caution should be taken when evaluating these results, as methods chosen for measurement may not be sensitive enough. In comparing pulse oximetry accuracy to capnography in dogs, cats, horses, and white-tailed deer, it has been demonstrated that the accuracy and consistency of pulse oximetry varies widely and does not provide readings as accurate as arterial blood gas analysis.[39,40] Although capnography may be a more accurate method than pulse oximetry, additional expense and technical skills make it difficult to apply on farm, and it was not chosen for this study. In addition, pulse oximetry results were difficult to collect once sows began regaining consciousness, as the probe needed to be clamped onto either a tongue or lip. Difficulty in placing the probe when sows were regaining consciousness resulted in less data collected for the Yohimbine sows.

In conclusion, on the basis of insensibility and physiologic measures, yohimbine was an effective reversal agent in sows anesthetized with xylazine, ketamine, and telazol. Overall anesthetic recovery time was shorter, and sows in an anesthetized state were able to maintain physiological parameters closer to normal homeostatic values. However, the effects of yohimbine on physical and behavioral recovery remain unknown. Video data analysis may provide additional information regarding the degree of post-anesthesia ataxia or thrashing with and without yohimbine. Yohimbine could be used by veterinarians to provide a desired analgesic and anesthetic effect while surgical procedures are performed, with a shorter recovery time that may decrease physiologic complications associated with anesthesia.

Implications

- Yohimbine is an effective reversal agent in sows anesthetized with xylazine, ketamine, and telazol administered simultaneously in a single syringe.
- Sows treated with xylazine, ketamine and telazol recover sooner when yohimbine is administered as a reversal agent, and physiological parameters return to normal homeostatic ranges more quickly.
- Recovery time after administration of xylazine, ketamine and telazol may be longer in sows than in nursery pigs, and anesthesia protocols may need to be adjusted for mature sows.

Conflict of interest

None reported.

References

1. American Society of Anesthesiologists. ASA physical status classification system. 2011. Available at: `www.asahq.org/clinical/physicalstatus.htm`. Accessed 25 June 2013.

*2. Petry C, Pereira ALB, Lemos JL, Mira A. Retrospective study: assessment of anesthetic risk of obese patients. *Proc World Small Anim Vet Assoc Cong*. Sao Paulo, Brazil. 2009; unpaginated.

*3. Sinclair M. Managing pediatric and geriatric patients. *Proc NAVC*. Gainesville, Florida. 2011; 166–169.

4. Trim CM, Braun C. Anesthetic agents and complications of Vietnamese potbellied pigs: 27 cases (1999–2006). *JAVMA*. 2011;239:114–121.

5. Engblom L, Eliasson-Selling L, Lundeheim N, Belak K, Andersson K, Dalin AM. Post mortem finding in sows and gilts euthanized or found dead in a large Swedish herd. *Acta Vet Scand*. 2008;50:25–35.

6. D'Allaire S, Drolet R, Brodeur D. Sow mortality associated with high ambient temperature. *Can Vet J*. 1996;37:237–239.

7. Chagnon M, D'Allaire S, Drolet R. A prospective study of sow mortality in breeding herds. *Can J Vet Res*. 1991;55:180–184.

8. Lu DZ, Fan HG, Kun M, Song ZL, Ming YS, Sheng J, Wang HB. Antagonistic effect of atipamezole, flumazenil, and naloxone following anaesthesia with xylazine, tramadol, and tiletamine/zolazepam combination in pigs. *Vet Anesth Analg*. 2011;38:301–309.

9. Williams PD, Malik N, Kingston PA. Coronary angiography and percutaneous coronary intervention in the porcine model: a practical guide to the procedure. *Animal*. 2012;6:311–320.

10. Dominguez HA, Carrasco MA, Olivera A, Santan I, Reyes Z, Rodriguez M, Murguia G, Alfonso C. Effect of sex on heart frequency in an Ischaemia/reperfusion model in pigs under intravenous total anaesthesia. *Revista Computadorizada de Produccion Porcina*. 2011;18:115–117.

*11. Solano G, Pijoan C. Diagnostic notes. A simple technique for tracheal culture to detect respiratory pathogens in live pigs. *Swine Health Prod*. 1997;5:30–31.

12. Jolie R, Backstrom L, Olson L, Chase C. Respiratory and systemic health parameters in pigs raised in a conventional farm or in isolation. *Swine Health Prod.* 1999;7:269–275.

*13. Shipley CF. Diagnostic notes. Breeding soundness examination of the boar. *Swine Health Prod.* 1999;7:117–120.

*14. Pelland C. Boar and sow euthanasia. *Proc AASV*. Dallas, Texas. 2009;333–334.

15. Bîrtoiu IA, Badea R, Sîrbu-Boeti M, Efrimescu C. Different anesthesia protocols used for experimental swine surgery *Lucrari Stiintifice.* 2008;41:526–529.

16. McClellan RO. Applications of swine in biomedical research. *Lab Anim Care.* 1968;18:120–126.

17. Swindle MM. Anesthesia, analgesia and perioperative care. In: Swindle MM, ed. *Swine in the Laboratory: Surgery, Anesthesia, Imaging and Experimental Techniques.* 2nd ed. Boca Raton, Florida: CRC Press; 2007:59–61.

18. St-Jean G, Anderson DE. Anesthesia and surgical procedures in swine. In: Straw BE, Zimmerman JJ, D'Allaire S, Taylor DJ, eds. *Diseases of Swine.* 9th ed. Victoria, Australia: Blackwell Publishing; 2006:1107–1131.

19. Green CJ, Knight J, Precious S, Simpkin S. Ketamine alone and combined with diazepam or xylazine in laboratory animals: a 10 year experience. *Lab Anim.* 1981;15:163–170.

20. Ko JC, Williams BL, Smith VL, McGrath CJ, Jacobson JD. Comparison of telazol, telazol-ketamine, telazol xylazine, and telazol-ketamine-xylazine as chemical restraint and anesthetic induction combination in swine. *Lab Anim Sci.* 1993;43:476–480.

21. Kim MJ, Park CS, Jun MH, Kim MC. Antagonistic effects of yohimbine in pigs anaesthetized with tiletamine/zolazepam and xylazine. *Vet Rec.* 2007;161:620–624.

22. Kitzman JV, Booth NH, Hatch RC, Wallner B. Antagonism of xylazine sedation by 4-aminopyridine and yohimbine in cattle. *Am J Vet Res*. 1982;43:2165–2169.

23. Mohammed FK, Zangana IK, Abdul-Latif AR. Reversal of medetomidine sedation in sheep by atipamezole and yohimbine. *Vet Hum Toxicol.* 1995;37:97–99.

24. Hsu WH, Lu ZX. Effect of yohimbine on xylazine-ketamine anesthesia in cats. *JAVMA*. 1984;185:886–888.

25.Marchant JN, Whittaker X, Broom DM. Vocalisations of the adult female domestic pig during a standard human approach test and their relationship with behavioural and heart rate measures. *Appl Anim Behav Sci.* 2001;72:23–39.

26. Heinonen ML, Raekallio MR, Olivero C, Ahokas S, Peltoniemi OAT. Comparison of azaperone-detomidine-butorphanol-ketamine and azaperone-tiletamine-zolazepam for anaesthesia in piglets. *Anesth Analg.* 2009;36:151–157.

27. Lee J, Kim M. Antagonistic effects of atipamezole and yohimbine against anesthesia with medetomidine and ketamine combination in pigs. *J Vet Clin*. 2011;28:291–296.

*28. Kim MC, Kim MJ, Jun MH, Park CS. Effect of yohimbine as a reversing agent of tiletamine/zolazepam and xylazine anesthesia in swine. *Proc IPVS.* Hamburg, Germany. 2004:569.

29. Dodman NH, Gray L, Williams R, Goldspink G. Intracompartmental muscle pressure, temperature and pH in the horse under general anesthesia. *J Equine Vet Sci.* 1985;5:11–15.

30. Smith AC, Swindle MM. Anesthesia and analgesia in swine. In: Fish RE, Brown MJ, Dannerman PJ, Karas AZ, eds. *Anesthesia and Analgesia in Laboratory Animals.* 2nd ed. Oslo, Norway: Academic Press; 2008:413–436.

31. Lamont, L. a_2-Agonists. In: Gaynor JS, Muir WW, eds. *Handbook of Veterinary Pain Management.* 2nd ed. St Louis, Missouri: Mosby; 2009:210–230.

32. Jackson PGG, Cockcroft PD. Investigations of clinical problems on pig farms. In: Jackson PGG, Cockcroft PD, eds. *Handbook of Pig Medicine*. Philadelphia, Pennsylvania: Elsevier; 2007:1–15.

33. Hsu WH. Xylazine-pentobarbital anesthesia in dogs and its antagonism by yohimbine. *Am J Vet Res*. 1985;46:852–855.

* 34. Posner L. Complications during anesthesia: evaluation and treatment. *Proc NAVC*. Orlando, Florida. 2010;131–133.

35. Byers CG. Cold critters: understanding hypothermia. *Vet Med.* 2012;107:82–87.

36. Knaepal A. Inadvertent perioperative hypothermia: a literature review. *J Perioper Pract.* 2012;22:86–90.

37. Klein C, Reinhold P. Analysis of respiratory mechanics by impulse oscillometry in non-sedated and diazepam-sedated swine. *Res Vet Sci.* 2001;70:181–189.

38. Gianotti GC, Beheregaray W, Passos W, Bianchi S, Santos Mombach V, Bonfirm Carregaro A, Contestino E. Swine in biomedical research: normal physiological values. *Acta Sci Vet*. 2010;38:133–137.

39. Matthews NS, Hartke S, Allen JC Jr. An evaluation of pulse oximeters in dogs, cats and horses. *Anesth Analg.* 2003;30:3–14.

40. Koenig J, McDonnell W, Valverde A. Accuracy of pulse oximetery and capnography in healthy and compromised horses during spontaneous and controlled ventilation. *Can J Vet Res.* 2003;67:169–174.

* Non-refereed references.

Estimated prevalence and impact of periweaning failure to thrive syndrome in Canada and the United States

Terri L. O'Sullivan, DVM, PhD; John C. S. Harding, DVM, MSc, Diplomate ABVP; Robert Friendship, DVM, MSc, Diplomate ABVP; Steve Henry, DVM, Diplomate ABVP; Darin Madson, DVM, PhD, Diplomate ACVP; Kent Schwartz, DVM, MSc

Summary

Objectives: To estimate the prevalence of periweaning failure to thrive syndrome (PFTS) in Canadian and American nursery-pig flows, to estimate the percentage of PFTS-affected pigs within an affected nursery flow, and to rank the common clinical signs observed by practitioners associated with PFTS on commercial farms.

Materials and methods: A questionnaire was designed, beta tested, and then made available through the American Association of Swine Veterinarians (AASV) and University of Guelph Web sites. Swine practitioners in major swine-producing regions of Canada and the United States completed the questionnaire to estimate the prevalence and impact of PFTS in nursery flows. To raise awareness and to aid in consistent recognition and reporting of the syndrome, a video was produced and accompanied the questionnaire. Oral, scientific-poster, and video presentations were also made at major swine-practitioner meetings across Canada and the United States to promote awareness of the syndrome and questionnaire.

Results: Fifty-five questionnaires were completed, with respondents servicing 1974 nursery flows. The reported mean flow prevalence of PFTS was 4.3% (95% CI, 0.9%-8.0%). The within-flow prevalence was reported to be variable (1% to 20%), with cases reported in five provinces and 11 states.

Implications: This report provides the first estimate of the mean flow prevalence and impact of PFTS in Canada and the United States. It is reasonable to expect this estimated prevalence to change as we continue to understand the syndrome. Video documentation, including demonstration of the clinical signs associated with PFTS, was an effective method to raise awareness of the syndrome.

Keywords: swine, periweaning failure to thrive syndrome, prevalence, survey, mortality

Received: February 12, 2013
Accepted: April 25, 2013

Resumen - Impacto y prevalencia estimados del síndrome porcino de retraso en el desarrollo en destete en Canadá y Estados Unidos

Objetivos: Estimar la prevalencia del síndrome porcino de retraso en el desarrollo en el destete (PFTS por sus siglas en inglés) en el flujo de cerdos en los destetes de los Estados Unidos y Canadá, estimar el porcentaje de cerdos afectados con el PFTS dentro de un flujo de destete afectado, y clasificar los signos clínicos comunes observados por médicos veterinarios relacionados con el PFTS en granjas comerciales.

Materiales y métodos: Se diseñó un cuestionario, se hizo una prueba beta, y se puso a disposición a través de las páginas Web de la Asociación Americana de Veterinarios Especialistas en Cerdos (AASV por sus siglas en inglés) y de la Universidad de Guelph. Los médicos veterinarios especialistas en cerdos en las regiones más importantes de producción porcina de Canadá y Estados Unidos respondieron el cuestionario para estimar la prevalencia e impacto de PFTS en los flujos de destete. Se elaboró un video que acompañó al cuestionario para despertar conciencia y ayudar a la identificación consistente y al reporte del síndrome. Para promover la conciencia del síndrome y del cuestionario, se hicieron presentaciones orales, del video, y se presentó un póster científico en las reuniones porcinas más impotentes de Canadá y Estados Unidos.

Resultados: Se llenaron cincuenta y cinco cuestionarios, con encuestados que dan servicio a 1974 flujos de destete. La prevalencia media de flujo reportada de PFTS fue de 4.3% (95% CI, 0.9%-8.0%). La prevalencia dentro del flujo fue variable (1% a 20%), con casos reportados en cinco provincias y 11 estados.

Implicaciones: Este reporte provee la primera estimación de la media de la prevalencia e impacto de PFTS en Canadá y Estados Unidos. Es razonable esperar que esta prevalencia estimada cambie mientras continuamos entendiendo este síndrome. La documentación de video, incluyendo la demostración de los signos clínicos asociados con el PFTS, fue un método efectivo para despertar la conciencia de este síndrome.

TLOS, JCSH: Department of Large Animal Clinical Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

TLOS, RF: Department of Population Medicine, University of Guelph, Guelph, Ontario, Canada.

SH: Abilene Animal Hospital, Abilene, Kansas.

DM, KS: Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University, Ames, Iowa.

Corresponding author: Dr Terri O'Sullivan, Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1, Canada; Tel: 519-824-4120 ext 54079; Fax: 519-763-3117; E-mail: tosulliv@uoguelph.ca.

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

O'Sullivan TL, Harding JCS, Friendship R, et al. Estimated prevalence and impact of periweaning failure to thrive syndrome in Canada and the United States. *J Swine Health Prod.* 2014;22(1):24–28.

Résumé - Prévalence estimée et impact du syndrome d'échec de croissance en période péri-sevrage au Canada et aux États-Unis

Objectifs: Estimer la prévalence du syndrome d'échec de croissance en période péri-sevrage (PFTS) chez les porcelets en pouponnière canadiens et américains, estimer le pourcentage de porcelets affectés par le PFTS à l'intérieur d'une pouponnière affectée, et classifier les signes cliniques communs associés au PFTS observés par les vétérinaires sur des fermes commerciales.

Matériels et méthodes: Un questionnaire a été élaboré, bêta testé, et par la suite rendu disponible via les sites Web de l'American Association of Swine Veterinarians (AASV) et de l'Université de Guelph. Les praticiens porcins dans les principales régions de production porcine du Canada et des États-Unis ont complété ce questionnaire afin d'estimer la prévalence et l'impact du PFTS dans le flot des pouponnières. Afin d'attirer l'attention et d'aider à être constant dans la reconnaissance et à rapporter ce syndrome, un vidéo a été produit et accompagnait le questionnaire. Des présentations orales, par affiches scientifiques et par vidéo ont également faites lors des principales rencontres de praticiens porcins à travers le Canada et les États-Unis dans le but de faire connaître ce syndrome et le questionnaire.

Résultats: Cinquante-cinq questionnaires ont été complétés, les répondants offrant leurs services auprès de 1974 flots de pouponnières. La prévalence moyenne rapportée de PFTS était de 4,3% (IC 95%, 0,9%-8,0%). La prévalence intra-flot a été rapportée comme étant variable (1% à 20%), avec des cas rapportés dans cinq provinces et 11 états.

Implications: Cet article fourni le premier estimé de la prévalence moyenne et de l'impact de PFTS au Canada et aux États-Unis. Il est raisonnable de s'attendre à ce que cette prévalence estimée change à mesure que nous apprenions à mieux connaître ce syndrome. La documentation vidéo, incluant une démonstration des signes cliniques associés au PFTS, était une méthode efficace de faire connaître ce syndrome.

Periweaning failure to thrive syndrome (PFTS) is a clinical condition in which weaned pigs develop anorexia and lose body condition, progressing to debilitation. Additionally, a subset of affected piglets often demonstrate oral behavioral changes resembling a continuous sham chewing motion, with most clinical signs apparent as early as 7 days post weaning.[1] The syndrome has generated interest among swine veterinarians and researchers over the past few years due to an increasing number of cases being unofficially and officially reported in Canada, Spain, and the United States from 2008 to 2012.[2-5]

Research conducted to date has been unable to elucidate definitive risk factors, etiologic agent(s), or the pathogenesis associated with the syndrome.[6] It has been suggested that inconsistent clinical recognition and inaccurate recording of cause of mortality by swine veterinarians and producers may have contributed to the lack of understanding of the syndrome.[7] In 2011, a clinical case definition was published to aid in case recognition and was based on information gained from research conducted on confirmed cases of PFTS through exhaustive exclusion of common porcine infectious agents and obtainment of a thorough herd history.[1] The case definition of PFTS used for this project was the currently published definition and is as follows:

> "PFTS is characterized clinically by the progressive debilitation of weanling (nursery) pigs in the absence of discernible and detrimental infectious, nutritional, managemental, or environmental factors that can explain the clinical syndrome. At weaning, affected pigs are of average to above average body weight, and neither affected pigs nor their cohorts show evidence of residual illnesses from the suckling phase. Within 7 days of weaning, affected pigs are anorexic and lethargic. They deteriorate and within 2 to 3 weeks of weaning demonstrate marked muscle weakness and loss of body condition. Some affected pigs in all affected farms show repetitive oral behaviour such as licking, chewing, or chomping. In affected farms, morbidity and mortality by batch varies over time, but case fatality is high."[1]

Some believe this case definition simply describes "starve out" or "fall back" pigs that have been observed in low frequency in most hog operations for decades. The authors do not necessarily disagree with this. However, when mortality reaches 10% to 20% in some batches without underlying management changes or presence of infectious pathogens, the authors hypothesize that unknown risk factors are associated with the elevated mortality, beyond what is related to a sporadic "starve-out" problem in these affected herds.

The prevalence and the proportionate mortality related to PFTS remain unknown and represent crucial epidemiological information required in order to assess the economic impact of the clinical syndrome and guide future research objectives. The objectives of this study were to estimate the prevalence of PFTS in Canadian and American nursery-pig flows, to estimate the percentage of PFTS-affected pigs within an affected nursery flow, and to determine the common clinical signs associated with PFTS cases observed by practitioners on commercial farms.

Materials and methods

This project was reviewed and approved by the Animal Research Ethics Board of the University of Saskatchewan.

Instructional video and awareness campaign

The initial phase of this project involved development of an instructional video for wide dissemination to swine veterinarians and producers in Canada and the United States. The video was a short narrated production that demonstrated pigs naturally affected with PFTS in all stages of the syndrome (as described in the above case definition) and also identified humane endpoints. The video was made available online via two different Uniform Resource Locators (URLs). One URL was accessible by members of the American Association of Swine Veterinarians (AASV) via the association home page. A second URL, made available at the University of Guelph, was password protected and available to any person requesting access.

A PFTS awareness campaign launched in September 2011 consisted of oral, scientific-poster, and video presentations. The presentations were made at major swine-practitioner and producer meetings in Canada and the United States, including the Allen D. Leman Swine Conference, Swine Disease Conference for Swine Practitioners (Iowa State University), Canadian Swine Health Board Forum, Western Canadian Association of Swine Veterinarians Conference, and the Ontario Association of Swine Veterinarians Fall Conference. The goal of showing the video as part of the PFTS awareness campaign was to assist with standardization of PFTS case identification and to familiarize practitioners with the presentation of PFTS that is currently being reported.

Questionnaire design and distribution

A questionnaire was developed and distributed in a three-stage process, including design of questions, beta testing of questionnaire, and distribution to swine veterinarians in major swine-producing regions of Canada and the United States. The participants were asked to view the instructional video to become familiar with the syndrome and standardize the case definition prior to completing the questionnaire. The questionnaire asked for the number of nursery flows the respondent attended as the primary person providing veterinary services on a regular basis, as well as the number of PFTS-affected flows (based on video description) within the nursery flows serviced. "Regular basis" was defined as two to three visits per year, in order to minimize the number of repeat reports on the same flow. For the purpose of this study, a nursery flow was defined as consecutive groups of pigs sourced from a single sow operation that supplied one or more nurseries, or consecutive groups of pigs sourced from multiple sow operations that supplied one or more nurseries. Flow prevalence was calculated by dividing the total number of PFTS-affected flows reported by the respondents by the total number of flows serviced by the respondents. Veterinarians were also asked to report on the percentage of PFTS characteristic clinical signs (similar to those demonstrated in the video) observed within affected flows and to estimate the percentage of PFTS-affected pigs within flows. Information was obtained regarding the type of veterinary practice (mixed-animal practice, swine specialty, swine corporate, industry, government, or academia), PFTS case location (state or province), practice location (state or province), year of graduation, and number of nursery pigs attended in the past 6 months. Respondents were also asked to report on their confidence in recalling herd information and PFTS case information.

Prior to wide dissemination of the questionnaire, a beta test was conducted, and the questionnaire was edited according to responses and the suggestions received. The URL for the questionnaire was sent to members of the AASV via the association's electronic membership list. Biweekly, September 1 to December 31, 2011, electronically generated reminders were sent to AASV members. The questionnaire was translated into French for distribution to swine veterinarians in the province of Quebec. In addition to online notification of the survey, veterinarians had the opportunity to complete a printed copy of the questionnaire at any of the conferences in which oral presentations were made during the awareness campaign or upon request from the project coordinator.

Statistical analysis

Survey results were tabulated and analysed in Stata (Stata Statistical Software, Release 11; StataCorp LP, College Station, Texas) using frequencies and the binomial exact test.

Results

A total of 55 questionnaire responses were submitted and tabulated. The 55 survey respondents provided veterinary services for 1974 nursery-pig flows in six Canadian provinces and 11 American states (Table 1). The mean flow prevalence of PFTS observed within the reported nursery flows was 4.3% (95% CI, 0.9%-8.0%). Two online respondents were from countries outside of North America, and this information was excluded from the study, as we were primarily interested in Canadian and American herds. Over 89.0% (95% CI, 77.8%-95.9%) of the respondents indicated that they were in some form of clinical swine practice and attended nursery pigs as the principal herd veterinarian. Year of graduation from veterinary school ranged from 1967 to 2009, and 92.7% (95% CI, 82.4%-98.0%) of the respondents indicated that > 50% of their practice time was devoted to swine. Thirty-two percent (95% CI, 20.6%-46.7%) of respondents indicated that they provided exact numbers for nursery-pig flows attended, and 45.5% (95% CI, 32.0%-59.4%) reported that they provided an estimate of the flow numbers, but they were > 50% confident in the accuracy of their estimate. Twenty-five veterinarians (45.5%) reported observing PFTS-affected pigs within the previous 6 months. Sixty percent (95% CI, 45.9%-73.0%) of respondents indicated that they were able to provide exact numbers of PFTS cases reported, and 25.5% (95% CI, 14.7%-39.0%) reported they provided estimates but were > 50% confident in the accuracy of their numbers. Approximately half of the respondents that reported on PFTS-affected flows stated that the proportion of PFTS-affected pigs within an affected flow was between 1% and 3%. Forty-four percent of respondents that reported on PFTS-affected flows reported higher mortality of 4% to 10% within affected flows (Table 2). The four most commonly reported clinical signs, on an affected-flow basis, were anorexia, loss of body condition, prolonged standing, and the oral behaviour of repetitive chomping and licking (Table 3).

In response to questions regarding respondents' awareness of PFTS prior to viewing the video or attending an awareness campaign presentation (taking into consideration all the swine veterinary-practice-type categories, not just respondents who reported seeing PFTS-affected flows), 3.6% (95% CI, 0.4%-12.5%) indicated they were completely unfamiliar with the syndrome, 18.0% (95% CI, 9.0%-30.9%) were aware of the syndrome but could not previously describe clinical signs, 20.0% (95% CI, 10.4%-33.0%) were aware of the syndrome but had not seen the syndrome or clinical signs, 32.7 % (95% CI, 20.7%-46.7%) were aware of the syndrome and may have seen an unconfirmed case, and 25.5% (95% CI, 14.7%-39.0%) were aware of the syndrome and had worked on a case of PFTS.

Discussion

Results of this survey and awareness campaign have provided the first and presently only crude estimate of the mean flow-prevalence of PFTS reported in Canadian and American nurseries. These estimates are not meant to be representative of all nursery flows in North America, as the response rate for this survey was low and based on a convenience sampling of veterinarians. A formal response rate could not be calculated because the questionnaire and video were distributed widely online, which resulted in an unknown number of distributed questionnaires (denominator). The secondary objective of the project was to raise awareness of the syndrome, and so wide distribution was felt to be important instead of limiting the survey to a smaller random sample. Having only 55 respondents complete the survey could be extrapolated to suggest an overall lack of concern or interest in the syndrome, and should be considered a source of response bias. In 2011, the AASV membership was 1266, with 48% of the membership recorded as being active in private practice (Dr Sue Schulteis, e-mail communication, July 2013). If these numbers were to be taken into consideration for calculating a response rate from practitioners,

Table 1: Geographic locations where 55 questionnaire respondents* attended nursery pigs and reported observing PFTS-affected nursery flows†

Location	PFTS reported‡
Canada	
Alberta	Yes
Manitoba	Yes
Ontario	Yes
Prince Edward Island	No
Quebec	Yes
Saskatchewan	Yes
United States	
Illinois	Yes
Iowa	Yes
Kansas	Yes
Minnesota	Yes
Missouri	Yes
Nebraska	Yes
North Carolina	Yes
Oklahoma	Yes
South Dakota	Yes
Texas	Yes
Virginia	Yes

* Based on responses from a questionnaire distributed to members of the American Association of Swine Veterinarians via the member electronic mailing list, September to December 2011. Printed copies of the questionnaire also were available during the same time period at swine-practitioner meetings or from the project coordinator.

† Clinical signs demonstrated in an information video accompanying the questionnaire for standardization of case definition. Nursery flow = consecutive groups of pigs sourced from a single sow operation supplying one or more nurseries, or consecutive groups of pigs sourced from multiple sow operations supplying one or more nurseries.

‡ PFTS-affected pigs in nursery flow(s) in state or province. Information aggregated to maintain confidentiality.

PFTS = periweaning failure to thrive syndrome.

the estimated questionnaire response rate is indeed low at approximately 9.0%. However, the respondents did provide routine and regular veterinary service for a large number of nursery-pig flows (n = 1974) and the results represent the only industry-wide estimates available to date. While it is unknown exactly how many individual pigs this represents, there is potential for this number to be large, as many of the respondents were from major pig-producing areas of Canada and the United States. It is reasonable to expect that the reported prevalence of the syndrome may change in time as we continue to learn and understand its epidemiology and pathogenesis.

The results of the reports on the most common clinical signs associated with the syndrome should serve as a guide for case selection of animals in future investigations. However, it should be kept in mind that additional on-farm epidemiological studies are necessary to further understand the risk factors at the pig level, flow level, and management level that may or may not contribute to the expression of PFTS. Moreover, discovering causative agents, either infective or non-infective, will greatly enhance our understanding of the clinical expression and impact of PFTS on commercial farms.

While awareness of the syndrome could be measured formally only in the survey respondents, the awareness campaign, including viewing the video, generated discussion and awareness of PFTS among veterinarians at practitioner meetings. The exact number of video viewings could not be determined, as the survey and video URLs were kept anonymous. However, during the campaign, the authors received numerous requests from Australia, Europe, North America, South America, and the United Kingdom to view the video. Subsequent correspondence made it apparent to the authors that PFTS is not unique to Canada and the United States. In addition, many comments received on the questionnaires and verbally during the awareness campaign also expressed appreciation for development of a video demonstrating the clinical signs and the humane endpoints associated with the syndrome. Continued awareness, accurate reporting, due diligence, and collaboration among swine veterinarians are crucial to the successful progression of our understanding and ultimate ability to manage or control PFTS. Consistency in recognizing and reporting PFTS will ultimately enable global comparisons.

Implications

- This report provides the first estimate of the mean nursery-flow prevalence of PFTS (4.3%; 95% CI, 0.9%-8.0%) in Canada and the United States.
- The results of this survey and awareness campaign indicate that PFTS cases have been reported broadly across pig-producing regions of Canada and the United States.
- In the context of this survey, the four most commonly reported clinical signs of PFTS are anorexia, loss of body condition, prolonged standing, and repetitive chomping and licking.
- Video is an effective method to raise awareness and develop consistency in the use of the case definition of PFTS.
- It is reasonable to expect the reported prevalence of PFTS to change as we continue to understand the epidemiology, case definition, and pathogenesis of the syndrome.

Acknowledgements

This project was supported financially by Agriculture and Agri-Food Canada through the Canadian Swine Health Board. The authors would like to thank the American Association of Swine Veterinarians for their assistance with dissemination of the

Table 2: Mean percentage of 25 questionnaire respondents reporting* on the estimated proportion of PFTS-affected piglets in PFTS-affected flows

	Respondents reporting in each category	
Questionnaire categories to estimate % PFTS-affected pigs	**%**	**95% CI†**
1-3 (low)	52.0	31.3-72.2
4-10 (low to moderate)	44.0	24.4-65.1
11-25 (moderate)	4.0	0.10-20.0
26-50 (high)	0.0	NA
> 50 (very high)	0.0	NA

* Questionnaire and distribution described in Table 1. Clinical signs of PFTS were demonstrated in an information video that accompanied the questionnaire for standardization of case definition. Nursery flow defined in Table 1.

† Binomial exact.

PFTS = periweaning failure to thrive syndrome; CI = confidence interval; NA = not applicable.

Table 3: Percentage of 25 questionnaire respondents* reporting clinical signs demonstrated by PFTS-affected nursery pigs in PFTS-affected flows

	Respondents reporting observation of specific clinical signs	
Observed clinical sign	**%**	**95% CI†**
Anorexia	100	86.3-100
Loss of body condition	88.0	68.8-97.5
Prolonged standing	84.0	63.9-95.5
Chomping or licking	76.0	54.9-90.6
Dazed demeanour	72.0	50.6-87.9
Diarrhea	68.0	46.5-85.1
Excessive investigative behavior	56.0	34.9-75.6
Sneezing	52.0	31.3-72.2
Dyspnea	45.8	25.5-67.2
Cough	40.0	22.1-61.3

* Questionnaire and distribution described in Table 1. Clinical signs were demonstrated in an information video that accompanied the questionnaire for standardization of case definition. Nursery flow defined in Table 1.

† Binomial exact.

PFTS = periweaning failure to thrive syndrome; CI = confidence interval.

survey and video. A special note of thanks is extended to the survey beta testers and participants for taking the time to complete the questionnaire.

Conflict of interest

None reported.

References

1. Huang Y, Henry S, Friendship R, Schwartz K, Harding J. Clinical presentation, case definition, and diagnostic guidelines for porcine periweaning failure to thrive syndrome. *J Swine Health Prod*. 2011;19:340–344.

*2. Gauvreau H, Harding J. Why are these nursery pigs dying? *Proc Western Can Assoc Swine Vet Conf*. Saskatoon, Saskatchewan. 2008:47–53.

*3. Dufresne L, Fangman TJ, Henry S. Post-weaning catabolic syndrome: complexities and perspectives. *Proc Allen D. Leman Swine Conf*. St Paul, Minnesota. 2008:79–85.

4. Moeser AJ, Borst LB, Overman BL, Pittman JS. Defects in small intestinal epithelial barrier function and morphology associated with PFTS in swine. *Res Vet Sci*. 2012;93:975–982.

5. Segalés J, Martinez J, Vidal E, Kekarainen T, Bragulat J, Quintilla C, Finestra A. Periweaning failure to thrive in pigs in Spain. *Vet Rec.* 2012;170:499.

6. Huang Y, Gauvreau H, Harding J. Diagnostic investigation of porcine PFTS: lack of compelling evidence linking common porcine pathogens. *J Vet Diagn Invest*. 2012;24:96–106.

*7. Friendship R, Harding J, Henry S. Periweaning failure to thrive syndrome – difficulties investigating an emerging clinical problem. *Proc Allen D. Leman Swine Conf*. St Paul, Minnesota. 2010:73–78.

*Non-refereed references.

Peer reviewed

Brief communication

Use of equine-origin antitoxins in piglets prior to exposure to mitigate the effects of *Clostridium difficile* infection – a pilot study

Alejandro Ramirez, DVM, MPH, PhD, Diplomate ACVPM; Eric W. Rowe, DVM, PhD; Paulo H. Arruda, DVM, MS; Darin M. Madson, DVM, PhD, Diplomate ACVP

Summary

Administration to newborn pigs of an oral or intraperitoneal dose of equine-origin *Clostridium difficile* antitoxin 4 hours before orogastric inoculation with a swine-origin *C difficile* field isolate resulted in lower histopathology scores 72 hours post challenge than in pigs receiving no antitoxin ($P < .05$).

Keywords: swine, *Clostridium difficile*, *Clostridium difficile*-associated disease, antitoxin, prevention

Received: April 11, 2013
Accepted: May 15, 2013

Resumen - Uso de antitoxinas de origen equino en lechones antes de la exposición para mitigar los efectos de la infección de *Clostridium difficile* – un estudio piloto

La administración a cerdos recién nacidos de una dosis intraperitoneal u oral de la antitoxina *Clostridium difficile* de origen equino 4 horas antes de la inoculación orogástrica con un aislado de campo de *C difficile* de origen porcino resultó en índices histopatológicos más bajos 72 horas después del reto que en cerdos que no recibieron la antitoxina ($P < .05$).

Résumé - Utilisation d'antitoxine d'origine équine chez des porcelets avant l'exposition afin de limiter les effets d'une infection par *Clostridium difficile* – une étude pilote

L'administration orale ou intra-péritonéale à des porcelets nouveau-nés d'une dose d'antitoxine contre *Clostridium difficile* d'origine équine 4 heures avant l'inoculation oro-gastrique d'un isolat de *C difficile* d'origine porcine a résulté en une diminution des pointages des lésions histopathologiques 72 heures post-inoculation comparativement à des porcelets ne recevant aucune antitoxine ($P < .05$).

In the last 10 years, *Clostridium difficile* has been implicated as a major cause of neonatal diarrhea in pigs.[1] *Clostridium difficile* infection (CDI) typically affects piglets ranging in age from 1 to 7 days. Clinical signs of CDI include diarrhea, abdominal distention, and scrotal edema, with most of the pathology being attributed to toxins A and B.[2] The prevalence of *C difficile* is widespread in the United States and has been referred to as the most important uncontrolled cause of neonatal diarrhea in the pig.[1] This is supported by many studies indicating a prevalence rate of about 50% and the fact that *C difficile* may affect litter productivity by as much as 10% to 15%.[1,3,4]

In human medicine, intravenous administration of immunoglobulins for treatment of CDI has variable results.[5-8] This variability may be due to differences in timing of antibody administration and toxin exposure.[7] In a mouse model, McPherson et al[5] reported that intravenous administration of immunoglobulins is most effective when performed at the same time as toxin infusion. The use of prophylactic antibiotics has been unsatisfactory and unrewarding for swine producers.

The objective of this pilot study was to investigate if administration of an equine-origin antitoxin would serve as a beneficial intervention in minimizing the clinical and histologic effects in neonatal pigs infected with *C difficile*.

AR, PHA, DMM: Department of Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

EWR: Department of Biomedical Science, College of Veterinary Medicine, Iowa State University, Ames, Iowa.

Corresponding author: Dr Alejandro Ramirez, Department of Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, 2231 Lloyd Veterinary Medical Center, Ames, IA 50011; Tel: 515-294-7463; Fax: 515-294-1072: E-mail: ramireza@iastate.edu.

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

Ramirez A, Rowe EW, Arruda PH, et al. Use of equine-origin antitoxins in piglets prior to exposure to mitigate the effects of *Clostridium difficile* infection – a pilot study. *J Swine Health Prod.* 2014;22(1):29–32.

Materials and methods

The experimental protocol was approved by the Iowa State University (ISU) Institutional Animal Care and Use Committee.

Animals and housing

Thirty-six newborn piglets were obtained from a commercial farrowing unit. Parturition was monitored on-farm and all piglets were farrowed onto a sterile drape or manually removed to prevent contact with the environment, as described by Lizer et al.[9] The piglets were immediately dried and placed in clean plastic totes under heat lamps. Colostrum was collected from farrowing sows and mixed to create a single pooled colostrum stock. All piglets were orogastrically intubated and fed 10 mL of pooled colostrum, followed by 15 mL of milk replacer (Esbilac liquid puppy formula; Pet-Ag, Hampshire, Illinois), tagged, and transported back to ISU within 4 hours of birth. Pigs were randomly assigned to six groups (Table 1) using a random number generator (Excel; Microsoft, Redmond, Washington). Inoculated pigs (Groups D, E, and F) were housed in one room while non-inoculated pigs (Groups A, B, and C) were in a separate room to prevent cross-contamination. All pigs were

Table 1: Experimental design for conventional newborn pigs receiving saline or an oral or intraperitoneal dose of equine-origin *Clostridium difficile* antitoxin and inoculated 4 hours later with sham inoculum (non-infected) or *C difficile* spores (infected)

Treatment group	Analysis group*	No. of pigs	Treatment†	Inoculation‡
A	NI	4	Saline	Sham
B	NI	4	Oral antibodies	Sham
C	NI	4	IP antibodies	Sham
D	IA	8	Oral antibodies	*C difficile*
E	IA	8	IP antibodies	*C difficile*
F	I	8	Saline	*C difficile*

* For purposes of statistical analysis, treatment groups were further categorized as NI (non-infected), IA (infected and received antibodies), or I (infected but received no antibodies).

† Treatments: either oral saline (control) or equine plasma from horses hyperimmunized against *C difficile* toxins A and B (Mg Biologics, Ames, Iowa) administered either orally or intraperitoneally (IP).

‡ Pigs were inoculated orogastrically either with sham inoculum (phosphate buffered saline; NI) or with 2×10^9 *C difficile* spores 4 hours after receiving treatment of either saline (I), or oral or IP antibodies (IA).

individually housed in raised plastic decks partitioned into individual pens (approximately 0.7 × 0.7 m) with solid dividing walls and individual feeding bowls as described by Lizer et al.[9] Pigs were fed milk replacer three times daily for the duration of the experiment (72 hours).

Study design

Pigs in groups B, C, D, and E (Table 1) received an oral or intraperitoneal (IP) dose of equine-origin *Clostridium difficile* antitoxin, and pigs in groups A and F received a saline placebo. Toxin-neutralizing antitoxin was administered at the same time as pooled colostrum. Serum samples from all pigs were tested for circulating toxin-neutralizing antibodies prior to administration of colostrum and antitoxin, and 24 hours post administration.

Inoculum

Inoculum preparation was performed as described by Lizer et al.[9] Briefly, pure pellets of *C difficile* (ISU isolate 13912–1) with a concentration of 2×10^9 spores per mL were used as the inoculum. This isolate is a 2008 field isolate from a 2-day-old scouring pig from northern Missouri that was submitted to ISU Veterinary Diagnostic Laboratory. Immediately prior to challenge, spores were heat shocked in a water bath at 80°C for 10 minutes. Brain heart infusion broth with 0.1% taurocholic acid and 5% fetal bovine serum was added to the heated spore suspension at a concentration of 25% volume per volume (v/v) and incubated 1 hour at 37°C. Sterile phosphate buffered saline was used in the place of spores for controls (sham inoculum). A 1.25-mL inoculum dose or phosphate buffered saline was administered via a sterile gastric tube and flushed with 20 mL milk replacer. Pigs were inoculated 4 hours post administration of colostrum and antitoxin or saline.

Antitoxin

Equine plasma from horses hyperimmunized against *C difficile* toxins A and B was obtained from Mg Biologics (Ames, Iowa). The hyperimmune equine plasma that was administered to the pigs had titers of 1:800 and 1:1600 for toxins A and B, respectively. Titers were determined by cell neutralization assay as described below.

Antibodies

Toxin-neutralizing antibodies were assessed in cell culture using Chinese hamster ovary cells according to the protocol established by Post et al.[10] Briefly, Chinese hamster ovary cells are exposed to dilutions of serum and known concentrations of toxins A and B. Toxin and serum are incubated for 1 hour at 37°C prior to cell exposure. Twenty-four hours later, the cells are assessed for cytopathic effect. The last dilution where no cytopathic effect is observed is reported as the antitoxin titer. The pooled colostrum sample was also tested for antibodies to toxins A and B.

Necropsy and histopathology

All pigs were euthanized by an intravenous overdose of pentobarbital at 72 hours post inoculation. At necropsy, weight, body condition (0 = normal, 1 = thin, 2 = emaciated), stomach fill (0 = empty, 1 = half full, 2 = full), consistency of large intestinal contents (0 = firm, 1 = normal, 2 = pudding-like, 3 = watery) were assessed with their respective scales, while dehydration, fecal staining of the perineum (used as a proxy for diarrhea), visible colonic necrosis and fibrin, and mesocolonic edema were assessed using a scale from 0 to 3 (0 = none, 1 = mild, 2 = moderate, 3 = severe) in a blinded fashion as previously described.[4,9]

Formalin-fixed tissues collected for histopathology included ileum, jejunum, descending colon, cecum, and a cross section through the spiral colon containing four to five loops. Tissues were evaluated for goblet cells, quantity of neutrophils in the lamina propria, mucosal alterations (ulcers and erosions), and mesenteritis (Lizer et al).[9]

Bacterial culture and toxin detection

After necropsy, spiral colon contents were cultured directly onto *C difficile* selective agar (CDSA; Remel, Lenexa, Kansas) in addition to routine aerobic and anaerobic plates. Toxin swabs collected from the rectum prior to inoculation and 48 and 72 hours post inoculation were assayed with a commercially available *C. difficile* Tox A/B II ELISA kit (TechLab, Blacksburg, Virginia) and analyzed on a microplate reader to grade the toxin levels on a scale from 0 through 4+ per manufacturer recommendations.

Statistical analysis

In analyzing the data, we combined scores into three general categories: clinical signs, gross lesions, and microscopic lesions. The scoring system for each category was based on that published by Lizer et al.[9] Clinical sign scores were calculated by summing scores for body condition, dehydration, and perineal staining. Gross lesions included the summed scores of necrotizing lesions, mesocolonic edema, toxigenic culture, and toxin. Microscopic lesion scores were the sum of all histopathology changes noted. For statistical analysis, pigs in groups A, B, and C were combined in Group NI (non-infected), pigs in groups D and E were combined in Group IA (infected and received antitoxin), and pigs in Group F were in Group I (infected only), as summarized in Table 1. Statistical differences ($P < .05$) in group outcomes were determined by ANOVA, Tukey's honestly significant difference (HSD) test, and Fisher's exact test using JMP Pro 10 (SAS; Cary, North Carolina) statistical software.

Results

Antibodies for toxins A and B were not detected in the pooled colostrum sample or in the serum sample from any pig prior to administration of hyperimmune equine plasma. Twenty-four hours later, all pigs that had received antitoxin either by IP or oral administration (groups B, C, D, and E) had measurable levels of circulating antitoxin. All but one pig (Group B, titer 1:2) had toxin-neutralizing titers of 1:16 or greater. Pigs that had not received antitoxin had no detectable antibodies to *C difficile* toxins 24 hours post administration of colostrum.

Clostridium difficile was isolated from the colon of all inoculated pigs at necropsy. One pig from Group A and one from Group B were culture-positive for *C difficile* at the end of the study and were excluded from all analyses. Both were from non-infected groups. Additionally, *C difficile* toxin was detected in six of the 16 pigs (37.5%) in group IA and four of the eight pigs (50.0%) in group I.

At the time of colostrum administration, mean body weight was 1.38 kg (SD 0.263). At 72 hours post challenge, the mean weights of the infected pigs (Group D, E, and F; 1.26 kg, SD 0.264) and non-infected pigs (Group A, B, and C; 1.40 kg, SD 0.329) did not differ ($P = .21$). Additionally, at necropsy, mean weights of infected pigs not receiving antitoxin (Group F; 1.21 kg, SD 0.270) and of those that did receive antitoxin (groups D and E; 1.29 kg, SD 0.265) did not differ ($P = .46$).

Results of scoring at necropsy are summarized in Table 2. There were no statistical differences in means among the groups. Two pigs in the I group and two in the IA group had mesocolonic edema. In the I group, both pigs had moderate edema, and in the IA group, one had mild and the other moderate edema. Intestinal content consistency did not differ among pigs regardless of treatment group. Gross intestinal lesions were not observed.

Microscopic lesions were summed to provide a total microscopic lesion score. Mean total scores for NI (2.90, SD 0.526) and IA pigs (3.69, SD 0.561) did not differ ($P = .86$). However, mean total score did differ between animals in Group I (7.88, SD 2.467) and either Group NI ($P = .02$) or Group IA ($P = .04$).

Discussion

Lower total microscopic lesion scores in infected pigs receiving antitoxin either orally or IP suggest a beneficial effect of administration of antitoxin prior to exposure to *C difficile*. Other parameters measured differed numerically in groups treated with antitoxin, but due to small sample sizes and wide variances in the groups they were not statistically significant. Although perineal staining did not differ among groups, it is interesting to note that all pigs from Group I had some degree of staining at necropsy, while five pigs in Group NI and five in Group IA had no staining.

Results of this pilot study also support findings by McPherson et al[5] in that intravenous administration of immunoglobulins can be effective in protecting mice when administered at the time of exposure. This intervention can easily be performed under routine swine production practices, as CDI is often predictable within a particular swine operation. Although our study size was small, there appeared to be no clinical or statistical difference in the parameters measured between pigs treated with immunoglobulins IP or orally. In routine field settings, oral administration would be simpler and less invasive for the pigs, assuming they are treated before gut closure has occurred.

In this study, we used harvested plasma containing immunoglobulins that had been specifically targeted against *C difficile* A and B toxins. Human studies[5-8] utilize immunoglobulins obtained from pooled human blood and containing antibodies to many different antigens. The ability to obtain plasma with high levels of *C difficile* A and B antitoxins maximizes the potential for effectiveness. The plasma used in this study is now available commercially (AbSolution Pg, Mg Biologics) at an approximate cost of US $0.50 per pig.

Our study was not designed to evaluate the effect of inoculation dose on CDI lesions. Prior work[11] has demonstrated that the dose of inoculum does appear to affect the severity of clinical and histopathologic lesions associated with CDI. The inoculum dose used in the present study was very high. The effectiveness of the antitoxin antibodies may even be greater under natural settings, although we did not study this.

Implications

- Lower total microscopic lesion scores in treated piglets in this study suggest beneficial effects from administration of antitoxin prior to exposure to *C difficile* in piglets.
- Under the conditions of this study, in piglets treated before gut closure occurs, oral administration of *C difficile* antitoxin may be more practical than IP administration under routine field settings.

Acknowledgements

This project was funded in part by Mg Biologics. The authors would like to thank Cathy Martens for laboratory assay work and the ISU Veterinary Diagnostic Laboratory Bacteriology section for help with aerobic and anaerobic cultures.

Conflict of interest

None reported.

References

1. Songer JG, Anderson MA. *Clostridium difficile*: an important pathogen of food animals. *Anaerobe*. 2006;12:1–4.

2. Songer J, Post K, Larson D, Jost B, Glock R. Infection of neonatal swine with *Clostridium difficile*. *J Swine Health Prod*. 2000;8:185–189.

3. Songer JG. The emergence of *Clostridium difficile* as a pathogen of food animals. *Anim Health Res Rev*. 2004;5:321–326.

4. Yaeger MJ, Kinyon JM, Songer JG. A prospective, case control study evaluating the association between *Clostridium difficile* toxins in the colon of neonatal swine and gross and microscopic lesions. *J Vet Diagn Invest*. 2007;19:52–59.

Table 2: Summary data from mean (± SE) necropsy scores for body condition, dehydration, perineal staining, and stomach fill for conventional newborn pigs in a *Clostridium difficile* antitoxin study*

	NI n = 10†	IA n = 16	I n = 8	*P*‡
Body condition	0.7 ± 0.21	0.8 ± 0.19	1.1 ± 0.23	.40
Dehydration	1.0 ± 0.33	1.1 ± 0.22	1.4 ± 0.26	.68
Perineal staining	0.8 ± 0.29	1.0 ± 0.24	1.4 ± 0.18	.38
Stomach fill	1.3 ± 0.26	1.3 ± 0.18	1.8 ± 0.16	.30

* Study design described in Table 1. All animals were euthanized 72 hours post inoculation. Scoring system: body condition, 0 = normal, 1 = thin, 2 = emaciated; dehydration and perineal staining, 0 = none, 1 = mild, 2 = moderate, 3 = severe; stomach fill, 0 = empty, 1 = half full, 2 = full as described by Yaeger et al.[4]

† Two of the original 12 NI pigs were culture-positive for *C difficile* and were excluded from analysis.

‡ Groups compared using analysis of variance with $P < .05$ considered statistically significant.

SE = standard error; NI = non-infected; IA = infected and treated with equine-origin antibodies to *C difficile*; I = infected only (no antibodies).

5. McPherson S, Rees CJ, Ellis R, Soo S, Panter SJ. Intravenous immunoglobulin for the treatment of severe, refractory, and recurrent *Clostridium difficile* diarrhea. *Dis Colon Rectum*. 2006;49:640–645.

6. Juang P, Skledar SJ, Zgheib NK, Paterson DL, Vergis EN, Shannon WD, Ansani NT, Branch RA. Clinical outcomes of intravenous immune globulin in severe *Clostridium difficile*-associated diarrhea. *Am J Infect Control*. 2007;35:131–137.

7. Bobo LD, Dubberke ER, Kollef M. *Clostridium difficile* in the ICU: the struggle continues. *Chest*. 2011;140:1643–1653.

8. Saito T, Kimura S, Tateda K, Mori N, Hosono N, Hayakawa K, Akasaka Y, Ishii T, Sumiyama Y, Kusachi S, Nagao J, Yamaguchi K. Evidence of intravenous immunoglobulin as a critical supportive therapy against *Clostridium difficile* toxin-mediated lethality in mice. *J Antimicrob Chemother*. 2011;66:1096–1099.

9. Lizer JT, Madson DM, Schwartz KJ, Harris H, Bosworth BT, Kinyon JM, Ramirez A. Experimental infection of conventional neonatal pigs with *Clostridium difficile:* A new model. *J Swine Health Prod*. 2013;21:22–29.

10. Post KW, Jost BH, Songer JG. Evaluation of a test for *Clostridium difficile* toxins A and B for the diagnosis of neonatal swine enteritis. *J Vet Diagn Invest*. 2002;14:258–259.

11. Arruda PHE, Madson DM, Ramirez A, Rowe E, Lizer J, Songer JG. Effect of age, dose and antibiotic therapy on the development of *Clostridium difficile* infection in neonatal piglets. *Anaerobe*. 2013;22:104–110.

Checkoff ready to help producers, as sow packers to require premises ID tags in 2015

In an effort to improve pre-harvest traceability and improve national disease surveillance in the pork industry, many major US packers and processors will require a United States Department of Agriculture (USDA)-approved, official premises identification number (PIN) tag as a condition of sale for breeding stock beginning January 1, 2015.

"This is a positive step for our industry as we continue to create a more robust surveillance and traceability system that can help protect our animals, our livelihoods, and our customers," said National Pork Board President, Karen Richter, a producer from Montgomery, Minnesota. "That's why I encourage any producers who may not already be using official PIN tags to register their premises and begin using the tags now."

According to Dr Patrick Webb, Pork Checkoff's director of swine health, the USDA-approved, official PIN tags for breeding swine are customizable with or without a management number and can be purchased in multiple colors.

"This allows producers to use the official tag in any color as a management tag or wait to apply the tag to sows and boars before leaving the production site to enter harvest channels," Webb said.

Allflex USA, Inc (DFW Airport, Texas), Destron Fearing (South St Paul, Minnesota), and Y-Tex Corp (Cody, Wyoming) have USDA approval to manufacture official PIN swine tags. When ordering, producers must provide the nationally standardized PIN for the breeding farm. If the site does not have a PIN, the producer can register for one by going to **www.pork.org/PINtag**.

For more information, contact Patrick Webb at **PWebb@pork.org** or 515-223-3441.

Checkoff consolidates PEDV research information

To make it even easier for producers and others in the pork industry to find information about porcine epidemic diarrhea virus (PEDV), the Pork Checkoff has created a shortcut Web address at **www.pork.org/pedv**. This link directs users to the main page of Checkoff-funded PEDV research reports that are continually updated. Also, the **pork.org** home page quickly directs users to all PEDV Update newsletters or the research and resources pages.

For more information about Checkoff-funded PEDV research, contact Paul Sundberg at **PSundberg@pork.org** or 515-223-2764.

PQA Plus gains PAACO accreditation

As further validation of the Pork Checkoff's PQA Plus program, the Professional Animal Auditor Certification Organization (PAACO) has certified it as meeting their standards of promoting the humane treatment of animals. The organization uses a formal process to review and certify audits that meet board-established minimum standards for a welfare audit.

Sherrie Niekamp, Pork Checkoff's director of animal welfare, said "The PAACO designation is significant because it shows the PQA Plus site assessment and verification have met the standards of a highly credible third party. It reinforces PQA Plus as an effective system for pork producers to maintain a high-quality pork supply."

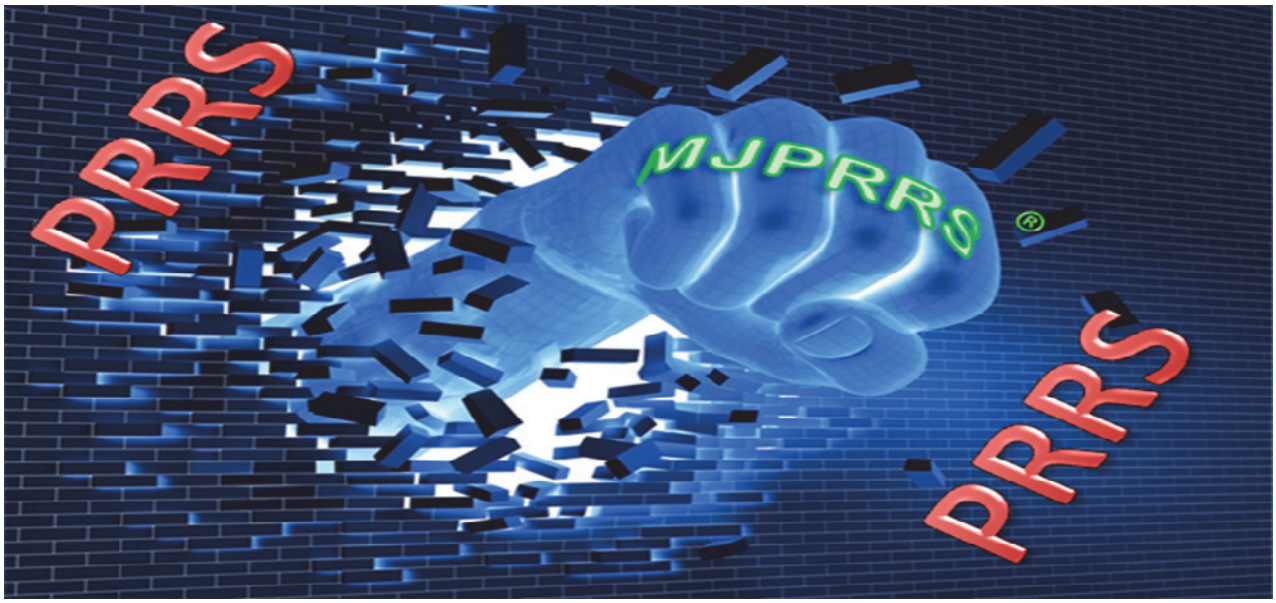
The latest version of PQA Plus also emphasizes the pork industry's "We Care" ethical principles and incorporates components on protecting public health, safeguarding natural resources, and providing a safe work environment.

For more information, contact Sherrie Niekamp at **SNiekamp@pork.org** or 515-223-3533.

NPB news continued on page 35

MJPRRS® VACCINE

Scientific Breakthrough in PRRS Control that Can Successfully Break the PRRS Cycle



After 5 Years of Field Use - MVP's Tailor-Made® MJPRRS® Vaccine Continues to Demonstrate True Performance in the Face of PRRS Outbreaks in All Ages of Pigs.

Contact MVP Laboratories or visit www.mjbio.com to learn more about this innovation in PRRS Vaccinology.

MJ BIOLOGICS
Innovation in animal biologics
www.mjbio.com
Tel: 507-385-0299
Fax: 507-385-0387

* Patent Pending

MVP LABORATORIES
www.mvplabs.com
Tel: 800-856-4648 Fax: 402-331-8776

Proud Sponsor of

Member of the AASV
American Association of Swine Veterinarians
Industry Support Council

NPB news continued from page 33

Checkoff launches PorkSquare to promote pork careers

PorkSquare, presented by the Pork Checkoff, is an interactive, social media-driven Web site (**https://www.porksquare.com**) that focuses on students interested in careers in the pork industry. The Web site is a "one-stop shop" for educational growth and job information regarding the pork industry. PorkSquare is a vehicle to build relationships for young professionals or industry leaders and to prospect internships, scholarships, mentoring programs, and events. Companies with a particular focus on the pork industry can create profiles that students can search and get a better sense of what a certain company has to offer. Building a company profile and adding internships, scholarships, events, and updates keeps potential young candidates in the loop of all the exciting things happening in the business.

For more information, contact Bryn Jensson at **BJensson@pork.org** or 515-223-2752.

Checkoff puts QR codes on pork labels

To meet the growing demand of consumers wanting to know where their food comes from, the Pork Checkoff is offering that information through quick response (QR) codes that link directly to production-related videos.

A mobile Web site was developed with four "We Care"-related videos. Consumers can click through and watch the videos, giving them the opportunity to know where their food is coming from and how dedicated the pork industry is to the quality of meat they share with their families. The videos include topics on swine nutrition, animal welfare, feed additives, and antibiotics. Coupled with a gift-card incentive, the numbers of scans by consumers has surpassed retailers' expectations.

For more information, contact Jarrod Sutton at **JSutton@pork.org** or 515-223-2766.

Environmental Stewards winners exemplify "We care" ethics

The Pork Checkoff recently announced its Environmental Stewards winners for 2013. This year's recipients are Russell Brothers LLC, Monticello, Iowa; Bacon Hill Farm, Dodge, Nebraska; Krikke Pork, Greenwich, Ohio; and Blue Mountain Farms, Milford, Utah.

"The forward-thinking 2013 stewards focus on innovative solutions and ideas on their farms," said Lynn Harrison, chair of the Environmental Stewards Selection Subcommittee and former president of the National Pork Board. "From turning manure into fuel to operate farm vehicles to generating enough power to light up to 3000 homes, the 2013 stewards are putting their own stamp on raising high-quality pork for customers. And like other farms, they are doing it while adhering to the industry's 'We Care' ethical principles."

Applications for the 2014 Environmental Stewards Awards are now being accepted by the National Pork Board. For more information, contact Mike King at **MKing@pork.org** or 515-223-3532.

FLEX

FLEXFAMILY

CUSTOMIZED CONTROL

Because every herd is unique.

FLEXcombo®

- PCV2 and Mycoplasma hyopneumoniae control in a single injection
- ImpranFLEX® adjuvant allows rapid onset of immunity
- Long duration of immunity
- FLEX Family; consistently proven safety and efficacy with over one billion doses administered to pigs

Boehringer Ingelheim

AASV NEWS

New member benefit: *Get it for me* document retrieval service

During its October meeting, the AASV Board of Directors approved an exciting new practitioner benefit. An agreement with the Texas A&M University Medical Sciences Library (MSL) allows AASV members to utilize the MSL's *Get it for me* document retrieval service.

Using the service, AASV members may request literature searches, and the MSL staff will conduct the search using databases appropriate to the topic and available to the library. Search results will be delivered within 2 business days, free of charge. Additionally, members may request copies of journal articles and book chapters available within the library's extensive collection. Requested items will be provided free of charge within 2 business days.

The *Get it for me* service is available to all AASV members except students and those with academic appointments, since they already have access to university library resources. Members must register in order to access the service. To register, follow the step-by-step instructions on page 40 and also available at **http://guides.library.tamu.edu/aasv**.

AASV board approves position statements

The American Association of Swine Veterinarians' Board of Directors held its fall meeting on October 3, 2013, in Des Moines, Iowa. During the meeting, the members approved three position statements crafted by the association's Pig Welfare Committee. The documents highlight the position of the organization on piglet processing activities, including permanent identification, tail docking and teeth clipping, and castration. The statements are available at **http://www.aasv.org/aasv/positions.htm**.

AASV to survey swine-veterinarian compensation

The AASV is conducting its fifth survey of swine-veterinarian income and benefits. Active Members of AASV (non-retired veterinarians) in the United States and Canada are asked to watch for information regarding the 2014 survey in the AASV e-Letter, and to participate using the electronic survey form on the AASV Web site.

Similar surveys have been conducted every 3 years since 2002. Members have found the resulting salary and benefit summary useful when seeking employment or preparing to hire veterinary professionals in the swine industry. The survey results have also been utilized to inform veterinary students about the career opportunities available in swine medicine.

Members of AASV are divided into two survey groups according to their employment type. The *practitioner* survey should be completed by members engaged in private practice, as well as those who oversee pig health for a production or genetics company. Members who work for a university, corporation, or government and are engaged in education, research, technical services, public health, or regulatory work should complete the survey for *public/corporate* veterinarians.

In addition to 2013 income and benefits, the survey requests information about education and training, employment type, and hours worked. Responses are confidential and the results are reported in a manner to assure participant anonymity.

The overall results of the salary and compensation review will be published and distributed for use by AASV members and students. Previous survey results are available for members to access on the AASV Web site under the "Member Center" menu tab.

Who moved my proceedings?

It is often said that the only constant thing is change, and during its 45 years of existence, the AASV has certainly not been a stranger to change. The AASV Board of Directors recently initiated a change to the AASV Annual Meeting when it voted to discontinue printing the conference proceedings in the year 2015. Recognizing that change is often difficult, the board allowed plenty of time for members to prepare for this step toward a paper-free proceedings and to voice their opinions regarding the decision.

The AASV will print and ship the 2014 proceedings book as usual. But beginning with the 2015 annual meeting in Orlando, the proceedings will be provided in electronic format only. This will save at least $22,000 per year in printing and shipping costs (not to mention a few trees). It will also enable the use of color charts and graphs within the proceedings papers.

AASV news continued on page 39

Enroflox™ 100
(enrofloxacin)

Swine Industry Asked For It, Norbrook Delivered

Introducing New Enroflox™ 100 (enrofloxacin) –
The cost-effective alternative to Baytril®100 (enrofloxacin) to stop SRD in its tracks

- FDA-approved, one-dose Swine Respiratory Disease (SRD) treatment
- Same active ingredient and formulation found in Baytril 100
- Approved in pigs of all ages
- For the treatment and control of Swine Respiratory Disease (SRD) associated with *Actinobacillus pleuropneumoniae* (APP), *Pasteurella multocida*, *Haemophilus parasuis* and *Streptococcus suis*

Enroflox™ 100 Injection … *The NEW Choice*
(enrofloxacin)

For use by or on the order of a licensed veterinarian. Federal law prohibits the extra-label use of this drug in food-producing animals. Swine intended for human consumption must not be slaughtered within 5 days of receiving a single-injection dose. Use with caution in animals with known or suspected CNS disorders. Observe label directions and withdrawal times. See product labeling for full product information.

FOR VETERINARY USE ONLY

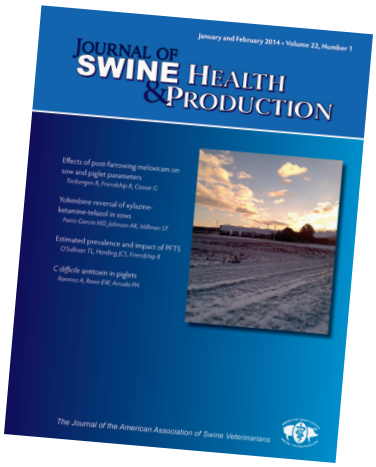
1013-495-I02B

www.norbrookinc.com

Norbrook®

AASV news continued from page 37

Read *JSHAP* on your iPad or Android tablet



Thanks to direction from the AASV Board of Directors and work by AASV Webmaster David Brown, the *Journal of Swine Health and Production* is now being made available as a single PDF file to download for reading on iPad or Android tablets. The download link is available at the top of each issue's online edition page at `https://www.aasv.org/jshap/issues/`, beginning with the November-December 2013 issue. Future *JSHAP* issues will continue to be provided in this format as each issue is published online.

Medical Sciences Library
4462 TAMU
Texas A&M University
College Station, TX 77843-4462
msl.library.tamu.edu
askMSL@library.tamu.edu

Medical Sciences Library

AASV Members
Literature Search and Document Supply Service
Texas A&M University Medical Sciences Library (MSL)

Register for *Get it for me*

- Go to **http://getitforme.library.tamu.edu/MSLLocal//**
- Click on the *MSL Affiliate Login* link.
- Click on the *Register* link.
- Read the registration information page and click on the *First Time Users Register Here* link.
  By clicking through this page you are agreeing to the terms and conditions listed.
- Fill in the *Personal Information*. All fields denoted with * are required.
  Choose *AASV member* as both your Status and Affiliation.
- Click on the *Submit Information* link.

Identify articles and book chapters

MSL Database Search Service for AASV members

- Submit your search request by email to **askMSL@library.tamu.edu** or phone to 979-845-7428.
- MSL will conduct the search for you.
- MSL will send the results, e.g., citations and abstracts, to you via email, generally within a business day.
- Choose the citations for which you want to request the full article or book chapter.

Identify article and book citations yourself

- You may request items you have identified without MSL conducting the search for you.
  These could be recommendations from colleagues, Internet searches, etc…
- If you want to search for yourself, MSL can provide advice about sources to search and search tips.

Request articles and book chapters through *Get it for me*

- Go to **http://getitforme.library.tamu.edu/MSLLocal//**
- Click on the *MSL Affiliate Login* link and logon.
- In the menu on the left, under the *New Request* heading, click the type of item you are requesting, e.g., article or book chapter.
- Complete the request form with as much information as you have.
- Click *Submit Request*.

Receive articles and book chapters through *Get it for me*

- You will receive email notification when each request is available, generally within 24-48 hours.
- Go to **http://getitforme.library.tamu.edu/MSLLocal//**
- Click on the *MSL Affiliate Login* link and logon.
- In the menu on the left, under the View heading, click *Electronically Received Articles*.
- Each request is listed with a link to a .pdf file.
  You may view, download, and/or print each file for 30 days from the day it is posted.

NOTE: MSL can supply copies of articles and book chapters from our onsite collection.
MSL cannot supply entire books nor can we supply from items we do not own.

If you have questions about your search, requests, or account send email to askMSL@library.tamu.edu or telephone 979-845-7428.

Our oath in practice

45th AASV Annual Meeting
March 1-4, 2014
Dallas, Texas

Howard Dunne Lecturer: Dr Daryl Olsen

Alex Hogg Lecturer: Dr Mark Engle

Sheraton Dallas Hotel
400 North Olive Street
Dallas, TX 75021
Tel: 888-627-8191 or 214-922-8000

For more information: https://www.aasv.org/annmtg

Protect your investment.

Elanco Animal Health
2500 Innovation Way
Greenfield, IN 46140

Pulmotil is indicated for the control of swine respiratory disease associated with *A. pleuropneumoniae* and *P. multocida*.

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

Feeds containing tilmicosin must be withdrawn 7 days prior to slaughter.

USSBUPPX00080

Elanco
Pulmotil®™

1-800-428-4441
www.elanco.us

AASV FOUNDATION NEWS

A tall tale as "Big as Texas!"

Do you want to keep the porcine epidemic diarrhea virus from pounding on your **ornate sculpted bronze pig door-knocker?** If so, you can use your trusty **15-inch fixed-blade Bowie knife** to cut all ties with any known risk factors. Once all risk is removed, you can sit back, pull out one of your **hand-turned wine-bottle stoppers** and pour yourself a glass of red while reading your **1925 copy of *Common Diseases of Swine*** harkening back to a simpler time of hog cholera, foot-and-mouth disease, and pseudorabies virus.

As you glance around the room, you suddenly notice your **1760 copper engraving of a wild boar**. Remembering that feral swine may pose a risk of disease spread, you rush to make sure all the fence gates and barn doors are closed. Once back at the office, you stop in the dispensary to count your bottles of **Enroflox 100**. Luckily, all 12 are still there. Confident in your ability to stop a respiratory infection, you decide to consult your ***American Heirloom Pork Cookbook*** to find something for dinner.

Following a fabulous pork loin dinner with all the trimmings, your thoughts shift to the **carved statue of breeding pigs** on your mantle – I'm not sure why you leave that thing on your mantle, maybe you should move it somewhere more "appropriate." Anyway, your spouse notices the "glimmer" in your eye, but rebuffs your advances saying, "There's a **hand-blown glass flying pig's** chance in hell that's going to happen until the dishes are done!" So you give in and join the little missus by the sink. She's already wearing the **hand-crafted cooking apron**, leaving you no choice but to don the **baby-bathing apron**.

Vacation time is coming up and you're struggling to decide whether to take your three friends **pheasant hunting in Iowa, duck hunting in North Dakota**, or maybe **walleye fishing in Minnesota**. Just then you notice the **G Loomis fishing rod with the Pflueger Patriarch spinning reel** sitting over in the corner under the **framed copy of Paul Harvey's "So God Made a Farmer" 1978 FFA speech**. You give the **wooden-barrel piggy bank** a good shake to see how the vacation fund is coming along and pull out your **iPad Mini** to start making travel arrangements to Minnesota.

The AASV Foundation auction will be here before you know it. Being that the 2014 AASV Annual Meeting is in Dallas, the foundation auction committee selected "**Big as Texas!**" as the theme for the fundraising auction. We've received some incredible items (as highlighted in this fanciful tale) so be sure to check them out at **https://www.aasv.org/foundation/2014/auctionlist.php**.

Remember the foundation! And do your part to help the foundation reach its $100,000 goal again this year.

AASV Foundation issues call for research proposals: $60,000 available

As part of its mission to fund research with direct application to the profession, the American Association of Swine Veterinarians Foundation seeks research proposals for funding in 2014. Proposals are due January 31, 2014, and may request a maximum of US $30,000 per project. A maximum of $60,000 will be awarded across two or more projects. The announcement of projects selected for funding will take place at the AASV Foundation Luncheon in Dallas, Texas, on Sunday, March 2, 2014 (awardees may be notified in advance).

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

The instructions for submitting proposals are available on the AASV Foundation Web site at **https://www.aasv.org/foundation/2014/research.php**. Proposals may be submitted by mail or e-mail (preferred).

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

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

For more information, or to submit a proposal, contact AASV Foundation, 830 26th Street, Perry, IA 50220–2328; Tel: 515-465-5255; Fax: 515-465-3832; E-mail: **aasv@aasv.org**.

AASV Foundation Mission Statement

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

- Enhancing the image of the swine veterinary profession,
- Supporting the development and scholarship of students and veterinarians interested in the swine industry,
- Addressing long-range issues of the profession,
- Supporting faculty and promoting excellence in the teaching of swine health and production, and
- Funding research with direct application to the profession.

AASV Foundation news continued on page 45

NEW DRAXXIN 25 TREAT AND CONTROL SRD IN SMALL PIGS

DRAXXIN 25 delivers the proven performance of **DRAXXIN** in a lower concentration for small pigs.

The convenient one-dose treatment is easy to administer and gives you the confidence that your small pigs receive the proper dose for **9** full days of protection.

To learn more about how you can protect your small pigs, speak with your Zoetis representative or visit **www.DRAXXIN.com.**

Important Safety Information

The preslaughter withdrawal time for DRAXXIN in swine is 5 days.
DRAXXIN should not be used in animals known to be hypersensitive to the product.

See Brief Summary of Prescribing Information on the next page.

zoetis™

AASV Foundation news continued from page 43

Swine veterinarians invited to apply for Hogg Scholarship

The American Association of Swine Veterinarians Foundation is pleased to offer the Hogg Scholarship, established to honor the memory of longtime AASV member and swine industry leader Dr Alex Hogg. Applications for the $10,000 scholarship will be accepted until February 1, 2014, and the scholarship recipient will be announced on Sunday, March 2, during the Foundation Luncheon at the AASV 2014 Annual Meeting in Dallas.

The intent of the 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.

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 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 Web site at `http://www.aasv.org/foundation/hoggscholarship.htm`.

Hogg Scholarship application requirements

An applicant for the Hogg Scholarship shall have

1. Five 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 addressed to AASV Foundation, 830 26th Street, Perry, IA 50220–2328, Tel: 515-465-5255; E-mail: `aasv@aasv.org`.

2013 was a busy year for the topic of antimicrobial use

The topic of antimicrobial use in food-producing animals saw a lot of activity in 2013. During the year, the National Institute for Animal Agriculture held its third antimicrobial use symposium in as many years, the Centers for Disease Control and Prevention (CDC) released its treatise on Antibiotic Resistance Threats in the United States, 2013 (**http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf**), and the American Veterinary Medical Association (AVMA) began reviewing its judicious use guidelines. Additionally, the Food and Drug Administration continued to move toward a voluntary withdrawal of medically important antimicrobial growth promotants and the transition of all feed-grade antimicrobials of human importance from over-the-counter to Veterinary Feed Directive status.

To me, the CDC's publication was the most telling. Of the 114-page document, only two pages were devoted to describing the involvement of antimicrobial use in food animals as it relates to resistance in humans. The report outlines four routes by which antimicrobials administered to food animals may harm public health: use of antibiotics in food-producing animals allows antibiotic-resistant bacteria to thrive while susceptible bacteria are suppressed or die; resistant bacteria can be transmitted from food-producing animals to humans through the food supply; resistant bacteria can cause infections in humans; and infections caused by resistant bacteria can result in adverse health consequences for humans.

The first pathway is true any time antibiotics are used. As the CDC notes earlier in the report, "simply using antibiotics creates resistance." That's the nature of the beast. Actually, all four statements are true, but notice the use of the word "can" in the last three. The fact that these things CAN happen doesn't mean that they do happen or that they happen with any frequency, and even if they do happen, it doesn't mean the consequences are of any concern.

"Whether you agree with the law or not, it is the law, and we are ethically, morally, and legally required to abide by it, while working to change it if necessary."

Activist groups state that more antimicrobials are used in livestock than in humans. The higher use in livestock makes sense, given that the drugs are dosed by body weight. As the CDC report noted, "it is difficult to directly compare the amount of drugs used in food animals with the amount used in humans...." The volume of antimicrobial used is irrelevant. The interaction between the drug and the bacteria drives resistance.

The CDC spent the majority of the publication addressing the human use (or misuse) of antimicrobials. The report outlined numerous examples of inappropriate dispensing by human physicians – stating that "up to 50% of all antibiotics prescribed for people are not needed..." and describes the unnecessary dispensing of antimicrobials in physicians' offices as "common." The report clearly highlights the overuse and misuse of antimicrobials in human medicine as the leading cause of hazardous resistance in the human population. There is still no compelling evidence that antimicrobial use in food animals causes any significant increase of antimicrobial resistance in humans resulting in harmful antimicrobial treatment outcomes. As a matter of fact, most risk assessments place the impact of livestock antimicrobial use as negligible relative to human resistance.

While veterinary use of antimicrobials plays a less significant role in resistance in the human population, all uses of antimicrobials contribute to resistance – as correctly stated by the CDC. Therefore, we all need to strive to use antimicrobials judiciously and according to label instructions or in an extra-label manner as outlined in the Animal Medicinal Drug Use Clarification Act. Any use of feed-grade antimicrobials in a manner not described on the product label is illegal – no excuses. Any extra-label use of a prohibited antimicrobial is illegal – no excuses. Even though some of the current regulations regarding extra-label use may seem nonsensical, it is the law, and we are ethically bound to abide by the legal restrictions.

Dr Mike Apley, clinical pharmacologist at Kansas State University, recently drew our attention to a research study published in the *Journal of the American Veterinary Medical Association* (JAVMA). This peer-reviewed study describes the illegal extra-label use of enrofloxacin to treat otitis in dairy calves. Food and Drug Administration regulation prohibits the extra-label use of fluoroquinolones in food animals. The article makes no mention of the legality of the suggested drug use. His concern is that such publications reflect on the attitude of the profession regarding the appropriate and judicious use of antimicrobials even though JAVMA has complete autonomy from the AVMA. His question to food-animal practitioners is "how significant is this 'subculture' that ignores or overlooks the regulations when using antimicrobials?"

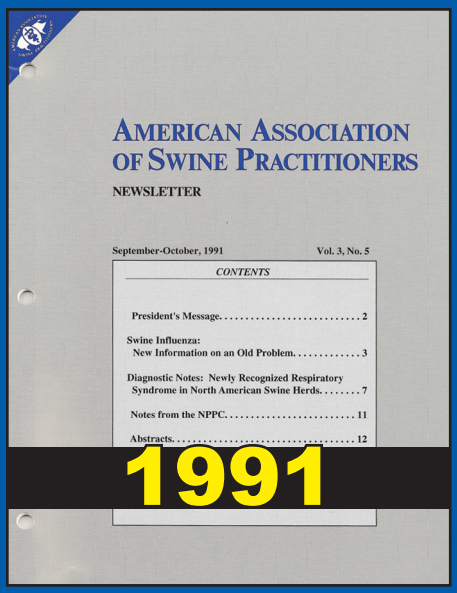
Some respondents justified the extra-label enrofloxacin use as legal, given that the product label is for the treatment of bovine respiratory disease, by making the case that

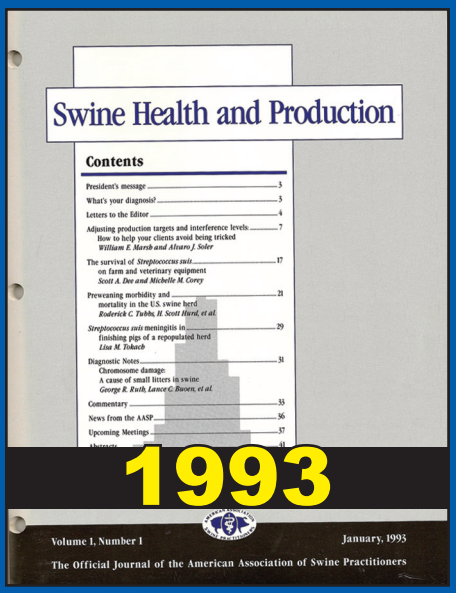
the ear is part of the respiratory tract. While I suppose that may be "technically" correct, I question whether it conforms to the spirit of the law.

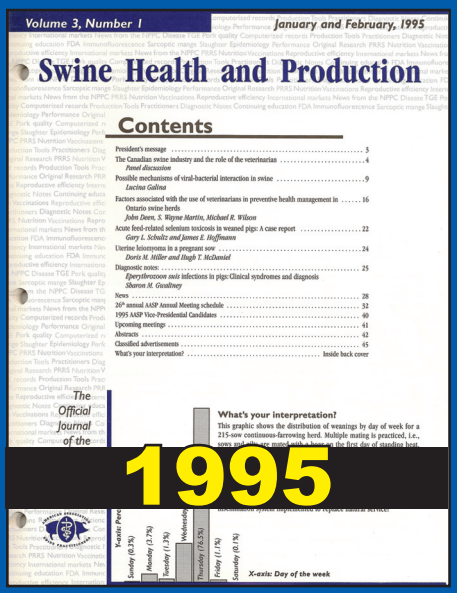
This example and Dr Apley's question should give us all reason to pause and think about what we're doing. Those of us who work with legislators, regulators, manufacturers, and activist groups have to be able to stand up for veterinarians as part of the solution, not the problem. We insist, and I continue to believe, that veterinarians are the best trained professionals to be overseeing the judicious use of antimicrobials for the health and well-being of the animals under our care, as well as the guardians of food safety and public health. The injudicious and illegal activities of a few jeopardize the ability of all of us to access the drugs we need to carry out our responsibilities. Whether you agree with the law or not, it is the law, and we are ethically, morally, and legally required to abide by it, while working to change it if necessary.

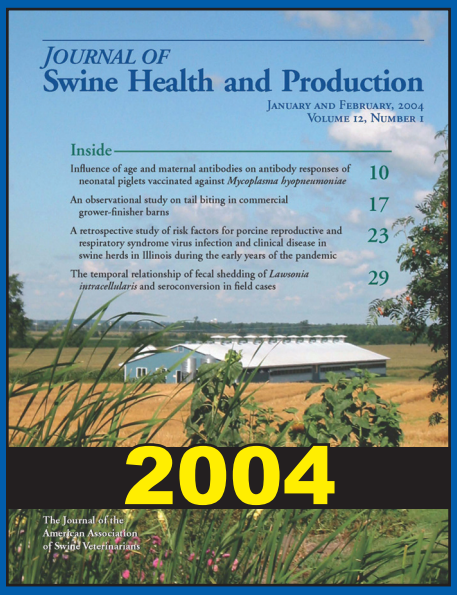
The evolution of the *Journal of Swine Health and Production*

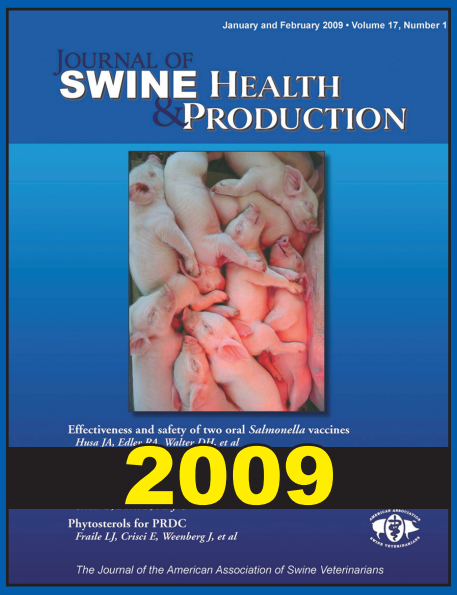
Informing and speaking for swine veterinarians
Striving for excellence through the years

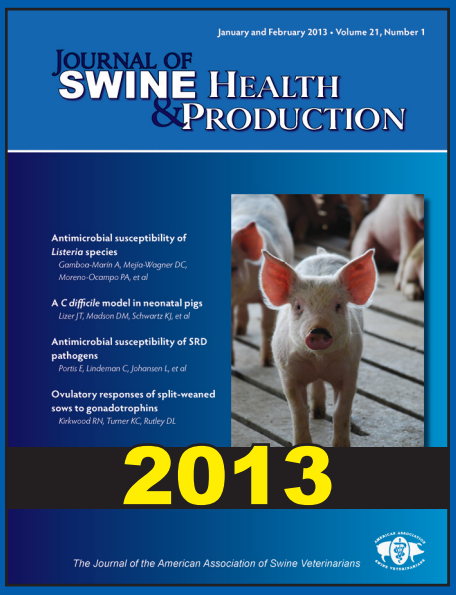












George Charbonneau

I am honored to have been nominated for the position of vice president of the American Association of Swine Veterinarians (AASV). Over the years, I have enjoyed the opportunity to work with AASV staff and members whose contributions to the art and science of veterinary medicine and our profession have been inspiring. The AASV has been a trusted source of continuing education and has provided great networking opportunities.

Growing up in a small rural town, I had opportunities to work in many different areas of agriculture. These jobs ranged anywhere from bee keeping, mixed farming, and beef feed lots to cash crop. I could see early on that the veterinary profession stood out as a career that would provide ongoing challenges and would demand life-long learning. Graduating from the Ontario Veterinary College in 1981, I elected to accept an offer to work in pork-production management. This provided an invaluable opportunity to learn about pork production from the producer's perspective. This single pork producer was also the first herd-health client for my fledgling swine practice. Over time, the practice client base continued to grow. In 1989, I convinced my wife, Ann, to become the practice manager. At the same time, we relocated to Stratford, as our children, Amy and Matt, were ready to start school. Stratford turned out to be a great community for us to raise our family and grow our business.

Stratford is very central to our Ontario pork industry. I have enjoyed serving as president of the Ontario Pork Congress. In 1996, a small group decided to develop a volunteer organization that would include the entire Ontario pork supply chain. I had the honor of serving as the founding chair of the Ontario Pork Industry Council when this organization came to fruition. Both of these organizations focus on creating cooperation amongst the various players in the pork supply chain. They also continue to teach volunteers how to work as part of a team. In addition to these industry organizations, I have had the opportunity to serve as president of the Ontario Association of Swine Veterinarians and the Canadian Association of Swine Veterinarians.

As swine veterinarians, we spend an ever-increasing amount of time dealing with industry issues. The AASV plays a pivotal role in managing these issues and allows us to collectively step up to the plate much more effectively than we could ever do as individuals. These issues present risks to our industry and profession, but they also present great opportunities.

Animal welfare. Consumers will decide outcomes by voting with their pocket books at the meat counter. Activists will continue to apply pressure to retailers in order to achieve their various agendas. Members of AASV are in a great position to focus on doing what is "right" for the animals and communicating this to the industry.

Food safety and antimicrobial resistance. Traceability translates into accountability. We play a central role in communicating the need for antimicrobials in order to relieve animal suffering, while understanding that food safety is critical to maintaining consumer confidence. As a profession, we continue to provide leadership by following the guidelines for prudent drug use.

Industry careers. The AASV continues to reach out to veterinary students and this presents a great opportunity to showcase a career in swine practice. There is equally an opportunity to tell our industry story to students who will not be involved with food-animal practice.

Animal health. Health continues to be the "800-pound gorilla" in the room. Regional disease control and elimination programs provide an excellent training ground for networking and information management. We need to provide industry leadership in the early detection, control, and elimination of emerging diseases. This is especially true of the so called "production-limiting" diseases, where it will be up to industry to take the lead.

George Charbonneau

Continuing education is a core function of AASV. The annual meeting, AASV e-Letter, AASV-L, podcasts, videos, Swine Information Library, *JSHAP*, and other venues provide multiple learning opportunities. The recent Web-based porcine epidemic diarrhea session provided an excellent resource for updating our membership on a real-time basis.

In recent years, I have had the opportunity to serve on several AASV committees. The growing spirit of cooperation in research, issues management, and regional disease control and elimination is a great example of how we are so much more effective as part of a bigger team. The AASV will need to work hard to maintain the trust of our industry partners and consumers, while at the same time remembering our role as advocate for what is right for the pig. I am fortunate to have grown up in a family and worked in a practice where service to the community was encouraged. I am truly honored to have been nominated, and if elected, I will do my best to serve the AASV.

Guidelines for authors submitting manuscripts

Prepare the manuscript in Word using Times New Roman 12-point font, double-spaced throughout. Submit manuscripts to the Publications Manager.

Please include:

- An electronic copy of your manuscript, with pages and lines numbered continuously;
- Files of all figures and tables;
- For all authors, names (first, middle initial, last), affiliations, and academic degrees beyond bachelor's level; and
- For the corresponding author, complete mailing address, telephone number, fax number, and e-mail address (please indicate whether you wish the e-mail address published).

Unless given alternate instructions, we will correspond with the first author, who will also receive reader inquiries and requests for reprints.

We will have your summary professionally translated into French and Spanish.

Editorial office

Karen Richardson, Publications Manager, *Journal of Swine Health and Production*; Tel: 519-856-2089; Fax: 519-763-3117; E-mail: **pub_mgr@aasv.org**.

Animal care

For experiments performed in research facilities or on commercial farms, include a statement at the beginning of the materials and methods indicating that the studies were reviewed and approved by the institutional animal care and use committee (or equivalent). For case reports and studies performed under field conditions in which animals are not manipulated beyond what would be required for diagnostic purposes, it must be clear that housing was adequate and that the animals were humanely cared for.

Permissions

If you are using copyrighted material, you must advise the editors of this when you submit your manuscript. You are responsible for securing permission to use copyrighted art or text, including the payment of fees.

Copyright transfer

When a manuscript is submitted to the *Journal of Swine Health and Production*, a pre-review copyright agreement and financial disclosure statement must be signed by all authors. It is the responsibility of the corresponding author to secure these signatures. This form is available from the Publications Manager. Submit signed copies to Karen Richardson. When your manuscript is accepted for publication, you will be required to transfer copyright to the American Association of Swine Veterinarians, with the exceptions of United States government employees whose work is in the public domain, and portions of manuscripts used by permission of another copyright holder.

Prior publication

We do not republish materials previously published in refereed journals. Sections of theses and extension publications that may be of particular value to our readership will be considered. Prior publication of an abstract only (for example, in a proceedings book) is generally acceptable.

Types of articles

The *Journal of Swine Health and Production* publishes the following types of peer-reviewed manuscripts:

- Original research
- Brief communication
- Case report
- Case study
- Literature review
- Production tool
- Peer-reviewed commentary
- Peer-reviewed diagnostic notes
- Peer-reviewed practice tip

Reference format

Authors are responsible for the accuracy of their references. References must be cited in the text using consecutive superscript numbers and listed at the end of the text in numerical order. Non-refereed references are marked with an asterisk to the left of the reference number. Only personal communications may remain in the text in parentheses. Refer to recent issues of the *Journal of Swine Health and Production* for examples of formatting for specific types of references.

Figures and tables

- Tables must be prepared using the table function in Word.
- Place the figure legends and the set of tables after the reference list in the manuscript.
- Do not paste figures into the word-processing document containing the text of the manuscript. Submit them separately, eg, submit figures created in Excel as Excel files, and submit figures created in other programs as .eps files (ie, save as .eps files from within the program that created the figures).
- Make reference in the text to all figures and tables, citing them in consecutive order.
- Provide us with numerical data for all figures, including SD or SE for means.
- Supply brief but complete titles for tables and legends for figures. Explain in footnotes abbreviations used in tables, using symbols to identify footnotes.
- For *P* values reported in a table or figure, provide the name of the statistical method used (eg, *t* test, ANOVA), not the name of the software.
- Submit photographs as individual high-resolution .jpeg images or in .tif files.

Measurements

The *Journal of Swine Health and Production* adheres, with a few exceptions, to the style of the American Medical Association. A conversion chart is included at the end of the Author Guidelines document on the Web site at **http://www.aasv.org/shap/guidelines.pdf**. Please see the Web version of Author Guidelines for full details on journal requirements for submitted manuscripts.

Upcoming meetings

Banff Pork Seminar
January 21-23, 2014 (Tue-Thu)
Banff Centre, Banff, Alberta, Canada

For more information:
Tel: 780-492-3651; Fax: 780-492-5771
E-mail: pork@ualberta.ca
Web: http://www.banffpork.ca/

2014 Pig-Group Ski Seminar
February 5-7, 2014 (Wed-Fri)
Copper Mountain, Colorado

For more information:
Lori Yeske
Pig Group
39109 375th Ave, St Peter, MN 56082
Tel: 507-381-1647
E-mail: pyeske@swinevetcenter.com
Web: http://www.pigski.net

American Association of Swine Veterinarians 45th Annual Meeting
March 1-4, 2014 (Sat-Tue)
Sheraton Dallas Hotel, Dallas, Texas

For more information:
American Association of Swine Veterinarians
830 26th Street, Perry, IA 50220-2328
Tel: 515-465-5255; Fax: 515-465-3832
E-mail: aasv@aasv.org
Web: http://www.aasv.org/annmtg

6th European Symposium on Porcine Health Management (ESPHM) 2014
May 7-9, 2014 (Wed-Fri)
Hotel Hilton Sorrento Palace, Sorrento, Italy

For more information:
MV Congressi S.p.A.
Via Marchesi, 26D, 43126 Parma, Italy
Tel: +39 0521 290191; Fax: +39 0521 291314
E-mail: esphm2014@mvcongressi.it
Web: http://www.esphm2014.org

World Pork Expo
June 4-6, 2014 (Wed-Fri)
Iowa State Fairgrounds, Des Moines, Iowa

For more information:
Alicia Irlbeck
National Pork Producers Council
10664 Justin Drive, Urbandale, Iowa 50322
Tel: 515-278-8012
E-mail: irlbecka@nppc.org
Web: http://www.worldpork.org

23rd International Pig Veterinary Society Congress
June 8-11, 2014 (Sun-Wed)
Cancun, Mexico
"Science and Excellence in Swine Production"

For more information:
E-mail: ipvs@congressmexico.com
Web: http://www.ipvs2014.org/

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

American Association of Swine Veterinarians
830 26th Street
Perry, IA 50220-2328

PRESORT STD
US POSTAGE
PAID
BROOKFIELD, MO
PERMIT NO. 50

Photo Corner

Three Iowa pigs.

Photo courtesy of Tina Smith

AASV Industry Support Council

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

Bayer Animal Health
Boehringer Ingelheim Vetmedica, Inc
Elanco
Harrisvaccines, Inc
Merck Animal Health
MVP Laboratories, Inc
Newport Laboratories
Norbrook, Inc
Novartis Animal Health US, Inc
PIC International
Zoetis