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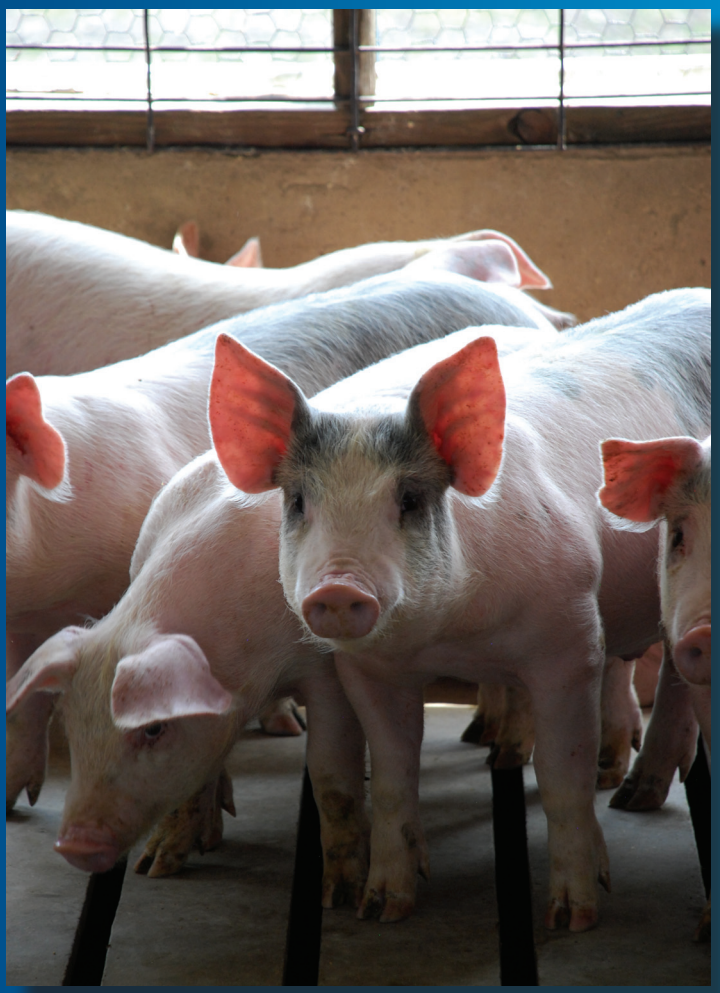
Journal of Swine Health & Production



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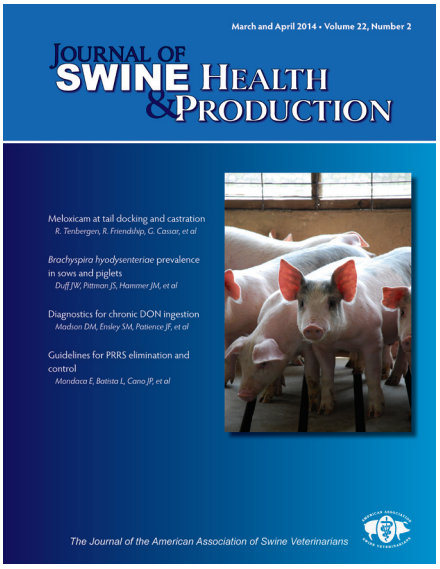

Iowa growers

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"I have confidence that our members will continue to make a difference. It is what drives us."

quoted from the President's message, page 57

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Making a difference

Welcome home again. As our annual conference in Dallas approaches, I am trying to collect my thoughts for what will be my last "president's message." In thinking about exactly what message I wanted to leave our members with, I went back and looked at the articles I have written and what was happening in our association at those times. It is astounding how quickly a year can go by and how many miles – both literally and figuratively – you can travel in it. From PEDV to PRRS, from leadership to advocacy, from public perception to "serving our patient," we have covered some ground this last several months.

Many of us have recently been challenged, both as individual veterinarians and as an association, to conform our views and our practices to better fit with public perception and opinion. Those challenges can become a bit pointed when they come within the context of gestation stalls or blunt force trauma. It is a plain and simple fact that those things don't look good on a video. When an industry serves consumers, it becomes profoundly important to consider what the consumer public thinks and believes. While I believe that challenge is generally a good and healthy thing, my innate concern with conforming to public perception is that all too often it falls victim to the human condition. Knee-jerk reactions have at times gotten people hung without the benefit of a trial. Who do we serve? That can be answered in many ways, but I believe the direct answer is that we serve the pig, our patient, and the owner, our client. If we generally have the welfare and best interest of the pig in mind, then we won't go far wrong. Making something aesthetically pleasing doesn't necessarily make it humane. If we truly want to progress, we may have to progress in both planes. I would assert that veterinarians have a moral obligation to be the voice of reason and the voice of science, not necessarily the voice of public perception and opinion.

"…making a difference is exactly what our association is about – finding solutions, fixing problems, discovering a better way."

One of our members, and a close friend of mine, recently told me of his future plan, telling me that it was an opportunity for him "to make a difference." I guarantee this individual has spent a lifetime making a difference, and if I mentioned his name I've no doubt that you would agree. His comment did give me pause in regard to realizing that making a difference is exactly what our association is about – finding solutions, fixing problems, discovering a better way. Whether it is eradicating disease or finding better housing alternatives, I have confidence that our members will continue to make a difference. It is what drives us.

As my year as AASV president comes to a close, I want to thank my partners for their willingness to do their share, and my share too, when I had to be gone. They have shown nothing but support and I appreciate it very much.

I would like to thank my family. I am busy enough and away enough as it is, and they have borne all that very graciously. Just to share a little story about my wife – when I was asked to run for vice president, I talked with her, thinking the timing was wrong and that it just wouldn't fit. She was excited for me and asked if it was something that I wanted to do. After a moment's thought, I said that yes, I think I do. She replied by saying then that I should run and that God would decide if the timing was right. I guess the timing was right. Her logic makes that a bit hard for me to argue with.

I would like to thank the AASV staff. You hear it often but not often enough – they are awesome and their dedication continues to inspire me. I would like to thank my fellow officers for their dedication and commitment – and their willingness to serve. I would also like to thank you, our association's members, who have been my friends and mentors. I once wrote that I have never been to one of our annual conferences when it didn't feel like coming home after an extended absence. And that every year when I leave I am re-grounded in my professional purpose, but leave feeling I should be doing a little more for our clients and our profession. I think that's called inspiration, and it isn't necessarily a result of the conference – it is a direct result of being around our members and of the example they set in regard to making a difference. Thank you for that example and the opportunity to serve.

Matt Anderson, DVM
AASV President

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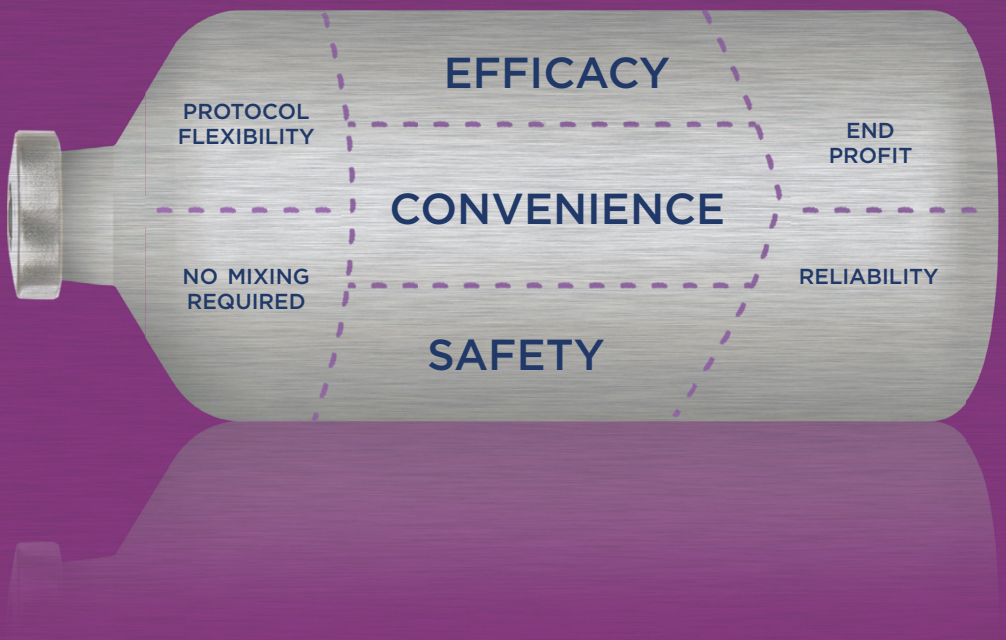

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A year of opportunity

With the AASV Annual Meeting upon us, I am both excited and humbled to accept the gavel and begin my year as AASV president. Going into my term, I see a year full of opportunities and untold challenges. Of course, we do know some of our upcoming challenges. Even without a crystal ball, I can predict that we will spend a fair amount of time this year discussing porcine epidemic diarrhea (PED). I'm sure food safety and public health issues will arise, including antimicrobial resistance, residue avoidance, and zoonotic diseases. And of course pig welfare topics, such as piglet processing procedures, euthanasia methods, and gestation housing designs, will receive attention. That seems like a pretty robust list – and I haven't even gotten to the potential untold challenges!

I take great pride in my duty to maximize the health and well-being of the pigs under my care, but I have to admit that I still have more questions than answers when it comes to PED. It is frustrating to deal with diseases for which we have no "silver bullets." It seems RNA viruses have plagued us in this category for years. While admitting that is humbling, it is also reassuring to know that we have fought similar battles (think porcine reproductive and respiratory syndrome) and have made tremendous progress in our quests for answers. As swine veterinarians, we are all eager to find new solutions to new (and old) problems. It is through our collective knowledge and experience that we will be able to assimilate information that will lead us to the best strategies for controlling or eliminating this novel pathogen. I hold out hope that the presentations and discussions held at the annual meeting will provide a significant contribution to our forward progress down that path.

While our primary role as veterinarians is to protect the health and welfare of our patients, we also took an oath to protect public health. With the lives of humans and animals increasingly intertwined, this role becomes more and more relevant. It is our duty to ensure that we are recommending judicious use of antimicrobials that will provide measurable health benefits to the treated animals without jeopardizing human health. Veterinarians also need to be at the forefront of discussions involving topics such as livestock exhibits at fairs and consumption of raw milk. It is our duty to serve as a resource for the public, who largely lack sound scientific information. Though the primary mission of the AASV is "to increase the knowledge of swine veterinarians," I think we can also play an important role in educating other veterinarians, legislators, consumers, and the general public.

As the current chair of the AASV Pig Welfare Committee and the AASV representative on the American Veterinary Medical Association Animal Welfare Committee, I already devote a significant portion of my time to animal welfare topics. I predict the amount of time I, and we as an association, spend on these issues will only increase in the future. As the growing population continues to be increasingly removed from their ancestors' rural roots, we have a growing knowledge gap regarding how food animals are raised and cared for in this country. As veterinarians, it is our responsibility to seek and provide scientifically valid answers to the difficult questions that are asked of us and our clients. As AASV members, we have quick and easy access to more scientifically relevant papers than ever before through *JSHAP*, Swine Information Library, and the "Get it for me" document retrieval service.

"It is frustrating to deal with diseases for which we have no 'silver bullets.'"

I like to think of challenges and opportunities as synonymous. Consequently, we have a whole lot of potential! With all the opportunities listed above (as well as those not mentioned or yet discovered), it is clear there is a vital need for swine veterinarians. It is also evident that we cannot tackle these issues alone, as they are larger than any of us as individuals. Therein lies the greatest strength of the AASV – its members. Individually, we are but one voice, one idea. Collectively, we are much more. I am likely biased, but I believe we have some of the profession's brightest, most dedicated veterinarians among our membership. I am proud to have you all at my side as we embrace these swine industry ~~challenges~~ opportunities together.

Michelle Sprague, DVM
AASV President-elect

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Vortex

As I write this in January, we are just coming out of some of the coldest weather in many years. The TV news is full of weather-related stories and features. The meteorologists have been busy reporting on the record-setting low temperatures and the unrelenting wind chill. Their biggest challenge is in coming up with new, unused adjectives to describe the cold. I have even learned a new term: "polar vortex." It seems that this is a sizable, rotating mass of bitterly cold air that is usually sitting over the polar region far to our north. It somehow found its way into the United States, including Iowa.

This vortex or spinning air flow is described on Wikipedia as a "turbulent flow" that can "move, stretch, twist, and interact in complex ways."[1] Not only is this an apt description of a weather phenomenon, but a vortex might be used to describe what is currently swirling around the pork industry. We find ourselves waiting for the next big issue to be flung out of the vortex into our faces, demanding our attention.

Pick your issue, whether it is antibiotic availability, sow housing, pig welfare, transboundary disease (eg, porcine epidemic diarrhea), foreign animal disease, porcine reproductive and respiratory syndrome, or a host of other pig diseases. There is no shortage of issues that have the potential to impact pork production. You are not alone if you feel like asking someone to stop the spinning so you can get out of this vortex. The trouble is that there is no one to stop the spinning. Just like the cold of the polar vortex, the flurry of issues is unrelenting and we have no choice but to face them.

Dealing with this vortex of issues can be frustrating and daunting. The broad range of issues and the forces underlying them require that time and effort be put into understanding and effectively responding. Unfortunately, there is no one to whom this can be passed off. Farmers and veterinarians, along with the organizations that represent them, are the people who will be impacted and thus must take a leadership role.

"...we must remain grounded in the science of swine health and production."

As veterinarians, our instinct is to diagnose and solve a problem with appropriate treatment, then move on to the next problem. Our strength lies in our ability to take care of the animals in our charge regardless of what Mother Nature throws in our faces in the form of weather or disease or even human nature. However, many of the issues confronting us today are not easily solved, nor can they be ignored or underestimated as to their impact on the farm.

For me, one of the keys to handling this vortex of issues is maintaining and remaining true to the core values of swine veterinarians and AASV. First and foremost, we must continue to be committed to the health and well-being of the pigs. We must ensure the availability and delivery of veterinary medicine to every farm in need. We must be committed to our clients, the pork producers who work on the farms providing daily care of the pigs. Lastly, we must remain grounded in the science of swine health and production.

Our core values cannot prevent change from occurring in the pork industry. It would be naive to think otherwise, given the external forces coming to bear. By naming our core values, we can set a foundation for meeting each issue head-on with no doubt as to where we stand. Some changes may not be for the best, and veterinarians will be instrumental in advocating for the pigs and producers. There will be times when compromise is the answer, but we as the profession of swine veterinary medicine must draw the line when the compromise infringes on our core values of what we know to be right.

Reference

1. Wikipedia. Polar vortex. Available at: **http://en.wikipedia.org/wiki/Polar_vortex**. Accessed 14 January 2014.

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Scientific writing

Scientific writing is a hard job. Many of my students struggle with writing their papers, thesis chapters, and case reports, and there is a trend in the excuses that they claim stifle their progress: "I don't feel inspired," "I can't find the time," "I don't know where to start," "I am still doing a literature search," and my favorite, "my hard drive crashed." I have recently joined a writing support group for faculty to help develop successful writing skills. In academia there is the somewhat terrifying phrase "publish or perish" that can keep you awake at night hoping that your manuscript is accepted by the journal you just submitted to. In this writers' group we were asked what are some of the road blocks that prevent you from getting your writing done when really the "publish or perish" phrase should be enough motivation? I bet you can guess what some of the answers were: "I don't feel inspired," "I can't find the time," I don't know where to start," "I am still doing a literature search," and.....wait for it... "my hard drive crashed." The first thing I did after this initial meeting was back up my hard drive.

So, what does this really have to do with veterinary practitioners in private practice? I guess I am just trying to illustrate that writing is difficult for those (academics and even editors) who are supposed to be writing daily, weekly, or monthly. How is a busy practitioner supposed to contribute to the scientific literature given the demanding nature of private practice? I believe that most practitioners see the value in the subject-specific (ie, swine) peer-reviewed literature and how it helps to guide evidence-based decision making in practice. But practitioners do not submit to journals as much as I would like, and I have had many conversations with practitioners that go like this:

Practitioner (name withheld for confidentiality reasons - you know who you are!): "I have a case report I keep meaning to write up that I think would be of interest to *JSHAP* readers."

Terri: "That is terrific – why don't you write that up and submit it?"

Practitioner: "I don't really know where to start and I can't seem to find the time...."

"Case reports, case series, and on-farm clinical trials can, and do, make important contributions to our scientific knowledge, so don't keep them in your back pocket."

The conversation goes on along this line and then usually ends talking about the weather or hockey. But what I want you to see is that the reasons for not writing follow the SAME TREND! We are all in the same boat that swallows up time and motivation. Case reports, case series, and on-farm clinical trials can, and do, make important contributions to our scientific knowledge, so don't keep them in your back pocket. Even though case reports do not "test a hypothesis," they contribute an important aspect of sharing clinical experiences and can be "hypothesis generating." Here is the bad news – case reports are hard to write, too, and yes, I know, the peer-review process can be brutal.

So how can you incorporate writing into busy practice life? Here are some of my own humble suggestions and some tips I have taken away from my scientific-writing support group:

1. Set up a writing group. This can help you to establish deadlines and set up some accountability for getting your case report (or other genre) written. The group can share drafts of the paper and provide feedback to one another. In clinical practice, this activity could easily be incorporated into your rounds and case discussions.
2. Put writing into your schedule and treat this blocked time like an important meeting that you cannot miss or change. The more times you sit down and write, the better, even if it is just 200 words a day or week.
3. Enroll the help of a DVM student. They can help edit and make suggestions.
4. Contact your local academic institution and see if they have scientific writing workshops or groups already set up that you can join.

I am sure there are many other ways to improve your success as a writer, and as I attend my own writing group I will be sure to share good tips with the *JSHAP* readership. But one more practice that I believe will improve your own writing is to get involved with the peer-review process. Contact a journal (eg, *JSHAP*) and express an interest in being a reviewer. By reading other manuscripts of any genre you can learn a lot about writing, attention to detail, and presentation of data or case descriptions.

Terri O'Sullivan, DVM, PhD
Executive Editor

ORIGINAL RESEARCH PEER REVIEWED

Investigation of the use of meloxicam for reducing pain associated with castration and tail docking and improving performance in piglets

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

Summary

Objectives: To determine the effect of meloxicam, administered to suckling piglets prior to castration and tail docking, on growth and mortality, and to determine evidence of pain reduction.

Materials and methods: Piglets (n = 2888) were alternately assigned either to meloxicam (extra-label use) or a placebo injected intramuscularly 30 minutes prior to processing, which included tail docking for females, and tail docking and castration for males. All piglets were weighed on the day of processing (5 to 7 days of age) and at weaning (19 to 21 days of age). Vocalization scoring during castration, behavioral observations, and analysis of plasma cortisol concentrations were performed on a subset of animals.

Results: Growth was not associated with treatment, but was positively correlated with weight at processing and negatively correlated with litter size. Mortality did not differ between treatment groups, but there was an interaction between treatment and parity, with piglets nursing older sows (parity > 5) and treated with placebo being 4.4 times more likely to die than piglets nursing older sows and treated with meloxicam (95% CI, 1.31-14.3) (P = .01). Behavior scores for isolation (isolating themselves from the other pigs) and plasma cortisol concentrations were higher for placebo-treated piglets than for meloxicam-treated piglets (P < .05).

Implications: Routine treatment of piglets with meloxicam prior to castration and tail docking (extra-label use) does not improve growth, but may reduce mortality in litters nursing older sows. Observations of behavior and analysis of cortisol concentrations indicate meloxicam treatment does reduce pain.

Keywords: swine, castration, meloxicam, pain, growth

Received: March 1, 2012
Accepted: May 28, 2013

Resumen - Investigación de la utilización del meloxicam para reducir el dolor asociado con la castración y el corte de cola y para mejorar el desempeño de los lechones

Objetivos: Determinar el efecto del meloxicam, administrado a lechones lactantes antes de la castración y del corte de cola, en el crecimiento y mortalidad, y determinar la evidencia en la reducción de dolor.

Materiales y métodos: Se asignaron lechones (n = 2888) alternativamente a meloxicam (uso de fuera de etiqueta) o a un placebo inyectado intramuscularmente 30 minutos antes del procesamiento de las camadas, que incluía corte de cola para las hembras y corte de cola y castración para los machos. Se pesaron todos los lechones en el día de proceso (5 a 7 días de edad) y en el destete (19 a 21 días de edad). Durante la castración se efectuaron valoraciones de vocalización, observaciones de la conducta, y análisis de la concentración de cortisol de plasma, en un subconjunto de animales.

Resultados: El crecimiento no estaba asociado con el tratamiento, pero se correlacionó positivamente con el peso al momento del proceso y se correlacionó negativamente con el tamaño de la camada. La mortalidad no difirió entre los grupos de tratamiento, pero hubo una interacción entre tratamiento y paridad; esto es, los lechones lactando de hembras adultas (paridad > 5) y los tratados con placebo tuvieron 4.4 veces más posibilidad de morir que los lechones lactando de hembras adultas y tratados con meloxicam (95% CI, 1.31-14.3) (P = .01). Los valoraciones de conducta por aislamiento (aislándose ellos mismos de otros cerdos) y las concentraciones de cortisol de plasma fueron mayores en los lechones tratados con placebo que en los lechones tratados con meloxicam (P < .05).

Implicaciones: El tratamiento rutinario de lechones con meloxicam antes de la castración y del corte de cola (uso fuera de etiqueta) no mejora el crecimiento, pero puede reducir la mortalidad en camadas lactando de hembras adultas. Las observaciones de conducta y el análisis de las concentraciones de cortisol indican que el tratamiento de meloxicam reduce el dolor.

Résumé - Étude sur l'utilisation du meloxicam dans le but de réduire la douleur associée à la castration et la taille de la queue et améliorer les performances chez les porcelets

Objectifs: Déterminer les effets du meloxicam administré à des porcelets à la mamelle avant la castration et la taille de la queue sur la croissance et la mortalité, et déterminer l'évidence de réduction de la douleur.

Matériels et méthodes: Des porcelets (n = 2888) ont été assignés en alternance au groupe recevant une injection intramusculaire de meloxicam (utilisation hors-homologation) ou un placébo 30 minutes avant les procédures qui incluaient la taille de la queue pour les femelles, et la taille de la queue et la castration pour les mâles. Tous les porcelets étaient pesés le jour des procédures

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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 for reducing pain associated with castration and tail docking and improving performance in piglets. *J Swine Health Prod.* 2014;22(2):64–70.

(5 à 7 jours d'âge) et au sevrage (19 à 21 jours d'âge). La vocalisation durant la castration, les observations du comportement, et l'analyse des concentrations plasmatiques de cortisol ont été effectuées sur un sous-groupe d'animaux.

Résultats: La croissance n'était pas associée avec le traitement mais était corrélée positivement avec le poids au moment du processus et corrélée négativement avec la taille de la portée. La mortalité ne différait pas entre les groupes, mais il y avait une interaction entre le traitement et la parité, les porcelets allaités par des truies plus âgées (> 5 parités) et traités avec le placébo étant 4,4 fois plus susceptibles de mourir que les porcelets allaités par des truies plus âgées et traités avec du meloxicam (IC 95%, 1,31-14,3) (P = ,01). Les pointages de comportement pour l'isolement (animaux s'isolant des autres porcs) et les concentrations plasmatiques de cortisol étaient plus élevés pour les porcelets traités avec un placébo comparativement aux porcelets traités avec du meloxicam (P < ,05).

Implications: Le traitement de routine avec du meloxicam préalablement à la castration et à la taille de la queue (utilisation hors-homologation) n'améliore pas la croissance, mais pourrait réduire la mortalité chez les porcelets allaités par des truies plus âgées. L'observation des comportements et l'analyse des concentrations de cortisol indiquent que le traitement avec du meloxicam réduit la douleur.

In North America, piglets raised under modern production conditions undergo a number of surgical procedures, including tail docking and castration of males. These procedures are generally performed without pain control such as anesthetic or analgesia. Research studies have shown that castration of piglets is painful,[1-3] as is tail docking.[4,5] From a welfare standpoint there is a need to examine how pain control might be practically and economically applied to improve welfare of suckling piglets undergoing these procedures.

Non-steroidal anti-inflammatory drugs (NSAIDs) are becoming licensed for use in food-producing animals, providing an opportunity to address the need for pain control during and after piglet processing. The relatively long-acting NSAID meloxicam has been studied extensively for its analgesic properties in various species[6] and may prove useful in dealing with pain associated with piglet castration and tail docking. Most studies that have investigated the use of meloxicam as an aid in reducing post-operative pain and stress in piglets have been relatively small controlled trials emphasizing behavior and physiology to determine the level of pain control. Keita et al[7] showed that pre-operative administration of meloxicam resulted in lower plasma cortisol concentrations and adrenocorticotropic hormone after surgical castration than in controls and mitigated behavioral alterations indicative of pain between 2 and 24 hours after the procedure. Similarly, Hansson et al[8] demonstrated that piglets receiving meloxicam after castration displayed less pain-related behavior on both castration day and the following day than did those not given meloxicam. However, these studies have been relatively small and therefore not able to adequately measure analgesic effects on growth performance and mortality under commercial production conditions. In order for producers and veterinarians to judge the cost-benefits of instituting an analgesic regimen as part of piglet processing, a large field trial is required to determine if analgesia affects performance.

The objectives of this study were primarily to determine the effect of meloxicam administered as a routine measure to piglets prior to castration and tail docking on subsequent growth and mortality in the suckling period and, secondarily, to determine whether piglets treated with meloxicam prior to processing experienced less pain than controls.

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 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. Piglets were fed by suckling their mother's milk. No additional diet was offered. Piglets had unlimited access to water nipples. No piglets were subjected to teeth clipping. The rooms were filled in an all-in, all-out manner and were cleaned and disinfected between groups.

Study design

This study involved 2888 piglets (1499 males and 1389 females) from 407 litters. Piglets received an injection of 200 mg of iron dextran and were ear notched within 48 hours of birth. Cross-fostering did occur in this herd prior to ear notching, but researchers were unable to document which pigs were moved from one litter to another. Once pigs were ear notched and litters identified for the study, no cross-fostering was allowed. At 5 to 7 days of age, piglets were weighed and alternately assigned to a treatment as they were picked up, with the first male pig given treatment A and the second male pig given treatment B; the females were assigned to a treatment in the same manner. Each piglet was identified by a number marked on the top of its head. Researchers were blind to treatment until the trial was complete. Treatment A was meloxicam (Metacam; Boehringer Ingelheim [Canada] Ltd, Burlington, Ontario, Canada; extra-label use) given at 0.4 mg per kg body weight, and treatment B was the same volume of a placebo (the vehicle for meloxicam, prepared by Boehringer Ingelheim [Canada] Ltd).

Piglets were returned to the farrowing crate for 30 minutes before processing. They were then picked up a second time, tail docked using side-cutters, and then castrated (if male) before being set down. Castration was carried out following methods of Van Beirendonck et al[9] by making an initial horizontal incision in the scrotum with a scalpel after which the testicles were removed by tearing the spermatic cords. Cryptorchid pigs and pigs with inguinal hernias were identified prior to treatment and not included in the study. Mortality data were collected daily. In addition, all piglets were individually weighed at processing and just prior to weaning (19 to 21 days of age) using a DYMO shipping scale (Pelouze, Albany, California). The scale had a maximum capacity of 68 kg and a resolution of 0.1 kg. Sows were categorized by parity and litter size at the time of the study.

Measurements

Weight at processing and weaning, as well as mortality data, were collected from all pigs. Additional measurements were undertaken in a smaller number of piglets to assess pain control. Vocalization was assessed during castration on a subset of 126 male piglets using a decibel meter (Decibel Meter Pro; Performance Audio for iOs devices, Apple Inc, Cupertino, California) to determine the amplitude of sound produced. The decibel meter was held as close to the snout as possible, without touching it, throughout the entire procedure. The call with the highest intensity level during the castration was recorded. Decibel (dB) is a unit for expressing the relative intensity or relative difference in

power between acoustic signals on a scale from 0 for the average least perceptible sound to approximately 130 for the average level causing pain. Decibels are the logarithm to base 10 (common logarithm) of the power ratio (I = 10 log (p1/p0). Because decibels are expressed as a logarithm scale, decibels were transformed to power gain units in Stata to meet the model assumptions of normality and homoscedasticity; for example 102 db = $10^{10.2}$ = 15,848,931,925 power gain units. For the interpretation of results, power gain unit values were re-transformed to decibels using an on-line calculator (available at **http://www.daycounter.com/Calculators/Decibels-Calculator.phtml**).

Behavior of piglets was scored for the period immediately following processing and for 30 minutes afterwards. On a day when several litters were to be castrated, one litter was chosen for observational studies. There was insufficient manpower to intensively monitor behavior in multiple litters at one time. Typically, a litter with at least four males and four females was chosen so that each treatment category was represented twice. Following tail docking and castration, piglet behavior was observed through continuous observation of instantaneous behaviors in15 litters (101 piglets). A total of 52 piglets (27 males and 25 females) were included in the meloxicam group and a total of 49 piglets (23 males and 26 females) were included in the placebo group. A detailed observation form with nine separate behaviors was used (Table 1), with the observer standing outside the farrowing crate and to the rear of the sow. Piglets were considered positive for a specific behavior if that behavior was observed during the period of observation.

Cortisol was measured in 236 blood samples representing piglets in 49 litters. Blood was collected in EDTA tubes at 30 minutes, 60 minutes, 90 minutes, and 4 hours after piglet processing. An individual pig was sampled once. A total of 119 pigs (56 females and 63 males) were included in the meloxicam group and 117 piglets (57 females and 60 males) in the placebo group. Blood was collected from 48 piglets in 16 litters at 30 minutes, from 44 piglets in 13 litters at 60 minutes, from 83 piglets in 11 litters at 90 minutes, and from 61 pigs in 9 litters at 4 hours after processing. In addition, 12 samples were collected from pigs prior to processing in order to establish a baseline. The blood samples were centrifuged at 3900*g* and 5°C for 20 minutes, 1 to 3 hours after collection. The plasma was stored in 2-mL micro tubes, PP (Sarstedt Inc, Montreal, Quebec) at -20°C until samples were analyzed for cortisol with a solid-phase, competitive chemiluminescent enzyme immunoassay (Immulite/Immulite Cortisol 1000; Siemens Healthcare Diagnostic Products Ltd, Oakville, Ontario, Canada). The test had an analytical sensitivity of 5.5 nmol per L with a calibration range of 28 to 1380 nmol per L.

Table 1: Piglet behaviors in a study to assess the effects of meloxicam on signs of post-operative pain*

Behavior	Description
Lying down	Body weight supported by belly or side
Standing	Body weight supported by four legs
Walking	Moving on four legs
Head low	Standing idle with the head held low, below the shoulder
Isolated	Lying or standing away from the main group of piglets
Tremble	Piglet's body is trembling
Tail-jam	Tail held tightly against body
Tail-wiggle	Tail wagging back and forth rather than hanging down, relaxed
Scooch	Piglet dragging its rump along the floor

* Behavioral observations were scored for 30 minutes after tail docking and castration for 52 piglets pretreated with meloxicam (Metacam; Boehringer Ingelheim [Canada] Ltd, Burlington, Ontario, Canada; 0.4 mg/kg intramuscularly; extra-label use) and 49 piglets receiving a placebo (vehicle for Metacam, prepared by Boehringer Ingelheim [Canada] Ltd). Piglets were considered positive when a specific behavior was observed.

Statistical analysis

Descriptive and quantitative statistical analyses were performed in Statistix (Statistix10, 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 average daily gain, cortisol concentrations, and vocalization (decibels) and treatment and gender were evaluated with a two sample T-test when continuous variables were normally distributed and with the Wilcoxon rank sum test when variables were not normally distributed. The simple association of birth weight, weight at castration, weight at weaning, average daily gain, and litter size with parity categories 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. Bonferroni correction was used to determine the significance among categories. A chi-square test was used to determine the simple association between treatments with behaviour variables, mortality, gender, and parity categories. Fisher's exact test was used in cases where the expected value in the 2 × 2 table was < 5 in at least one of the cells. A P value of < .05 was considered significant, and P values < .10 but > .05 were considered a trend.

Mixed linear regression models were used to determine the association of piglets' average daily gain (ADG) with treatment, parity, litter size, weight at castration, and gender. Individual interactions between treatment and parity, gender, litter size, and weight were evaluated for significance. In this model, treatment, parity, gender, litter size, and weight at castration were considered fixed effects, and the identity (ID) of the individual litter that each pig was born into was modeled as a random intercept. Models with and without the interaction terms of significant variables were compared using the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) values. These are two measures that provide information on the overall assessment of the model and can be used to compare models. Residuals were visualized after fitting the model to determine normality of residuals and the presence of unusual observations that would require further analysis.

The association of pig mortality from castration to weaning with treatment, gender, parity, litter size, and weight at castration were analyzed using a multilevel mixed effects logistic regression model. In this model, treatment, parity, gender, litter size, and

weight at processing were evaluated as fixed effects, and ID of the individual litter that each pig was born into was modeled as a random intercept. The interactions of treatment with parity, gender, litter size, or weight at processing were evaluated for significance.

Regression models were used to determine whether plasma cortisol concentrations and intensity of vocalization differed between meloxicam and placebo groups. A log transformation was performed for cortisol concentrations for the residuals to meet the model assumptions of normality and homoscedasticity. Decibels were transformed to power units. A logistic regression model was used to determine whether specific behavior categories after tail docking and castration differed between treatment groups.

Results

Pig performance

Weight at weaning and weight at processing were positively correlated with ADG ($P < .001$), and litter size at the time of piglet processing was negatively correlated with ADG ($P < .001$). Weight at weaning and ADG were normally distributed. Weight and litter size at the time of processing and parity were not normally distributed. Parities of the sows were categorized as parity 1-2 (Young), parity 3-5 (Mid-age), and parity > 5 (Old). Treatment was not significantly associated with ADG, weight at processing, weight at weaning, litter size, or parity ($P > .05$). A total of 105 piglets died between the time of processing and weaning. Mortality was not significantly different between pigs receiving meloxicam and piglets given a placebo ($P > .05$). A total of 48 of 1509 piglets (3.18%) died in the placebo group and 57 of 1484 (3.84%) died in the meloxicam group.

The placebo group included 787 males and 722 females, and the meloxicam group included 777 males and 707 females. Means and standard deviations of ADG by treatment groups and gender are summarized in Table 2. Average daily gain and mortality did not differ among treatment groups or between genders.

Litter size at the time of piglet processing ranged from four to 15 piglets. Parity and litter size at processing were categorized for further analysis. Parity was categorized as follows: Young, 915 piglets; Mid-aged, 730 piglets; and Old, 1348 piglets. Average daily gain differed among parity categories ($P < .001$). The average daily gain of piglets from Young sows was lower (0.161 kg) than that of piglets from Mid-age or Old sows (0.179 and 0.175 kg, respectively). Mortality differed by parity ($P < .001$). A total of 20 pigs died in the Young group (2.18%), 16 in the Mid-age group (2.19%), and 69 in the Old group (5.11%).

Litter size at processing was based on 50% percentiles: small litters with ≤ 10 pigs (1436 pigs) and large litters with ≥ 11 pigs (1557 pigs). Average daily gain differed between litter-size categories ($P < .001$). Pigs from large litters at the time of processing gained less weight (0.166 kg per day, standard deviation [SD] 0.05) than pigs from small litters (0.177 kg per day, SD 0.05). Mortality was not significantly different between litter-size categories: a total of 49 pigs (3.41%) died in small litters compared to 56 (3.59%) in large litters ($P > .05$).

The multivariable mixed linear models were built using ADG as a dependent variable. Treatment and gender and all possible interactions with treatment were not significant. Weight at the time of processing was significant in all models, and ADG varied significantly by litter ($P < .01$). In general, pigs that were heavier at processing gained more weight during the suckling period.

The mixed multi-level logistic models for mortality included treatment, weight at processing, and the interaction of treatment × gender, treatment × weight at processing, and treatment × parity. Mortality did not differ significantly between treatment groups; however, weight at processing differed significantly ($P < .001$) and mortality differed significantly ($P < .001$) between litter sizes. Pigs with lower weights at processing were more likely to die than heavier pigs. The interactions of treatment × gender or treatment × weight were not significant; however, pigs nursing Old sows in the placebo group were 4.4 times more likely to die (95% CI, 1.31-14.3) than pigs nursing Old sows in the meloxicam-treated group ($P = .01$).

Measurements of pain

Male pig vocalization. A total of 66 and 60 male pigs were included in the meloxicam and placebo groups, respectively. Intensity of vocalization ranged between 102 and 107 dB. The mean dB intensity for both the placebo group and the meloxicam group was 105 dB (SD 98.7; $P = .97$). The intensity of vocalization ("power gain") was not correlated with weight and age at castration ($P = .40$ and $P = .10$, respectively). The mean weight and age at castration of the 126 male pigs included in the vocalization test were 2.77 kg (SD 0.82 kg) and 5.61 days of age (SD 0.88 days), respectively. In the regression model, no significant differences in maximum amplitude of vocalization were observed between pigs receiving placebo and those treated with meloxicam ($P > .05$). Maximum amplitude of vocalization did not differ with respect to piglet weight or age at castration ($P > .05$), and none of the interactions were significant.

Pig behavior after tail docking and castration. A total of 101 pigs were evaluated for behaviour after tail docking and castration. The placebo group included 49 piglets (26 males and 23 females) and the meloxicam group included 52 piglets (27 males and 25 females). Lying down, standing, and walking were behaviors commonly observed in males after castration and tail docking and in females after tail docking. Head held low, "scooch" movement, and trembling (Table 1) were not significantly different between treatments. Isolation was the only behavior significantly different between meloxicam and placebo groups ($P < .05$).

Table 2: Mean ± standard deviation of average daily gain (ADG) and mortality by treatment group and gender from the day of tail docking (and castration of males) at 5 to 7 days of age to weaning at 19 to 21 days of age*

Treatment	n	ADG (g/day)	Mortality (%)
Males			
Meloxicam	743	171.9 ± 53.8	4.38
Placebo	756	173.6 ± 52.3	3.94
Females			
Meloxicam	684	169.3 ± 54.2	3.25
Placebo	705	172.3 ± 51.9	2.35
P†	NA	.48	.16

* Pigs were treated with meloxicam or a placebo at the time of tail docking for females and tail docking plus castration for males, as described in Table 1.

† One-way ANOVA for ADG comparisons and chi-square test for mortality comparisons.

A total of 32.6% of the pigs in the placebo group isolated themselves from the other pigs in the group compared to 13.5% in the meloxicam group. Lying down was significantly different between males and females ($P < .05$). A total of 90.6% of males showed lying-down behavior compared to 69.2% of females. Table 3 includes the summary statistics of each specific behavior to assess post-operative pain by treatment and gender. Tail-jam, isolation, and head held low tended to be different ($P < .10$) between treatment groups and gender.

The final logistic regression model included isolation, tail-jam, gender, and the interaction tail-jam × gender. Pigs in the meloxicam group were less likely to be isolated than the placebo group (OR = 0.26; 95% CI, 0.09-0.76; $P = .01$). In addition, piglets in the meloxicam group were less likely to have a behavior of tail-jam than the placebo group (OR = 0.11; 95% CI, 0.02-0.63; $P = .01$). However, the interaction of tail-jam × gender showed that this behavior varied by treatment and between males and females ($P = .04$) (Table 3).

Cortisol concentrations. The average baseline concentration of cortisol in 12 pigs was 85.6 nmol per L before tail docking and castration. Baseline cortisol concentrations were significantly lower than concentrations 30 minutes after castration and tail docking ($P < .05$). Cortisol concentrations were not normally distributed and ranged from 28 to 839 nmol per L. In general, plasma cortisol differed significantly between males (160.4 nmol per L, SD 134.4) and females (82.7 nmol per L, SD 61.9) ($P < .001$). Summary statistics of plasma cortisol concentrations by treatment and gender are shown in Table 4. In the regression model, concentrations of cortisol were significantly lower at 60 minutes, 90 minutes, and 4 hours after processing than at 30 minutes. In the regression model, concentrations of cortisol decreased significantly at 60 minutes (40.6 nmol per L lower than at 30 minutes), 90 minutes (85.6 nmol per L lower than at 30 minutes), and 4 hours (80.9 nmol per L lower than at 30 minutes). Cortisol concentrations tended to decrease between 60 minutes and 90 minutes after processing by 49.4 nmol per L ($P = .06$). The concentration of cortisol at 90 minutes post processing was lower in meloxicam pigs than in the placebo group ($P < .001$), by 49.4 nmol per L when controlling for time and gender. The concentration of cortisol in gilts at 90 minutes post processing was significantly lower than in barrows ($P < .001$), by 76.7 nmol per L. However, a significant interaction showed that cortisol concentrations varied by treatment and gender ($P < .001$) (Table 4). No significant interactions were observed between treatment and times of blood collection.

Discussion

Overall, meloxicam administered 30 minutes before processing did not result in an improvement in ADG or survival over the subsequent 2-week period. These results are in agreement with other reports, which found no relationship between pain-control treatment at processing and weight gain.[7,8] A study[10] using older pigs noted a tendency for castrated piglets to isolate themselves and miss suckling opportunities. One explanation for why this does not appear to happen in piglets under a week of age is that the activity of suckling provides some analgesia or calming effect.[11] Clearly, if the pain and stress of processing does not disrupt nursing, then growth rate is not likely to be improved with administration of an analgesic. Preweaning growth rates in pigs can be quite variable depending on a variety of factors, including genetic potential, environmental conditions, availability of nutrition, and stressful events.[12] In the present study, it was noted that important factors affecting growth included the weight of piglets at the time of processing, litter size, and age of the sow, and it was important to control for these factors when attempting to determine the effects of analgesia. It is possible that there were confounding factors that were not evaluated in the current study. For example, some litters contained piglets that had been fostered in during the first 48 hours after birth. By 5 to 7 days of age, the litters were expected to have stabilized with regard to teat order and social hierarchy, but ideally this variable (fostering) should have been controlled and this is a limitation of the study.

Mortality in general was not affected by

Table 3: Summary statistics of piglet behaviors used to assess post-operative pain between gender and treatment groups in a subset of piglets treated with meloxicam or a placebo*

Behavior†	Placebo		Meloxicam		*P*‡
	Males (%) n = 26	Females (%) n = 23	Males (%) n = 27	Females (%) n = 25	
Lying down	23 (88.5)	18 (78.3)	25 (92.6)	18 (72)	.19
Walking	13 (50)	12 (56.5)	13 (48.1)	13 (52)	.94
Standing	11 (42.3)	6 (26.1)	10 (37.0)	9 (36)	.69
Isolated	10 (38.5)[a]	6 (26.1)[a]	5 (18.5)[a]	2 (8)[b]	.06
Tail-jam	9 (34.6)[a]	3 (13.0)[ab]	2 (7.4)[b]	5 (20)[ab]	.08
Tail-wiggle	5 (19.2)	5 (21.7)	4 (14.8)	4 (16)	.91
Head low	5 (19.2)[a]	0[b]	1 (3.7)[ab]	2 (8)[ab]	.06
Tremble	1 (3.8)	4 (17.4)	2 (7.4)	1 (4)	.36
Scooch	1 (3.8)	3 (13.0)	3 (11.1)	1 (4)	.56

* Behaviors and treatments described in Table 1. Pigs described in Table 2.

† Behavioral observations after tail docking in female piglets and tail docking plus castration in male piglets for the period immediately following treatment with meloxicam (52 piglets) or placebo (49 piglets), and for 30 minutes afterwards.

‡ Chi-square test.

[ab] Within a row, values with no common superscript are significantly different ($P < .05$; chi-square).

Table 4: Mean plasma cortisol concentration (± standard deviation) at 30, 60, and 90 minutes (min) and 4 hours after processing (tail docking for females, and tail docking plus castration for males) in piglets treated pre-operatively with meloxicam or a placebo*

Time	Meloxicam		Placebo		*P*†
	n	Plasma cortisol (nmol/L)	n	Plasma cortisol (nmol/L)	
Males					
30 min	12	169.4 ± 50.8	13	344.4 ± 150.0	< .01
60 min	7	107.9 ± 29.6	14	292.5 ± 210.0	.02
90 min	25	79.2 ± 44.7	20	156.4 ± 105.4	< .01
4 hours	19	106.2 ± 60.0	13	124.6 ± 48.9	.45
Females					
30 min	10	106.7 ± 71.3	13	117.2 ± 107.4	.13
60 min	10	78.1 ± 38.6	13	67.7 ± 24.1	.49
90 min	19	98.8 ± 62.7	19	72.4 ± 28.8	.46
4 hours	17	89.4 ± 53.6	12	79.8 ± 35.7	.92

* Treatments described in Table 1. Blood was collected from individual piglets only once.

† Kruskal-Wallis one-way ANOVA.

treatment except in litters nursed by older sows (parities > 5). Among the litters of older sows, piglets receiving a placebo were 4.4 times more likely to die than pigs from the same sow age group that received meloxicam at processing. It is possible that because mortality is higher among the litters of older sows, the benefits of pain control may be more obvious in this subset of litters.

The lack of obvious gains in piglet performance as a result of medication with meloxicam suggests that pork producers cannot factor in an economic payback from instituting this as part of the farm's standard operating procedures. The reason for using meloxicam needs to be based on the animal welfare benefits of this regimen. Evidence from this trial and others suggest that meloxicam does reduce pain associated with tail docking and castration.

The present study found that plasma cortisol concentrations up to 90 minutes post castration were significantly lower in piglets that received meloxicam than in piglets that received the placebo, suggesting a reduction in the effects of castration on stress and pain when meloxicam is administered. Similar to the present study, Keita et al[7] found that plasma cortisol concentrations were significantly lower 30 minutes post castration with pre-operative administration of meloxicam, compared to concentrations in a placebo group. Also, in agreement with the present study, Prunier et al[13] observed that plasma cortisol concentrations in piglets were higher 15 to 90 minutes after castration than after sham castration or no handling, with no difference between the sham-castrated and not-handled groups. In addition, Prunier et al[13] reported that peak concentrations of plasma cortisol were found between 30 and 60 minutes after surgical castration, and that the return to pre-surgery concentrations occurred within 3 hours after the procedure. The present study supported this finding, with no significant difference in plasma cortisol concentrations between treatment groups 4 hours after castration.

There are limitations of the use of cortisol concentration as an objective indicator of stress and pain in response to painful procedures such as castration. For example, cortisol concentrations may become elevated as a result of stresses such as handling,[2] or vary over the course of the day. However, research suggests that increased concentrations of plasma cortisol after castration can be attributed mainly to the procedure itself, as they are of much lower amplitude and duration in sham-castrated pigs than in surgically castrated animals, and this difference is likely related to pain or tissue damage.[13]

Tail docking did not seem to elicit a physiological stress response in female piglets, suggesting that there is an insufficient nociceptive stimulus caused by tail docking. These results are supported by Prunier et al,[13] who also found no significant changes in plasma cortisol concentrations after tail docking. Similarly, Sutherland et al[14] found that anesthetic treatment was not effective at significantly changing the physiological or behavioural response from tail docking in pigs. They found that cortisol concentrations were higher in tail-docked pigs than in control-handled pigs 60 minutes after tail docking, and Noonan et al[4] observed that behaviors such as tail-jamming and tail-wagging were greater in tail-docked pigs than in control-handled pigs. These results suggest that pigs do experience pain during and in the hours after tail docking, but the results from the present study demonstrate that these effects may be of short duration and may not be improved by administration of an analgesic.

Behavioural indices such as vocalizations, postures, specific pain-related behaviors, and general behaviors are relevant parameters to assess pain and discomfort induced by painful procedures.[15] However, behavioral measurements tend to be subjective, and observers must be kept "blind" to the treatment. In addition, behavioral indices of pain are difficult to assess because there is so much individual variation between animals, and pain-related behaviors tend to be more difficult to assess after the acute phase.[1] Despite these limitations, the present study found that administering meloxicam to piglets before castration resulted in less isolation behavior. This is in agreement with previous studies which have demonstrated that castrated piglets avoid social contact with their littermates.[1,2] Isolation

behavior is unusual for such social animals as pigs and suggests that the piglets may be experiencing pain or adapting a protective strategy to avoid being bumped and jostled, which might generate pain.[1,15] In the present study, tail-jam, isolation, and head held low tended to be different between treatment groups and genders. An increase in tail-jamming behavior has been reported by other researchers observing pigs after undergoing tail docking compared to non-processed piglets, and they have suggested that this behavior may indicate distress.[4]

Although it is common for piglets to vocalize when they are handled, a clear difference between vocalizations produced when being handled and when being surgically castrated exists.[16] Piglets produce high frequency vocalizations of higher intensity and longer duration during surgical castration than when they are sham-castrated or castrated under local anaesthesia.[16] It has been suggested that a parameter describing a single moment in the call, such as peak intensity, is more representative than parameters describing mean intensity.[8,17] Measuring peak amplitude is a practical approach when conducting a field trial, because many devices are readily available for occupational health reasons, but peak frequency might be a better indicator of pain.[16] The present study did not find a difference between the peak amplitudes of cries produced among treatment groups. In previous studies, the use of analgesics has been useful in mitigating the post-operative pain experienced in the hours after the procedure, but not effective in blocking the acute pain associated with the surgery itself, in particular the severing of the spermatic cord.[7,8]

This current study supports earlier trials that have shown that pre-operative administration of meloxicam contributes to the relief of stress and post-operative pain associated with castration in piglets.[7,8] No negative side effects were noted when piglets were treated preoperatively with meloxicam, in that the growth rate and mortality overall were similar with respect to treatment and gender. Van Beirendonck et al[18] found that piglets surviving the nursing period were significantly heavier at birth than piglets that died before weaning, and that mortality rate was higher in processed piglets than in non-processed piglets. Birth weights were not recorded in the present study, but mean weights at castration and tail docking were similar between males and females. There were no controls that did not undergo at least one surgical procedure, and therefore no comparison could be made to determine if processing affected performance. Contrary to the current study, Baxter et al[19] investigated sex-biased mortality and found that males had significantly higher preweaning mortality than did females, despite having a higher average birth weight. These authors suggested that male piglets tend to suffer more from crushing by the sow and disease-related deaths than do females, and males also show less effective thermoregulation than do females.[19] Possibly in a herd with higher preweaning mortality and either a lower level of management or a higher level of disease challenge than the herd used in this study, this difference in gender may be observed.

In summary, pork producers in the future may need to consider using pain control as part of their standard operating procedures in order to meet the requirements of industry codes of practice and the expectations of the general public. The results of this study provide information that might be helpful for producers and their health advisors considering using meloxicam as a preoperative analgesic or anti-inflammatory medication.

Implications

- Routine treatment with meloxicam prior to castration and tail docking does not improve growth during the suckling period, but may reduce mortality in certain circumstances, such as in litters nursed by older sows.
- Behavior observations and analysis of cortisol concentrations indicates that meloxicam treatment does reduce post-operative pain.

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Conflict of interest

None reported.

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Original research

Prevalence of *Brachyspira hyodysenteriae* in sows and suckling piglets

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Summary

Objective: To estimate the prevalence of *Brachyspira hyodysenteriae* (B hyo) in breeding animals, lactating sows, and their suckling offspring in swine dysentery- (SD-) positive herds.

Materials and methods: Study 1: lactating sows and suckling piglets. Rectal swabs were collected eight times at 1- to 4-week intervals from an SD-positive breed-to-wean farm. At each sampling, rectal swabs were collected from 60 "sets" of animals (individual swabs from a sow and three suckling piglets). Piglet samples were tested as a litter. Samples were tested by *Brachyspira* species culture and confirmed by culture-based polymerase chain reaction (PCR). Study 2: breeding herds. Five SD-positive sow farms, varying in size, were selected for evaluation of breeding-herd prevalence of B hyo. Rectal swabs were collected once per farm from 150 randomly selected sows. Samples were tested by *Brachyspira* species culture and confirmed by culture-based PCR.

Results: Study 1: lactating sows and suckling piglets. The percentage of sows on a farm that were positive for B hyo ranged from 0% to 5%, with an overall prevalence of 1.04%. The percentage of litters culture-positive and PCR-positive for B hyo ranged from 0% to 5%, with an overall prevalence of 1.88%. Study 2: breeding herds. The percentage of sows positive for B hyo ranged from 0% to 1.33%. Only three of the five farms tested positive.

Implications: Sampling breeding herds and suckling-age piglets could serve as a valuable alternative to traditional surveillance schemes. Understanding the prevalence of SD on endemically infected sow farms could enhance current surveillance programs.

Keywords: swine, *Brachyspira hyodysenteriae*, sows, piglets, prevalence

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Resumen - Prevalencia del *Brachyspira hyodysenteriae* en hembras y lechones lactantes

Objetivo: Estimar la prevalencia de la *Brachyspira hyodysenteriae* (B hyo por sus siglas en inglés) en animales de cría, hembras lactantes, y sus crías en lactancia en hatos positivos a la disentería porcina (SD por sus siglas en inglés).

Materiales y métodos: Estudio 1: hembras lactantes y lechones en lactancia. Se recolectaron hisopos rectales ocho veces a intervalos de 1 a 4 semanas en una granja de cría a destete, positiva al SD. En cada muestreo, se colectaron hisopos rectales de 60 "grupos" de animales (hisopos individuales de una hembra y tres lechones lactantes). Las muestras de los lechones se analizaron como una camada. Las muestras se analizaron por medio del cultivo de especies de *Brachyspira* y se confirmaron por medio de la reacción en cadena de la polimerasa (PCR por sus siglas en inglés) basada en cultivo. Estudio 2: hatos de cría. Se seleccionaron cinco granjas de hembras de diversos tamaños, positivas a la SD para evaluar la prevalencia de B hyo en el hato de cría. Se recolectaron hisopos rectales, una vez por granja, de 150 hembras seleccionadas al azar. Se analizaron las muestras por medio del cultivo de especies de *Brachyspira* y se confirmaron por PCR basado en cultivo.

Resultados: Estudio 1: hembras lactando y lechones lactando. El porcentaje de hembras en una granja positivas a B hyo varió en un rango de 0% a 5%, con una prevalencia total de 1.04%. El porcentaje de camadas positivas al cultivo y positivas a B hyo por medio de PCR basado en cultivo varió en un rango de 0% a 5%, con una prevalencia total 1.88%. Estudio 2: hatos de cría. El porcentaje de hembras positivas a B hyo varió de 0% a 1.33%. Sólo tres de las cinco granjas resultaron positivas.

Implicaciones: El muestreo de los hatos de cría y lechones en edad de lactancia podría ser una valiosa alternativa frente a las estrategias de vigilancia tradicionales. El entendimiento de la prevalencia de la SD en granjas de hembras infectadas endémicamente podría mejorar los programas de vigilancia actuales.

Résumé - Prévalence de *Brachyspira hyodysenteriae* chez des truies et des porcelets à la mamelle

Objectif: Estimer la prévalence de *Brachyspira hyodysenteriae* (B hyo) chez des animaux reproducteurs, des truies en lactation, et des porcelets à la mamelle dans des troupeaux positifs pour la dysenterie porcine (DP).

Matériels et méthodes: Étude 1: Truies en lactation et porcelets à la mamelle. Des écouvillons rectaux ont été prélevés huit fois à des intervalles de 1 à 4 semaines dans une

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ferme de type maternité-naisseur positive pour DP. À chaque échantillonnage, des écouvillons rectaux ont été prélevés de 60 sets d'animaux (un écouvillon individuel d'une truie et trois porcelets à la mamelle). Les échantillons de porcelets ont été testés comme une portée. Les échantillons ont été testés par culture pour les espèces du genre *Brachyspira* et confirmation par réaction d'amplification en chaîne par la polymérase (PCR) sur culture. Étude 2: Troupeaux de reproducteurs. Cinq fermes positives pour DP, variables en taille, ont été sélectionnées pour évaluer la prévalence de B hyo dans les troupeaux reproducteurs. Des écouvillons rectaux ont été prélevés une fois par ferme à partir de 150 truies sélectionnées de manière aléatoire. Les échantillons ont été testés pour les espèces du genre *Brachyspira* et confirmés par PCR sur les cultures.

Résultats: Étude 1: Truies en lactation et porcelets à la mamelle. La proportion de truies sur une ferme qui étaient positives pour B hyo variait de 0% à 5%, avec une prévalence globale de 1,04%. Le pourcentage de portées positive par culture et positive par PCR pour B hyo variait de 0% à 5%, avec une prévalence globale de 1,88%. Étude 2: Troupeaux de reproducteurs. Le pourcentage de truies positives pour B hyo variait de 0% à 1,33%. Seulement trois des cinq fermes étaient positives.

Implications: La prise d'échantillons dans les troupeaux de reproducteurs et chez les porcelets non-sevrés pourrait être une alternative valable aux schémas traditionnels de surveillance. Une connaissance de la prévalence de DP dans les fermes de truies infectées de manière endémique pourrait augmenter les programmes de surveillance actuels.

Swine dysentery (SD), caused by *Brachyspira hyodysenteriae* (B hyo), has worldwide distribution and results in increased production expenses by decreasing feed efficiency, reducing growth rate, increasing mortality, and increasing medication costs.[1] For several decades, SD reached a very low, almost non-existent prevalence in North America; however, in recent years there has been a re-emergence of SD, and a clinically indistinguishable mucohemorrhagic colitis, caused by provisionally named *Brachyspira hampsonii*, in the United States and Canada.[2-4] Historically, SD has been characterized by typhlocolitis and mucohemorrhagic diarrhea, but in modern swine-production systems, clinical signs vary and depend on cofactors such as diet composition, co-infections, immune status, and treatment protocols.[1,5] Currently, most of the epidemiological work on SD has been in grow-finish pigs, while, in contrast, the epidemiology of B hyo in large breeding herds has not been studied extensively. Endemically infected breeding herds are often asymptomatic, in contrast to herds suffering an acute outbreak.[1,5-7] In endemically affected herds, a small percentage of "carrier" sows can transmit B hyo to their piglets during lactation, which allows for maintenance and transmission of disease in groups of weaned or commingled pigs.[8-10] Many commercial breeding herds in modern swine-production systems in North America are large breed-to-wean facilities where pigs are weaned to off-site locations at 3 to 4 weeks of age or less. Separating the susceptible grow-finish animals from the breeding herd often impedes the diagnosis of SD at herd level, since clinical disease is more prominent in locations housing large numbers of immature growing pigs. While SD status of grow-finish pigs is a good predictor of source breeding-herd status,[11] it is not definitive for multi-site production, as infection of grow-finish animals can occur from postweaning facilities (eg, pigs, barns, manure, rodents), contamination via transport units, or lateral introductions (eg, boots, equipment, rodent migration). For the modern integrated swine-production systems, it is imperative that the SD status of breeding herds be known before control or elimination efforts are undertaken. Therefore, a better understanding of SD epidemiology is needed to determine the true status of breeding herds with confidence.

Current breeding-herd SD surveillance programs involve timed and controlled exposure to manure from inventoried breeding females (commonly called "feedback"), clinical evaluation for a period after exposure, and diagnosis at the onset of clinical diarrhea in "sentinel" animals (ie, naive replacement gilts). The goal of the program is to "create a synchronized acute infection in the sentinels to increase the effectiveness of diagnostic testing."[5] Thus, these surveillance protocols are highly dependent on within-herd shedding prevalence of B hyo and the concentration of organisms in manure. In addition, compliance to the program by farm staff, medications being used at the time of exposure, the severity of resultant clinical disease, immune status of replacement breeding stock, sample size and diagnostic test sensitivity, and frequency of sentinel deliveries to the breeding herd can influence successful programs. Diagnosing SD in a sow herd remains difficult, with sows often developing immunity in endemically infected herds.[7,12] Isolation of B hyo from naturally infected breeding stock and suckling-age piglets has not been reported often, and when reported, authors demonstrated variable success.[6-8,13,14]

Songer[8] initially described the isolation of B hyo from asymptomatic adult sows and suckling piglets. Two known positive herds located in Iowa were studied. In Herd A, one of 86 sows sampled (1.2%) and seven of 190 suckling pigs less than 2 weeks of age (3.7%) were positive for B hyo by culture. In Herd B, none of the 42 sows and 76 suckling piglets sampled were positive by culture; however, B hyo was diagnosed in growing pigs. It is important to note that the seven positive suckling pigs in Herd A were asymptomatic and were from a litter of nine piglets from the one positive asymptomatic sow. This finding demonstrated the concept of "carrier sows" and the important epidemiological fact that a small number of carrier animals (sows or piglets) can transmit B hyo to uninfected animals and maintain the infection within herds or recipient herds. Songer[8] commented that this finding may indicate that the "stress of farrowing may be a factor in shedding by carrier animals," but this has not been further reported in the literature.

Windsor and Simmons[15] supported the asymptomatic-carrier theory when they investigated an outbreak of SD in 25 herds in East Anglia and indicated that there was strong evidence in 23 of the herds that the disease had entered in asymptomatic purchased pigs.

Høgh and Knox,[13] using an indirect fluorescent antibody technique (IFAT), demonstrated B hyo from 12 of 543 sows (2.2%) and 136 of 680 weaned pigs (20.0%) from 26 non-clinical Danish herds. The herd or within-herd prevalence, herd size, sow parity, stage of reproductive cycle, or age of the weaned pigs was not reported.

van Leengoed et al[6] characterized the outbreak of SD in a 170-sow breeding herd in which it was suspected that asymptomatic carrier replacement gilts had infected the herd. Clinically significant signs lasted for 3 months. Sows were sampled approximately

10 weeks after a pulse of arsanilic acid in feed (400 g per tonne for 9 days), and 16 of 64 asymptomatic sows (25.0%) were subsequently found positive. In addition, 11 months after the initial infection, B hyo was cultured from three asymptomatic weaned pigs, but the authors did not report the age or total number tested.

Jakubowski et al[14] studied one closed breeding herd in Poland over a 2-year period. Of 317 asymptomatic sows sampled at 14 days prior to farrowing, 29 (9.2%) were positive for B hyo by culture. The authors also found 76 of 481 litters (15.8%) positive for B hyo. After treatment of sows prior to farrowing with olaquindox or ronidazol, 0% of the sows and only one of 317 litters (0.3%) were positive for B hyo, giving support to the idea that effective timing of medication can limit transmission. This finding supports that transmission of B hyo from sow to litter occurs; however, environmental transmission cannot be fully excluded.

Mirko and Bilkei[11] evaluated risk factors for B hyo herd infection in 139 breed-to-finish units in Eastern Europe ranging in size from 101 to 289 sows, with separate breeding and grow-finish facilities. The median number of sow samples positive was five, with a range of zero to nine. Of the 139 farms, 51 (36.7%) were considered positive (at least three positive samples), while in 39 herds (28.1%), test results were inconclusive (one or two positive samples). This study presented a strong association between the B hyo status of the breeding herd and that of the grow-finish herd, further supporting vertical transmission of the organism.

Fellström et al[7] used culture and PCR techniques to evaluate five herds in Sweden that varied in type of production, clinical signs, and SD history. *Brachyspira hyodysenteriae* was diagnosed in three of the five herds (Herds 1, 2, and 4). Only Herd 1 demonstrated B hyo in adults (three of 50; 6.0%) or suckling piglets (four of six; 66.7%), and was also the only herd that demonstrated clinical signs during the study period. In Herd 2, B hyo was diagnosed in on-site 13- to 16-week-old growing gilts, destined for recipient sow herds, on three occasions at 3, 8, and 12 months after the initial study sampling. In Herd 4, only two of 26 weaned pigs (7.7%), 6 to 12 weeks of age, were identified as positive. Herds 3 and 5 never demonstrated a positive B hyo sample.

In the above reviewed cases, it is important to note that many herds had growing pigs on-site, and the largest herd sampled was 289 sows. To the authors' knowledge, no published work has described the prevalence of B hyo in large breed-to-wean herds (eg, > 1000 sows), where disease dynamics and associated management factors are very likely to be different and influential.

A better understanding of within-herd prevalence in breeding animals, lactating females, and suckling piglets in large herds would provide guidelines for appropriate methods of surveillance testing to determine true status with a higher level of confidence. Therefore, a series of cross-sectional studies were undertaken to estimate the within-herd prevalence of B hyo in breeding sows, lactating sows, and 3-week-old suckling piglets on six B hyo-positive breed-to-wean herds. Rectal swabs were collected from selected animals and subsequently tested by *Brachyspira* species culture and confirmed by culture-based PCR.

Materials and methods

Study 1: Lactating sows and suckling piglets

Study 1 was conducted on a 2200-sow breed-to-wean North Carolina breeding farm (Farm A) with an on-site gilt development unit. The sows and pigs utilized in this study were cared for under Pork Quality Assurance Plus (PQA Plus) guidelines (**http://www.pork.org/Certification/2341/pqaPlusMaterials.aspx**). Every 16 weeks, the gilt development unit received replacement breeding stock varying in age from 10 to 24 weeks. Piglets were weaned at approximately 3 weeks of age to an off-site nursery facility. At the time of the study, the farm was being actively depopulated for SD and porcine reproductive and respiratory syndrome virus (PRRSV) elimination, with emphasis placed on rodent control and sanitation. Approximately 1 year prior to the study, in August 2010, six fecal swabs had been collected from replacement gilts in the gilt development unit as part of a sentinel surveillance program.[5] One of six fecal swabs (16.67%) was both culture-positive and culture-based PCR-positive for B hyo at the Iowa State University Veterinary Diagnostic Laboratory, Ames, Iowa (ISU-VDL). A second sampling from the same group of gilts approximately 14 days later again isolated B hyo. Growing pigs originating from this breeding herd also experienced clinical disease, with a confirmed diagnosis of SD in off-site grow-finish units.

At each sampling, 60 lactating sows within a week prior to weaning were randomly selected from the current herd inventory using the random number generator function in Microsoft Excel (Microsoft Corporation, Redmond, Washington). Selected sows, ranging from gilts to 7th parity sows, represented the herd parity distribution at the time of sampling. Sows and gilts received no medications through the water or feed. A convenience sample of three piglets was selected from each litter. Rectal swabs were collected from the lactating sow and three piglets from her litter. Farm protocol allowed for cross-fostering of piglets within 24 hours of birth; therefore, dam origin of each piglet selected was not known, but it was assumed that risk of exposure occurred from the sow from which the piglet predominantly suckled. Rectal swabs were collected eight times over 18 weeks, at weeks 1, 5, 10, 12, 13, 14, 17, and 18 when visits could be scheduled by the authors. At each sampling, rectal swabs were collected from 60 "sets" of animals (based on 95% confidence in detecting at least one positive sample at a disease prevalence of 5%). The sample size for Study 1 was derived by considering low prevalence detection as well as the laboratory and economic constraints at the time of the study.

Study 2: Breeding herds

Study 2 was conducted on five breed-to-wean North Carolina farms (Farms B through F) ranging in size from 2400 to 3600 sows. Each farm had been confirmed positive for B hyo within the previous 12 months by fecal-swab culture and culture-based PCR in replacement gilts using the previously mentioned sentinel program.[5] In addition, growing pigs originating from each of the five breeding herds had expressed clinical SD, with confirmatory diagnosis of B hyo in off-site grow-finish units. Each of the five farms included in this study had an on-site gilt development unit. Sows were randomly selected from the current herd inventory using the random number function in Microsoft Excel (Microsoft Corporation), representing all parities and stages of production (breeding, gestating, lactating) on the farm. Selected sows represented the herd parity distribution. Replacement

breeding animals that were on-farm for less than 5 weeks were excluded from the sampling because not all breeding herds have a separate gilt development unit, and the goal of the study was to assess the breeding herd proper. Sows and gilts received no medications through the water or feed. Individual rectal swabs were collected from 150 individual sows (95% confidence in detecting at least one positive sample at a disease prevalence of 2%) at a single point in time at each farm. The Study 2 sample size was based on the Study 1 results, while also accounting for laboratory and economic constraints at the time of the study.

Sampling collection and culture methods

For all studies, a single individual rectal swab (BBL CultureSwab with liquid Stuart medium; Becton, Dickinson and Company, Sparks, Maryland) was collected from each animal. Swabs were sent on ice within 48 hours of collection to the ISU-VDL for *Brachyspira* species culture. Culture was conducted on both colistin-vancomycin-spectinomycin (CVS)[16] and spectinomycin-colistin-vancomycin-spiramycin-rifampicin (BJ)[17] blood agar plates for isolation of *Brachyspira* species. A sample was determined to be culture-positive if *Brachyspira* species growth occurred on either CVS or BJ blood agar plates. The routine use of both media types for *Brachyspira* species isolation balances the more selective properties of the BJ media with the less restrictive properties of the CVS media.[17,18] Results were reported globally as either culture-positive or culture-negative, with no differentiation based on the type of media. For sow samples, half of a culture plate was utilized per sample. In Study 1, piglet swabs were individually streaked on the top, middle, or bottom of the blood agar plates, with results reported on a per-litter basis. A litter was considered positive if at least one piglet from the litter was positive. No distinction was made in the results if more than one piglet from the litter was positive. Plates were incubated anaerobically at 42°C for 6 days. Any strongly beta-hemolytic culture-positive samples were confirmed by PCR for B hyo.[19,20] Isolates in Study 1 that were weakly beta-hemolytic on culture and untypeable by PCR were speciated using 16s ribosomal sequencing. Weakly beta-hemolytic isolates in Study 2 were not further characterized.

Prevalence estimation

To estimate true prevalence, a 95% confidence interval of the group prevalence (Study 1) or farm prevalence (Study 2) was calculated using two different approaches. A frequentist method of prevalence estimation was calculated using AusVet Epi Tools "Estimated true prevalence using an imperfect test" on-line calculator (**http://epitools.ausvet.com.au/content.php?page=TruePrevalence**) based on work by Rogan and Gladen.[21] Sample sizes of 60 (Study 1) or 150 (Study 2) were used along with the following assumptions, as reported by Achacha and Messier:[18] B hyo culture sensitivity of 89.7%, culture specificity of one, and sensitivity sample size of 145. Blaker's exact estimates and confidence limits were utilized.

The Bayesian method of estimation was compared to the frequentist method, since no true "gold standard" test for B hyo exists, and a priori information on culture sensitivity was available. To accomplish this estimation, the AusVet Epi Tools "Estimated true prevalence using one test with a Gibbs sampler" on-line calculator (**http://epitools.ausvet.com.au/content.php?page=OneTest**), based on work by Joseph et al,[22] was used. The required beta distributions were calculated with a priori estimates of prevalence beta ($\alpha = 1, \beta = 1$), culture sensitivity beta ($\alpha = 131, \beta = 16$) from Achacha and Messier,[18] and specificity beta ($\alpha = 88.28, \beta = 1.88$) using the AusVet Epi Tools beta distribution utility with a mode of 0.99 and a 95th percentile of 0.95 to approximate a high culture specificity.

Results

Study 1: Lactating sows and suckling piglets

Over the eight sampling periods, the percentage of sows positive for B hyo ranged from 0% to 5%, with an overall prevalence rate of 1.04%. In three of eight samplings there was at least one positive sow. The percentage of litters positive for B hyo ranged from 0% to 5%, with an overall prevalence rate of 1.88%. In five of eight samplings there was at least one positive litter. Table 1 shows the percentages of sows and litters positive for B hyo by sampling week and total study period, along with the associated estimated true prevalence and confidence intervals using the two methods described. Table 2 shows the distribution of positive sows and litters by parity. Overall, 14 of 960 samples (five sows and nine litter samples; 1.46%) were positive for B hyo. In two of 480 sample sets (0.42%), both the sow and litter were positive for B hyo.

Throughout the study, several weakly beta-hemolytic *Brachyspira* species were identified, including *Brachyspira murdochii*, *Brachyspira innocens*, and *Brachyspira alvinipulli* (data not shown). No strongly beta-hemolytic *Brachyspira* species other than B hyo were isolated in Study 1.

Study 2: breeding herds

The percentage of sows positive for B hyo ranged from 0% to 1.33%. Only three of the five farms demonstrated at least one B hyo-positive culture. Table 3 shows the percentage of sows positive for B hyo and the estimated true prevalence and confidence intervals for each sow farm. Several other weakly beta-hemolytic *Brachyspira* species were identified during sampling. No strongly beta-hemolytic *Brachyspira* species other than B hyo were isolated in Study 2.

Discussion

Brachyspira hyodysenteriae was cultured from rectal swabs of adult breeding and lactating sows and suckling piglets from known SD-positive breeding herds on four of six breed-to-wean farms. However, on two farms known to have SD, our testing method failed to detect B hyo. In addition, for the SD-positive farm in Study 1, our testing method failed to detect B hyo in three of eight sampling points. If broken down further, our testing method failed to detect B hyo in five of eight sampling points in sows, and three of eight sampling points in piglets. Furthermore, in the breeding herds in Study 2 known to be SD-positive, our testing method failed to detect B hyo on two of the five farms. These results highlight the difficulty in determining the true SD status of breeding herds. The methods employed for these two studies – repeated sampling and a large number of samples – are costly and time consuming and require coordination between the veterinarian and the diagnostic laboratory, but do provide a method of detecting B hyo in breeding herds. The results of these studies should be of value to those wanting to explore the true B hyo status of swine breeding herds prior to undergoing a system-level elimination project, evaluating the success of an elimination program (depopulation or medication), or selling breeding stock.

In Study 1, the litters of two of the five sows identified as B hyo-positive were also diagnosed as B hyo-positive, potentially demonstrating the importance of carrier sows transmitting to carrier piglets in the epidemiology of the disease.

Table 1: Percentage of sows and litters positive for *Brachyspira hyodysenteriae* on a 2200-sow, breed-to-wean, North Carolina farm by sampling week and total study period (Study 1, Farm A)*

Sampling week	No. sows positive (%) n = 60	Estimated true prevalence (95% CI)		No. litters positive (%) n = 60	Estimated true prevalence (95% CI)	
		Frequentist†	Bayesian‡		Frequentist†	Bayesian‡
1	1 (1.67)	1.9 (0.1, 9.6)	2.3 (0.1, 9.2)	1 (1.67)	1.9 (0.1, 9.6)	2.3 (0.1, 9.2)
5	3 (5.00)	5.6 (1.5, 15.2)	4.9 (0.4, 13.9)	3 (5.00)	5.6 (1.5, 15.2)	4.9 (0.4, 13.9)
10	1 (1.67)	1.9 (0.1, 9.6)	2.3 (0.1, 9.2)	2 (3.33)	3.7 (0.7, 12.4)	3.5 (0.2, 11.5)
12	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)
13	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)	1 (1.67)	1.9 (0.1, 9.6)	2.3 (0.1, 9.2)
14	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)
17	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)	2 (3.33)	3.7 (0.7, 12.4)	3.5 (0.2, 11.5)
18	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)	0 (0.0)	0.0 (0.0, 6.6)	1.3 (0.0, 6.6)
Total N = 480	**5 (1.04)**	**1.2 (0.5, 2.7)**	**0.6 (0.0, 2.1)**	**9 (1.88)**	**2.1 (1.0, 3.9)**	**1.1 (0.0, 3.1)**

* Sixty sows and three pigs from each sow's litter were sampled by rectal swab weekly for 8 sampling weeks (total 480 sows). Swabs were tested by culture for *B hyodysenteriae*. A litter was considered positive if at least one pig tested positive.

† Frequentist approach estimates and intervals calculations based on work by Rogan and Gladen.[21]

‡ Bayesian approach estimates and intervals calculations based on work by Joseph et al.[22]

Table 2: Distribution of sows and litters positive for *Brachyspira hyodysenteriae* by parity on a North Carolina breed-to-wean farm (Study 1; Farm A)*

Parity	No. samples	No. sows positive (%)	No. litters positive (%)
1	119	1 (0.84)	0 (0.00)
2	145	2 (1.38)	4 (2.76)†
3	69	0 (0.00)	1 (1.45)
4	71	1 (1.41)	4 (5.63)†
5	54	0 (0.00)	0 (0.00)
≥ 6	22	1 (4.55)	0 (0.00)

* Study farm and diagnostic testing described in Table 1.

† One sow and litter pair were both positive for *B hyodysenteriae* in each indicated parity grouping.

In both Study 1 and Study 2, there was no effect of parity on culture result. Further studies on parity influences and other potential confounders on B hyo status should be conducted to provide better sampling guidelines for at-risk animals.

One limitation in the methods of this study is the use of culture as a diagnostic test. Sensitivity and specificity of *Brachyspira* species culture has not been studied extensively. One report by Achacha and Messier[18] estimated culture sensitivity at 89.7%, but did not report specificity. Culture has been shown to be more sensitive for detection of *B hyo* than current direct fecal PCR techniques, and culture allows for detection of other *Brachyspira* species (eg, *B hampsonii*) that may be missed by PCR due to primer or probe specificity.[7,23,24] Fecal shedding of *Brachyspira*, especially in recovered carrier animals, may be intermittent, and thus negative culture does not provide information on previous exposure and potential for carrier status.[1] In 1986, Olson and Rodabaugh[25] outlined a procedure by which sodium arsanilate could be fed to pigs at 220 grams per tonne for 21 days in order to induce the asymptomatic SD carrier to show typical clinical signs, thereby increasing the likelihood that carriers could be identified. While this method could help with identification of carriers, it should be noted that at the time of this publication, the sale of sodium arsanilate in the United States and Canada has been voluntarily suspended. In regions where sodium arsanilate is available and its use in sows is legal, its use to assist in the diagnosis of SD should be evaluated. Furthermore, the concept of inducing clinical disease in carrier animals could be further explored through means such as removal of medications[26] or by utilizing feed ingredients that can induce clinical dysentery (ie, nondigestible feedstuffs).[27,28]

Comparison of the frequentist and Bayesian methods of prevalence estimation showed no meaningful differences in the estimated prevalence or confidence intervals. The Bayesian methodology appeared to have a more conservative prevalence and precise confidence interval than the frequentist method; however, the differences were small. For example, the estimated true prevalence when one of 60 sow samples was positive was 1.9 and 2.3 for the frequentist and Bayesian methods, respectively, with confidence intervals of 0.1 to 9.6 and 0.1 to 9.2, respectively. Biologically, this is not a significant difference, and is likely due to the overall low prevalence of the disease in the herds. The estimated upper 95% confidence level of true prevalence in Study 1 was

Table 3: Percentage of sows positive for *Brachyspira hyodysenteriae* for each of five North Carolina sow farms (farms B through F; Study 2)*

Farm	No. positive (%)	Estimated true prevalence (95% CI)	
		Frequentist†	Bayesian‡
B	2 (1.33%)	1.5 (0.3, 5.3)	1.2 (0.0, 4.4)
C	1 (0.67%)	0.7 (0.0, 3.8)	0.8 (0.0, 3.7)
D	0 (0%)	0.0 (0.0, 2.7)	0.5 (0.0, 2.7)
E	0 (0%)	0.0 (0.0, 2.7)	0.5 (0.0, 2.7)
F	1 (0.67%)	0.7 (0.0, 3.8)	0.8 (0.0, 3.7)

* Rectal swabs collected from 150 sows on each farm were cultured for *B hyodysenteriae*.

† Frequentist approach estimates and intervals calculations based on work by Rogan and Gladen.[21]

‡ Bayesian approach estimates and intervals calculations based on work by Joseph et al.[22]

between 6.6% and 15.2% in weekly lactation sows and weaned-pig batches, and in Study 2, between 2.7% and 5.3% in breeding herds. Interpretation of estimated prevalence should consider the characteristics of the sampling and diagnostic methodologies used. Culture only identifies animals shedding above the detection threshold (10^2 colony forming units per g feces) at the time of sampling, and may underestimate the true prevalence of exposure or carrier status.[24] The data presented herein provides veterinarians with a reference for estimated prevalence rates of carrier animals to be used in developing future diagnostic sampling methodologies.

During the course of this study, several weakly beta-hemolytic *Brachyspira* species were identified from breeding animals. Both *B murdochii* and *B innocens* have been shown to cause colitis in swine, but little is understood about the role these isolates may play in breeding-herd enteric infections and immunity.[29-31] The confirmation of *B alvinipulli* by both 16s and *nox* gene sequencing, also isolated from breeding sows in Study 1, represents a unique case in which a *Brachyspira* species seldom reported in swine was isolated (Thomson J, e-mail communication, and Hampson D, e-mail communication, 2012). To the authors' knowledge there have been no reports to date on the impact or significance of *B alvinipulli* in swine, but it has been associated with enteritis in chickens and laying hens, and fibrinonecrotic typhlocolitis in laying geese.[32,33]

Given the results of the studies included herein and the literature currently available, the authors suggest that a multi-tiered approach to diagnosis of *B hyodysenteriae* in breed-to-wean herds be pursued, given the following four assumptions. The use of culture is currently the most sensitive and definitive method of diagnosis for all *Brachyspira* species (especially the pathogenic *B hyodysenteriae, B hampsonii,* and *B pilosicoli*); however, direct fecal PCR and serologic tests could help screen herds and improve laboratory and economic constraints. Apparent prevalence is likely < 5%, due to epidemiology, low shedding of carrier animals, and sensitivity of diagnostic method. True prevalence may vary depending on the time point at which pathogen introduction occurred (endemic versus epidemic). Susceptible populations may be more likely to express clinical disease in endemic herds (ie, higher prevalence in recent gilt introductions, lactating sows, or suckling piglets). Therefore, strategic exposure and sampling of susceptible replacement animals utilizing the sentinel-gilt program, in combination with random sampling of susceptible suckling weaning-aged piglets at a prevalence detection level ≤ 2% over multiple sampling periods, should increase level of confidence in determining the true status of the breeding herd. The true SD status can determine if a farm goes through an expensive elimination program (eg, depopulation, medication program), if those programs were effective, or if animals can be confidently sold to potential markets for growth or genetic replacement. Understanding within-herd B hyo prevalence is necessary in designing effective surveillance protocols. Further research on detection methods for carrier animals (PCR, serology), prevalence estimates of susceptible subpopulations (ie, replacement breeding stock, lactating sows, and suckling piglets), and prevalence within parities would continue to improve upon the surveillance methodologies of *Brachyspira* species in breeding herds.

Implications

- Sampling breeding animals, suckling-age piglets, or both for *Brachyspira hyodysenteriae* could serve as a valuable supplement to the traditional surveillance schemes that utilize sentinel animals.
- A better understanding of the prevalence of *B hyodysenteriae* on endemically infected sow farms should assist veterinarians in developing enhanced surveillance programs.
- Current diagnostic testing methodologies for *B hyodysenteriae* in breeding herds or weaning groups should target low prevalence rates (ie, ≤ 2%).

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Conflict of interest

Novartis Animal Health US, Inc provided the funding for all of the diagnostic tests utilized in this study. While funding was provided by Novartis Animal Health US, Inc, all diagnostic tests were conducted by Iowa State University's Veterinary Diagnostic Laboratory.

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Diagnostic assessment and lesion evaluation of chronic deoxynivalenol ingestion in growing swine

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Summary

Deoxynivalenol (DON) is a common mycotoxin contaminant of cereal grains and is associated with reduced feed intake or refusal in swine. The objective of this assessment was to determine if diagnostic tests or lesions could assist in diagnosing chronic DON ingestion in swine. Twenty-four 11-week-old cross-bred pigs of both genders were fed either an ad libitum diet without deliberate contamination of DON (Control; n = 6) or a diet containing approximately 5 mg per kg DON (DON-fed; n = 18). Dried distillers' grains with solubles were the source of DON for the diets. Serum analytes were measured at the beginning and conclusion of the 120-day study. All pigs were necropsied and liver analyte concentrations, bone density, and bone ash were determined. Differences in serum analyte concentrations, macroscopic or microscopic lesions, and bone ash and density were not detected between treatment groups ($P > .05$). Liver selenium concentrations were lower ($P = .02$) in DON-fed pigs. Results suggest DON ingestion is not correlated with lesions or bone integrity, but can significantly lower liver selenium concentrations.

Keywords: swine, deoxynivalenol, DON, selenium, vomitoxin

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Resumen - Valoración diagnóstica y evaluación de lesiones en cerdos de crecimiento de ingestión de deoxynivalenol crónica

El deoxynivalenol (DON por sus siglas en inglés) es un contaminante de micotoxina común de granos de cereal y está asociado con el consumo reducido o rechazo de alimento en cerdos. El objetivo de esta valoración fue determinar si las pruebas de diagnóstico o las lesiones podrían ayudar en el diagnóstico de ingestión crónica de DON en cerdos. Veinticuatro cerdos de 11 semanas de edad, de raza cruzada y de ambos géneros fueron alimentados con dieta ad libitum sin contaminación deliberada de DON (Control; n = 6) o una dieta con contenido de aproximadamente 5 mg por kg de DON (alimentado con-DON; n = 18). La fuente de DON para las dietas fueron granos secos de destiladores con solubles. Se midieron los analitos de suero al principio y a la conclusión del estudio de 120 días. Se hizo necropsia a todos los cerdos y se determinaron las concentraciones de analitos del hígado, y se determinó la densidad y la ceniza de hueso. No se detectaron diferencias en las concentraciones de analitos de suero, lesiones microscópicas o macroscópicas, ni en la densidad y ceniza de hueso entre los grupos de tratamiento ($P > .05$). Las concentraciones de selenio del hígado fueron más bajas ($P = .02$) en cerdos alimentados con DON. Los resultados sugieren que la ingestión de DON no está correlacionada con lesiones o integridad del hueso, pero pueden disminuir significativamente las concentraciones de selenio del hígado.

Résumé - Appréciation diagnostique et évaluation des lésions d'ingestion chronique de déoxynivalenol chez des porcs en croissance

Le déoxynivalenol (DON) est une mycotoxine contaminant naturellement les grains de céréales et est associée à une diminution ou un refus de la prise de nourriture chez les porcs. L'objectif de la présente étude était de déterminer si les tests diagnostiques ou les lésions pouvaient aider à diagnostiquer l'ingestion chronique de DON chez le porc. Vingt-quatre porcs croisés des deux sexes et âgés de 11 semaines ont été nourris soit ad libitum avec une alimentation sans contamination intentionnelle par du DON (Témoin; n = 6) ou une alimentation contenant approximativement 5 mg par kg de DON (DON-alimenté; n = 18). Des grains de distillerie partiellement séchés étaient la source de DON pour les rations. Des composantes sériques ont été mesurés au début et à la fin de l'étude de 120 jours. Tous les porcs ont été soumis à une nécropsie et les concentrations de composantes hépatiques, de poudre d'os, et la densité osseuse ont été déterminées. Aucune différence dans les concentrations de composantes sériques, dans les lésions macroscopiques ou microscopiques, la densité osseuse, et de poudre d'os ne fut détectée entre les groupes de traitement ($P >$,05). Les concentrations hépatiques de sélénium étaient plus faibles ($P =$,02) chez porcs DON-alimentés. Les résultats suggèrent que l'ingestion de DON n'est pas corrélée avec des lésions ou l'intégrité osseuse, mais peut significativement faire diminuer les concentrations hépatiques de sélénium.

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Deoxynivalenol (DON), also known as vomitoxin, is a mycotoxin produced by *Fusarium* species, which under the correct growing conditions may contaminate cereal grains, especially maize (corn).[1] DON is elevated in cereal grains that are stressed during maturation or harvested with high moisture content, and can increase with inadequate drying and improper storage. The consequence of feeding DON-contaminated feed to livestock can vary from negligible at low concentrations to complete feed refusal in highly contaminated feedstuffs.[1]

Numerous animal species are affected by DON contamination. However, swine are highly sensitive to its effects. DON is rapidly absorbed from the upper gastrointestinal tract following oral exposure, with minimal subsequent metabolization.[2] The main toxic effect of DON is decreased protein synthesis causing multiple cellular functional abnormalities that may lead to cell death.[3] Immunosuppression caused by impaired protein synthesis can also occur in animals fed DON-contaminated feed.[4] Increased disease susceptibility and delayed immune responses may occur with intermediate (1 to 5 mg per kg) to high concentrations (> 5 mg per kg) of DON being fed to pigs.[5-7]

An accurate diagnosis of acute or chronic DON ingestion in swine can be difficult. Suboptimal feed intake and growth performance and increased morbidity are clinical effects resulting from chronic exposure. In addition, DON ingestion can be obscured by other diseases resulting from its immunosuppressive effects. Testing complete feed or primary-source ingredients for DON is the most reliable way to determine exposure. However, diagnosing DON contamination by analyzing the feed from the bulk bin of apparently clinically affected animals can be challenging if the distribution of DON in the feedstuffs is intermittent or highly variable.

The objective of this assessment was to determine appropriate diagnostic tests and tissue specimens necessary to accurately diagnose chronic DON ingestion in pigs consuming 5 mg per kg DON in complete feed for 120 days.

Materials and methods

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

The twenty-four 11-week-old cross-bred pigs of both genders assessed in the present study were a subset of pigs used in a larger feeding trial evaluating the effects of DON and commercial mycotoxin binding agents on growth performance.[8] Pigs were initially allocated to pens on the basis of body weight (22.9 ± 4.3 kg) and gender, and were assigned to a treatment group using a random number generator in a complete block design.[8] Pigs included in the present study were randomly selected (by random number generator) from control pens (Control; n = 6) fed a diet that contained 0.2 to 0.7 mg per kg DON or from highly contaminated groups (DON-fed; n = 18) receiving diets containing approximately 5 mg per kg DON. Mycotoxin binders were not included in either diet during the feeding period.

Pigs were housed in a 1040-head commercial finishing facility with a computerized feeding system (Feedlogic System, Willmar, Minnesota) to deliver specific diets in measured quantities to each pen. Pens were equipped with one feeder and two nipple waterers. Pigs were fed ad libitum a corn-soy-based diet containing 20% dried distillers' grains with solubles (DDGS), with DON obtained from DDGS from two different corn ethanol plants. Highly contaminated (18.6 mg per kg DON) and clean DDGS (0.81 mg per kg DON) were procured from plants in Indiana and Iowa, respectively. Pigs were phase-fed six balanced diets[8] according to age, with all diets containing 9 g per tonne virginiamycin (Stafac; Phibro, Ridgefield Park, New Jersey). Dietary inclusion of selenium, fed as sodium selenite, was 0.3 mg per kg of complete feed.[8] Delivered feed samples were saved from all diets, and samples from phases two, three, and five were analyzed by liquid chromatography-tandem mass spectrometry for confirmation of DON quantities according to the Iowa State University Veterinary Diagnostic Laboratory (ISU-VDL) standard operating procedure.

Pigs were vaccinated with commercial vaccines for porcine circovirus type 2 and *Mycoplasma hyopneumoniae* prior to the study. Pigs were serologically positive for porcine reproductive and respiratory syndrome virus.

Serum samples were collected from Control and DON-fed pigs at the start of the study (Day 0) and at Day 117. Blood samples were allowed to clot and were chilled and centrifuged within 3 hours of collection, and sera were distributed in 5-mL aliquots for storage at -80°C. Serum analyte concentrations were measured the day of collection (Vitros 5.1 Chemistry Analyzer; Ortho Clinical Diagnostics, Johnson and Johnson, Rochester, New York). Analytes included sodium, potassium, chloride, bicarbonate, calcium, phosphorus, magnesium, blood urea nitrogen (BUN), creatinine, glucose, total protein, albumin, aspartate aminotransferase (AST), creatine kinase (CK), alkaline phosphatase (ALP), gamma glutamyl transferase (GGT), and anion gap. Globulin concentrations were calculated by subtracting albumin concentration from the total protein value.

Control and DON-fed pigs were weighed on Day 0 and again on Day 120, and then were necropsied. Macroscopic lesions were recorded by a veterinary pathologist blinded to treatment group. Tissues collected included thymus, thyroid, heart, lung, liver, gall bladder, pancreas, adrenal glands, kidneys, urinary bladder, spleen, stomach (glandular and pars esophagea regions), duodenum, jejunum, ileum, colon, bone (second rib), and tracheobronchial, mesenteric, and inguinal lymph nodes. Individual weights were recorded for the thyroid and adrenal glands. Fresh tissues were stored at -80°C.

Fresh liver samples were quantitatively assessed for concentrations of cadmium, calcium, cobalt, copper, chromium, iron, phosphorus, potassium, magnesium, manganese, molybdenum, selenium, sodium, and zinc by inductively coupled plasma-mass spectrometry (ICP-MS) (ICP-mass spectrometer; Varian, Santa Clara, California) according to the ISU-VDL standard operating procedure. Briefly, two 1-gram samples were weighed into Teflon vessels (MARSXpress TFM digestion vessels; CEM Corporation, Matthews, North Carolina) with 2 mL of 18 MΩ water (Aries 1105D, Direct Feed Laboratory Water System; Aries filter works, a division of Resintech, Inc, West Berlin, New Jersey) followed by 10 mL of trace-metal grade concentrated nitric acid. Vessels were sealed, vortexed, and subsequently microwaved to digest the sample. After cooling, samples were filtered (Whatman #40 filter paper, ashless, circles, 90 mm; Whatman Inc, Piscataway, New Jersey) and diluted to 25 mL with 18 MΩ water. Filtered samples were diluted 1:10 in 1% nitric acid for calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, and zinc assays, and were diluted 1:3 for cadmium, chromium, cobalt, molybdenum, and selenium assays. Samples were analyzed with internal standards and control liver that bracketed the concentration range of each analyte.

Bone ash and density were determined from the second rib according to the ISU-VDL standard operating procedure.[9] Soft tissue, periosteum, and the distal costochondral portion were discarded. A 5-cm section of the remaining rib was removed and tested. Individual samples were dried, weighed, placed in a beaker of water, and vacuum sealed overnight to remove air bubbles. The following day, the weight of the bone suspended in water was recorded. Density was calculated using Archimedes' principle. Bone ash was determined by recording the weight of the second rib used for the density measurement prior to placement in a muffle oven overnight at 500°C. Percent bone ash was calculated by dividing the weight of the bone ash by the weight of the original bone.[9]

Formalin-fixed tissues were paraffin-embedded, sectioned, stained with hematoxylin and eosin, and evaluated by a veterinary pathologist blinded to treatment group. Microscopic lesions were assessed in all tissue sections. Stomach, small intestine, and colon were individually scored for the amount of inflammation in the mucosa and the submucosa (0, normal; 1, mild; 2, moderate; 3, marked) and for the amount of gut-associated lymphoid tissue (GALT) hyperplasia (0, none; 1, mild; 2, moderate; 3, marked). An average score for the small intestine was calculated using the individual scores from five different sections evaluated. A total score was calculated for stomach, small intestine, and colon by combining the mean values for mucosa, submucosa, and GALT with possible scores ranging from 0 to 9.

Summary statistics (JMP software version 8.0.2; SAS Institute, Cary, North Carolina) were calculated for all groups to assess the overall quality of the data set. A two-tailed Student *t* test was used for mean comparisons between treatment groups. For serum chemistry values, analysis of variance (ANOVA) was conducted with an effects test to measure the effect of time. Differences were considered statistically significant at $P < .05$.

Results

Growth rate, as measured by average daily gain (ADG), did not differ between Control pigs (0.79 ± 0.02 kg) and DON-fed pigs (0.77 ± 0.01 kg) evaluated in the present study ($P > .05$). Few macroscopic lesions were apparent at necropsy. Mild chronic fibrosing pleuritis with adhesions to the thoracic cavity was observed in one Control pig and two DON-fed pigs. The DON-fed group included one pig with chronic pericardial fibrosis and one pig with mild fibrosing peritonitis. All other organs and organ systems appeared normal in both groups.

Serum chemistry values at Days 0 and 117 did not differ between the Control and DON-fed groups ($P > .05$). However, a significant effect of date (age) was observed between Day 0 and Day 117 for several analytes that decreased with age, including phosphorus ($P < .001$), potassium ($P < .001$), magnesium ($P < .001$), and AST ($P < .001$), while glucose ($P = .02$), BUN ($P < .001$), and CK ($P < .01$) increased (data not shown).

Liver analyte values are reported in Table 1. Liver selenium concentrations (reference interval 0.40 to 1.20 mg per kg[10]) were significantly lower ($P = .02$) in the DON-fed group than in the Control pigs. Adrenal gland weight and thyroid weight as percentages of body weight, bone ash percentage, and bone density did not differ between treatment groups (Table 2).

Microscopic lesions were not evident in examined sections of bone, heart, lymph nodes, pancreas, spleen, thymus, thyroid, or urinary bladder in either group. Sporadic inflammatory lesions were noted in both groups and included interstitial pneumonia, interstitial nephritis, scant lymphocytic adrenalitis, and mild cholecystitis. Neither hepatocellular necrosis nor vacuolar degeneration was observed in the sections examined in either group.

Gastrointestinal lesion scores did not differ between Control and DON-fed pigs. Mean microscopic lesion scores for stomach, small intestine, and colon in Control pigs were 2.67, 1.20, and 2.83, respectively. Mean scores for DON-fed pigs were 3.34, 1.17, and 3.61 for stomach, small intestine, and colon, respectively. The pars esophagea region of the stomach, which included squamous and non-squamous areas, contained moderate to marked GALT hyperplasia in three Control and 11 DON-fed pigs. These nodular lymphocytic aggregates were present within the lamina propria and sometimes extended into the submucosa. Epithelial erosions or ulcerations were not identified.

Discussion

Each year, approximately 25% of cereal grains produced globally are contaminated with DON.[11] DON is more abundant in grains harvested in regions with high humidity and cool temperatures and is further amplified by storing grains contaminated with *Fusarium* species at high moisture levels.[1] In 2009, high atmospheric humidity and abnormally cool temperatures during corn harvest in the US corn belt resulted in soaring DON concentrations, which were subsequently fed in large amounts to production livestock. Further compounding the issue for some livestock producers was the inclusion of DDGS in the diet. Fermentation of corn to ethanol does not degrade mycotoxins, but amplifies their concentration three-fold in the finished corn by-product.[12]

The predominant clinical effects of feeding high concentrations of DON to pigs are reduced feed intake or refusal, resulting in suboptimal growth performance. In the larger study from which these pigs were derived, pigs receiving highly contaminated DON feed had significantly lower ADG than did pigs receiving feed that contained only 0.2 to 0.7 mg per kg DON.[8] Differences in ADG were not detected in the subset pigs evaluated in this study, likely due to the smaller sample size of the Control pigs. Vomiting, occasional diarrhea, and the potential for rectal prolapse has been documented after feeding DON.[3] Furthermore, smaller thyroid size and squamous hyperplasia of the pars esophagea region were reported in swine fed increasing levels of DON (up to 3 mg per kg) for 28 days, compared to pigs without DON-contaminated feed.[13] In contrast, the results in the present study did not detect significant differences in thyroid weights between groups after 120 days, and squamous hyperplasia in the stomach was not evident. However, pigs can adapt to DON ingestion.[14] Therefore, the lack of significant differences between the groups described in this study may be due to pigs acclimating to high levels of DON in the diet with subsequent resolution of lesions over time.

Other investigators have evaluated organ weights after feeding different levels of DON. Reports do not agree and fail to account for differences in kidney, liver, and spleen weights relative to body weight. Additional reports have demonstrated higher relative liver and kidney weights with DON ingestion.[13,15-17] Individual liver, spleen, and kidney weights were not evaluated in this study. However, adrenal glands were weighed as a potential determinant of reduced protein synthesis caused by feeding elevated DON concentrations. Under the conditions of this assessment, significant differences in adrenal weights were not detected.

Table 1: Swine liver analyte concentrations measured by inductively coupled plasma-mass spectrometry after feeding diets minimally contaminated with deoxynivalenol (Control pigs; 0.2 to 0.7 mg per kg feed) or highly contaminated (DON-fed pigs; approximately 5 mg per kg feed) for 120 days*

Analyte	Control (n = 6)		DON-fed (n = 18)		*P*‡
	Mean (mg/kg)†	Range (mg/kg)	Mean (mg/kg)†	Range (mg/kg)	
Cadmium	0.019 ± 0.002	0.012-0.023	0.017 ± 0.001	0.012-0.022	.29
Calcium	63 ± 3	56-74	66 ± 2	54-82	.51
Chromium	0.075 ± 0.025	0.046-0.198	0.089 ± 0.025	0.032-0.126	.71
Cobalt	0.013 ± 0.001	0.009-0.015	0.012 ± 0.001	0.009-0.034	.89
Copper	10.2 ± 1.1	7-14	18.5 ± 7.8	7-151	.31
Iron	225 ± 26	131-298	198 ± 14	96-305	.39
Magnesium	169 ± 6	152-193	168 ± 3	150-188	.85
Manganese	2.3 ± 0.1	2.1-2.8	2.4 ± 0.1	1.8-2.8	.40
Molybdenum	1.13 ± 0.07	0.87-1.41	0.97 ± 0.03	0.73-1.18	.08
Phosphorus	2816 ± 114	2368-3060	2725 ± 50	2309-3149	.48
Potassium	2933 ± 44	2752-3046	2738 ± 48	2530-3321	.93
Selenium	0.718 ± 0.039	0.620-0.840	0.576 ± 0.033	0.501-0.760	.02
Sodium	1028 ± 46	840-1170	936 ± 29	763-1275	.12
Zinc	62.5 ± 3.6	53-73	69.4 ± 7.2	38-158	.40

* Pigs were 11 weeks of age at the start of the feeding period. Dried distillers' grains with solubles were the source of the DON contamination.

† Mean analyte concentrations ± standard error of the mean.

‡ A two-tailed Student *t* test was used for mean comparisons between treatment groups.

DON = deoxynivalenol.

Table 2: Thyroid, adrenal gland, and bone parameters* measured in pigs after feeding diets minimally contaminated with deoxynivalenol (Control pigs; 0.2 to 0.7 mg/kg feed) or highly contaminated (DON-fed pigs; approximately 5 mg/kg feed) for 120 days†

Treatment		Thyroid (%)		Adrenal gland (%)		Bone ash (%)		Bone density (g/mL)	
	n	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Control	6	0.008 ± 0.0002	0.006-0.009	0.007 ± 0.0004	0.004-0.009	55.8 ± 0.5	53.7-57.5	1.38 ± 0.01	1.36-1.41
DON-fed	18	0.007 ± 0.0001	0.005-0.009	0.006 ± 0.0001	0.004-0.010	56.5 ± 1.1	37.6-65.4	1.39 ± 0.02	1.23-1.49

* For thyroid and adrenal gland, weights are expressed as percentage of total body weight. Percent bone ash was calculated by dividing the weight of the ash by the weight of the original bone. Bone density was calculated using Archimedes' principal. For all parameters, values are expressed as the mean ± standard error of the mean.

† Values did not differ between the DON-fed and Control groups (two-tailed Student *t* test; $P > .05$).

DON = deoxynivalenol.

Consistent with previous reports,[18,19] serum analyte values did not differ between groups in the study described here. Alternatively, others have described lower serum calcium, phosphorus, cholesterol, ALP, total protein, and globulin,[20-23] and higher serum chloride, ALP, and albumin in pigs ingesting higher concentrations of DON than controls.[15,17,24] Serum analyte changes noted in previous reports may be due to feeding DON for periods of time shorter than those used in this study. The authors acknowledge that analyte values may have varied throughout the feeding period. From a diagnostic perspective, serum analyte values are highly variable and may be dependent on both the duration and dose of DON ingestion.

Inductively coupled plasma-mass spectrometry, bone ash, bone density, and liver analysis may be used to assess the long-term effects of DON ingestion and how it alters the storage of different analytes. To the authors' knowledge, these methods have not been reported for pigs being fed DON-contaminated feed for extended periods of time. Selenium was the only analyte that was significantly lower in the DON-fed group. DON ingestion has multiple effects on cellular functions, including decreased protein synthesis and lipid peroxidation. Selenium is a well-known antioxidant as a component of superoxide dismutase and

is important for both immunity and cell survival through limiting the effects of lipid peroxidation.[25,26] Lower liver selenium concentrations in DON-fed pigs were not unexpected, but to the authors' knowledge, this has not been previously reported. Supplementing with higher levels of selenium in DON-contaminated feed decreases liver lipid peroxidation in rats[27] and reversed the adverse effects on the immune system in chickens.[28] These results raised speculation that increased antioxidants in swine diets known to be contaminated with DON may reduce the physiological effects associated with ingestion. Bone ash and density did not differ between groups. Under the conditions of this study, these results suggest that DON has no physiological effect on bone growth or bone integrity and further confirms that serum calcium and phosphorus disturbances measured in other reports may be transient or unrelated to DON ingestion.

Few studies have evaluated microscopic lesions associated with feeding DON. Similar to other measured parameters, inconsistent microscopic lesions are likely associated with dose and timing of sampling the animals after DON ingestion. Previous studies have reported variations in the presence of microscopic lesions ranging from none detected[16] to lesions that were considered relevant to DON ingestion.[29] Recently, it was documented that intravenous administration of DON to pigs results in lymphocyte apoptosis in multiple lymphoid organs and other tissues, with more severe lesions observed at 24 hours. Hepatocellular apoptosis has also been reported.[30] Following a 6-week feeding study with DON-contaminated feed, lymphocytic depletion was apparent in the spleen, and hepatic vascular dilatation and thickening and focal hemorrhagic and necrotizing lymphadenitis were reported.[22] Two other groups observed an increase in hepatic fibrosis separating lobules.[15,31] However, both studies had mixed mycotoxins in the feed, including DON and aflatoxin and DON and zeralenone contamination, respectively. The complete feed used in this study contained minimal quantities of zeralenone (0 to 0.6 mg per kg) and fumonisin B1 (0 to 1.1 mg per kg), but not aflatoxin.[8] These concentrations are considered within normal limits in swine feed. Evidence of previous or persistent hepatic degeneration or necrosis was not observed. These data suggest that liver histopathology cannot be reliably used to diagnose chronic DON ingestion.

An important aspect of this study was its extensive evaluation of the gastrointestinal tract for microscopic lesions that may be linked to DON ingestion. Feeding diets contaminated with DON alone has been demonstrated to cause mild villous atrophy, edema, and hyperemia during the acute post-feeding period.[32] Feeding diets with multiple mycotoxin contaminants (DON, T-2 toxin, and zeralenone) resulted in mild inflammation, goblet cell loss, and increased crypt necrosis.[33] A study in mice fed DON and nivalenol reported inflammation and crypt necrosis of the small intestine, and gastric ulceration and inflammation.[34] Furthermore, DON can alter intestinal microflora by increasing aerobic mesophilic bacteria.[35] DON consumption has also been shown to promote uptake of *Salmonella* serovar Typhimurium by macrophages, suggesting there may be an increased susceptibility to gastrointestinal pathogens in swine.[7] For these reasons, in this study, an intestinal inflammatory score was recorded along with morphological changes. Diagnostic changes associated with abnormal villi, loss of goblet cells, crypt changes including necrosis or increased mitoses, or colonic glandular changes were not apparent in examined sections of small and large intestine. These data suggest that either higher doses of DON may be needed to cause gastrointestinal inflammation, or pigs chronically fed DON physiologically adapt with time.

Evaluating swine tissues macroscopically and microscopically, performing bone analysis, or measuring serum analytes (including liver enzyme activity) demonstrated limited diagnostic value in determining chronic DON ingestion in pigs fed 5 mg per kg DON in complete feed for 120 days. Alternatively, these data suggest that measuring liver selenium concentrations may aid in the diagnosis of chronic DON exposure in pigs.

Implications

- Under the conditions of this study, chronic DON ingestion does not cause significant macroscopic or microscopic tissue lesions.
- Under the conditions of this study, in pigs fed 5 mg per kg DON in complete feed for 120 days, bone and serum analyte analysis are of limited diagnostic value.
- Liver trace-mineral analysis may provide a useful diagnostic tool suggesting chronic DON ingestion.
- Additional studies are necessary to evaluate the effects of chronic DON ingestion in pigs fed concentrations of DON > 5 mg per kg of feed.

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Conflict of interest

None reported.

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General guidelines for porcine reproductive and respiratory syndrome regional control and elimination projects

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Summary

Porcine reproductive and respiratory syndrome (PRRS) continues to be a costly disease affecting the swine industry worldwide. While veterinarians have developed a variety of strategies to control and eliminate the disease from pig herds, the risk of re-infection remains high even with the best current practices of management and biosecurity. The repeated failures of non-coordinated control and elimination efforts and the ease with which the disease is transmitted from one herd to another strongly suggest that a regional approach will be necessary. The regional approach for fighting PRRS proposes control in areas of high PRRS prevalence and high pig density, while elimination is potentially feasible in areas of low PRRS prevalence and low pig density. The purpose of this document is to outline a plan to implement PRRS regional control and elimination projects. The plan consists of five phases: evaluate the feasibility of the project, identify pig-related facilities in the area, classify pig sites according to their PRRS virus infection status, design PRRS control strategies, and execute and monitor these PRRS control strategies. Eventually, the focus of individual projects will be to merge with adjacent regional projects and, depending on overall infection risk and feasibility, pursue PRRS elimination.

Keywords: swine, porcine reproductive and respiratory syndrome, control, elimination, regional

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Resumen - Lineamientos generales para proyectos de control y eliminación regional del síndrome reproductivo y respiratorio porcino

El síndrome reproductivo y respiratorio porcino (PRRS por sus siglas en inglés) continúa siendo una enfermedad costosa que afecta a la industria porcina en todo el mundo. A pesar de que los veterinarios han desarrollado diversas estrategias para controlar y eliminar la enfermedad de los hatos de cerdos, el riesgo de reinfección sigue siendo alta aún con las mejores prácticas de manejo y bioseguridad actuales. Los repetidos fracasos de los esfuerzos no coordinados de control y eliminación y la facilidad con la que la enfermedad se transmite de un hato a otro, fuertemente sugieren que será necesaria una estrategia regional. La estrategia regional para combatir el PRRS propone el control en áreas de alta prevalencia del PRRS y de alta densidad porcina, mientras que la eliminación es potencialmente viable en áreas de baja prevalencia del PRRS y baja densidad porcina. El propósito de este escrito es presentar un plan para implementar los proyectos de control y eliminación del PRRS. El plan consta de cinco de fases: evaluar la vialidad del proyecto, identificar las instalaciones existentes en el área relacionadas con cerdos, clasificar los sitios porcinos de acuerdo con su estatus de infección del virus de PRRS, diseñar estrategias de control contra el PRRS, y ejecutar y monitorear estas estrategias de control del PRRS. Eventualmente, el enfoque de proyectos individuales será el de unirse con proyectos regionales adyacentes y, dependiendo del riesgo general de infección y la viabilidad, buscar la eliminación del PRRS.

Résumé - Directives générales pour des projets régionaux de limitation et d'élimination du syndrome reproducteur et respiratoire porcin

Le syndrome reproducteur et respiratoire porcin (SRRP) continue d'être une maladie coûteuse affectant l'industrie porcine à travers le monde. Bien que les vétérinaires aient développé une variété de stratégies pour limiter et éliminer la maladie des troupeaux porcins, le risque de réinfection demeure élevé malgré les meilleures pratiques actuelles de régie et de biosécurité. Les échecs répétés des efforts non-coordonnés de limitation et d'élimination, et la facilité avec laquelle la maladie est transmise d'un troupeau à l'autre suggèrent fortement qu'une approche régionale sera nécessaire. L'approche régionale pour combattre le SRRP propose la maîtrise de la maladie dans les régions à prévalence élevée de SRRP et à forte densité de porcs, alors que l'élimination est potentiellement réalisable dans les régions à faible prévalence de SRRP et à faible densité de porcs. Le but du présent document est d'élaborer un plan pour mettre en place des projets régionaux de limitation et d'élimination du SRRP. Le plan est en cinq phases: évaluer la faisabilité des projets, identifier les installations porcines dans la région, classifier les sites porcins en fonction de leur statut d'infection pour le SRRP, élaborer des stratégies de limitation du SRRP, et finalement exécuter et surveiller ces stratégies. Éventuellement, le focus de projets individuels sera de fusionner avec des projets régionaux adjacents et, selon le risque d'infection global et la faisabilité, poursuivre l'élimination du SRRP.

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The economic impact of porcine reproductive and respiratory syndrome (PRRS) has been recognized worldwide, and several studies on the cost of PRRS have been generated through the years. In 1990, Polson et al[1] estimated losses at US $236 per sow due to infertility, abortions, stillbirths, and neonatal mortality. Then, in 2005, Neumann et al[2] reported a total cost of $560 million per year due to PRRS in the United States. This study also reported that 88% of the total cost of PRRS is due to the effect of the virus in postweaning pigs (ie, poor feed efficiency, high mortality, and suboptimal average daily gain). In a recent study by Holtkamp et al,[3] the total cost of PRRS to the US swine industry was estimated at $640 million annually. However, in Holtkamp's report,[3] the growing-pig herds accounted for 55% of the total cost, down from 88% in the 2005 study.

It is known that pigs and semen are sources of PRRS virus (PRRSV) transmission between herds, but currently other sources of infection are thought to be of great importance, as well. Torremorell et al[4] reported that over 80% of new infections in a commercial system in the United States were due to area spread from neighboring units, movement of pigs in PRRSV-contaminated transport vehicles, and lack of compliance with biosecurity protocols. Airborne transmission appears to play an important role in PRRSV transmission, implying that farms located in pig-dense areas are at greater risk of contracting PRRS. The term "area spread" is used to describe the situation where virus appears to move among farms within an area. While the exact mechanism of transmission remains unidentified, recent studies support the hypothesis that long-distance airborne transport of PRRSV (up to 9.1 km) can occur.[5]

Coordinated efforts will likely be necessary to effectively combat diseases like PRRS and other emerging swine diseases, rather than isolated efforts on individual farms, which are often frustrated by the reappearance of the disease. The regional approach for fighting PRRS proposes control in areas of high PRRS prevalence and high pig density, while elimination is potentially feasible in areas of low PRRS prevalence and low pig density. On the basis of previous experiences by various researchers and industry efforts in conducting pilot projects of regional PRRS control,[6-8] a general five-phase plan is proposed as follows: assess the feasibility of the project, identify pig-related sites in the project's area, characterize the pig sites in the region, design PRRS control strategies, and execute and monitor PRRS control strategies.

Phase 1: Assess the feasibility of the project

Objective

The objective of the first phase is to determine if the region's pork industry meets the minimal requirements to start a regional project of PRRS control. The local pork industry players will initiate a meeting to discuss and analyze the six key components of the project shown in Box 1.

Participants responsible for Phase 1 are people involved in the initial meeting or those selected by them. The execution period is the 4 months after the initial meeting.

Methodology

The support of local practitioners and producers is fundamental to provide leadership, coordination, and cooperation in the regional group. Information must be collected about regional density of pig sites, PRRS prevalence in the area, composition of the local swine industry, and flow of pigs in and out of the area.

The regional group will be in charge of contacting sponsors for funding the project. At the time of writing, potential resources for funding, materials, labor, and expertise are federal government with grant money (**www.usda.gov**), legislators, National Pork Board with grant money (**www.pork.org**), local and state pork producer associations, state universities and veterinary colleges, local veterinary clinics, producers and production systems, the American Association of Swine Veterinarians with an annual grant (**www.aasv.org**), and other supporting institutions. Note that the cited sources of funding are subject to change over time. The regional group will appoint a person to be the direct contact between the group and the funding and support entities. It is highly recommended that this person be closely related to the local swine industry. Responsibilities of the local coordinator are outlined in Box 2. The regional group will establish guidelines for preserving confidentiality and appropriately sharing necessary information among the participants in the project. Documents include a project participants' registration format, a project status updater, and templates for participation, confidentiality, and hold-harmless agreements. Suggested resources for project management and communication are Basecamp (37 Signals, Chicago, Illinois), a project management program that is identity and password protected and allows for shared documents to be posted and accessed by all members (**www.basecamphq.com**) and by other electronic communication tools, including e-mail, Skype (Microsoft, Luxembourg), and GoToMeeting (Citrix, Santa Barbara, California). Members of regional projects should participate in workshops held throughout the calendar year that are intended for regional group members and associated active participants or supporters. The main purpose of the workshops is to share information on new and updated projects, to support or coach those considering launching new projects in their regions, and to review key questions and knowledge gaps regarding regional control of PRRS and what research efforts are in process to address them.

Note for all execution periods

Months in the phase(s) are only estimates. Projects can and will advance faster or slower depending on pro-activeness of project leader(s) and local responsiveness to requests. During the progress of the project, some regional groups may finish the five individual phases at different paces, ie, there might be some overlap of the phases. However, a phase will not be completed until all the sites in the project have finished all the assignments required.

Box 1: Key components of a regional porcine reproductive and respiratory syndrome (PRRS) control project

1. Participation of local producers and practitioners
2. Characterization of area pork production and PRRS prevalence
3. Funding sources
4. A local coordinator for the project
5. Agreement to share specific information
6. Communication with other regional groups

Box 2: Profile of the local regional project coordinator of a regional porcine reproductive and respiratory syndrome (PRRS) control project

A. Job description
To coordinate activities and manage resources in support of one or several PRRS regional control and elimination projects

B. Reports to
Project's regional group

C. Duties and responsibilities
1. Promote and facilitate communication between regional group and stakeholders (ie, veterinarians, producers, universities, government agencies, and advisory group):
    a. Schedule
        i. Local group meetings
        ii. Stakeholders meetings
    b. Assemble periodical newsletters
    c. Prepare and send mass e-mails
    d. Manage and update project Web site
2. Organize and maintain useful databases, such as:
    a. Stakeholders directory
    b. Farm location directory
    c. PRRS virus status per farm
3. Track and communicate programmed activities and completion of milestones
4. Assist local veterinarians and producers to schedule sample collection
5. Assist on sample submission to diagnostic laboratories
6. Assist on diagnostic results tracking and organization
7. Input Production Animal Disease Risk Assessment Program survey information
8. Keep records on expenses related to the project
9. Prepare quarterly summaries for stakeholders

D. Term of employment
Variable

E. Qualifications
1. Excellent organization skills
2. Ability to communicate technical information to multiple audiences
3. Knowledge of the local swine industry
4. Proficient with Word, Excel, and Internet navigation

Phase 2: Identify pig-related sites in the project's area

Information from this phase and from Phase 3 will constitute the foundations for the Phase 4 strategies for PRRS control.

Objective

The objective of this phase is to identify the general characteristics of the pork industry within the region at the site level, ie, number of sites and their locations, production type, PRRS status information (available historical enzyme-linked immunosorbent assay, polymerase chain reaction, and sequencing).

Participants responsible for Phase 2 are local veterinarians and producers, who will provide the information; the project coordinator(s), who will collect data; and the external supporting team, which will generate maps. The execution period is the 4 to 6 months after the initial meeting.

Methodology

The coordinator must contact local swine-industry participants to obtain basic information about pig sites and pig-related sites in the area. It is fundamental to obtain the geographical location (latitude-longitude) of farms, slaughter plants, feed mills, transport sanitation facilities, exhibition pigs, and external suppliers. If the site location has not been determined by latitude-longitude coordinates, they must be acquired using a global positioning system device or a Web-based service such as Google Earth (Google, Mountain View, California). In states where USAherds (`http://usaherds.org/`) database is current and functional, the project coordinator may interact with this consortium to obtain all necessary information. Information about PRRS status – assumed or confirmed – and type or phase of production will be included. A mapping software program such as ArcView (ESRI, Redlands, California) may be used to generate maps to visualize the distribution of pig sites in the region and the PRRS status of each site.

Phase 3: Characterize the pig sites in the region

In this phase of the project, data from individual operations will be collected to create a region's database, classifying the sites by PRRSV infection status.

Objectives

The objectives of this phase are to determine actual PRRSV infection status, animal flow, and risk of becoming infected.

Participants responsible for Phase 3 are local veterinarians, who will be in charge of collecting samples, performing risk assessments, and providing information; project coordinator(s), who will collect data; and the supporting team that will analyze the data. The execution period is the 4 to 12 months after the initial meeting.

Methodology

The project's participants will confirm PRRSV infection status of all sites in the region in order to categorize the sites. A baseline sampling strategy will be determined by the regional group and supporting parties, according to the general guidelines proposed by Holtkamp et al,[9] and the prevalence of PRRSV infection and the distribution PRRSV isolates will then be determined within the area.

Information provided by the local veterinarians and producers will be used by the local coordinator to record pig movement into and out of the area and establish swine-network connections within the area.

In this phase of the project, Production Animal Disease Risk Assessment Program (PADRAP) surveys (`www.padrap.org`) will be applied by site to determine the risk of becoming PRRSV infected, and the participants will sign confidentiality agreements and permissions to access PADRAP information.

All collected information will be used to classify sites in the area according to the model proposed by Holtkamp et al.[9]

The use of ArcView is suggested for mapping the geographical locations of sites and

to visualize type of production, PRRSV infection status, size of site, and routes of pig movement, among other features.

It is suggested that all swine facilities execute basic farm biosecurity protocols.[10]

Phase 4: Design PRRS control strategies

On the basis of the information obtained in Phases 2 and 3, the local group will outline the guidelines for herd, flow, and neighboring plans to reduce overall PRRSV infection prevalence in the area.

Objectives

The objectives of this phase are to design herd and flow strategies that are coordinated within neighborhoods.

Participants responsible for Phase 4 are local veterinarians, who will design herd plans and will discuss neighborhood guidelines, and the project coordinator(s) and supporting team, who will organize and coordinate control interventions. The execution period is the 6 to 15 months after the initial meeting.

Methodology

The local group will organize the region by neighborhood or township, depending on specific characteristics such as proximity, natural barriers, and pig flow.

The local group will also design strategies for PRRS control by site, supporting neighborhood guidelines and consistent with the first four steps of the five-step process shown in Figure 1. The strategies to control PRRS include gilt acclimation, herd closure, depopulation-repopulation, live-virus inoculation, modified-live vaccination, inactivated-virus vaccination, test and removal, and partial depopulation.

In anticipation of emergencies in the operation, contingency plans or courses of action must be designed, discussed, and posted.

Phase 5: Execute and monitor PRRS control strategies

In this phase, the local group will implement specific strategies to maintain or reduce PRRSV infection prevalence by farm and neighborhood.

Objectives

The objectives of this phase are to execute and monitor PRRS control strategies by site and neighborhood.

Figure 1: The five-step process form to be filled out by producers in order to design a strategy for regional control of porcine reproductive and respiratory syndrome (PRRS) on their farms. ADG = average daily gain; FE = feed efficiency.

Producer: _____ **Date:** _____

1. Identify desired goals

What would you consider an improvement or win with respect to PRRS in your operation?

Performance ADG, FE, mortality, culls…	**Clinical signs** Cough, abortions…	**PRRS Status** Negative or stable

2. Determine current status

Describe your current PRRS situation

Clinical observations What signs, when, how long?	**Performance effects** Mortality, slowed growth…	**Diagnostics** Serum, oral fluids, tissues

3. Understand current constraints

Describe your operation

Site/flow/system Type, ownership	**Biosecurity** Proximity, trucks…	**Other diseases** PCV2, *Mycoplasma*…	**Opinion leaders** Vet opinion/ involvement

Possible next steps:	**Notes:**
☐ Meeting (producer, vet, manager) ☐ Farm visit ☐ Additional diagnostics ☐ PRRS risk assessment ☐ Biosecurity discussion/education ☐ Other_____	

4. Develop solution options

5. Implement and monitor preferred solution

Participants responsible for Phase 5 are local veterinarians, who will implement herd plans and surveillance strategies, and the project coordinator(s) and supporting team, who will coordinate interventions and analyze results. The execution period is the 16 to 60 months after the initial meeting.

Methodology

The local group will implement herd and neighborhood plans for PRRS control, follow a biosecurity protocol to prevent the spread of PRRSV,[10] and monitor preferred solutions. Sampling strategy will depend on the specific characteristics of each site, neighborhood, or region.

Eventually, the focus of individual projects will be to merge with adjacent regional projects and, depending on overall infection risk and feasibility, pursue PRRS elimination.

Conclusion

After more than 2 decades of unsuccessfully fighting PRRS in non-coordinated control and elimination efforts, it is desirable to combat PRRS utilizing a coordinated, regionalized approach. A summary describing the basic steps to initiate and execute projects of PRRS control using a coordinated, regional approach has been outlined here. This document proposes a five-phase process to implement programs of regional control and elimination of PRRS: evaluate the feasibility of the project; identify pig-related facilities in the area; classify pig sites according to their PRRSV infection status, and design execute, and monitor PRRS control strategies. Implementation of these basic guidelines will vary depending on the specific characteristics of the local swine industry in different regions, but should always be based on the principles of cooperation, good communication, and coordination between producers, veterinarians, and supporting entities.

Conflict of interest

Boehringer Ingelheim Vetmedica, Inc, sponsored development of the protocol and, at the time of writing, employed all of the authors. Currently, Dr Laura Batista is an independent consultant.

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* Non-refereed references.

Checkoff offers combined FAD materials

The Pork Checkoff now has foreign animal disease (FAD) push packs with communications materials targeted to US pork producers. These resources have been in development over the last 2 years through a cooperative effort between the National Pork Board, the American Association of Swine Veterinarians, United States Department of Agriculture-Animal and Plant Health Inspection Service-Veterinary Services (USDA-APHIS-VS), and Iowa State's Center for Food Security and Public Health. Some materials in the packs include a laminated poster for producer biosecurity, visitor biosecurity, and information on classical swine fever, African swine fever, foot-and-mouth disease, and swine vesicular disease. The packs (Item #04892) are available at the Pork Checkoff Store, accessible via **www.pork.org**.

Veterinarians and others interested in providing these resources in bulk at events where you will be interacting with pork producers are urged to contact Patrick Webb, Checkoff's Director of Swine Health and Information, at **PWebb@pork.org** or 515-223-3441.

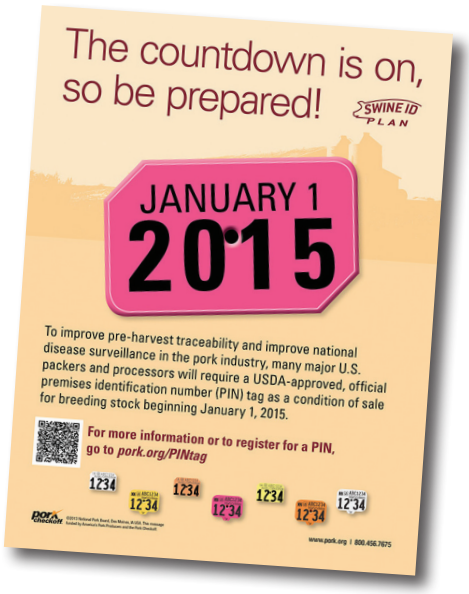
Checkoff increases messaging on sow packer's 2015 PIN tag requirement

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 USDA-approved, official premises identification number (PIN) tag as a condition of sale for breeding stock, beginning January 1, 2015. To help communicate that message, the Pork Checkoff is running national print ads in farm media and using other communications tools and outreach methods.

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 to be used as a management tag or just before sows and boars leave the production site to enter harvest channels.

Allflex USA, Inc (DFW Airport, Texas), Destron Fearing (South St Paul, Minnesota), and Y-Tex Corporation (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.

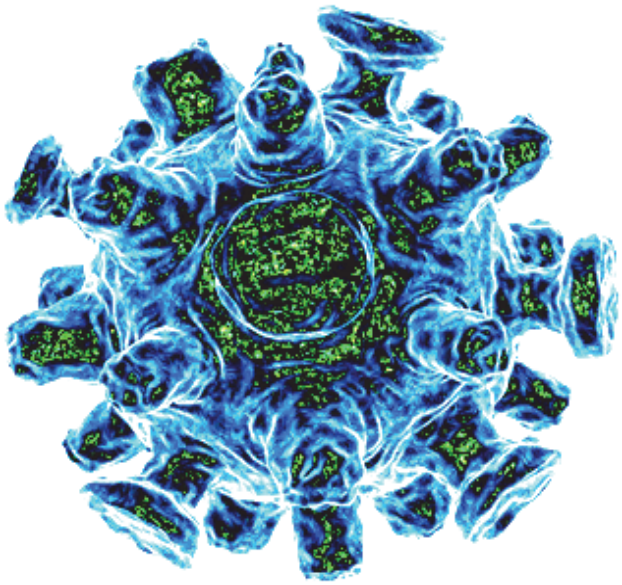


Checkoff increases frequency of PEDV Update Newsletter

To give producers, veterinarians, and others in the industry even more access and updated information on porcine epidemic diarrhea virus (PEDV), the Pork Checkoff relaunched its PEDV Update electronic newsletter in January. Now, recipients receive it every 2 weeks with new PEDV-related features, fact sheets, and related information. If you do not receive the newsletter, please contact Mike King, Checkoff's Science Communications Manager, at **MKing@pork.org** or 515-223-3532.

NPB news continued on page 91

Are You Satisfied With Your SIV Vaccine Performance?



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- **Now available in a concentrated 0.5 mL dose option**
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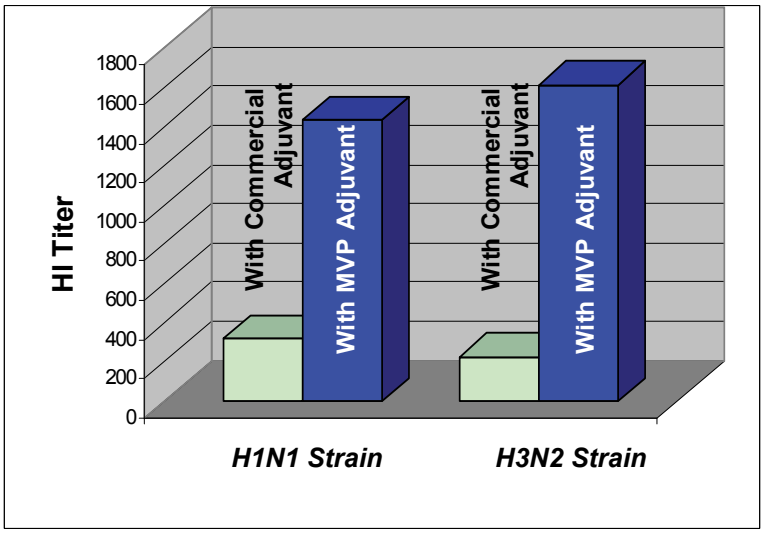
MVP's EMULSIGEN®-D adjuvant and a commercial SIV adjuvant were used as diluents for the same freeze-dried SIV antigen. The MVP Adjuvanted SIV vaccine produced a significantly higher antibody titer to both H1N1 and H3N2 (evaluated by ISU) as shown in the graph. Antibody titers have been directly correlated with protection against SIV.

EMULSIGEN®-D combined with concentrated SIV allows MVP to offer a 0.5 mL dose option.

Comparison of Pig Antibody Titers Produced by Commercial Adjuvanted SIV Vaccine and MVP EMULSIGEN®-D Adjuvanted SIV Vaccine.



B.C. Lin, et al., AASV March 2006

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Environmental Stewards application deadline approaches

As swine veterinarians, many of you likely know multiple pork producers who demonstrate the high environmental standards and other "We Care" ethical principles that the Environmental Stewards program represents. If so, please take a few minutes to forward an application to them or notify your state pork association of your potential nominees. The deadline for applications, which are found on **pork.org**, is March 31, 2014.

For more information, contact Mike King at **MKing@pork.org** or 515-223-3532.

Pork Checkoff sets course through 2020

As the National Pork Board sets its course for 2015 through 2020, the organization's strategic planning task force is using the most current information available on top trends in the economic and food-production environments that are most likely to impact the Pork Checkoff program. The analysis is part of the National Pork Board's strategic planning initiative. The task force met for the first time in December 2013.

"Our overarching objective is to assess the role the Pork Checkoff plays in an ever-changing world and to identify strategic opportunities for us to help move the pork industry forward," said Chris Novak, Chief Executive Officer of the National Pork Board. He added, "This may mean developing programs that increase consumer trust and comfort in purchasing pork. Consumer needs regarding food safety and transparency and producer needs to protect the environment and provide the best possible animal care will be front and center."

For more information on Pork Checkoff's strategic planning, contact Paul Sundberg, Checkoff's Vice President of Science and Technology, at **PSundberg@pork.org** or 515-223-2764.

New National Swine Reproduction Guide available

The US Center for Pork Excellence (USCPE) is now offering a Web-based troubleshooting guide presented in a decision-tree format. Solving reproductive problems has a very high return on investment, but the problems are often multi-faceted and are difficult to identify. This online guide, partially funded by the Pork Checkoff, can help pork producers and their support network to identify these problems and find solutions.

The guide is organized into three themes based upon gilt, sow, or boar (semen). Once a user gets beyond these primary themes, the main problems are identified, which places the user into a decision tree. From there, the user can answer a series of questions which have answers, academic background, fact sheets, and references. The Internet-based guide costs $75 per year and is available via USCPE's site, **www.usporkcenter.org**.

For more information, contact Chelsey Branderhorst at **CBranderhorst@usporkcenter.org** or 515-223-2641.

Dave Pyburn

Checkoff adds Pyburn to sci-tech team

Beginning his second stint at the National Pork Board, Dave Pyburn has been named as assistant vice president of the Pork Checkoff's Science and Technology Department. Previously, Pyburn had been director of veterinary science at the Checkoff from 1997 until 2000, when he joined the swine health staff of USDA-APHIS-VS. While at USDA, Pyburn represented APHIS-VS to a variety of producer, veterinarian, researcher-academic, and domestic and foreign government audiences and was a primary liaison between the agency and the pork industry.

For more information, contact Dave Pyburn at **DPyburn@pork.org** or 515-223-2634.

AASV NEWS

AASV surveys salaries and benefits

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.

Alternate Student Delegate selected for AASV board

The AASV Student Recruitment Committee is pleased to announce the selection of Chris Sievers (Iowa State University, 2016) as the incoming Alternate Student Delegate to the AASV Board of Directors.

Chris grew up on a family farm that had a farrow-to-finish swine operation until the early 2000s and then raised contract finishing pigs. He also raised swine for 4H and FFA projects and participated in 4H livestock judging. Prior to entering veterinary school, he received an undergraduate degree in animal science from Iowa State. As an undergraduate, Chris participated on the Meats and Livestock Judging Teams, as well as the Swine Interest Group in the Block and Bridle Club. In addition, he had summer internships with Niman Ranch and the Iowa State Swine Veterinary Internship program as a flex intern for Boehringer Ingelheim. He also interned in Fairmont, Minnesota, sponsored by Zoetis.

He became "hooked on swine medicine" during his first year of veterinary school and was accepted into the master's program in Preventative Animal Medicine, with a swine project and core courses in epidemiology, swine medicine, statistics, and also microbiology and pathology.

He presented a poster at the AASV Annual meeting in 2013, and noted "a very tight-knit group of veterinarians that truly cared about the industry and its future, and was almost like family." He came home thinking, "That's a profession I want to be involved in." When the announcement came to apply for the student delegate position, he knew this would be a great opportunity to become more involved and give back to AASV.

Chris will assume duties as Alternate Student Delegate during the 2014 AASV Annual Meeting. The former alternate delegate, Amy Daniels (University of Illinois, 2015), will ascend to the delegate position. Amy and Chris will represent student interests within AASV as non-voting members of the board of directors and the Student Recruitment Committee.

Please join us in welcoming Chris to the AASV Board of Directors!

Chris Sievers

Looking for a scientific paper? Texas A&M will "get it for you"

An agreement between AASV and the Texas A&M University Medical Sciences Library (MSL) now allows AASV members to utilize the MSL's *Get it for me* document retrieval service. Members of AASV will have the opportunity to learn more at the AASV Annual Meeting in Dallas, where MSL representatives will be available to provide information and answer questions about the service.

Using *Get it for me*, 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 available at **http://guides.library.tamu.edu/aasv**.

The ins and outs of extra-label drug use in animals: A resource for veterinarians

Are you aware that failing to administer the second dose of an antimicrobial labelled as a two-dose treatment constitutes an extra-label use and may be illegal? As a practicing veterinarian, you've likely prescribed a drug for an extra-label use. What does that mean? What gives you the legal ability to do so? What conditions must be met? By explaining FDA's requirements for extra-label drug use in animals, this article answers these questions and more. Every food-animal veterinarian should read this article. It is posted in its entirety on the AASV Web site at **http://www.aasv.org/documents/ELDU_VetResource.pdf**.

To prescribe drugs in an extra-label manner, you need to follow FDA's extra-label drug-use requirements, as stated in the FD&C Act and FDA regulations. You should also educate your clients, particularly food-animal producers, on these requirements and on FDA's recommendations for the judicious use of antimicrobial drugs (**http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/JudiciousUseofAntimicrobials/default.htm**).

Before Congress passed the Animal Medicinal Drug Use Clarification Act (AMDUCA) in 1994, federal law did not permit extra-label drug use in animals. The AMDUCA provisions amended the FD&C Act to allow veterinarians to prescribe approved human and animal drugs for extra-label uses in animals under specified conditions. The key points are the following:

- Valid veterinarian-client-patient relationship
- General conditions for extra-label drug use
- Conditions for extra-label drug use in food-producing animals
- Compounding
- Drugs prohibited from extra-label uses in animals

This article examines each point separately and describes how FDA's judicious use recommendations affect extra-label drug use in food-producing animals.

FDA takes significant steps to address antimicrobial resistance

The US Food and Drug Administration (FDA) is implementing a plan, "Guidance for Industry 213," to help phase out the use of medically important antimicrobials in food animals for food-production purposes, such as to enhance growth or improve feed efficiency. The plan would also phase in veterinary oversight of the remaining appropriate therapeutic uses of such drugs.

In the final guidance, the FDA lays out a road map for animal pharmaceutical companies to voluntarily revise the FDA-approved use conditions on the labels of these products to remove production indications. The plan also calls for changing the current over-the-counter (OTC) status to bring the remaining appropriate therapeutic uses under veterinary oversight. Once a manufacturer voluntarily makes these changes, its medically important antimicrobial drugs can no longer be used for production purposes, and their use to treat, control, or prevent disease in animals will require veterinary oversight.

The FDA is asking animal pharmaceutical companies to notify the agency of their intent to sign on to the strategy within the next 3 months. These companies would then have a 3-year transition process.

In order to help phase in veterinary oversight of drugs covered by the guidance that are intended for medically appropriate uses in feed, the FDA also has issued a proposed rule to update the existing regulations relating to Veterinary Feed Directive (VFD) drugs. The use of VFD drugs requires specific authorization by a licensed veterinarian using a process outlined in the agency's VFD regulations. The VFD proposed rule is intended to update the existing VFD process and facilitate expanded veterinary oversight by clarifying and increasing the flexibility of the administrative requirements for the distribution and use of VFD drugs. Such updates to the VFD process will assist in the transition of OTC products to their new VFD status.

The guidance for animal pharmaceutical companies (GFI 213) is now in final form, and the proposed VFD rule is open for public comment until March 12, 2014. To electronically submit comments on the proposed VFD rule, go to **http://www.regulations.gov** and insert docket FDA-2010-N-0155. Send written comments to the Division of Dockets Management, Food and Drug Administration, Room 1061, 5630 Fishers Lane, Rockville, MD 20852.

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AASV FOUNDATION NEWS

Remember the foundation!

In the ambitious effort to surpass the $100,000 fund-raising mark for the AASV Foundation (which would secure a generous $25,000 in matching funds from MVP Laboratories), the auction committee is once again selling raffle tickets for the chance to win one of four fabulous prizes! The raffle drawing will take place during the auction in Dallas on March 3, but ticket holders do NOT need to be present to win. That means you – yes, YOU – can purchase a ticket to support the foundation and participate in the drawing to win.

1st prize: 1-year Dean & Deluca Wine Club subscription, donated by Zoetis

2nd prize: $1000

3rd prize: 2015 AASV Annual Meeting registration

4th prize: 2015 AASV Annual Meeting registration

Contact the AASV office or one of the auction committee members listed below to purchase raffle tickets, which sell for $100 each (please note, the IRS says raffle-ticket purchases are not deductible.) Please join your fellow AASV members in making this year's foundation fundraiser "Big as Texas"!

The AASV Foundation Auction Committee is chaired by Dr Daryl Olsen and includes Drs Matt Anderson, Butch Baker, John Baker, Joe Connor, Scanlon Daniels, Tom Gillespie, Peggy Anne Hawkins, Rod Johnson, Ruth Loula, Darrell Neuberger, Max Rodibaugh, Larry Rueff, Tom Wetzell, and Warren Wilson.

Up to $500 available to veterinary students for swine externships

The AASV Foundation encourages veterinary students with an interest in swine medicine to gain extra-curricular, "hands-on" experience working with swine practitioners in a private practice or production company. The foundation's swine externship grant program, now in its thirteenth year, provides financial support to veterinary students who participate in a qualifying externship. The grants are available year-round, and range from $200 to $500 per student, based upon the actual expenses incurred during the externship.

Veterinary students who plan to complete an externship of at least 2 weeks' duration in a swine practice or a mixed practice with a considerable swine component may apply for the grant. Both the student and at least one member of the hosting practice must be members of the AASV. Members who are willing to host students are encouraged to provide their contact information to AASV for inclusion on the list of externship opportunities on the AASV Web site at **http://www.aasv.org/members/career/internships.php**.

In addition to student information, the grant application requests a letter from the hosting practice containing details of the planned externship. After the externship has been completed and the practice has confirmed the student's participation, the student submits a brief report of his or her experiences along with expense receipts to the AASV Foundation before the funds are disbursed. The foundation has awarded grants to more than 100 students from the United States and Canada since the program's inception in 2002.

The grant application is available at **http://www.aasv.org/students/externgrant.htm**, and should be submitted prior to the start of the externship. There is a limit of one grant per student. For more information, contact the AASV Foundation: Tel: 515-465-5255; Fax: 515-465-3832; E-mail: **aasv@aasv.org**.

AASV Foundation news continued on page 97

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AASV Foundation news continued from page 95

Veterinary students selected for mentorship in swine medicine

The AASV Foundation and AASV Student Recruitment Committee are pleased to announce the recipients of the 2014 National Pork Industry Foundation (NPIF) veterinary internship stipends. Six first- and second-year veterinary students were selected from a pool of 65 applicants to receive the $3300 stipends. Each NPIF intern will be linked with a volunteer practitioner-mentor with whom they will spend a 1-month internship during the summer of 2014. The students selected to participate in this popular program are the following:

Justin Brown, sophomore, University of Georgia

Lauren Geiger, sophomore, University of Missouri

Kaley Ladner, freshman, Western University of Health Sciences

Claire LeFevre, freshman, University of Wisconsin

Lynn Pavlovic, sophomore, University of Pennsylvania

Corrine Stoffel, freshman, University of Illinois

The NPIF veterinary internship stipend program is now in its sixth year. The stipend of $3300 per student defrays the cost of travel, lodging, and compensation during the 1-month internship. Additionally, the interns are encouraged to utilize their practitioner-mentor as a resource throughout the year, and to attend the AASV Annual Meeting and Leman Swine Conference in an effort to increase their knowledge and exposure to swine medicine. Each intern submits a written report and evaluation upon completion of the program.

The AASV Student Recruitment Committee developed the NPIF veterinary internship stipend program in an effort to attract veterinary students to swine medicine and to provide interested students with exposure to the life of a swine veterinarian. The $20,000 funding for the program is provided by the NPIF, a charitable corporation that promotes activities in the swine industry related to research and education. The funds are administered by the AASV Foundation.

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AASV Foundation Fundraising

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Held in conjunction with the AASV Annual Meeting
March 3, 2014 – Dallas, Texas

We extend our sincere appreciation to the individuals, veterinary practices, and companies who have contributed to the auction. Since all of the items have been donated, 100% of the auction proceeds will benefit the AASV Foundation!

WE OFFER SINCERE THANKS TO OUR MANY GENEROUS DONORS!

Matching funds

MVP Laboratories will donate 25 cents for every dollar raised at the auction, up to a total donation of $25,000.

WOW! Now it's up to AASV members to reach the $100,000 goal and achieve the maximum match!

Thank you, MVP LABORATORIES!

Items up for bid

Thanks to our ALL of our generous auction donors, we have an exciting slate of items up for bid!
Take a look at **www.aasv.org/foundation/2014/auctionlist.php**.

Everyone can bid!

If you're not attending the AASV Annual Meeting, you can submit your bids by phone (515-465-5255) or e-mail (aasv@aasv.org) prior to February 25.

For information about the AASV Foundation, go to **http://www.aasv.org/foundation**.

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*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.

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Put a PIN on it!

In support of the United States Department of Agriculture's (USDA's) Animal Disease Traceability program, over 95% of USDA-estimated swine premises are registered. The USDA assigns registered premises a unique seven-character alphanumeric identifier known as a Premises Identification Number or PIN. Swine producers support using the PIN to identify their farms on official documents such as bills of lading, certificates of veterinary inspection, and diagnostic submission forms. Veterinarians need to start using these numbers when submitting diagnostic samples or certifying pig movements.

If we've learned anything from our experience with porcine epidemic diarrhea virus (PEDV), it's the value of accurate and complete diagnostic information. Since PEDV is a non-regulatory, non-reportable disease, there is no "official" mechanism for tracking the movement of the virus. Our only indication of disease presence and distribution is the diagnostic laboratory submission. Failure to include a unique site identifier such as the PIN on the submission form, or submitting a form with an incomplete signalment (history, animal age, stage of production, clinical signs, etc) makes it impossible to provide an accurate assessment of the disease impact, distribution, rate or method of spread, or prevalence. These are all critical bits of information necessary to conduct any epidemiological analysis of the disease outbreak.

"Because of the lack of PIN information on diagnostic forms associated with PEDV submissions, the information we publish about the disease is highly suspect, rendering the data useless for any type of epidemiologic analysis."

The National Pork Board makes it easy to verify and use the PIN on official forms and diagnostic samples. Their Web site provides a means by which a producer or veterinarian can enter a PIN or group of PINs to validate the address and print out barcode labels that can then be affixed to a form or sample containers. Utilizing the pre-printed barcodes reduces the risk of transposing characters when trying to record the PIN code by hand. Although most veterinary diagnostic laboratories now have barcode readers, the barcode label contains the barcode, the PIN code, and a site descriptor so a barcode reader is not required to read the label. Visit **http://www.pork.org/Programs/3118/PremisesVerification.aspx** and follow the steps to utilize this service.

Providing a unique site identifier allows the diagnostic laboratory to differentiate samples collected from a new site versus those representing a repeat or follow-up sample from a previously reported infection. In addition, with producer permission, it allows state and federal animal health officials to map disease outbreaks in order to provide that information

to industry stakeholders to facilitate disease tracking and control measures. Because of the lack of PIN information on diagnostic forms associated with PEDV submissions, the information we publish about the disease is highly suspect, rendering the data useless for any type of epidemiologic analysis. It is, at best, an index of disease-reporting trends over time.

Access to accurate premises information is even more critical when we are faced with a trade-limiting or zoonotic disease. Understanding where the infected premises are located is critical if the industry wants to maintain business continuity or establish disease-negative compartments. Now that producers have recognized the importance of sharing premises identification information, it is incumbent on veterinarians to ensure that we get in the habit of providing accurate and complete information on diagnostic-sample submission forms. So encourage your clients to let you include the PIN on diagnostic submissions, verify the PIN, print off the labels, and then make sure you "Put a PIN on it!"

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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

Upcoming meetings

American Association of Swine Veterinarians 45th Annual Meeting

March 1-4, 2014 (Sat-Tue)
Sheraton Dallas Hotel, Dallas, Texas

For more information:
Tel: 515-465-5255; Fax: 515-465-3832
E-mail: aasv@aasv.org
Web: http://www.aasv.org/annmtg

National Institute for Animal Agriculture (NIAA) Annual Conference

March 31-April 2, 2014 (Mon-Wed)
Omaha, Nebraska

For more information:
National Institute for Animal Agriculture
13570 Meadowgrass Drive, Suite 201, Colorado Springs, CO 80921
Tel: 719-538-8843; Fax: 719-538-8847
E-mail: NIAA@AnimalAgriculture.org
Web: http://www.animalagriculture.org/2014AnnualConferenceTrichomoniasisStandardsForum.htm

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, IA 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/

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An Illinois swine facility

Photo courtesy of Dr John Waddell

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