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Cappuccio JA, Dibarbora M, Bessone FA, et al

M hyo DNA detection by qPCR in diagnostic cases submitted to the ISU VDL from 2004 to 2016

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“I would personally like to thank all the peer-reviewers for their hard work and contributions to the journal over the past year. Thank you!”

quoted from the Executive Editor’s message, page 301
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Not only that, but according to a peer-reviewed article recently published in the *Journal of Swine Health and Production*, Uniferon® is the only injectable product for use in baby pigs that showed undetectable levels of arsenic and lead.

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---


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Refining the problem: African swine fever outbreaks

With our global experience with African swine fever, classical swine fever, porcine epidemic diarrhea virus, and Seneca Valley virus, it seems obvious we need to do everything we can to understand how swine foreign animal diseases are being transmitted around the world. One of the beautiful things about the human mind is that it can be refocused on new problems. It’s a stark contrast to facilities and machines that have defined purposes or limits.

Taking time to brainstorm and figure out the unknown links for disease transmission can be a frustrating but ultimately rewarding process. So how can we refocus our minds to address new problems? Thomas Wedell-Wedellsborg has suggested that we often diagnose the problem too quickly in our desire to get to action we think will help.1 The result of this is that we spend our time implementing changes that will sadly be ineffective. Traditional problem-solving tools like Six Sigma, Root Cause Analysis, and 5 Whys are very helpful but can also lead us in the wrong direction because many problems are multi-causal. Likewise, we rely on experimentation too much. Experimentation is great at validating better outcomes, but it can limit us from identifying what may be the best option. The solution to this is problem reframing. What is problem reframing?

There are seven practices to reframing a problem:

1. Establish legitimacy of the reframing process. Your problem-solving team needs to have a basic understanding of this approach to minimize the frustration of those that want action now.
2. Bring outsiders into the discussion. Outsiders can help you avoid falling in love with a favorite solution, also known as group think. Look for “boundary spanners,” those who understand but are not fully part of your world. Seek those who will speak freely. Expect input on the problem, not solutions.
3. Get people’s definitions in writing. Pay close attention to wording because slight differences can elucidate a different perspective on a problem.
4. Ask what’s missing. Don’t jump to debating details of what’s already been identified.
5. Consider multiple categories of problems. Are there incentives, expectations, attitudes or usability to consider, not just the hard science?
6. Analyze positive exceptions. Look for situations where there isn’t a problem and delve deeply into the reasons why.
7. Question the objective. Clarifying the objectives around the problem can help focus solutions with maximal impact.

This method requires different listening skills. It requires us to hold back from offering solutions right away. A deep understanding of the problem is gained from really listening to how people describe and talk about their problem. Really effective thinking and traditional testing can result in radically more effective change. Try this method on some of the problems you’ve been frustrated with, or the new one on our minds right now – African swine fever.

C. Scanlon Daniels, DVM
AASV President

Reference

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One-dose Swine Respiratory Disease (SRD) treatment

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Same SRD pathogens as Baytril® 100

Associated with Actinobacillus pleuropneumoniae (APP), Pasteurella multocida, Haemophilus parasuis and Streptococcus suis

Enroflox (enrofloxacin)

For the treatment and control of Swine Respiratory Disease (SRD) and Control of Colibacillosis

Not for Use In Female Dairy Cattle 20 Months Of Age Or Older Or In Calves To Be Processed For Veal

Brief Summary: Before using Enroflox® 100, consult the product insert, a summary of which follows.

CAUTION: Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian.

Federal (U.S.A.) law prohibits the extra-label use of this drug in food-producing animals.

To assure responsible antimicrobial drug use, enrofloxacin should only be used as a second-line drug for colibacillosis in swine following consideration of other therapeutic options.

Federal (U.S.A.) law prohibits the extra-label use of this drug in food-producing animals.

To assure responsible antimicrobial drug use, enrofloxacin should only be used as a second-line drug for colibacillosis in swine following consideration of other therapeutic options.

PRODUCT DESCRIPTION: Each mL of Enroflox 100 contains 100 mg of enrofloxacin. Excipients are L-arginine base 200 mg, n-butyl alcohol 30 mg, benzyl alcohol (as a preservative) 20 mg and water for injection q.s.

INDICATIONS:

Cattle - Single-Dose Therapy: Enroflox 100 is indicated for the treatment of bovine respiratory disease (BRD) associated with Mannheimia haemolytica, Pasteurella multocida, Mycoplasma bovis in beef and non-lactating dairy cattle; and for the control of BRD in beef and non-lactating dairy cattle at high risk of developing BRD associated with M. haemolytica, P. multocida, H. somni and M. bovis.

Cattle - Multiple-Day Therapy: Enroflox 100 is indicated for the treatment of bovine respiratory disease (BRD) associated with Mannheimia haemolytica, Pasteurella multocida and Staphylococcus aureus in beef and non-lactating dairy cattle.

Swine: Enroflox 100 is indicated for the treatment of swine respiratory disease (SRD) associated with Actinobacillus pleuropneumoniae, Pasteurella multocida, Haemophilus parasuis, Streptococcus suis, Bordetella bronchiseptica and Mycoplasma hyopneumoniae. Enroflox 100 is indicated for the control of colibacillosis in groups or pens of weaned pigs where colibacillosis associated with Escherichia coli has been diagnosed.

RESIDUE WARNINGS:

Cattle: Animals intended for human consumption must not be slaughtered within 38 days from the last treatment. This product is not approved for female dairy cattle 20 months of age or older, including dry dairy cows. Use in these cattle may cause drug residues in milk and/or in calves born to these cows. A withdrawal period has not been established for this product in pre-ruminating calves. Do not use in calves to be processed for veal.

Swine: Animals intended for human consumption must not be slaughtered within 5 days of receiving a single-injection dose.

HUMAN WARNINGS: For use in animals only. Keep out of the reach of children. Avoid contact with eyes. In case of contact, immediately flush eyes with copious amounts of water for 15 minutes. In case of dermal contact, wash skin with soap and water. Consult a physician if irritation persists following ocular or dermal exposure. Individuals with a history of hypersensitivity to quinolones should avoid this product. In humans, there is a risk of user photosensitization within a few hours after excessive exposure to quinolones. If excessive accidental exposure occurs, avoid direct sunlight. For customer service, to obtain a copy of the Safety Data Sheet (SDS) or to report adverse reactions, call Norbrook at 1-888-561-3777.

PRECAUTIONS: The effects of enrofloxacin on cattle or swine reproductive performance, pregnancy and lactation have not been adequately determined.

The long-term effects on arthritic joint cartilage have not been determined in pigs above market weight.

Subcutaneous injection can cause a transient local tissue reaction that may result in trim loss of edible tissue at slaughter.

Enroflox 100 contains different excipients than other enrofloxacin products. The safety and efficacy of this formulation in species other than cattle and swine have not been determined.

Quinolone-class drugs should be used with caution in animals with known or suspected Central Nervous System (CNS) disorders. In such animals, quinolones have, in rare instances, been associated with CNS stimulation which may lead to convulsive seizures. Quinolone-class drugs have been shown to produce erosions of cartilage of weight-bearing joints and other signs of arthropathy in immature animals of various species. See Animal Safety section for additional information.

ANIMAL SAFETY: Cattle: Clinical signs of depression, incoordination and muscle fasciculation were observed in calves when doses of 15 or 25 mg/kg were administered for 10 to 15 days. Clinical signs of depression, inappetence and incoordination were observed when a dose of 50 mg/kg was administered for 3 days. An injection site study conducted in feeder calves demonstrated that the formulation may induce a transient reaction in the subcutaneous tissue and underlying muscle.

Swine: Subcutaneous Safety: Incidental lameness of short duration was observed in all groups, including the saline-treated controls. Musculoskeletal stiffness was observed following the 15 and 25 mg/kg treatments with clinical signs appearing during the second week of treatment. Clinical signs of lameness improved after treatment ceased and most animals were clinically normal at necropsy. An injection site study conducted in pigs demonstrated that the formulation may induce a transient reaction in the subcutaneous tissue.

Intramuscular Safety: Transient decreases in feed and water consumption were observed after each treatment. Mild, transient, post-treatment injection site swellings were observed in pigs receiving the 37.5 mg/kg BW dose. Injection site inflammation was found on post-mortem examination in all enrofloxacin-treated groups.

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10 October 2017

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The coming storm

I am sitting in my office in Perry, Iowa watching the news stories chronicling the advancing hurricane named Florence. If measured by the number of news correspondents giving reports from a North Carolina beach setting, then Florence must be a huge storm. By the time you read this, we will know just how big it was and how much damage actually occurred. It is awe-inspiring to consider this massive force of nature as it bears down on the east coast of the United States.

There is another force of nature approaching the United States and this one is not weather related. It is the disease known as African swine fever (ASF). As I write this, a case of ASF has just been confirmed in Belgium. It is the first case in Belgium since 1985. An alarming fact about this case is that it appears to be a long distance from other known infected countries. At this point in time there is little known about the mode of spread in this case, but long distances between cases can indicate a pandemic.

Other ASF-infected countries include Africa, China, several Eastern European countries, and Russia. I won’t bore you with too many of the details of this virus. Suffice it to say, it is a hardy and lethal agent when introduced into pigs. There is no vaccine currently available. In the United States, ASF is considered a foreign animal disease that will immediately halt movements of pigs as well as the export of pork. There is no other way to describe an ASF incursion into the United States than devastating. Besides the potential mass casualties of infected pigs, there will be wholesale depopulation of all pigs within a zone around infected farms.

"Unfortunately, we don’t have ASF radar to inform us about the coming storm, so we are left to do the best we can with the resources and resolve we can muster."

The lessons learned in 2013 and 2014 with the spread of porcine epidemic diarrhea virus (PEDV) are still fresh. The initial arrival of PEDV occurred nearly simultaneously in multiple herds over a wide geographic area. Research since then has proven the hypothesis that PEDV can survive the trip in certain feedstuffs from the Far East to the heartland of the United States. I will leave it to you to connect the dots. That disease also demonstrated that the industry we have built to efficiently move pigs and inputs is also quite capable of rapidly disseminating highly infectious viral diseases. Market trucks, lairages, feed mills, and a plethora of fomites that came in contact with the virus were quickly contaminated with PEDV.

In the news stories about Florence, you could see governmental agencies (eg, Federal Emergency Management Agency), non-governmental organizations (eg, Red Cross), and industries (eg, utilities) start marshaling and staging resources and personnel for the post-hurricane task of rescue and recovery. The scale of this planning and deployment was impressive and time will tell how effective it was. Likewise, an introduction of ASF into the United States will require a massive effort to bring all needed resources together to stop the spread of this disease.

One advantage we have with ASF over a hurricane is that there is, at least as of this writing, an opportunity for us to prevent ASF from entering the United States. Prevention should be on the mind of everyone within the swine industry. It can’t be a “wink and a nod” and then go on with business as usual. We all need to confront the reality of the ASF virus and its ability to survive in and on several contaminated fomites including meat products, feedstuffs, vehicles, and equipment.

The role of feed in viral spread can be debated but there is a strong case to be made that contaminated feed is a serious and real risk. The brutal fact is the US pork industry imports a substantial number and quantity of feed additives and ingredients from countries with ASF. This is a wide-open door for incursion unless the US Department of Agriculture, the US Food and Drug Administration, and the feed industry either prevent or mitigate ASF virus-contaminated feed from entering the United States.

Unfortunately, we don’t have ASF radar to inform us about the coming storm, so we are left to do the best we can with the resources and resolve we can muster. Pork producer organizations and the AASV are active in assessing the risks posed by ASF and either implementing the actions needed to thwart the entry of the virus or advocating for action by the appropriate governmental agencies. This also includes the funding of research to fill the gaps in knowledge. Swine veterinarians working on farms can play a vital and active role in identifying risks and improving biosecurity aimed at the exclusion of the virus in all possible fomites coming onto a farm.

Prevention of ASF from entering the United States is a daunting and difficult task but that fact can’t be allowed to develop into an excuse. George Washington Carver put it this way, “Ninety-nine percent of the failures come from people who have the habit of making excuses.” After the storm passes, let’s be glad to have done our best to prevent ASF and not be the ones still making excuses.

Tom Burkgren, DVM
Executive Director
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Porcine circovirus Type 2 (PCV2) changes rapidly. Be sure your pigs are protected with Fostera® Gold PCV MH, the only vaccine that contains two PCV2 genotypes as well as long-lasting Mycoplasma hyopneumoniae coverage. All to help keep your pigs safe from lurking threats. Get the broadest antigenic and longest-lasting PCV2 coverage available with Fostera Gold PCV MH.

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Executive Editor’s message

Remembering and Giving Thanks

Once again, I really enjoyed reading the manuscript contributions that have formed the scientific component of this issue of the journal. I hope you also enjoy reading this edition of the Journal of Swine Health and Production (JSHAP). The papers and messages within this issue are the result of a major team effort that brings together applied and diverse topics to our swine information library. As many of you know, the November-December issue of JSHAP publishes a list of all the reviewers who have graciously reviewed manuscripts for the journal over the previous year. I invite you to turn to that list and recognize all those individuals who have volunteered their time and expertise to provide a peer-review. If you see one of these peer-reviewers in your daily travels or at a conference, please pass on a thank-you.

I would personally like to thank all the peer-reviewers for their hard work and contributions to the journal over the past year. Thank you!

In some of my previous messages I have described the peer-review process for JSHAP. I wanted to revisit this topic so that we remember how many people are involved in the process and the time commitment required. The November-December issue is also a timely issue for giving thanks and for remembering, as many of us celebrate Thanksgiving, Remembrance Day, Veterans Day, and many other significant holidays.

The peer-review process of scientific manuscripts can be quite variable from journal to journal. Regardless of the review system in place, the process takes a considerable amount of time and hard work. As a starting point to gaining an appreciation for the time commitment in the length of the process, I ask you to consider the two dates published on the online version of a manuscript: the received date and the accepted date (Figure 1). The received dates published in JSHAP reflect the date the manuscript is submitted to the journal office and the accepted dates represent the date of conditional acceptance for publication. You will see that the time frame between these two dates varies greatly from manuscript to manuscript.

Why do we keep track and publish this information? There are multiple reasons, but one important reason from an administration standpoint is to help the journal monitor the length of time a manuscript takes to go through the review and editing process. We like to monitor this information and see if there are ways or areas where we can streamline the process.

The length of time from submission to acceptance and then publication can depend on many things and it is not unusual for JSHAP to experience delays in the review process. It is a coordinated effort to keep things moving while balancing author and reviewer schedules, eg, changes in personal schedules and reviewer availability during the process. Not to mention the journal’s timelines and deadlines, international time zones delaying communications, holidays, etc. I think you get the idea. For all these reasons, JSHAP does not have a guaranteed publication timeline as there are many factors out of our direct control. However, we are sensitive to timely publication and strive to keep timelines reasonable. Karen Richardson, our publications manager, looks after keeping track of the manuscripts, timelines, and people.

To elaborate further, the specific review process begins with me, the executive editor. I read the manuscript and decide if it is within the scope of the journal. If the manuscript is out of the journal’s scope, it is returned to the author and not accepted for a full peer-review. Additionally, manuscripts are returned to the author for revision if they have not followed the author guidelines, further delaying the review process. Two areas where authors most often fail to follow the guidelines is with providing information regarding animal use and general formatting. These steps and attention to detail are important so that we don’t overwhelm our reviewers with requests to review poorly presented manuscripts or manuscripts that do not suit the journal.

Once the manuscript is accepted for review, I request one of the members of the editorial board to act as a lead reviewer. This is a critical component of the review process as the lead reviewer will guide the review process for the individual manuscript from here and help to narrow down the reviewer search for the submission. Typically, 2 or 3 additional reviewers are obtained for each manuscript and the reviewers are given 3 to 4 weeks to return their reviews. The work of the editorial board members brings a wealth of expertise to the review process, the journal, and the body of published scientific literature in general.

I would like to personally thank all the lead reviewers, past and present, for their contributions to the journal. Thank you!

“Two areas where authors most often fail to follow the guidelines is with providing information regarding animal use and general formatting.”

Executive Editor’s message continued on page 303
In 2017, Newport Laboratories officially became part of Boehringer Ingelheim, uniting the strengths of both companies to give producers and veterinarians access to a more well-rounded and comprehensive portfolio of animal health solutions.

Located in Worthington, Minnesota, Newport Laboratories has been in business for more than 20 years and is pioneering technological advancements in diagnostics and research for creating autogenous, or custom-made vaccines.

**WHY CUSTOM VACCINES?**

Custom-made vaccines can help fill the gaps in disease prevention, complementing the protection producers are already getting from commercial vaccines. When a herd has an infection a commercial vaccine can’t address, a custom vaccine may be the solution.

Using molecular-biology techniques to quickly diagnose complex diseases and identify the specific pathogen strains causing infections on farms, Newport Laboratories creates custom vaccines that provide targeted protection against those strains.

But how the company goes about selecting the isolates from which it produces a vaccine is one of the things that makes Newport Laboratories unique. Newport Laboratories is the only custom-vaccine manufacturer that conducts its own in-house research for its proprietary database of field-sampled isolates. Newport Laboratories references customer isolates against this data-base to help determine which to use in a vaccine. A field sample may come in containing many different isolates, but not all of them may be good candidates for vaccine creation. Newport Laboratories has the advantage over other custom-vaccine manufacturers of being able to cross-reference field samples against its database and select the specific isolates that have proven themselves to be the most effective at triggering a protective immune response.

**ADVANCED DIAGNOSTICS**

In addition to custom-vaccine creation, Newport Laboratories operates one of the largest private diagnostic laboratories in the country and is leading the way in both traditional diagnostic services and new molecular diagnostic tools and techniques.

One such tool is metagenomics, which allows Newport Laboratories to provide a complete snapshot of pathogens faster than traditional diagnostics by using fecal or tissue samples instead of cultures. This gives veterinarians the answers they need in less time and with less effort.

Newport Laboratories’ diagnostic laboratory uses novel molecular technologies, developed in house, to further characterize isolated pathogens, compare them genetically to genes associated with important virulence factors, and recognize emerging variants. These techniques aid in the selection of those new strains for use in custom vaccines, addressing pathogens for which vaccines were previously unavailable.

Newport Laboratories’ diagnostic services also include bacteriological culturing, antibacterial-susceptibility testing, serological profiling to monitor herd-pathogen exposure, and isolation of viral pathogens.

**START WITH YOUR VET**

Herd health starts by working with your veterinarian. Newport Laboratories is dedicated to working with veterinarians to ensure proper sampling and submission, quick turn- around and accurate results. Talk to your veterinarian about whether custom-made vaccines are right for your operation, or visit www.newportlabs.com to learn more.
Once the reviews are complete and submitted to the journal office, the lead reviewer will take all the reviews into consideration and make a publication recommendation. At this point, I review the publication recommendation and make the decision to conditionally accept, request revisions, or reject the manuscript. If revisions are requested, the manuscript is returned to the author and they are given 3 weeks to respond. Once the revised manuscript is returned to the journal office, it is sent back to the reviewers for re-consideration. This is the period where a manuscript can accumulate quite a bit of time and skew the distribution of the time to acceptance statistic. Depending on any further revisions required, the manuscript may be conditionally accepted at this time, returned for further revisions, or rejected.

Once the manuscript is conditionally accepted it is forwarded to Sherrie Webb, our associate editor. Any changes usually required at this point are corrections in grammar, punctuation, format, and copy-editing concerns that the associate editor manages. However, some minor revisions or requests for clarification from reviewers may also need to be addressed at this point. Once this phase is completed, the manuscript is converted into an author proof by Tina Smith, our graphic designer, and returned to the author for final proofreading. Once this phase is completed, the review process is finished. Phew!

As you can see, the process is thorough and lengthy and requires the efforts of many critical people and opinions in the process. It seems that the epidemic of ‘busy schedules’ continues to escalate with many of us experiencing increased work demands, and it perhaps seems to be approaching a pandemic phase. I recognize it is often difficult to take on additional work and I hope you can now remember that reviewing a paper thoroughly is a big job requiring the time of many people. At the time of writing this message the journal has received 36 manuscript submissions in 2018 and we still have many weeks left in the year. While this is nice to report healthy submission rates for the journal, it also means active recruiting of peer-reviewers remains challenging. Once again, thank you to those who take on extra work during this epidemic of busy schedules. Additionally, in a previous message I put out a call for “JSHAP’s Most Wanted.” We always need peer-reviewers! If you would like to be on JSHAP’s “Most Wanted List” as a willing peer-reviewer, please use the following link to complete the short survey (5 to 10 minutes): uoguelph.eu.qualtrics.com/jfe/form/SV_3q6Wc4gJKegOGGh.

Thank you to everyone who has contributed, and continues to contribute, considerable amounts of time and effort to this process for JSHAP.

Terri O’Sullivan, DVM, PhD
Executive Editor

References
Evaluation of pig pneumonia at slaughter using polymerase chain reaction and histopathology in Argentina

Javier A. Cappuccio, DVM, PhD; Marina Dibarbora, DVM, PhD; Fernando A. Bessone, DVM, MSc; Valeria S. Olivera; Inès Lozada, DVM; Fabrisio E. Alustiza, DVM, PhD; Alejandra Quiroga, DVM, PhD; Estefanía M. Pérez, DVM, PhD; Gustavo C. Zielinski, DVM, PhD; Carlos J. Perfumo, DVM, PhD; Ariel J. Pereda, DVM, PhD; Daniel R. Pérez, PhD

Summary
Histopathology and polymerase chain reaction were conducted on 81 lungs collected at slaughter from 13 swine farms free of porcine reproductive and respiratory syndrome virus and pseudorabies virus infection. Pasteurella multocida and Mycoplasma hyopneumoniae were the most common pathogens detected. Suppurative and catarhal bronchopneumonia was present in 59 (72.8%) cases.

Keywords: swine, bronchopneumonia, slaughter, Argentina, porcine respiratory disease complex

Received: January 9, 2018
Accepted: June 9, 2018

In pig production systems, slaughter checks are routinely used to estimate prevalence and severity of respiratory disease as well as for detecting subclinical disease. The term porcine respiratory disease complex (PRDC) is used to describe polymicrobial respiratory infections that affect growing and finishing pigs and are associated with economic losses. The etiology of PRDC varies among countries, regions, and farms.1-4 The most common pathogens reported worldwide associated with PRDC are Actinobacillus pleuropneumoniae (Ap), influenza A virus (IAV), Mycoplasma hyopneumoniae (Mh), Pasteurella multocida (Pm), porcine circovirus type 2 (PCV2), porcine reproductive and respiratory syndrome virus (PRRSV), and pseudorabies virus (PRV).1,4 In Asia, Europe, and North America the predominance of PRRSV in cases of PRDC is well documented.2,4

Argentina is free of PRRSV, whereas PRV is under an eradication plan with most confinement farms free of infection. Under this scenario, the agents that are most frequently associated with PRDC in Argentina remain unknown. The aim of this study was to investigate the relationship between respiratory pathogens detected by polymerase chain reaction (PCR) and histopathological lung lesions in lungs with pneumonia lesions obtained from PRRSV- and PRV-free pigs at slaughter.

Materials and methods
All samples were collected from three slaughterhouses in Argentina which operate in accordance with slaughtering procedures...
approved in the country. A non-probability sampling scheme was applied, only lungs with bronchopneumonia lesions that affected more than 20% of the entire lung area were selected. To avoid cross-contamination in sample processing, sterile instruments were used for each sample collected and samples were individually placed in sterile bags and stored at 4°C. A total of 81 samples were collected from pigs originating from 13 farms (6 to 7 samples from each farm), located in the main swine production areas of the country: Buenos Aires, Entre Rios, and Santa Fe provinces. All 13 farms used the same commercial single-dose, single-injection Mh and PCV2 combined vaccine at the time of weaning (FLEXcombo, Boehringer Ingelheim, St. Joseph, Missouri). No other vaccines against respiratory pathogens were used.

For histopathology analysis, samples were collected and assigned an identification number by a practitioner at the abattoir and then routinely processed according to Laboratorio de Patología Especial Veterinaria procedure manual by a laboratory technician. The prepared blocks were then analyzed in a blinded manner by a single pathologist. Lung lesions were diagnosed into one of the following categories: suppurative broncho-pneumonia (SBN) defined by the presence of neutrophils, macrophages, and mucus in bronchioles and alveoli; catarhal broncho-pneumonia (CBN) defined by bronchiole and alveoli filled with mucus exudate, macrophages, and scarce or no neutrophils present; bronchiointerstitial pneumonia (BIN) defined by macrophages and lymphocytes infiltrating the alveolar and peribronchiolar septa, bronchiolar necrosis, or hyperplasia of pneumocytes type II; bronchitis and bronchiolitis defined by inflammation or necrosis restricted to airway walls and presence of neutrophils and cellular debris in airway lumen; fibrinous bronchopneumonia (FB) defined by alveoli and interlobular connective tissue filled with serofibrinous exudate, presence of oat cells, and thrombosis of capillaries and lymphatic vessels; or no lesions.

For PCR assays, lung homogenates were processed according to Cappuccio et al. Extraction of DNA and RNA was made using Roche High Pure PCR Template Preparation Kit and High Pure RNA Isolation Kit (Roche Diagnostics, Mannheim, Germany). Polymerase chain reaction assays were performed on Veriti Thermal Cycler or StepOnePlus Real-Time PCR System (Applied Biosystems, Foster City, California). The presence of IAV, PCV2, Mh, Pm, and Ap were determined as previously described (Table 1).

The statistical relationship between frequency of detection of each pathogen and the histopathological category was evaluated by Fisher’s exact test using manual calculation. Statistical significance was set to $P < .05$.

**Results**

The most common pathogens detected in 81 samples tested by PCR were Pm in 64 cases (79%) and Mh in 59 cases (72.8%). Our study revealed no PCR positive samples to Ap. Viral pathogens were detected in a lower percentage of samples: PCV2 in 17 cases (21%) and IAV in 6 cases (7.4%) (Figure 1). Coinfections of two or more pathogens were detected in 52 cases (64.2%), with the most common coinfection being Pm and Mh coinfection in 34 of 52 samples (65.4%). In relation to viral pathogens, PCV2 was detected as a coinfection in 15 cases and the 6 IAV positive cases were coinfections.

In relation to histopathology analysis, SBN and CBN were present in 59 (72.8%) of the 81 cases (Figure 2) and were most commonly found with either single Mh (7 of 59 cases, 11.9%) or Pm (10 of 59 cases, 16.9%) infections or a combination of both pathogens in 27 of 59 cases (45.8%). Detection of PCV2 occurred in 9 of 34 cases (26.5%) categorized as SBN, of which 3 were also positive for Mh.

**Table 1: Polymerase chain reaction assays used to measure respiratory pathogens present in lung tissue samples**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Primer sequence</th>
<th>Amplicon size (bp)</th>
<th>Specificity</th>
<th>Type of PCR</th>
<th>Threshold of detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAV*</td>
<td>5´-GACCRATCTCTGTACCTCCTGAC-3´</td>
<td>60</td>
<td>Matrix</td>
<td>RT-PCR</td>
<td>$4.17 \times 10^5$ TCID50/reaction</td>
</tr>
<tr>
<td>PCV2†</td>
<td>5´-GGGGAGGATGTTTTACATA-3´</td>
<td>460</td>
<td>ORF2</td>
<td>PCR</td>
<td>$4.42 \times 10^6$ copies/μL</td>
</tr>
<tr>
<td>Ap‡</td>
<td>5´-GGGGAGTACTCGTGATT-3´</td>
<td>377</td>
<td>ApxIV</td>
<td>qPCR</td>
<td>5 CFU/reaction</td>
</tr>
<tr>
<td>Pm§</td>
<td>5´-ATCCGGTATTTCACCAGTGG-3´</td>
<td>460</td>
<td>KMT1</td>
<td>PCR</td>
<td>$4.09 \times 10^3$ organisms</td>
</tr>
<tr>
<td>Mh¶</td>
<td>5´-GAGCTTCTTCAACCTCACAAGA-3´</td>
<td>649</td>
<td>16S ribosomal</td>
<td>N-PCR</td>
<td>80 organisms</td>
</tr>
</tbody>
</table>

* The presence of IAV was determined as previously described.† The presence of PCV2 was determined as previously described.‡ The presence of Ap was determined as previously described.§ The presence of Pm was determined as previously described.¶ The presence of Mh was determined as previously described.

bp = base pair; PCR = polymerase chain reaction; IAV = influenza A virus; RT-PCR = reverse transcription PCR; TCID50 = 50% tissue culture infective dose; PCV2 = porcine circovirus type 2; ORF2 = open reading frame 2; Ap = Actinobacillus pleuropneumoniae; ApxIV = Actinobacillus pleuropneumoniae toxin IV; qPCR = quantitative PCR; CFU = colony-forming units; Pm = Pasteurella multocida; KMT1 = Pasteurella multocida species identification gene; Mh = Mycoplasma hyopneumoniae; N-PCR = nested PCR.
and Pm, 3 were also positive for Mh, Pm, and IAV, 1 was also positive for Pm, 1 was also positive for IAV, and 1 showed no sign of coinfection. Only 3 cases categorized as CBN were positive for PCV2 and were also positive for Mh and Pm (Figure 2). Ten cases were categorized as BIN and tested positive for either Mh, Pm, or both but only 2 cases were PCV2 positive. Only 2 cases were categorized as FB and were negative to Ap and positive to Pm. No statistical association ($P > .05$) was detected between histopathological classification and pathogen detection by PCR.

Regardless of histopathological classification, necrotizing bronchiolitis and bronchiolesclerosis were detected in 33 of 81 cases (40.8%), which were most frequently categorized as SBN (23 of 33 cases, 69.7%) and were positive for Mh and Pm (30 of 33 cases, 90.9%). Only 7 cases with necrotizing bronchiolitis and bronchiolesclerosis were positive for PCV2 (5 of 33 cases, 15.2%) or IAV (2 of 33 cases, 6.1%).

**Discussion**

Few studies have been done to investigate the relationship among pathogen detection and histopathological lesions in PRDC affected pigs. Two to four of the authors’ knowledge, this is the first study carried out in Argentina that investigated lung lesions collected from pigs at the time of slaughter. However, it must be taken into consideration, upon interpretation of results, that only a small number of non-randomly selected herds were included in this study and hence, this represents a biased sample of the Argentinian swine population. Regardless of this bias, Pm and Mh were the pathogens most frequently detected. The detection rate of these pathogens is consistent with studies carried out in Asia, Europe, and North America. The detection of Mh should not be considered a lack of vaccine effectiveness as vaccination reduces clinical signs and lung lesions, but does not prevent the colonization of the organism. The incidence of viral infections was lower than in previously published studies. Two or more pathogens were detected in a high number of cases (52 of 81; 64%), with the most common being Pm and Mh coinfection. Most of the PCV2 positive cases were coinfections (15 of 17; 88%) further supporting the possible role of PCV2 in coinfections. Influenza A virus was detected in a low number of cases and always in coinfections. The authors hypothesize that the predominance of bacterial detection over viral detections in this study is related to the absence of PRRSV infection and the implementation of vaccination against PCV2 in the farms evaluated but must also reiterate that this was not a randomly generated sample of lung lesions. In the case of IAV, the low detection rate could be affected by a combination of factors including the age of pigs at which the sample was collected, the acute nature of the infection, and the short persistence of the virus in the lungs.

Similar to previous studies, SBN and CBN were the most common histopathological diagnosis and could be explained by the higher number of samples positive to Pm, Mh, and their coinfection. When CBN or SBN occurs with a bacterial infection without evidence of viral infection, the bronchiolar epithelium is generally normal. It is commonly accepted that virus replication leads to inflammation and necrosis of the bronchioles with concomitant obstruction of the lumen that ultimately affects clearance of bacteria and exudates from the alveoli leading to more severe lesions. In this study, necrotizing bronchiolitis or bronchiolesclerosis was detected in 41% of the cases, most frequently associated with SBN and Pm and Mh detection. Bronchointerstitial pneumonia occurs particularly in viral infections and is the more frequent lung lesion associated with PCV2 infections. In this study, however, all BIN cases tested positive for either Mh, Pm, or both. Previous studies describe interstitial and peribronchial...
Figure 2: Frequency of histopathological categories detected for pathogens present in 81 lung samples collected at slaughter in Argentina. Histopathological categories were: suppurative bronchopneumonia (SBN; 34 samples) defined by the presence of neutrophils, macrophages, and mucus in bronchioles and alveoli; catarrhal bronchopneumonia (CBN; 25 samples) defined by bronchiole and alveoli filled with mucus exudate, macrophages, and scarce or no neutrophils present; bronchointerstitial pneumonia (BIN; 10 samples) defined by macrophages and lymphocytes infiltrating the alveolar and peribronchiolar septa, bronchiolar necrosis, or hyperplasia of pneumocytes type II; bronchitis and bronchiolitis (BB; 8 samples) defined by inflammation or necrosis restricted to airway walls and presence of neutrophils and cellular debris in airway lumen; fibrinous bronchopneumonia (FB; 2 samples) defined by alveoli and interlobular connective tissue filled with serofibrinous exudate, presence of oat cells, and thrombosis of capillaries and lymphatic vessels; and no lesions (NL; 2 samples). Mh = Mycoplasma hyopneumoniae; PCV2 = porcine circovirus type 2; Pm = Pasteurella multocida; IAV = influenza A virus; PCR = polymerase chain reaction.

Infiltration lesions to be associated with Mh and Pm infections. The 2 cases of FB were positive for Pm and negative for Ap. The relationship between Pm and FB has been previously reported to be associated with toxin production. It is highlighted that only one pathologist scored the lung lesions and pathological analysis was performed in a different laboratory than the PCR assays.

The lack of statistical association between histopathological diagnosis and PCR detection of each pathogen could be related to the small number of samples evaluated. Further studies using a more comprehensive epidemiological approach are needed to verify this lack of relationship.

This brief communication reports on the polymicrobial nature of PRDC in slaughter-aged pigs presumed free of PRRSV and PRV infections and that were vaccinated for Mh and PCV2 at weaning. The presence of bacterial and viral coinfections with SBN lesions in this study supports the continued need to control respiratory infection on swine farms in Argentina. Slaughterhouse inspection of carcasses is used to protect public health by ensuring food safety. However, these data collected also have value for other purposes such as passive surveillance activities. For example, the data has been used to estimate prevalence of a particular disease or pathological condition, determine risk factors associated to pleurisy or pneumonia, and to determine the economic effect of pneumonia. More recently, a well-established slaughterhouse national surveillance system has been considered valuable as an early warning system for an emerging disease or as an initial database to design specific studies (eg, pleurisy or tail lesions). In this context, slaughter surveys can be applied to generate significant information about the etiology, severity, and interactions of PRDC.

Implications
- Under the conditions of this study, Pm and Mh were the most frequently detected pathogens from grossly affected lungs collected from pigs at slaughter in Argentina.
- This study supports the necessity for the development of a national based slaughterhouse monitoring or surveillance system to continue to document and understand lesions and pathogens present in the Argentinian swine population.

Acknowledgements
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Conflict of interest
None reported.

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References

Conflict of interest
None reported.

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General overview of the detection of *Mycoplasma hyopneumoniae* DNA by quantitative polymerase chain reaction in diagnostic cases submitted to the Iowa State University Veterinary Diagnostic Laboratory from 2004 to 2016

Gaurav Rawal, DVM; Paulo Arruda, DVM, PhD; Christopher Rademacher, DVM; Ran Bi, MS; Daniel C. L. Linhares, DVM, MBA, PhD

Summary

*Mycoplasma hyopneumoniae* (Mhp) is the etiologic agent of enzootic pneumonia and a major causative agent of the porcine respiratory disease complex. This study summarizes and describes the general diagnostic trends on Mhp detection by quantitative polymerase chain reaction (qPCR) in cases submitted to the Iowa State University Veterinary Diagnostic Laboratory from 2004 to 2016. The following variables were included in the analysis: animal age, geographic location, sample type, season, and submission year. The overall frequency of detection found was 27.04% and ranged from 17.9% to 40.7%. Lung homogenates and bronchial swabs had a greater Mhp qPCR detection rate than other sample types (*P* < .001) followed by bronchoalveolar lavage (*P* < .001), while oral fluids had the lowest Mhp detection rate (*P* < .001). The fall season had a greater percentage of positive Mhp qPCR results when compared to other seasons (*P* < .001), while spring had the lowest percentage. Finishing-age pigs had a greater percentage of Mhp qPCR detection when compared to other age groups (*P* < .001), while suckling pigs had the lowest percentage (*P* < .001).

Keywords: swine, *Mycoplasma hyopneumoniae*, polymerase chain reaction

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This article is available online at [http://www.aasv.org/shap.html](http://www.aasv.org/shap.html).

Mycoplasma hyorhinis (Mhp) is the causative agent of enzootic pig pneumonia, a respiratory disease affecting pigs worldwide, characterized by significant economic losses due to slower growth, poor feed conversion, and death. The losses associated with Mhp were estimated in the range of $375 to $400 million annually in the United States. Mycoplasma hyorhinis increased the cost of production by $2.50 per pig in the grow-finish phase with an additional increase in the cost of therapeutics by $0.75 to $0.90 per pig at weaning in the United States. The isolation of Mhp is challenging due to the fastidious culture requirements and the relatively slow Mhp growth, often resulting in overgrowth by other mycoplasmas including M. flocculare and M. hyorhinis. Therefore, detection of Mhp for diagnostic purposes is typically performed by quantitative polymerase chain reaction (qPCR), which offers rapid turnaround at a high sensitivity and specificity. Multiple specimens including bronchial swabs, bronchoalveolar lavages, laryngeal swabs, lung homogenates, lungs, nasal swabs, oral fluids, and tracheal swabs have been used to detect Mhp in pigs.

The Iowa State University Veterinary Diagnostic Laboratory (ISU VDL) is one of the largest in the United States receiving over 80,000 cases annually, of which over 75% are swine related. The objective of this study was to summarize and describe the patterns of Mhp DNA detection rate by qPCR over time from cases received at the ISU VDL from 2004 to 2016. Mycoplasma hyorhinis detection rate was reported by year, age group, specimen, season, and US geographic location.

Materials and methods
This study was based on data derived from diagnostic laboratory submissions, so an Institutional Animal Care and Use Committee approval was not needed.

Eligibility and exclusion criteria
All porcine cases where Mhp qPCR was performed were gathered. For this study, a case was defined as one accession identification number with at least one sample. A case was considered positive when there was at least one sampling positive for Mhp by qPCR. The data were screened and cases with non-conventional sample types for Mhp diagnostics, including cell cultures, conjunctival swabs, environmental, extract, inoculum, liver, semen, and vaccine, were excluded from the analysis. Infrequent sample types (those comprising less than 1% of submissions) such as fibrin, fibrin swab, fluid, fresh tissue, lymph node, tonsil, and tonsil scrapings were also excluded from the analysis, as were cases with inconclusive or suspect results. Submissions were classified by season (December through February as winter, March through May as spring, June through August as summer, and September through November as fall), age group (pigs less than 3 weeks of age were defined as suckling, 3 to 6 weeks as nursery, 7 to 11 weeks as growing, 12 weeks to 200 days as finishing, and greater than 200 days as adult), and sample type, which included bronchial swab, bronchoalveolar lavage, laryngeal swab, lung, lung homogenate, nasal swab, oral fluid, swab, tracheal swab, and other. All specimens are described using the same terminology reported in the VDL submission form. Samples labeled as saliva were included under the oral fluid category and samples labeled as lung swab, multiple, oropharyngeal swab, pharyngeal swab, pleural swab, serum, and tonsil swab were identified as other.

Microsoft Excel (Microsoft, Redmond, Washington) was used to organize the data and Tableau (Tableau, Seattle, Washington) was used to produce plots.

Statistical analysis
Statistical analysis was performed with SAS 9.4 software (SAS Institute Inc, Cary, North Carolina). For statistical analysis, the frequency of positive results was compared across groups (age, season, and sample type) with Pearson’s Chi-square test. The significance level was determined at α = .05.

The K-means clustering method was implemented to categorize the Mhp detection rate as low, medium, or high for specimen types. The aim of the K-means algorithm is to divide the set of observations into K groups, minimizing the within-cluster sum of squares. The K-means procedure searched for 3 partitions with locally-optimal, within-cluster sum of squares by moving points from one cluster to another.

Results
A total of 94,986 qPCR results from 37,574 cases were used in the analysis. In total, 1128 qPCR results were excluded from the data analysis due to non-conventional or infrequent sample types and 178 qPCR samples were excluded due to inconclusive status of results. Analysis were conducted with 93,680 samples, from which 25,339 (27%) tested positive for Mhp qPCR, ranging from 17.9% to 40.7% (Table 1).

The most common sample types submitted for Mhp qPCR at the ISU VDL were lung, followed by oral fluids, nasal swab, and bronchoalveolar lavage (Figure 1). The Mhp qPCR detection rate was 64% in bronchial swab (2503 of 3909), 49% in bronchoalveolar lavage (3370 of 6872), 18% in laryngeal swab (313 of 1777), 33% in lung (13517 of 40633), 66% in lung homogenate (962 of 1455), 10% in nasal swab (808 of 7892), 8% in oral fluids (1850 of 23804), 18% in swab (341 of 1922), 34% in tracheal swab (606 of 1777), and 27% in other (965 of 3574). Lung homogenate and bronchial swab had a greater Mhp qPCR detection rate than other sample types (P < .001), followed by bronchoalveolar lavage (P < .001), while oral fluids had the lowest Mhp detection rate (P < .001). Using the K-mean clustering method, bronchial swab, bronchoalveolar lavage, and lung homogenate had a high detection rate; lung, tracheal swab, and other had a medium detection rate; and laryngeal swab, nasal swab, oral fluid, and swab had a relatively low detection rate. The fall season had a greater percentage of positive Mhp qPCR results when compared to other seasons (P < .001), while spring had the lowest percentage (P < .001) (Figure 2). Finishing-age pigs had a greater percentage of Mhp qPCR detection when compared to other age groups (P < .001), while suckling pigs had the lowest percentage (P < .001) (Figure 3). The majority (30%) of cases submitted to the ISU VDL for Mhp testing by qPCR were from Iowa, but there were cases from 33 other states (Figure 4).

Bronchoalveolar lavage had a greater detection rate of Mhp by qPCR, as compared to other specimens, for all age groups except growing pigs (Figure 5). In growing pigs, lung homogenate had the highest detection rate among the specimens. Nasal swab had the lowest Mhp detection rate for the suckling- and finishing-age groups. In growing pigs, oral fluid had a relatively low Mhp detection rate.
Table 1: *Mycoplasma hyopneumoniae* DNA detection by qPCR at the ISU VDL from 2004 to 2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Total porcine case submissions, No.</th>
<th>Porcine case submissions for Mhp qPCR testing, No. (%)</th>
<th>Cases positive for Mhp, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>17,744</td>
<td>1175 (6.6)</td>
<td>263&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2005</td>
<td>20,916</td>
<td>2402 (11.5)</td>
<td>680&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2006</td>
<td>28,112</td>
<td>4391 (15.6)</td>
<td>1235&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2007</td>
<td>27,846</td>
<td>4241 (15.2)</td>
<td>1195&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2008</td>
<td>25,254</td>
<td>4456 (17.6)</td>
<td>1499&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>2009</td>
<td>22,992</td>
<td>6291 (27.4)</td>
<td>1187&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>2010</td>
<td>25,216</td>
<td>5014 (19.9)</td>
<td>1646&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>2011</td>
<td>28,938</td>
<td>8948 (30.9)</td>
<td>2789&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>2012</td>
<td>33,892</td>
<td>8667 (25.6)</td>
<td>3527&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>2013</td>
<td>38,656</td>
<td>9022 (23.3)</td>
<td>2133&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2014</td>
<td>51,146</td>
<td>9163 (17.9)</td>
<td>2513&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2015</td>
<td>53,382</td>
<td>13,609 (25.5)</td>
<td>3756&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2016</td>
<td>55,275</td>
<td>16,301 (29.5)</td>
<td>2916&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>abcdef</sup> Different letters indicate significant differences (*P* < .005; Chi-square analysis for percent of Mhp positive cases over time).

qPCR = quantitative polymerase chain reaction; ISU VDL = Iowa State University Veterinary Diagnostic Laboratory; Mhp = *Mycoplasma hyopneumoniae*.

Figure 1: *Mycoplasma hyopneumoniae* DNA detection by specimen type using qPCR on cases submitted to the ISU VDL from 2004 to 2016. For each bar, blue indicates cases that tested negative and red represents cases with at least 1 positive sample. The number at the top of each bar indicates the percentage of positive cases within each specimen. Different letters indicate significant differences (*P* < .05; Chi-square analysis). qPCR = quantitative polymerase chain reaction; ISU VDL = Iowa State University Veterinary Diagnostic Laboratory; Mhp = *Mycoplasma hyopneumoniae*. 
**Figure 2:** Detection of *Mycoplasma hyopneumoniae* DNA by season using qPCR on cases submitted to the ISU VDL from 2004 to 2016. Seasons are defined as March through May as spring, June through August as summer, September through November as fall, and December through February as winter. A, the number of Mhp cases submitted in each season per year. B, the percentage of positive cases in each season. qPCR = quantitative polymerase chain reaction; ISU VDL = Iowa State University Veterinary Diagnostic Laboratory; Mhp = *Mycoplasma hyopneumoniae.*
Figure 3: Detection of *Mycoplasma hyopneumoniae* DNA by age group and season using qPCR on cases submitted to the ISU VDL from 2004 to 2016. Seasons were defined as March through May as spring, June through August as summer, September through November as fall, and December through February as winter. Pigs less than 3 weeks of age were defined as suckling, 3 to 6 weeks as nursery, 7 to 11 weeks as growing, 12 weeks to 200 days as finishing, and greater than 200 days as adult. qPCR = quantitative polymerase chain reaction; ISU VDL = Iowa State University Veterinary Diagnostic Laboratory; Mhp = *Mycoplasma hyopneumoniae*. 
Discussion

*Mycoplasma hyopneumoniae* is one of the most economically important respiratory pathogens in the US swine industry. This study provides valuable information regarding the distribution of Mhp qPCR results over age group, geographic location, season, specimen, and time. The relatively low positivity rate of Mhp detection by qPCR in 2016 (17.9%) was associated with increased testing from adult- and suckling-age groups and from oral fluids. There was a relative and consistent increase in the total Mhp qPCR performed from 2004 to 2016 at ISU VDL but the percentage of the positive results remained relatively similar, which may be due to the endemicity of Mhp. Finishing-age pigs had a greater number of total cases and greater prevalence of Mhp detection compared to other age groups, which was expected as Mhp is a pathogen known to cause clinical disease in that age group of pigs. The trend of increasing submissions from adult and suckling pigs, as compared to growing pigs, may reflect the implementation of monitoring programs within breeding herds as part of disease control or elimination efforts. Due to a relatively long incubation period and low transmission rate, enzootic pneumonia is usually not reported in pigs younger than 6 weeks of age. Therefore, in this study, Mhp detection was relatively low in suckling and nursery pigs as compared to finishing pigs. Bronchoalveolar lavage fluid and tracheobronchial samples have been reported as specimen types with greater sensitivity when tested with nested PCR to detect Mhp infection, as compared to other specimen types such as nasal, tonsil, and tracheobronchial swabs and lung tissues. In this study, Mhp qPCR detection rate was 49% in bronchoalveolar lavage fluid, 64% in bronchial swab, and 34% in tracheal swab. Likewise, nasal swabs and lung tissues had a relatively lower Mhp detection rate in experimentally infected pigs. In our study, Mhp qPCR detection rate was 10% in nasal swab, and 33% in lung.

The number of cases submitted and the percentage testing positive for Mhp by qPCR were highest during the fall season (September, October, and November). Although not entirely comparable, similar results have been reported in *Mycoplasma pneumoniae* infection in humans. The increased sample submissions in the fall season may be partly attributed to the seasonality of other respiratory pathogens including porcine reproductive and respiratory syndrome virus and influenza A virus. The majority of cases were from the Midwest region of the United States with the greatest number of cases from Iowa, which is not surprising due to the high density of swine in Iowa and the location of the ISU VDL.

Limitations of this study include the fact that testing positive for Mhp by qPCR does not necessarily imply clinical disease. Despite most cases being associated with field investigations, cases involving monitoring and surveillance projects were also included which could have affected conclusions. Also, this analysis was limited to cases submitted to the ISU VDL.

Implications

- Despite the relative and consistent increase of Mhp qPCR performed from 2004 to 2016, the percentage of the positive results remained relatively similar. The overall increase of Mhp qPCR performed is likely a reflection of the overall increase of diagnostic cases submitted to the ISU VDL during this period.
- While the results from samples submitted to the ISU VDL for Mhp qPCR testing had variable detection rates, it is important to keep in mind that these results are based on passive surveillance data.
- The recent increase of Mhp qPCR from samples of suckling and adult pigs may reflect more recent efforts to monitor the progress towards Mhp control and elimination projects rather than investigations of clinical disease in those age groups.

Figure 4: State of origin for cases submitted to the ISU VDL for *Mycoplasma hyopneumoniae* DNA testing by qPCR from 2004 to 2016. The intensity of the blue color represents the number of cases submitted for Mhp testing to the ISU VDL. ISU VDL = Iowa State University Veterinary Diagnostic Laboratory; qPCR = quantitative polymerase chain reaction; Mhp = *Mycoplasma hyopneumoniae*.
Figure 5: LS Means (with standard deviation) of Mhp DNA detection frequency by age group and specimen type using qPCR on cases submitted to the ISU VDL from 2004 to 2016. Pigs less than 3 weeks of age were defined as suckling, 3 to 6 weeks as nursery, 7 to 11 weeks as growing, 12 weeks to 200 days as finishing, and greater than 200 days as adult. Mhp = Mycoplasma hyopneumoniae; qPCR = quantitative polymerase chain reaction; ISU VDL = Iowa State University Veterinary Diagnostic Laboratory.

Acknowledgements
The authors appreciate the cooperation of the ISU VDL in making the database available for assessment.

Conflict of interest
None reported.

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References

* Non-refereed references.
Evident similarity of porcine postparturient dysgalactia to subclinical porcine coliform mastitis

Andreas Pospischil, DVM, Prof emeritus; Hans U. Bertschinger, DVM, Prof emeritus

Summary

The present commentary aims to motivate future research and initiate new investigation on porcine periparturient disorders. After a short characterization of the clinical presentation of coliform mastitis, this commentary concentrates on the subclinical variant. The subclinical form of the disease resembles in most aspects what is referred to as postparturient dysgalactia syndrome of sows, and is considered highly prevalent in the field. Since the recent introduction of the ill-defined postparturient dysgalactia syndrome, experimental work has declined. Except for review articles, there is a shortage of recent publications in this area. Previously published experimental data led to a promising approach to prevent coliform mastitis by reducing the level of teat contamination by coliform bacteria. With the ongoing need to reduce antimicrobial use in food-producing animals, there is a continued need to investigate preventive strategies.

Keywords: swine, review, mastitis, dysgalactia, prevention

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Coliform mastitis

Brief characterization of clinical coliform mastitis

Coliform mastitis (CM) is a febrile peripartum disease, formerly called milk fever, most often observed during the first 24 h after parturition but can also be observed on the day before and up to 2 days post parturition. In addition to pyrexia, clinical signs reported include reluctance to allow nursing, anorexia, constipation, thickened white vaginal discharge, increased respiratory rate, reluctance...
to rise, signs of insufficient caloric intake in piglets, and lower weight gain in piglets.\textsuperscript{2,6,8} These signs are nonspecific and not pathognomonic.\textsuperscript{9} To a producer monitoring their animals closely, these clinical signs are more obvious than lesions in the udder.\textsuperscript{10} Mastitis is caused by coliform bacteria, ie, members of the family Enterobacteriaceae, that invade through the teat duct.\textsuperscript{11} The mode of the bacterial invasion and their spread within the mammary gland determine the irregular expansion of the inflammation.\textsuperscript{12,13}

Diagnosis of CM

Classical signs of inflammation, such as swelling, firmness, increased local skin temperature, soreness, and reddening of the skin, may or may not be present. In one field study, only half of the mastitic glands were diagnosed by clinical examination where isolation of \textit{Escherichia coli} was possible and where cytologic smears showed inflammatory cells.\textsuperscript{14} In most cases, the udder lesions are limited to single complexes, subcomplexes, or foci of a few centimeters or less in diameter.\textsuperscript{15} According to a comprehensive histological study based on 25 tissue blocks per inoculated gland, the most numerous foci and the most severely affected areas are situated dorsally in the udder, ie, close to the abdominal wall and therefore not easily accessible by manual palpation.\textsuperscript{13} The glandular tissue is infiltrated by edema, fat, and covered by relatively thick skin.\textsuperscript{2} During the critical time postpartum, a variable proportion of glands remain partially or totally unsuckled and therefore can remain congested with colostrum.\textsuperscript{16}

These aspects of mastitis presentation in the sow support why it is often difficult to diagnose clinical mastitis even by careful external examination of the udder. This difficulty in diagnosis likely plays a role in the underdiagnosis of mastitis by many clinicians and producers with relation to post-parturient disorders.

A valid determination of mastitis and intramammary infection is only possible if milk samples are collected from each subcomplex of the gland.\textsuperscript{2,8} If milked as usual, a sample from a teat is a composite sample of the secretions originating from the two subcomplexes. According to the experience of the authors, a mixed sample will primarily be composed of the secretion of the healthy or healthier subcomplex due to the higher viscosity of the secretion from the affected tissue. The low secretory activity of mastitis-affected foci will also decrease the ability to diagnose mastitis in samples from focally affected subcomplexes. The involution of complexes not suckled by a piglet renders the interpretation of cytological results difficult due to the increased total somatic cell counts (SCC) from such glands which may be significantly higher than counts from mastitic glands.\textsuperscript{15,16} Markedly elevated counts of polymorphous neutrophils (PMN) are present as well in secretions from glands undergoing involution. Wegmann and Bertschinger\textsuperscript{16} proposed the use of a threshold value composed of a combination of SCC and PMN to discriminate between involution and mastitis. Thus, a SCC of 5 x 10^6 cells/mL is indicative for mastitis if the proportion of PMN exceeds 70%.\textsuperscript{16} The authors experience shows this threshold value is not applicable to samples obtained later than 2 days after parturition. In a more recent paper, a threshold for SCC of 2 x 10^6 cells/mL was used. However, Kotserav et al\textsuperscript{17} did not explain how they distinguished mastitis from involution without PMN determination.

To the authors’ knowledge, a reliable and rapid test for on-farm diagnosis of mastitis is currently not available. Tests developed for use in cattle are not recommended due to the generally higher cell content of sow milk.\textsuperscript{3} Additionally, the measurement of milk pH is of limited diagnostic value.\textsuperscript{6,14} A study comparing postmortem lesions in affected sows with control sows demonstrated a significant association between agalactia and mastitis.\textsuperscript{6} However, necropsy results in mild cases were not necessarily reliable since inflammatory lesions may be too small to be sampled and affected areas cannot easily be differentiated from unaffected glandular areas macroscopically.\textsuperscript{12} In view of the independent processes started by different organisms and at different times, this variability of the mastitic foci in a given sow is not unexpected.\textsuperscript{2}

The sensitivity of histologic examination of affected glandular tissue is highly dependent on the way the udder is sectioned and on the number of tissue blocks examined. The most prevalent histologic findings in affected and control sows are edema and congestion.\textsuperscript{6} In addition, affected areas show an acute catarrhal-purulent mastitis with conserved acinar structure of the gland. The lactic ducts are filled with epithelial and inflammatory cells. In more severe cases, extensive necrotic foci are sometimes surrounded by neutrophil demarcation.\textsuperscript{12,13} Histological findings in other organ tissues have not been significantly correlated with the disorder.\textsuperscript{9,12,15}

The results of bacteriological examination of tissue samples taken at the time of necropsy are more reliable than those based on milk samples, since the contamination with environmental or teat skin flora during milk collection is difficult to avoid. Samples from the teat skin and samples of milk exhibit a similar flora when analyzed following enrichment in a fluid medium.\textsuperscript{18} This sampling contamination has led to variability and the confusing conclusion that secretions from glands with and without mastitis contain a similar bacterial flora.\textsuperscript{5,19,20} Investigators who inoculated solid culture media directly with material from superficially sterilized affected mammary tissue could reliably identify Enterobacteriaceae.\textsuperscript{21,22} Since inflammatory lesions persist for longer time periods than culturable bacteria, the latter cannot be consistently isolated from sites with microscopic lesions.\textsuperscript{13,14,23} Other non-coliform bacteria, such as \textit{Streptococci} and \textit{Staphylococci}, are only rarely associated with mastitis of mild degrees.\textsuperscript{22}

To improve on the effort to obtain a tentative diagnosis based on cytology and bacteriology of the secretion, there have been attempts to utilize clinical pathology criteria for the diagnosis of CM. A marked transitory leukopenia has been observed in experimental acute mastitis.\textsuperscript{5,13} However, in field cases this finding is less marked, probably due to the variable time between the onset of an infection in individual glands and the sampling period.\textsuperscript{15} Other investigators have observed and reported an increased erythrocyte sedimentation rate and a decreased ratio of plasma protein to fibrinogen.\textsuperscript{8} These parameters were confirmed in sows with subclinical mastitis as well.\textsuperscript{15} Following experimental inoculations, tumor necrosis factor-\textit{z} and IL-6 were found to be promising markers for the severity of mastitis\textsuperscript{24} while other acute phase proteins proved to be less specific.\textsuperscript{24,25}

In summary, the diagnosis of CM in the field is still a challenge. Even with efforts to examine secretions from each gland, some degree of uncertainty in reaching a diagnosis remains.

Subclinical CM

Sows affected by CM may exhibit a wide range of clinical signs ranging from subclinical and
mild hypogalactia to severe mastitis with severe systemic signs. The authors believe that subclinical mastitis, ie, mastitis without visible clinical signs, has not been thoroughly investigated and gaps in our knowledge remain. In postmortem studies comparing mammary glands from mastitis-affected sows to healthy control sows, a variable proportion of the latter showed inflammatory lesions in the glands as well. However, as a rule, foci were less numerous and showed a lower degree of inflammation. It appears that spontaneous mastitis of all degrees of severity occurs more frequently than the severe cases would indicate. In a field study report, samples of colostrum from 59 sows from 15 herds with a mastitis problem were examined cytologically and bacteriologically. Eighty-three percent (49 of 59) of the sows were affected by mastitis and coliform bacteria were isolated from 71.2% (42 of 59) of the sows. However, no more than 39% (23 of 59) of these sows were febrile at the time of examination. In a research swine herd with an extremely low incidence of clinical CM, subclinical mastitis diagnosed cytologically was detected in 61% (97 of 159) of the farrowings. A Swedish study based on a population of clinically healthy sows, mastitis with pure cultures of E coli and significantly increased SCC was observed in 15.6% (15 of 96) of farrowings on the first day of lactation. Persson et al reported that the bacteria were eliminated between days 3 and 8 of lactation. The importance of subclinical mastitis was also emphasized in a recent study by Kotsarev et al. However, since the exclusion of glands undergoing involution was not mentioned and only SCC were reported, the results cannot be directly compared to other studies. Additionally, the economic significance of subclinical CM has received little attention to date. The increased erythrocyte sedimentation rates and the decreased ratio of plasma protein to fibrinogen in sows with subclinical mastitis indicate a negative health effect of the disease in affected sows.

Effect of subclinical CM on suckling piglets

Data on milk yield of sows with subclinical coliform mastitis are rare. When average daily gain of piglets from spontaneously agalactic sows with clinical CM was compared to piglets from unaffected sows, piglets from agalactic sows lost weight on the first 2 days postpartum and gained significantly less weight on the third day. Sows experimentally inoculated with E coli experienced high piglet mortality due to piglet starvation. The surviving piglets grew significantly slower on days 1 through 3 of age but were not significantly lighter at 14 days of age than piglets from resistant and non-inoculated sows. The experimentally inoculated sows that did not develop mastitis had no piglet mortality compared to litters of susceptible sows and piglet average daily gain through 14 days of age was identical to control litters suckling non-inoculated sows. Piglet weights and health of the mammary glands suckled by the piglets were sequentially recorded in a study focusing on the hygiene of the farrowing environment. Subclinical CM developed in 16 of 24 sows (66.7%). Piglets suckled 64.9% (185 of 285) of the healthy glands and 43.5% (27 of 62) of the glands with positive cytology. During the first 4 days of lactation, piglets suckling healthy glands had an average daily gain of 125 g as compared to 105 g in piglets which had suckled glands with mastitis. Average daily gain from day 5 through day 21 was identical regardless of the gland suckled.

In another project studying the influence of four farrowing systems on CM, 159 farrowings were observed. Clinical CM developed in 4 farrowings and subclinical CM was diagnosed in 97 farrowings. The percentage of piglets dying of starvation increased linearly to the incidence of mastitis. Increased piglet mortality is most often caused by starvation. Piglet mortality in a litter is negatively correlated with the weight gain in the first 3 days of life of the surviving litter mates suggesting that low milk production by the sow is associated with piglet starvation. Thompson and Fraser saw marked variation in weight gain within litters in the first 3 days of life. Average daily gains of piglets were negatively correlated with the rectal temperature of the sow. Litters with low initial gains showed more variable gains as well. Such litters were not associated with obvious mastitis suggesting that subclinical disease of the sow might lead to inadequate milk production. In a Swedish study based on 369 farrowings, piglet mortality in the first week and the within-litter standard deviations for weights at 3 weeks of age were correlated to the rectal temperature of the sow in the first 48 h postparturition. Many of these correlations were significant even though the sows affected by clinical mastitis were omitted from the analysis. This indicates that subclinical mastitis negatively affects production performance.

Factors affecting CM severity

The virulence of the pathogen can normally be considered an important factor for the severity of the subsequent disease. However, in the case of CM, such an influence is not well documented. When sows are inoculated intramammarily, the course of the experimental disease induced with identical bacterial cultures may vary greatly. The number of bacteria inoculated does not explain the variable outcome. This observation serves as an argument against an increased susceptibility of certain sows. In accordance, sequential observation of 39 sows over six consecutive farrowings resulted in no evidence for individual disposition to CM.

Sows from a specific-pathogen-free herd were resistant to a standardized experimental infection, whereas sows from a conventional herd were highly susceptible. One of several explanations to support these divergent outcomes could be an apparent viral or bacterial infection in the conventional herd leading to some sort of immunosuppression. Further, a functional difference was detected in the PMN of susceptible sows possibly indicating impaired PMN function. This latter result differs from the findings from a study involving experimental inoculation of 12 sows shortly before parturition. Four sows developed clinical mastitis but this did not appear to impact the functional traits of the circulating granulocytes such as chemotaxis, phagocytosis, or CD18 expression. Österlundh et al concluded that factors other than granulocyte function determine whether a sow will develop clinical mastitis following infection with E coli.

Bacteria in the secretion within the mammary gland are immediately exposed to a new microenvironment. Their proliferation is an important factor for the host-microbe balance. The severity of experimental CM depends on the proliferation of the inoculated bacteria. Numerical estimates of the bacteria sequentially recovered from the secretion indicate that glands of susceptible sows harbor substantially more organisms than resistant sows. However, further information to support this finding is scarce. Two strains of E coli isolated from CM grew significantly faster in lactoserum taken on
the day of farrowing compared to lactose-
rum sampled later. These *E. coli* strains also
grew faster in lactose-rich sows infected with 
masitis compared to lactose-free sows without 
symptoms. When a greater number of 
isolates were examined in untreated colo-
strum and milk, the situation appeared to be 
more complex. Not all isolates from porcine 
CM behave in a similar manner. There are 
isolates with much slower growth. In ad-
dition, there is variation in the bacterial 
growth rate in secretions from individual 
swows. In secretions from a healthy, suckled 
gland, a strain of *E. coli* exhibited continual 
growth throughout lactation, whereas the 
viable count of the same strain remained 
either constant or was even reduced in the 
secretions from healthy, non-suckled glands 
or from glands with mastitis. The latter 
finding corresponds with the spontaneous 
elimination of the organisms from infected 
glands within about one week.

During gestation, the mammary secretion 
strongly reduces the growth of coliform bac-
teria. Following experimental intramammary 
inoculation two days prior to parturition or 
external contamination of the teat orifices at 
the same time, signs of mastitis develop only 
after the start of parturition. The mecha-
nism of this inhibition is not known.

**Mammary gland exposure to coli-
form bacteria**

Coliform mastitis is an example of a non-
contagious infectious disease. Under the 
conditions of outdoor pig production, it is rare. In 9 Danish herds with outdoor far-
rowing systems, only 1.1% (13 of 1206) of 
sows developed CM as compared to 17.1% 
(286 of 1674) of sows from 9 other herds 
managed in a traditional indoor confine-
ment system. These observations may 
indicate a fecal contamination of the teats and 
as a potential source of the infection.

To further test the role of fecal contamina-
tion of the teats, 12 sows farrowed in an 
experimental pen designed to allow the sow 
to choose where to lay and 12 sows farrowed in 
a conventional farrowing crate. Viable Enterobacteriaceae counts were performed 
from the floor in the laying area and from 
the surface of every teat apex from 3 days be-
fore until 1 day after parturition. Colostrum 
was collected from every teat beginning 
immediately after parturition and repeated 
every 12 h. Bacterial counts on the floor and 
the teats differed between the two systems 
by a factor of 10 to 1000. Furthermore, 
*E. coli* was isolated from 3 mammary glands 
in the experimental pen as compared to 27 
glands in the conventional crate and about 
half of the infections were detected in the 
first sample collected after parturition. In 
glands with positive cytology but no viable 
bacteria, mastitis must have been of shorter 
duration.

Farrowing systems were compared under 
field-like conditions in another study. Forty sows were assigned to one of four far-
rowing systems. Viable counts of coliforms on 
the teat ends were done on gestation day 112 and colostrum was aseptically col-
lected once within 36 h after parturition. 
Clinical CM was very rare, but subclinical 
masitis developed in 61% (97 of 159) of the 
farrows. The incidence of mastitis was 
significantly dependent on the design of the 
farrowing system which differed with regard 
to the separation of the areas for laying and 
for defecation. The incidence of mastitis cor-
related to enterobacterial counts on the teat 
ends.

**Prevention of CM**

Research on CM has identified ways to 
prevent the disease by protecting the teats 
from contamination with coliform bacteria 
during late gestation and the first 3 days of 
lactation. Coliform bacteria are natural in-
habitants of the digestive and urinary tract 
of the sow. The farrowing system should be 
designed in a way to prevent the sow from 
lying in her own excreta. Visual absence of 
any fecal traces on the ventral skin of the sow 
is a simple criterion, but not always easy to 
accomplish with indoor climatic conditions 
changing throughout the year. If coliform 
bacteria can successfully be kept away from 
the lactiferous system of the gland, other 
 prophylactic measures, eg, antibiotic treat-
ment, become less necessary.

The role of the sow’s own microbiome as a 
reservoir of coliform bacteria sheds light on 
the reasons surrounding failure of sanitation 
measures for the prevention of CM. For 
example, details such as the type of bedding 
may be important. In a survey of 3000 far-
rowings in units where wood shavings were 
used as bedding, 180 (6%) of the farrows 
needed treatment for mastitis. Following a 
change to straw bedding, the incidence over 
the next 1800 farrowings dropped to 2.5% 
(45 farrowings). In cattle, where coliform 
masitis causes significant loss, maintenance 
of low levels of coliform bacteria in the 
bedding is the only effective method of 
control. Coliform bacteria have the capac-
ty to pass through the bovine streak canal 
between milking times. The frequency of 
this event depends on the number of organ-
isms applied. Highest coliform counts are 
found in sawdust bedding. Incubation of 
contaminated sawdust at temperatures above 
22°C has been reported to allow 1 or 2 log10 
proliferation of the organisms.

**Postparturient dysgalactia 
syndrome**

**Terminology**

Many clinically healthy sows nurse litters 
without increased mortality and poor un-
ev even growth rates. The various physiological 
processes occurring around parturition make 
it difficult to differentiate health problems in 
these apparently non-diseased sows. There-
fore, the early lactation problems should be 
described as PPDS. That term is preferred 
over the more traditionally used mastitis-
metritis-agalactia (MMA) syndrome. Variations in criteria, assessments, and 
reporting explain the difficulty to precisely 
define PPDS. A differentiation of PPDS 
from MMA is not clearly possible. Careful investigations revealed that metritis is rather 
uncommon in sows with problem litters and 
complete agalactia is a very rare exception. 
Thus, the authors believe that MMA has 
become a widely used misnomer. Reiner 
et al preferred the term PPDS over MMA 
because lactational failure can be a conse-
quency of different pathological processes 
and lactational failure is the cardinal sign of 
the economically important average daily 
gain of piglets. Coliform mastitis is consid-
ered a subtype of PPDS or the emerging 
tip of the iceberg represented by PPDS.

**Diagnosis of PPDS**

Reports on clinical trials in PPDS are quite 
rare. Epidemiological research often relies on 
data collected by animal caretakers. Not all 
signs must be expressed at the same time in 
the same sow so a generally accepted cli-

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ered a subtype of PPDS or the emerging 
tip of the iceberg represented by PPDS.
change in backfat thickness through lactation\textsuperscript{45,50} or body weight,\textsuperscript{50} constipation, or vaginal discharge.\textsuperscript{25,45,46,50}

Piglet vitality has been assessed by recording mortality during the first weeks of lactation,\textsuperscript{45,50} piglet daily body weight gain\textsuperscript{45,50} or observation of changes in piglet behavior.\textsuperscript{19,44,47} A weakness of the literature is that some investigations into piglet nutrition and development were performed without a detailed look at the health of the sow.\textsuperscript{51-53} Colostrum yield through 24 h postpartum was calculated from the weight change of the litters.\textsuperscript{51} The wide variability of colostrum was calculated from the weight change of the litters.\textsuperscript{51} The wide variability of colostrum yield was attributed to hormonal, environmental, and nutritional factors. Surprisingly, litter size is known to have a strong influence on milk production but does not affect colostrum yield.\textsuperscript{51} Sows producing a low amount of colostrum were characterized by leaky mammary epithelium and reduced synthesis of lactose, which may be related to hormonal changes prior to parturition.\textsuperscript{52} The within-litter variation of piglet performance until 3 weeks of age appears to be significantly correlated with birth weight and milk intake, whereas birth order and location of the preferred teat do not have a significant influence.\textsuperscript{53} A recent review emphasizes the need for more research to improve the yield and composition of colostrum, yet makes no reference to sow health.\textsuperscript{54} In summary the authors feel that veterinarians, epidemiologists, and animal science researchers have investigated similar shortcomings of piglet performance without drawing on the expertise of supporting professions.

**Etiology and pathogenesis of PPDS**

A primary difficulty is the establishment of a functional definition for PPDS. Microbiologists see PPDS primarily as an infectious disease, endocrinologists see it as a hormonal disturbance, and others consider it a nutritional disease.\textsuperscript{55} Several studies attribute a central role to endotoxins.\textsuperscript{42,43,55} It is well established that inoculation of endotoxin into a pig's circulation induces a systemic disorder which mimics the general signs of CM, whereas oral administration of endotoxin does not induce obvious clinical symptoms. The pig is the least sensitive of mammalian species to parenterally applied endotoxin.\textsuperscript{56} Furthermore, local mammary lesions have never been reproduced by endotoxin application except when given intramammarily and endotoxin has been detected in the blood of affected sows only in a minority of CM cases.\textsuperscript{57} In a manner similar to that seen in ruminants, De Ruijter et al\textsuperscript{58} showed that coliform mastitis-causing bacteria in sows induce acute-phase mediators, which are locally released into the mammary gland, enter the circulation, and act on other tissues including the thermoregulatory central nervous center. Endotoxins, however, essentially remain in the affected gland. Extremely high doses of endotoxin must be inoculated into the mammary gland to be detectable in the blood.

A team of experts in PPDS have presented a new explanation for the syndrome calling it a change in homeorhesis, ie, a fault in the orchestrated changes in metabolism of body tissues necessary to support a physiological state like gestation or lactation.\textsuperscript{20} They propose the dys-homeorhesis occurs during the shift from gestation to lactation inciting the development of PPDS and that the physiopathology of PPDS includes feed and feeding in gestation, endotoxemia, and stress. The concept of dys-homeorhesis is broadly discussed at length but the intended benefit of the new theory remains unclear.\textsuperscript{20}

Reports addressing results of laboratory examinations of mammary secretions or of necropsy results of sows affected with PPDS were not identified by the authors. Nor has detailed literature regarding the performance of litters from affected sows been detected. The implied multifactorial nature of PPDS\textsuperscript{42,43} may limit investigators from analyzing the syndrome in more detail. It must be kept in mind that any factor affecting the lactation performance of the sow is defined to take part in the syndrome. In consequence, the search for disease causing or disease accelerating mechanisms may be unrewarding. The authors believe the introduction of PPDS as a new concept coupled with the perceived decrease of active research in CM is very likely due to the idea that the new concept would offer alternative solutions to the problem.

The search for risk factors for PPDS is the only research field where some publications have appeared. The risk factors are typically linked with multifactorial diseases. Many of the factors were found to have minor effects if present independently but found to cause disease if more than one were present.\textsuperscript{5} From field observations, the associations of risk factors are not additive but synergistic.\textsuperscript{55} Risk factors are often identified based on questionnaires completed by herd owners who diagnose sows affected by PPDS. Examples of statistically significant risk factors are feed and feeding regime, housing, management practices,\textsuperscript{43} time of moving sows to the farrowing unit, farrowing induction, feeding sows ad libitum during lactation, frequent farrowing supervision,\textsuperscript{59} integration of gilts into the herd after the first farrowing, firm fecal consistency in gestating sows, soiled troughs in lactating sows, low water flow rate in drinking nipples, and high prevalence of lameness.\textsuperscript{60}

**Similarities between PPDS and subclinical CM**

The authors propose that PPDS presents with evident similarities to subclinical CM. The characteristic period of occurrence immediately before and after parturition, the clinical signs in the sow such as fever, anorexia, reluctance to nurse and move, increased vaginal discharge, reduced milk production in the absence of gross mammary lesions, and insufficient milk supply for piglets do not allow distinction of the two affections (Table 1). Clinical CM is considered the proverbial tip of the iceberg of subclinical CM as well as for PPDS.\textsuperscript{20}

Both PPDS and subclinical CM occur at a high incidence and are assumed to be the cause of uneven development of piglets and litters. Differences are restricted to limited laboratory results for mammary secretions and necropsies in the case of PPDS as well as speculative explanations about the etiology and pathogenesis of PPDS.\textsuperscript{55}

**Implications**

- In view of the wide distribution of subclinical CM and PPDS, investigations into the potential relationship between these two conditions remain an important research area.
- Should further research support that the syndromes are indistinguishable from each other, the development of economically sustainable farrowing systems that aim to reduce the incidence of the syndromes is necessary.
- So far, PPDS is only described in the porcine species and so it is the opinion of the authors that PPDS is indistinguishable from subclinical CM and that a return to the use of subclinical CM terminology will allow future investigators to take advantage of the many parallels to CM in the bovine species and thus inspire new research approaches.
### Table 1: Studies reporting clinical signs observed in sows diagnosed with subclinical coliform mastitis or postparturient dysgalactia syndrome

<table>
<thead>
<tr>
<th>Clinical sign</th>
<th>Subclinical coliform mastitis</th>
<th>Postparturient dysgalactia syndrome</th>
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<tbody>
<tr>
<td>Fever</td>
<td>Blood et al(^2)</td>
<td>Pendel et al(^{25})</td>
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<tr>
<td></td>
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<td>Preissler et al(^{44})</td>
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<td>Ross et al(^{15})</td>
<td>Guillon et al(^{30})</td>
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<td>Hermansson et al(^{10})</td>
<td>Guillon et al(^{30})</td>
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<tr>
<td>Reluctance to rise</td>
<td>Blood et al(^2)</td>
<td>Pendel et al(^{25})</td>
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<td>Guillon et al(^{30})</td>
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* Clinical signs absent in the subclinical variant.

### References

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### Conflict of interest
None reported.

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*Non-refereed references.*
### Conversion tables

#### Weights and measures conversions

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<th>Multiply by</th>
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<tr>
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<td>1 mi</td>
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<td>0.62 mi</td>
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<td>1 in²</td>
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#### Temperature equivalents (approx)

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

#### Conversion chart, kg to lb (approx)

<table>
<thead>
<tr>
<th>Pig size</th>
<th>Lb</th>
<th>Kg</th>
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<tbody>
<tr>
<td>Birth</td>
<td>3.3-4.4</td>
<td>1.5-2.0</td>
</tr>
<tr>
<td>Weaning</td>
<td>7.7</td>
<td>3.5</td>
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<tr>
<td>Nursery</td>
<td>11</td>
<td>5</td>
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<tr>
<td>Grower</td>
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<td>Finisher</td>
<td>37</td>
<td>15</td>
</tr>
<tr>
<td>Sow</td>
<td>99</td>
<td>45</td>
</tr>
<tr>
<td>Boar</td>
<td>110</td>
<td>50</td>
</tr>
</tbody>
</table>

1 tonne = 1000 kg
1 ppm = 0.0001% = 1 mg/kg = 1 g/tonne
1 ppm = 1 mg/L
Genetic companies have done an amazing job creating sow lines that produce more live pigs. But this gain comes with a challenge: having enough nutrition to support piglet viability and larger litter growth.

Sometimes we forget that farrowing is not the end of development. In the first 10 days of life, the absorptive surface area of a pig’s intestinal tract doubles. During this critical developmental period, nutritional supplementation of the intestinal tract can help pigs achieve maximum productivity and reach their full potential. This is why we recommend feeding Tonisity Px™ to pigs from 2 to 8 days of age.

**Boost intestinal development**

Producers have a real opportunity to improve production with Tonisity Px, a one-of-a-kind intestinal development solution. Unlike anything else on the market, it nourishes the enterocytes of the piglet intestine and has the same composition as its body’s cells, making it easily absorbed. Equally important is its taste profile. It is designed just for pigs with a taste that baby pigs love and will eagerly consume in the first days of life. When you supplement pigs with Tonisity Px Days 2-8, it keeps them eating, drinking – and growing. Research shows Tonisity Px improves intestinal integrity by increasing surface area, giving every pig a chance to maximize productivity. This results in more pigs weaned, less size variability and faster weight gain. These benefits provide pigs a solid foundation for continued performance and economic success.

*Learn more about Tonisity Px at www.tonisity.com.*

---

**Why intestinal development matters**

Keeping pigs eating and drinking is crucial, says Nicholas Gabler, Ph.D., Iowa State University swine nutrition specialist. “Keeping the intestine hydrated and providing it with nutrients improves its development and ability to recover,” he says.

Dr. Gabler says products like Tonisity Px support the structural and functional aspects of the intestine. “Good intestinal function allows the pig to optimize nutrient, water and energy absorption to support growth,” he explains.

“If we can provide nutritional and energetic support to the intestine – the largest immune organ in the body – we can help the pig facilitate efficient and effective nutrient digestion and absorption. Doing so allows for optimal uptake of nutrients to support lean tissue growth.”

*By Mark Eisenhart, DVM, Director of Technical Services, Tonisity*
News from the National Pork Board

Pork groups working together with US Department of Agriculture to protect the United States from African swine fever

The National Pork Board, along with the American Association of Swine Veterinarians, the National Pork Producers Council, the Swine Health Information Center, and the US Department of Agriculture (USDA), continues to work on key strategies and tactics to keep US pig farms free of African swine fever (ASF).

The USDA Animal Plant and Health Inspection Service has a disease response strategy for African swine fever called FAD PReP. States and the pork industry use this information to do state-specific planning. They have also committed to work with the industry to develop and host an ASF-specific exercise in 2019 to test key response functions necessary for successful ASF management and containment. Exercise participants will include pork producers, swine veterinarians, packer and processors, and allied industry. Invitations to participate will be sent to Canada and Mexico.

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

Illinois farmer becomes new America’s Pig Farmer of the Year

This year’s finalists vying for the National Pork Board’s America’s Pig Farmer of the Year program were Patrick Bane of Arrowsmith, Illinois; Bill Luckey of Columbus, Nebraska; Brad Lundell of Kiron, Iowa; and Kevin Rasmussen of Goldfield, Iowa. After an in-depth interview with a third-party national judging panel, Bane took the top honor and will be traveling over the next year to represent the nation’s pig farmers.

“The finalists in this competition demonstrate how pig farmers embrace the We Care ethical principles as their daily standard of care,” said National Pork Board President Steve Rommereim, a pig farmer from Alcester, South Dakota. “We congratulate Pat Bane. We know he will do a great job over the next year.”

For more information about the program or to nominate someone for the 2019 program, contact Mike King at MKing@pork.org or 515-223-3532.

Pork industry focuses on feed ingredients to combat African swine fever threat

With the ongoing outbreak of African swine fever (ASF) in China, the National Pork Board, along with the American Association of Swine Veterinarians, the National Pork Producers Council, the Swine Health Information Center (SHIC), and the US Department of Agriculture, are working closely to help keep the United States free of ASF and other foreign animal diseases (FAD). This includes focusing on the importation of feed ingredients, a key area of potential high risk of disease transport.

Thanks to Checkoff-funded research conducted after the porcine epidemic diarrhea virus outbreak, swine industry experts now have some peer-reviewed science to rely on when looking at ways to mitigate the current risk posed by ASF in China and other countries. This includes work done on imported feed ingredients.

Paul Sundberg, DVM, director of the Swine Health Information Center, cites SHIC-funded research that shows viruses do have the potential to travel long distances via feed ingredients, which proves the theoretical ability of a FAD pathogen to reach US shores. To help prevent this potential risk from becoming a reality, swine industry experts have compiled these seven critical points for pig farmers to raise with their feed and feed-ingredient suppliers with the objective of starting a dialog about feed ingredient safety. They are:

1. Describe the facility’s biosecurity program to minimize the spread of pathogens from people, vehicles, and ingredients.
2. Describe the facility’s employee training on feed safety.
3. Describe the facility’s pest control program.
4. Describe the facility’s traceability program.
5. Describe the facility’s supplier approval program.
6. Is the facility certified by a third-party certification body for food safety?
7. Does the facility utilize ingredients that were manufactured or packaged outside of the United States?

For more information, go to www.securepork.org and www.pork.org/FAD.
START EARLIER. LAST LONGER.  

FOR PROTECTION THAT BEGINS AS YOUNG AS 3 DAYS, DOI of up to 5 months and over a decade of success with more than 100 million pigs vaccinated, veterinarians and pig producers choose Circumvent® G2.

Producers who use Circumvent® G2 see reduced mortality, fewer culls, improvement in ADG and improved feed conversion rates, all of which help to elevate herd health – and protect your bottom line.²
Who will make history at the 50th AASV Annual Meeting?

Twenty-five years ago, at the 1994 AASP Annual Meeting, Dr Beth Lautner became the first woman – one of only two ever – to receive the prestigious Howard Dunne Memorial Award. At the same meeting, Dr Alan Davis, a practitioner from Flanagan, Illinois, was named the Swine Practitioner of the Year, and AASP charter member Dr Wally Brandt received the Meritorious Service Award. Dr Brandt was instrumental in recording the history of the first 25 years of the association, raising the question: Who will make history at the 50th AASV Annual Meeting?

Do you know an AASV member whose dedication to the association and the swine industry is worthy of recognition at this milestone meeting? The AASV Awards Committee requests nominations for the following five awards to be presented at the upcoming AASV Annual Meeting in Florida.

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

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

Swine Practitioner of the Year – Given annually to the swine practitioner who is an AASV member and who has demonstrated an unusual degree of proficiency in the delivery of veterinary service to his or her clients.

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

Young Swine Veterinarian of the Year – Given annually to a swine veterinarian who is an AASV member, 5 years or less post-graduation, and has demonstrated the ideals of exemplary service and proficiency early in his or her career.

Nominations are due December 15. The nomination letter should specify the award and cite the qualifications of the candidate for the award. Submit to: AASV, 830 26th Street, Perry, Iowa 50220, Email: aasv@aasv.org.

AASV members receive discount on the 11th edition of Diseases of Swine - now with color photos

The classic veterinary reference Diseases of Swine has been completely revised, and preorders for the 11th edition may be placed now at www.wiley.com. The publisher anticipates a mid-April 2019 release date. AASV members receive a 20% discount when purchasing the book using the order code available at www.aasv.org/members.

Diseases of Swine has been the definitive reference on swine health and disease for over 60 years. This new edition has been completely revised to include the latest information, developments, and research in the field. Now with full color images throughout, this comprehensive and authoritative resource has been redesigned for improved consistency and readability, with a reorganized format for more intuitive access to information.

The book’s editors, Drs Jeffrey Zimmerman, Locke Karriker, Alejandro Ramirez, Kent Schwartz, Gregory Stevenson, and Jianqiang Zhang, are all AASV members and faculty at Iowa State University.

Diseases of Swine covers a wide range of essential topics on swine production, health, and management, with contributions from more than 100 of the foremost international experts in the field. This revised edition makes the information easy to find and includes expanded information on welfare and behavior.

Written for veterinarians, academicians, students, and individuals and agencies responsible for swine health and public health, Diseases of Swine is considered by many to be an essential guide to swine health.
Three awards of $35,000 each will be presented
Projects can be in the areas of PCV2, Mhp, IAV-S and PRRS
Open to veterinarians, researchers and academia
Established in 2002 by Boehringer Ingelheim to help advance solutions to the PRRS challenge

Proposal Deadline: January 15, 2019

Visit www.SwineResearchAwards.com
for complete information and application instructions.
1-800-325-9167
Just DO it!

The time is NOW to join the efforts to achieve $2 million in AASV Foundation restricted funds before the 2019 AASV Annual Meeting. All AASV members can play a part in achieving this goal and in celebrating 50 years of educational opportunities with our organization.

Our AASV Foundation endowment provides financial help in many ways to our swine veterinary profession. The Foundation funds scholarships for exceptional veterinary students as well as for members seeking advanced degrees and certifications, including 4 individuals pursuing board certification in animal welfare. It supports research into the diseases that affect every day and emerging disease, too. The Foundation provides dollars to veterinary students seeking swine practice experience, and funds travel stipends for students attending our annual meeting. In addition, it supports funding for annual meeting keynote lectures that inspire and motivate our membership every year.

Because we all have benefited from one or more of these foundation-funded programs, it is time for each of us to rise to the challenge! Please help continue the legacy of support that has enabled the foundation to accomplish so much - donate to the AASV Foundation endowment. Endowed contributions are invested to produce income to ensure the availability of funding well into the future. Your donation will have a lasting impact on the profession.

AASV Foundation endowed giving programs

Leman

If you’re not already a Leman Fellow, you should be! Named for the late industry leader and former AASV president, Dr Allen D. Leman, this giving program confers the title of Leman Fellow upon those who contribute $1,000 or more to the foundation endowment.

AMVC golfers earn first place at foundation fundraiser

With a team score of 59, the foursome from AMVC took top honors at this year’s AASV Foundation golf fundraiser. The event took place on August 23 at Landsmeer Golf Club in Orange City, Iowa. Golfers Mike Bauer, Josh Ellingson, Nick Weihs, and Gavin Yaeger combined their efforts in the best-ball tournament to secure the win over ten other teams on the course.

Dave Bomgaars, Austin DeZeuw, Dave Iverson, and Doug Sullivan made up the second-place team, hosted by Elanco Animal Health. The golf outing coordinator, Josh Ellingson, announced the team and individual contest winners as follows:

Regardless of their placings, the 43 golfers enjoyed an afternoon filled with contests, drawings, and giveaways as they made their way around the course thanks to exceptionally strong support from sponsors. Fifteen companies chipped in to provide financial support for the outing in the form of beverage, lunch, dinner, and golf hole sponsorships. Besides adding to the enjoyment of the participants, their support increased the event’s profitability for the foundation. The proceeds from the annual golf outing support foundation programs including scholarships, research grants, travel stipends for veterinary students to attend the annual meeting, tuition support for the Swine Medicine Education Center, swine externship grants for veterinary students, and more.

The event concluded with the awards dinner sponsored by Boehringer Ingelheim Animal Health. The golf outing coordinator, Josh Ellingson, announced the team and individual contest winners as follows:

Championship flight

First place team hosted by AMVC (score of 59): Mike Bauer, Josh Ellingson, Nick Weihs, and Gavin Yaeger

Second place team hosted by Elanco Animal Health (score of 61): Dave Bomgaars, Austin DeZeuw, Dave Iverson, and Doug Sullivan

Third place team hosted by NPPC (score of 63): Jack Bair, Derek Kindwall, Jeff Kindwall, and Greg Thornton

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The Legacy Fund provides an opportunity to recognize a principal donor or an honoree through a significant contribution to the endowment. A donor, multiple donors, or a veterinary practice may establish and name a Legacy Fund with a monetary gift of $50,000 or more. The fund may be named after the donor, another individual, or group.

In addition to monetary donations, Heritage and Legacy Fellows may select from additional contribution options, including the assignment of in-force life insurance policies and stock transfers.

For more information about the AASVF endowment giving programs or to make a contribution, see aasv.org/foundation, or contact the AASV Foundation by phone, 515-465-5255, or email, aasv@aasv.org.
First flight

First place team hosted by Boehringer Ingelheim Animal Health (score of 65): Jeff Blythe, Brent Carmichael, Tom Grady, and Justin Rustvold

Second place team hosted by Ceva Animal Health (score of 65): Keith Bretey, Jeff OKones, Julie Schwalbe, and Jon Thompson

Third place team (score of 66): Daryl Hammer, Michael Lash, and Dan Rosener

Second flight

First place team hosted by Fast Genetics (score of 67): Marcus Kehrli, Kent Schwartz, Steve Sprague, and Jeff Zimmerman

Second place team hosted by Pharmgate Animal Health (score of 71): Adam Gutierrez, Jeff Hall, Alex Hintz, and Ralph Wilson

Third place team hosted by Topigs Norsvin (score of 71): Mitch Christensen, Jordan Graham, Sam Holst, and Mike Terrill

Individual contests

Hole #3, Closest to 100-yard marker: Jack Creel
Hole #4, Closest to the pin: Jeff OKones
Hole #8, Closest 2nd shot: Nick Weihs
Hole #9, Longest putt: Jeff Zimmerman
Hole #10, Longest drive: Nick Weihs
Hole #13, Closest to the pin: Tom Grady
Hole #17, Longest putt: Daryl Hammer
Hole #18, Drawing for cooler: Steve Sprague

The team hosted by AMVC took top honors at this year’s AASV Foundation Golf Outing. Left to right: Josh Ellingson, Gavin Yaeger, Mike Bauer, and Nick Weihs.

The second place team was hosted by Elanco Animal Health. Left to right: Austin DeZeuw, Dave Bonggaars, Doug Sullivan, and Dave Iverson.
Foundation extends call for research proposals, due January 18

As part of its mission to fund research with direct application to the profession, the American Association of Swine Veterinarians Foundation is accepting research proposals to be considered for funding in 2019. Proposals are due January 18, 2019 and may request a maximum of $30,000 per project. A maximum of $60,000 will be awarded across two or more projects. The announcement of projects selected for funding will take place at the AASV Foundation Luncheon in Orlando, Florida on Sunday, March 10, 2019. Awardees will be notified in advance.

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

The instructions for submitting proposals are available on the AASV Foundation Web site at www.aasv.org/foundation/2019/research.php. Proposals may be submitted by mail or email (preferred).

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

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

For more information, or to submit a proposal:

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

AASV Foundation Mission Statement

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

- enhancing the image of the swine veterinary profession
- supporting the development and scholarship of students and veterinarians interested in the swine industry
- addressing long-range issues of the profession
- supporting faculty and promoting excellence in the teaching of swine health and production
- funding research with direct application to the profession
AASV semicentennial anniversary celebration: Our golden jubilee

Orlando, what a great place to be visiting and relaxing with friends, colleagues, and family at the end of a hard winter. Undoubtedly this is the family vacation center of the world. As you know, this meeting marks a great milestone in the life history of AASV (AASP). We achieved 50 years and it is time to celebrate, but also a time for reflection and commitment. Please give back to AASV at our foundation auction, thus assuring a legacy for those yet to come.

The Foundation Committee is calling this our semicentennial for a great reason. Fifty years of AASV stardom will soon be past and it is nearly certain another 50 years will proceed. In the United Kingdom and other Commonwealth countries, a golden jubilee celebration is held in the 50th year of a monarch’s reign. While there have been no monarchs in our realm, our dedicated leaders and membership have built a profession to last. There has been much progress over the past 50 years through dedicated leadership producing a world class organization based on cumulative experience, shared scientific progress, and new technological breakthroughs. We are here to stay and remain relevant to veterinary medicine and the swine industry.

From another perspective, a golden wedding anniversary is a celebration of 50 years of life spent together and great things accomplished with love and commitment. Typically, a 50th anniversary is considered a great honor for that couple’s endurance, love, and devotion. Golden wedding anniversaries should be marked with memorable gifts and celebrations. Likewise, we have given our hearts and commitments to AASV and our clients, thus it is time to celebrate our 50th year and contribute memorable gifts supporting the lasting existence of AASV through the Foundation.

So, “Let’s Go for the Gold!”
If you have questions or just want to discuss possibilities, please contact any of the committee members. Download the donation form at [www.aasv.org/foundation/2019/Donationform.pdf](http://www.aasv.org/foundation/2019/Donationform.pdf) and submit a description and image of your item(s) by December 1. Your contribution will be recognized in the printed auction catalog as well as on the auction website, and your name will appear in the JSHAP full-page spread recognizing all our auction item donors. If that’s not enough, there’s a good chance Dr Harry Snelson will say something witty about your donation in the AASV e-Letter, too!

The AASV Foundation is committed to ensuring the future of the swine veterinary profession. Proceeds from the auction enable funding for AASV Foundation programs, including:

- Administering endowments for the Howard Dunne and Alex Hogg Memorial Lectures
- Administering the Hogg Scholarship for a swine veterinarian pursuing an MS or PhD
- Administering funding for veterinary student scholarships
- Scholarships for veterinarians pursuing board certification in the American College of Animal Welfare
- Co-sponsoring travel stipends for veterinary students attending the AASV Annual Meeting
- Providing swine externship grants to veterinary students
- Funding swine research with direct application to the profession
- Providing support for Heritage Videos
- Providing tuition support for out-of-state veterinary students to attend the Swine Medicine Education Center

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<tr>
<td>Natalie Baker</td>
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<tr>
<td>Laura Bruner</td>
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<tr>
<td>Dynaeh Classen</td>
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<tr>
<td>Joe Connor</td>
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<td>Jack Creel</td>
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<td>Chris Deegan</td>
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<td>Bill Hollis</td>
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<td>Derald Holtkamp</td>
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<td>Sarah Probst Miller</td>
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<td>Nathan Schaefer</td>
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<tr>
<td>Cameron Schmitt</td>
</tr>
<tr>
<td>Chase Stahl</td>
</tr>
<tr>
<td>Jon Van Blarcom</td>
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<td>John Waddell</td>
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Veterinary students: Apply for $5000 scholarships by December 31

The AASV Foundation and Merck Animal Health are pleased to announce the continuation of the AASVF-Merck Animal Health Veterinary Student Scholarship Program. Ten $5000 scholarships will be awarded to sophomore and junior veterinary students in 2019. Now in its fourth year, the program seeks to identify future swine veterinarians and assist with their educational expenses. Applications are due December 31, 2018 for scholarships that will be announced at the 2019 AASV Annual Meeting.

Second- and third-year veterinary students enrolled in AVMA-accredited or -recognized colleges of veterinary medicine in Canada, the Caribbean Islands, Mexico, South America, or the United States are eligible to apply. All applicants must be current (2018-2019) student members of AASV. Students who have previously been awarded one of the scholarships are not eligible to reapply.

To apply, students submit a resume and the name of a faculty member or AASV member to serve as a reference, along with written answers to four essay questions. The application and instructions are available at www.aasv.org/foundation/2019/AASVF-MerckScholarships.php.

A committee of four conducts the selection process. Two AASV Foundation board members and two AASV members at-large rank the applicants by scoring their past and current activities, level of interest in swine veterinary medicine, future career plans, and financial need. The scholarship recipients will be announced during the 2019 AASV Annual Meeting in Orlando, and the scholarship funds will be disbursed after the conference.

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

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Swine veterinarians invited to apply for Hogg Scholarship

The American Association of Swine Veterinarians Foundation is pleased to offer the Hogg Scholarship, established to honor the memory of longtime AASV member and swine industry leader Dr Alex Hogg. Applications for the $10,000 scholarship will be accepted until February 1, 2019, and the scholarship recipient will be announced on Sunday, March 10 during the Foundation Luncheon at the AASV 2019 Annual Meeting in Orlando.

The intent of the scholarship is to assist a swine veterinarian in his or her efforts to return to school for graduate education resulting in a master's degree or higher in an academic field of study related to swine health and production.

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

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

Hogg Scholarship Application Requirements

An applicant for the Hogg Scholarship shall have:

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

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

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

Applications and requests for information may be addressed to:

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

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Journal of Swine Health and Production — Volume 26, Number 6
EMULSIBAC®-APP

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- Phibro Animal Health’s EMULSIBAC-APP is for the vaccination of healthy swine over four weeks of age against pneumonia caused by Actinobacillus pleuropneumoniae.
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  - Unique emulsified oil-in-water adjuvant
  - An oil-based adjuvant approved by USDA for either intramuscular or subcutaneous injection of swine
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**EMULSIBAC-APP Protects Against the Profit-Robbing Effects of Pneumonia Caused by APP**

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To learn more, visit www.PAHC.com
The editorial staff of the *Journal of Swine Health and Production* would like to acknowledge the invaluable assistance of the following individuals for their service as referees for the manuscripts that were reviewed between September 23, 2017, and September 22, 2018.

Thank you, reviewers

Working together and creating a journal to be proud of!

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Celebrating 50 Years of Progress

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March 9-12, 2019
Lake Buena Vista, Florida

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www.aasv.org/annmtg
SATURDAY, MARCH 9

8:00 AM
Entrance examination: American Board of Veterinary Practitioners, Swine Health Management

Pre-conference seminars
1:00 PM – 5:00 PM (except Seminar #5, 12:00 PM - 5:15 PM)

Seminar #1  AASV’s Got Talent
Jeff Harker, chair

Seminar #2  Swine Welfare and Behavior
James Kober, chair

Seminar #3  Emerging Technologies for the Swine Industry
Chris Rademacher and Dale Polson, co-chairs

Seminar #4  Conducting Effective Outbreak Investigations: Learning from Our Mistakes
Derald Holtkamp, chair

Seminar #5  Operation Main Street Training
Al Eidson, chair

Seminar #6  Leading People: Leadership Styles Training for Developing More Effective and Productive Working Relationships
Emily Byers, chair

Seminar #8  Swine Nutrition: Setting the Foundation
Duain Guggenbiller, chair

Seminar #9  Diagnostics
Fabio Vannucci, chair

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

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

8:00 AM
Comparison of different cell lines for improving porcine reproductive and respiratory syndrome virus isolation from clinical samples
Wannarat Yim-Im

8:15 AM
Investigating biosecurity aspects related to porcine reproductive and respiratory syndrome virus outbreaks
Gustavo de Sousa e Silva

8:30 AM
Comparison of production impact following porcine reproductive and respiratory syndrome clinical outbreaks in breeding herds adopting killed or attenuated porcine reproductive and respiratory syndrome virus vaccination protocols
Gaurav Rawal

8:45 AM
Economic and production benefit of 2 porcine reproductive and respiratory syndrome modified live virus doses compared to a single dose vaccination program on nursery pigs
Cesar Moura

SUNDAY, MARCH 10

Canadian Swine Veterinarians
8:00 AM – 12:00 PM

Pre-conference seminars
8:00 AM – 12:00 PM

Seminar #7  Boar Stud Topics
Darwin Reicks, chair

9:00 AM
Modeling the dilution effect of porcine reproductive and respiratory syndrome virus RNA in processing fluid field samples on the probability of virus detection by quantitative polymerase chain reaction
Will Lopez
9:15 AM  |  Put a CLAMP on it! Polymerase chain reaction-based strategy to selectively sequence wild-type porcine reproductive and respiratory syndrome virus in vaccinated herds  
Karen Harmon

9:30 AM  |  Use of oropharyngeal swabs and udder wipes to monitor porcine reproductive and respiratory syndrome virus in breeding herds  
Jorge Garrido Mantilla

9:45 AM  |  Experimental transmission of influenza A virus and porcine reproductive and respiratory syndrome virus from nurse sows to adopted pigs during lactation  
Jorge Garrido Mantilla

10:00 AM |  REFRESHMENT BREAK

10:15 AM  |  Shedding of a newly commercialized live attenuated influenza vaccine under field conditions  
Gustavo Lopez

10:30 AM |  Identification of metabolite markers for enzootic pneumonia in pigs  
Maria Pieters

10:45 AM |  Mycoplasma hyosynoviae diagnostics: What experimental data can tell us about field strains  
Nubia Macedo

11:00 AM |  Oral infectious dose of African swine fever virus when consumed naturally in feed and liquid  
Megan Niederwerder

11:15 AM |  Efficacy of an inactivated Seneca Valley virus vaccine in nursery-aged pigs  
Alexandra Buckley

11:30 AM |  Transmammary delivery of firocoxib from medicated sows to nursing piglets reduces stress and improves average daily gain after castration, tail docking, and teeth clipping  
Hans Coetzee

11:45 AM |  Potential risk factors for pelvic organ prolapses: Survey of 104 US commercial breeding herds  
Chris Rademacher

12:00 PM |  Session concludes

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

**12:00 PM – 5:00 PM**

Poster authors present from 12:00 PM to 1:00 PM
Poster display continues on Monday, 9:00 AM to 5:00 PM

**Concurrent sessions**

**1:00 PM – 5:15 PM**

- **Session #1**  
  **Student Seminar**  
  Andrew Bowman and Maria Pieters, co-chairs

- **Session #2**  
  **Industrial Partners**  
  George Charbonneau and Jessica Seate, co-chairs

- **Session #3**  
  **Industrial Partners**  
  Peggy Anne Hawkins and Brent Pepin, co-chairs

- **Session #4**  
  **Industrial Partners**  
  Melissa Hensch and Amy Maschhoff, co-chairs

---

**MONDAY, MARCH 11**

**General Session**

**Built to Last: Celebrating 50 Years of Progress**

**8:00 AM – 12:15 PM**

**Program and Session Chair: Nathan Winkelman**

**8:00 AM**  
**Howard Dunne Memorial Lecture**  
Built to last: 50 years of AASV  
John Waddell

**9:00 AM**  
**Alex Hogg Memorial Lecture**  
Today’s swine veterinarian: Challenges and opportunities for the future  
Deborah Murray

**10:00 AM**  
**REFRESHMENT BREAK**

**10:30 AM**  
**AASV Golden Anniversary Video**

**10:45 AM**  
**US pork production: Your Pork Checkoff dollars at work**  
Bill Even

**11:15 AM**  
**International pork markets and the influence of global megatrends**  
Brett Stuart

**12:15 PM**  
**LUNCHEON**
## Concurrent Session #1: Disease Control and Elimination

**2:00 PM – 5:30 PM**

**Session chair:** Bill Hollis

### Part 1: Porcine Reproductive and Respiratory Syndrome

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
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<tbody>
<tr>
<td>2:00 PM</td>
<td>Elimination failures and live virus inoculation experiences&lt;br&gt;<strong>Jay Miller</strong></td>
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<tr>
<td>2:15 PM</td>
<td>Economic models of porcine reproductive and respiratory syndrome control&lt;br&gt;<strong>Dale Polson</strong></td>
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<tr>
<td>2:30 PM</td>
<td>Herd closure time analysis&lt;br&gt;<strong>Daniel Linhares</strong></td>
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<tr>
<td>2:45 PM</td>
<td>Porcine reproductive and respiratory syndrome monitoring methods&lt;br&gt;<strong>Will Lopez</strong></td>
</tr>
<tr>
<td>3:00 PM</td>
<td>Porcine reproductive and respiratory syndrome control and elimination: Question and answer roundtable&lt;br&gt;<strong>Miller, Polson, Linhares, and Lopez</strong></td>
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<td>REFRESHMENT BREAK</td>
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### Part 2: Mycoplasma

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<tr>
<th>Time</th>
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<tr>
<td>3:45 PM</td>
<td>Diagnostic methods for effective <em>Mycoplasma hyopneumoniae</em> control and elimination&lt;br&gt;<strong>Maria Pieters</strong></td>
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<tr>
<td>4:00 PM</td>
<td><em>Mycoplasma</em> isolation and elimination experiences&lt;br&gt;<strong>Bob Thompson and Maria Jose Clavijo</strong></td>
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<tr>
<td>4:15 PM</td>
<td>What if a naïve herd breaks?&lt;br&gt;<strong>Dyneah Classen</strong></td>
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<tr>
<td>4:30 PM</td>
<td><em>Mycoplasma</em> control and elimination: Question and answer roundtable&lt;br&gt;<strong>Pieters, Thompson, Clavijo, and Classen</strong></td>
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### Part 3: Porcine Epidemic Diarrhea Virus

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<th>Time</th>
<th>Presentation</th>
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<tbody>
<tr>
<td>4:45 PM</td>
<td>Porcine epidemic diarrhea virus: People during breaks&lt;br&gt;<strong>Mary Battrell</strong></td>
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</table>

**5:00 PM** Porcine epidemic diarrhea virus elimination and persistence<br>**Laura Batista**

**5:15 PM** Porcine epidemic diarrhea virus control and elimination: Question and answer roundtable<br>**Battrell and Batista**

**5:30 PM** Session concludes

## Concurrent Session #2: Practical Vaccinology and Immunology for the Swine Veterinarian

**2:00 PM – 5:30 PM**

**Session co-chairs:** Marie Culhane and Emily Byers

### Part 1: General Immunology, Gastrointestinal Immunology, and Vaccinology

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
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<tbody>
<tr>
<td>2:00 PM</td>
<td>General immunology: Concepts and key points for swine veterinarians&lt;br&gt;<strong>Brian Aldridge</strong></td>
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<tr>
<td>2:25 PM</td>
<td>Gut immunology&lt;br&gt;<strong>Adam Moeser</strong></td>
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<tr>
<td>2:50 PM</td>
<td>Impact of vaccination on transmission of <em>Lawsonia intracellularis</em>&lt;br&gt;<strong>Fabio Vannucci</strong></td>
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<tr>
<td>3:10 PM</td>
<td>Farm application of wean-to-finish vaccines for enteric diseases&lt;br&gt;<strong>Nate Winkelman</strong></td>
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<td>REFRESHMENT BREAK</td>
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### Part 2: Respiratory Immunology and Vaccinology with a Flu Focus

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<tr>
<th>Time</th>
<th>Presentation</th>
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<tr>
<td>3:55 PM</td>
<td>Respiratory immunology&lt;br&gt;<strong>Amy Vincent</strong></td>
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<tr>
<td>4:20 PM</td>
<td>Universal influenza vaccines&lt;br&gt;<strong>Daniela Rajao</strong></td>
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<tr>
<td>4:45 PM</td>
<td>Herd immunity and transmission&lt;br&gt;<strong>Montse Torremorell</strong></td>
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<tr>
<td>5:00 PM</td>
<td>Influenza vaccinations: Live versus killed&lt;br&gt;<strong>Chong Li</strong></td>
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### Part 3: Porcine Epidemic Diarrhea Virus

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<tr>
<td>4:45 PM</td>
<td>Vaccinations in antibiotic-free farms&lt;br&gt;<strong>Marlin Hoogland</strong></td>
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<tr>
<td>5:15 PM</td>
<td>Session concludes</td>
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Current program information is online at [www.aasv.org/annmtg](http://www.aasv.org/annmtg)
Concurrent Session #3: Production Innovations

2:00 PM – 5:30 PM
Chair: Deborah Murray

2:00 PM  Sow mortality: The Danish perspective
          *Michael Agerley*

2:15 PM  Low sow mortality: What’s the secret?
          *Ron Ketchem*

2:30 PM  Production drivers that drive mortality
          *Pedro Mosqueira*

2:55 PM  Training, motivation, and a culture of safety
          *Tia Landry*

3:10 PM  Production Innovations: Question and answer roundtable
          *Agerley, Ketchem, Mosqueira, and Landry*

3:30 PM  REFRESHMENT BREAK

4:00 PM  Comparative lameness: What are we learning in other species?
          *Jan Shearer*

4:35 PM  Structural and pathological changes in growing pig lameness compared to sow lameness
          *Stephanie Rossow*

4:55 PM  Antibiotic use measurement: Where are we at?
          *Peter Davies*

5:10 PM  The politics of antibiotic use in food-producing animals
          *Liz Wagstrom*

5:30 PM  Session concludes

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TUESDAY, MARCH 12

General Session: Transboundary Disease Threats and Outbreak Preparedness

8:00 AM – 12:00 PM
Session chair: Nathan Winkelman

8:00 AM  African swine fever: A global threat
          *Klaus Depner*

8:45 AM  A China perspective: Diseases, diagnostics, and biosecurity
          *Keith Erlandson*

9:10 AM  The foreign animal disease risk of feed
          *Scott Dee*

9:40 AM  Industry and AASV response to foreign animal disease risk
          *Paul Sundberg*

10:00 AM  REFRESHMENT BREAK

10:30 AM  Fifty-plus years of US swine disease eradication
          *Joe Connor*

11:00 AM  What’s next for disease elimination: *Mycoplasma hyopneumoniae*, porcine reproductive and respiratory syndrome, porcine epidemic diarrhea, or ileitis?
          *Paul Yeske*

11:30 AM  When “IT” hits the fan: Will we be prepared?
          *Patrick Webb*

12:00 PM  Session and meeting conclude

Current program information is online at www.aasv.org/annmtg
African swine fever: What is the government’s role?

I wanted to provide an update on AASV activities regarding African swine fever (ASF). New outbreaks of ASF continue to be reported in China. In addition, Bulgaria and Belgium have reported their first outbreaks of the disease. The United States swine industry continues to monitor the situation closely and is focusing on efforts to prevent the introduction of the virus into the US herd.

Dr Tom Burkgren and I, along with representatives from the National Pork Board, the National Pork Producers Council, and the Swine Health Information Center, met with United States Department of Agriculture (USDA) and Food and Drug Administration (FDA) officials on September 5, 2018 to discuss ASF prevention concerns. Although the meeting focused mainly on prevention, discussion topics also included diagnostic testing, surveillance, feed and feed ingredient issues, garbage feeding controls, and monitoring the importation of pork casings. In summary, the prevention issues discussed were:

Communication
- The USDA is scheduling biweekly calls for updates and discussion of ASF-related issues.
- The USDA has set up a website dedicated to ASF at www.aphis.usda.gov/animalhealth/animal-disease-information/swine-health and will update the website as the situation evolves.

Waste feeding and the Swine Health Protection Act
- The USDA’s Animal and Plant Health Inspection Service (APHIS) has had controls in place for decades on international garbage, including food waste from ships, airlines and international conveyances. These controls require all international garbage to be disposed of appropriately and under APHIS supervision, for example, garbage transported under seal to approved incineration facilities.
- The authority to ban the feeding of plate waste containing meat is under the regulatory oversight of individual states, not with USDA.
- The USDA will assess what needs to be done, if anything, to improve inspection of licensed waste-feeding facilities and enforcement on unlicensed facilities.

Importing meat products
- Import restrictions imposed by APHIS prohibit the entry of untreated animal products, including meat and meat products, from countries or regions considered affected with certain diseases. Fresh and frozen pork is prohibited from regions affected with ASF, classical swine fever, foot-and-mouth disease, or swine vesicular disease, while meat that has been cooked is allowed under APHIS regulations.
- The European Union is transparent in their review and zoning of the current ASF situation.
- Members of APHIS are in regular contact with the European Union about current zoning status.
- Safe trade in meat and meat products around the world is built on the understanding that government veterinary authorities in the product country of origin inspect and certify those products in accordance with the requirements of the country of destination. Imposing additional requirements, such as testing products for viruses after arrival in the country of destination, destroys the credibility of the certification system and leads to consequences of reciprocal testing of US exports.

“You should ensure that tonsil is included with all laboratory submissions.”

Swine casings
- Swine casings that originate from ASF-positive countries or regions are prohibited entry into the United States under APHIS regulations.
- Entry of Chinese-origin swine casings was denied by APHIS when ASF was found in China.
- Current APHIS regulations allow US-origin swine casings to be processed in ASF-affected countries or regions under certain conditions. With strong support of the casings industry, APHIS is working to review the processing of US-origin swine casings in Chinese facilities.
- Casings are shipped with a 6-week transit time to and from facilities in saturated brine solutions that will inactivate foreign animal disease (FAD) viruses as referenced in the World Organization for Animal Health’s guidelines.

Testing imported feed and feed ingredients
- Both USDA and FDA identified many concerns and potential consequences that could arise from testing imported feed and feed ingredients.
- Both USDA and FDA believe there are currently many unknowns and data gaps that should be identified to help define or validate feed risk. In the absence of information regarding the predictive ability of unvalidated test results to accurately determine the potential risk associated with feed, the design and implementation of a testing strategy is not feasible.

Advocacy in action continued on page 343
Include tonsil with all laboratory submissions!

Tonsil tissue is an important tool in diagnosing a number of endemic swine diseases as well as classical swine fever and African swine fever.

www.aasv.org/aasv/documents/GotTonsil.pdf

Download the brochure for complete details on proper technique for sample collection and submission.
Advocacy in action continued from page 341

- There are significant logistics issues, including whether a validated test and a validated sampling method exist, who does the sampling, who pays for the testing, who pays for storage or demurrage charges while product is held, that would present challenges.

- Testing could bring potential consequences that must be considered such as false interpretation of results, the different industries that could be impacted by testing as some ingredients are shared between the human and animal food streams, and the impact on US exports if additional testing requirements are imposed.

- Without further information and because of recognized data gaps, a government testing program is not feasible currently.

- Both USDA and FDA continue to work with industry representatives to assess the potential risk of non-animal origin feed ingredients to US agriculture and the feed supply.

- The National Animal Health Laboratory Network (NAHLN) will issue a guidance to the veterinary diagnostic labs advising them to not do unofficial FAD testing.

Other key discussion points

- The pork industry will need to work with the feed industry and other affiliated industries to develop programs to address feed safety. Both APHIS and FDA are willing to help with these discussions and processes.

- The FDA is willing to facilitate expedited regulatory review with any sponsor submitting a possible mitigation product that can be added to feed that may help address the animal health concerns associated with FAD transmission.

- The USDA has asked US Customs and Border Protection to target inspections of passengers and cargo coming from ASF-positive regions.

- The USDA is on heightened alert for illegal pork products in non-traditional markets.

In addition, we also discussed concerns with diagnostic capabilities including sample validation and lab capacity issues. Currently, the only sample type approved for use by the NAHLN labs is whole blood. Whole blood was chosen due to the virus’ predilection for macrophages, but it is not a sample routinely collected by swine veterinarians. The USDA indicated that tonsil would be approved for the NAHLN labs by the end of September and oral fluids sometime in 2019. Following approval, tonsil will be validated for both classical swine fever and African swine fever at the diagnostic labs. You should ensure that tonsil is included with all laboratory submissions. The AASV developed a brochure on tonsil collection and submission entitled “Got Tonsil”. The brochure can be ordered from the AASV office (aasv@aasv.org) or downloaded from the AASV website at www.aasv.org/aasv/documents/GotTonsil.pdf. We are also encouraging USDA to evaluate and validate lungs and spleen, as these are common diagnostic tissues submitted by swine veterinarians.

Diagnostic and private labs are considering requests to test feed and feed ingredients for ASF. Given there are no validated tests or sampling methodologies for feed and considering the severe consequences of a false-positive finding, USDA will not allow non-official ASF testing at the NAHLN laboratories.

To address potential sources of infection, the four industry organizations are encouraging producers and veterinarians to interact with their feed and feed-ingredient suppliers on issues associated with the importation of products which may pose a heightened risk of disease exposure. To facilitate this interaction, the group has published a list of questions for producers and veterinarians to pose to their suppliers. A link to this list can be found on the AASV website at www.pork.org/news/pork-industry-focuses-feed-ingredients-combat-african-swine-fever-threat/

The group also compiled a list of frequently asked questions regarding the role of USDA and FDA in ASF prevention. That list is posted on the AASV website at www.aasv.org/documents/ASFFAQ91018.pdf. We will continue to keep our members informed as these interactions proceed. Please feel free contact me with any questions.

Harry Snelson, DVM
Director of Communications
Index by title 2018


Index by author 2018


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*Frozen formulation; non-frozen formulation label does not include DOI.
Upcoming meetings

2018 ISU James D. McKean Swine Disease Conference  
November 1-2, 2018 (Thu-Fri)  
Scheman Building, Iowa State University, Ames, Iowa

For more information:  
Registration Services  
Iowa State University  
1601 Golden Aspen Drive #110, Ames, Iowa 50010  
Tel: 515-294-6222; Fax: 515-294-6223  
Email: registrations@iastate.edu  
Web: register.extension.iastate.edu/swinedisease

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

Humane Endings Symposium  
November 2-4, 2018 (Fri-Sun)  
Westin O’Hare, Rosemont, Illinois  
Hosted by American Veterinary Medical Association

For more information:  
Email: humaneendings@avma.org

2018 North American PRRS Symposium  
December 1-2, 2018 (Sat-Sun)  
Chicago Marriott, Downtown Magnificent Mile

For more information:  
Dr Bob Rowland, Executive Director  
Email: naprrs@vet.k-state.edu  
Web: www.vet.k-state.edu/na-prrs/

Passion for Pigs Seminar and Trade Show  
December 4, 2018 (Tue)  
Columbia, Missouri

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

2019 Pig-Group Ski Seminar  
February 13-15, 2019 (Wed-Fri)  
Copper Mountain, Colorado

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

American Association of Swine Veterinarians 50th Annual Meeting  
March 9-12, 2019 (Sat-Tue)  
Hilton Orlando Buena Vista Palace  
Lake Buena Vista, Florida

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

Asian Pig Veterinary Society Congress 2019  
August 26-28, 2019 (Mon-Wed)  
BEXCO, Busan 55, APEC-ro, Haeundae-gu, Busan  
Republic of Korea  
Tel: +82 51-740-7300

For more information:  
Amy Chang (Secretariat of APVS 2019):  
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Tel: +82 2-2190-7331  
Email: moon@innon.co.kr  
Sue Jo (Secretariat of APVS 2019):  
Tel: +82 2-2190-7327  
Email: sue@innon.co.kr  
Web: www.apvs2019.com

Pig Welfare Symposium  
November 13-15, 2019 (Wed-Fri)  
Hosted by the National Pork Board

For more information:  
Web: www.pork.org/pws

26th International Pig Veterinary Society Congress  
June 2-5, 2020 (Tue-Fri)  
Florianopolis, Brazil

For more information:  
Tel: +55 31 3360 3663  
Email: ipvs2020@ipvs2020.com  
Web: www.ipvs2020.com

For additional information on upcoming meetings: www.aasv.org/meetings
AASV Industry Support Council

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Photo Corner

Thirsty pigs at University of Missouri Swine Teaching Center.

Photo courtesy of Barbara Molnár Smith

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