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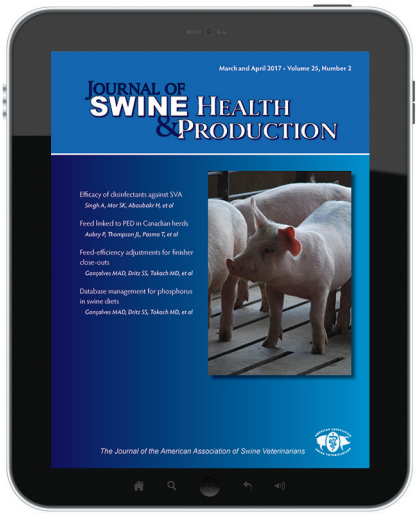

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A pig in an Iowa facility

Photo courtesy of Tina Smith

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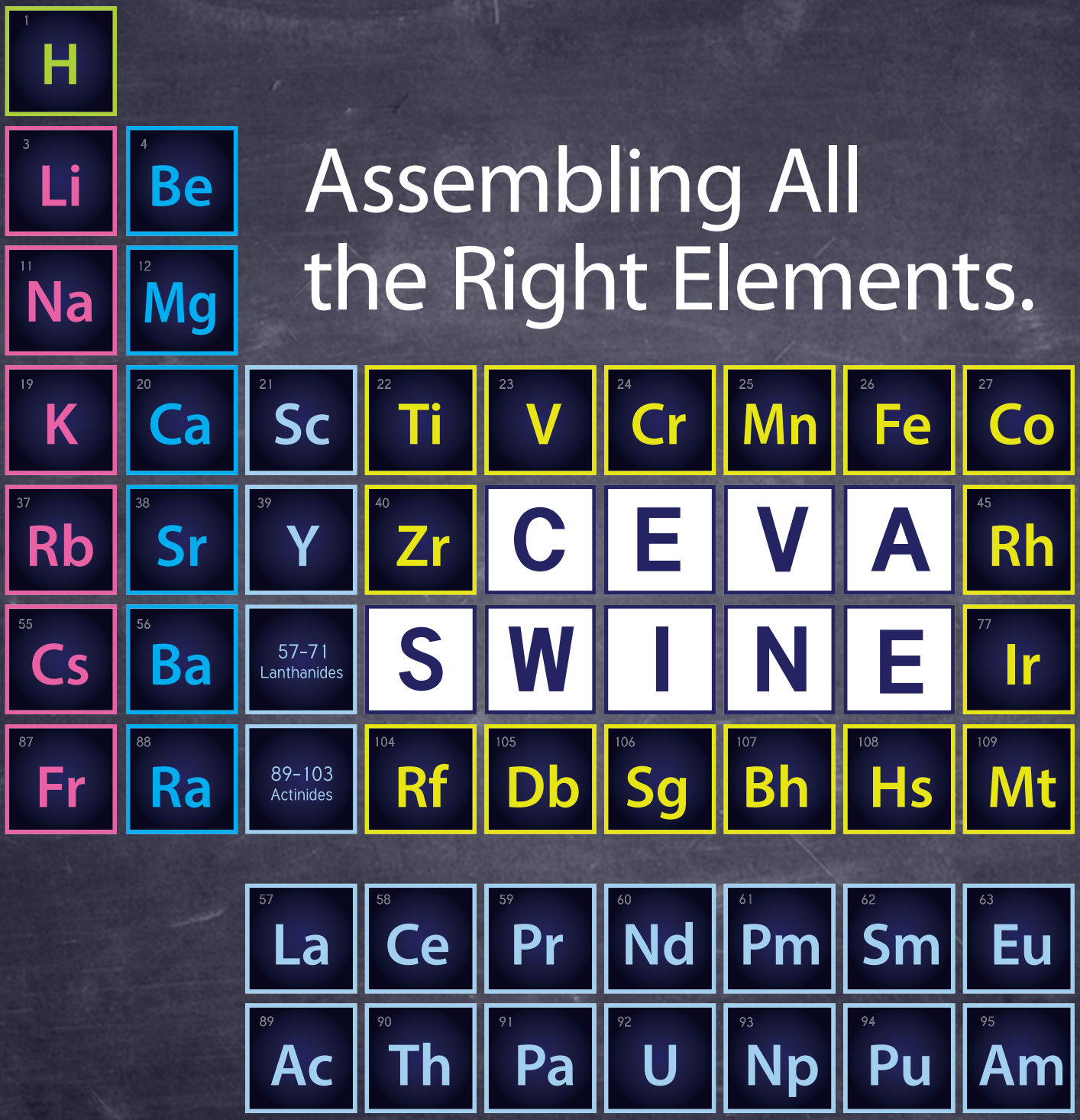
Table of contents

"Veterinarians will play an integral role in ensuring the responsible use of the remaining antibiotics. We cannot allow responsible use to be defined as no use."

quoted from the Executive Director's message, page 61



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One Health: Earning our seat on the lifeboat!

Family gatherings are a special time for catching up on recent goings-on. Lately I have been listening to the conversations of our younger generations at these gatherings. Most of our families' "millenials" are either finishing up post-secondary education or are starting careers and young families of their own. Education, climate change, work-life balance, and the human condition in general are common discussions. Any disputed facts seem to be resolved in real time with the assistance of multiple concurrent smartphone queries. The passion about wanting to be an agent for change is quite evident.

I think back to the conversations that I was having at family gatherings when I was that age. I don't recall work-life balance being on the radar screen, although in hindsight it would have been a very good thing. I do recall discussions about "limits to growth." Could improvements in agricultural efficiency allow us to feed a growing population? Would there be a limit to economic prosperity based on a finite number of resources? We didn't talk about "One Health," but the seed of the concept was there and today we can recognize that the objectives of sustainable human, animal, and ecosystem health are intricately interwoven. Where do we fit in to the problem solution as food-animal veterinarians?

"The work that we do in delivering animal health and welfare for the animals in our care, the clients that we serve, and society as a whole, is worthwhile."

I often think about a paper written by Dr Frederick A. (Ted) Leighton over a decade ago. He is a diplomate of the American College of Veterinary Pathologists and has focused on wildlife conservation and its importance to ecological stability and human wellbeing. As such, he has been a practitioner of One Health long before its more recent popularity. In this short paper Dr Leighton described what he referred to as the parable of the "lifeboat test."[1] The lifeboat test was meant to be a simple way of describing the social relevance of various human activities. In this parable we are to imagine a Titanic-like ship carrying passengers that represent the full spectrum of human enterprise. The ship strikes an iceberg and is going down fast, and unfortunately, as on the Titanic, there are not enough lifeboats to save everyone on board. Some tough decisions must be made about who will be offered a seat in the limited number of lifeboats. The gallantry of "women and children first" is replaced by selecting skill sets that are most essential to human existence.

Not surprisingly, Dr Leighton argued that food producers will be shuffled into one of the first available lifeboats. A no brainer. What I did not see coming was that Dr Leighton went on to argue that veterinarians involved in food-animal production, food inspection, research, and public health would follow close behind. When I first read this I thought "How cool is that!" This should not have been a surprise. The work that we do in delivering animal health and welfare for the animals in our care, the clients that we serve, and society as a whole, is worthwhile. The skill sets that we have developed in thinking about population health are just as important.

Is there an "iceberg" looming ahead that will test the value of our contributions to society as food-animal veterinarians? The exploding demand for energy resources and reduced availability of arable land, forests, and potable water are about to collide with exponential global population and economic growth: "Iceberg dead ahead!"

Dr Alex Ramirez and the program committee have helped us to better understand that swine veterinarians worldwide will need to work together to improve the health and wellbeing of pigs, while at the same time collaborating across animal species and with our human-health counterparts on common issues. Today we are heading down the path of tackling the issue of antimicrobial resistance and must be seen to be passionate stewards of what is increasingly considered to be a scarce resource. I suspect that this issue is simply the thin edge of the wedge of many resource-management issues to come. I fully expect that we will continue to earn our seat on that lifeboat.

As this is my last president's message, I would like to take this opportunity to say that it has been a great privilege to work with a very talented and dedicated group of AASV officers, directors, committee chairs, and members. A special thanks to our incredible AASV and JSHAP staff for being the glue that holds our organization together. I would like to take this opportunity to thank you, the AASV members, for allowing me the opportunity to serve.

Reference

1. Leighton FA. Veterinary medicine and the lifeboat test: a perspective on the social relevance of the veterinary profession in the 21st century. *Can Vet J.* 2004;45:259–263.

George Charbonneau, DVM
AASV President

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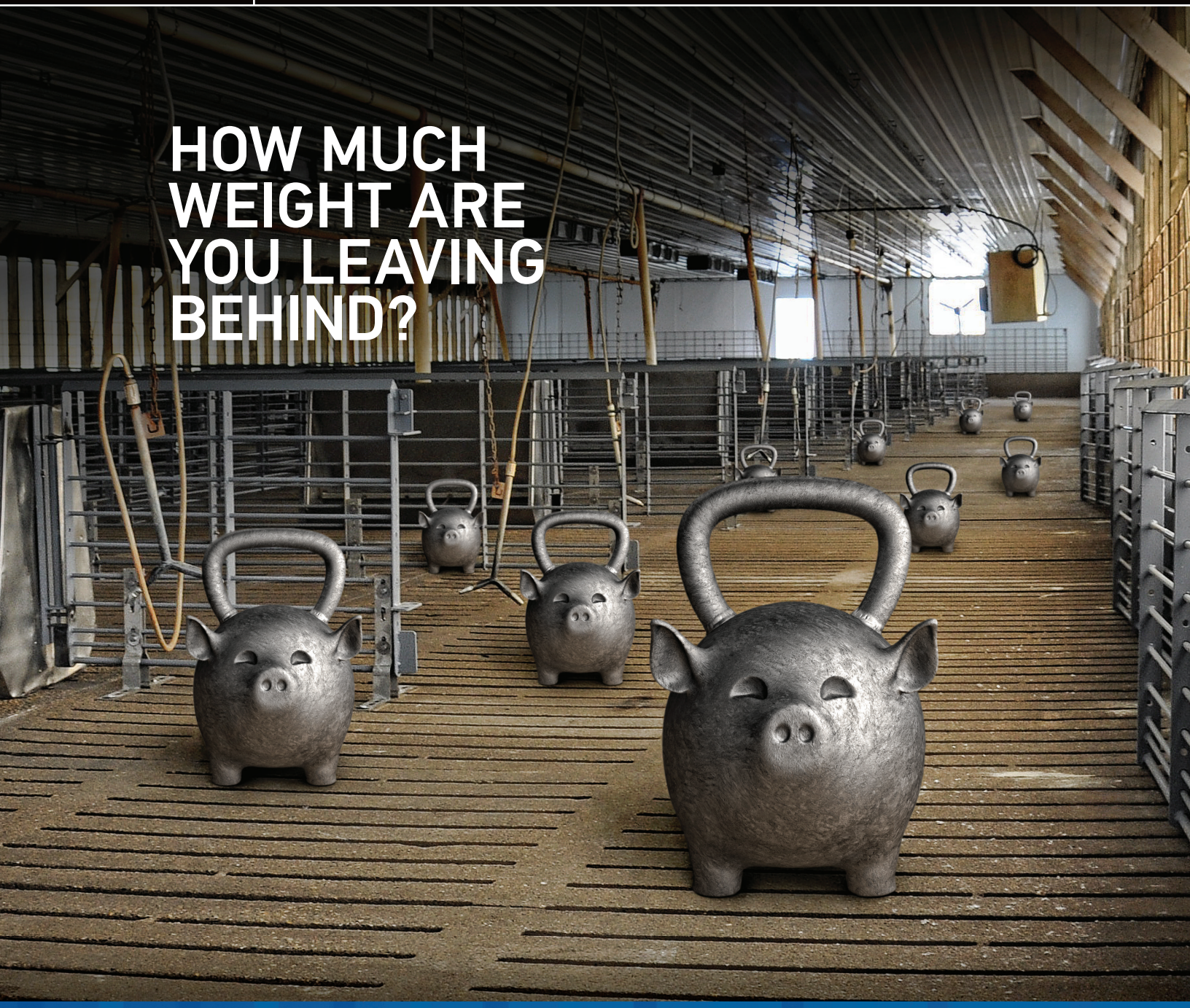

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One world

It is truly an honor for me to serve our membership as the new president for our great association. This year our annual meeting emphasized the reality that in fact we are one world. As swine professionals, we cannot look just at what is going on in our practice area and ignore everything else. We have not only learned the value of increased awareness of world events from a business or political perspective, but also the values and health challenges of people and pigs worldwide.

We live in one world. In 2016, our association had members from 44 different countries, including the United States. What we do here in the United States has value and impact worldwide. What our colleagues do in their own countries has value and impact in the United States. We are all truly focused on helping improve the health and wellbeing of pigs throughout the world. Recent disease outbreaks have emphasized the importance of recognizing that events in Illinois, Minnesota, Iowa, North Carolina, etc, will sooner or later impact the pigs in our own state, just as any disease in Africa, Asia, Australia, Europe, or the Americas is of concern to the United States. The time of isolationism is history. The rich background and experiences of all our members is what makes our association strong. It is our desire and passion to help pigs and people that make us essential. Yes, I do specifically mean essential.

Pork is the most widely consumed meat in the world, although poultry is approaching us very quickly.[1] This demand creates opportunity as well as some responsibilities. As veterinarians, we have taken an oath for "the protection of animal health and welfare, the prevention and relief of animal suffering, the conservation of animal resources, the promotion of public health...." All this requires us to be attentive to what is going on everywhere (nationally and internationally) so we can be better prepared. Ultimately, we are focused on producing safe pork for the consumer. This is a big responsibility, and I feel comfortable that we do an excellent job at it. The challenge comes when we have to deal with consumers. Not because we don't like them, but today's consumers are quite uninformed about animal agriculture, and in their desire to do the right thing, can be easily misguided by misinformation. As J. J. Jones from the Center for Food Integrity explained to us at our annual meeting, we must stay engaged and continue to gain the trust of our consumers.

Misinformation comes not only from local sources, but also from a national and sometimes even an international perspective. It is difficult for those not associated with livestock to fully understand what we are doing. Personally, I feel we have been doing our job so well that most don't realize what we do. According to the United States Department of Agriculture Economic Research Service, the United States has the lowest percent of consumer expenditure spent on food for the 86 selected countries reported. In 2014, for the United States, that share was 6.6% of consumer expenditures, compared to 9.2% for Canada, 11.4% for Denmark, 15.6% for Brazil, 23.3% for Mexico, 30.7% for India, and 56.6% for Nigeria.[2] When looking at the United States alone, our total dollars of per capita food expenditure (standardized to 1988 prices) has increased by just over 37% from $1651 in 1959 to more than $2251 in 2014, while the food expenditure by families and individuals (both at home and away from home) as a share of disposable personal income has decreased by 39.4%, from 18.8% to 11.4%.[2] With less income being spent on food (a critical expenditure for life), more income has become available to help support the economy in other areas. That is, most people don't realize the major role we all play in keeping food costs down so that Americans can live the lives they have become accustomed to. This is also happening while we continue to provide some of the safest food in the world. It has become so safe that everyone has taken it for granted.

"Ultimately, we are focused on producing safe pork for the consumer."

Are we sure we are providing proper animal care and wellbeing? Absolutely! It is a continuous improvement process. It is ever changing. Swine veterinarians are known to be progressive and focused on the science. With our annual meeting just over, we must all now go and use this knowledge to continue promoting the health and wellbeing of pigs and a safe pork supply not only in the United States, but worldwide. I look forward to working for you this next year as president of this great organization. Keep up your great work!

References

1. Food and Agricultural Organization of the United Nations. Food Outlook – Biannual Report on Global Food Markets. October 2016. Available at http://www.fao.org/3/a-i6198e.pdf. Accessed 19 December 2016.

2. United States Department of Agriculture Economic Research Service. Food Expenditure. 2016. Available at https://www.ers.usda.gov/data-products/food-expenditures.aspx. Accessed 19 December 2016.

Alex Ramirez, DMV
AASV President-elect

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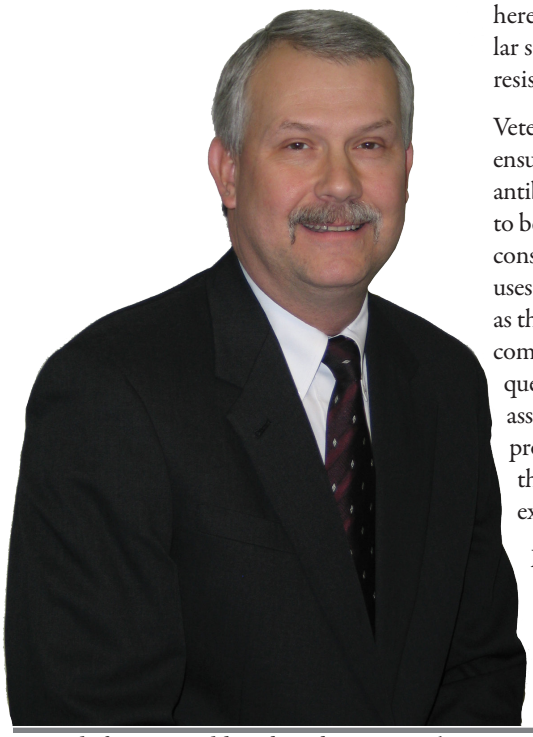
My view from the hospital pen

On November 21, 2016, I underwent full knee replacement surgery on my right knee. The surgery went fine as did the subsequent physical therapy. I was up, moving, and bearing weight without crutches in a matter of days. I was fully confident that this was a piece of cake and I had it whipped! Then on December 4th, I experienced a persistent, sharp pain in the rear of my chest and then severe shortness of breath. A quick trip to the local emergency room revealed multiple pulmonary emboli in both lungs originating from a deep vein thrombosis in my right leg. A couple more days in the hospital, several rounds of warfarin injections and I was back on my way to recovery, albeit a bit weaker and feeling very mortal, perhaps even a bit more reflective, both personally and professionally.

All I will say from a personal note is that surviving a life-threatening condition certainly makes you appreciate who you love and cherish the most: family, friends, and colleagues. It does help to focus your attention on how you wish to spend your remaining time on what is important. It also helps to highlight what is really the small stuff that should not be sweated.



On a professional level, my reflection began with how thankful I am to have had the privilege to be a veterinarian for the last 36 years. Even more than that, I am so thankful to have been associated with the AASP-AASV for that entire 36 years, first as a member and then as staff. I am now entering my 24th year as an AASV employee. Over that time I have watched the pork industry and the AASV evolve and change. I believe that both will continue to evolve and change with the future. There are some issues and challenges I think will continue to develop over the course of the next few years.

"Veterinarians will play an integral role in ensuring the responsible use of the remaining antibiotics. We cannot allow responsible use to be defined as no use."

The use of antibiotics will continue to draw attention from many different segments. Beginning on January 1, 2017, we have experienced an unprecedented removal of feed-grade antibiotics from the market and a reclassification of antibiotics used as water medications. The scrutiny from regulators, media, consumers, and activists will not stop here. Animal agriculture has become a popular scapegoat for the issue of antimicrobial resistance and this will be true for the future.

Veterinarians will play an integral role in ensuring the responsible use of the remaining antibiotics. We cannot allow responsible use to be defined as no use. Part of our role is to constantly review and consider any routine uses that occur on the farm. It is up to us as the medical professionals to not become complacent with the status quo, but to question every routine use as well as every assumption. If we fail to act as the medical professional on the farm, then we abdicate that role to others with less knowledge and experience.

My recent experience with pain mitigation leads me to believe that as a profession we need to do more to understand the relief of pain in pigs. I know there are legal limitations on pain medications in food animals. Let's look at solutions with the regulatory body (United States Food and Drug Administration) as well as interested companies with resources to research and develop products. We need to advocate for the pigs in our care and assert ourselves as animal welfare professionals. Too often we leave the high ground to be occupied by others whose so-called concern for animal welfare is just another marketing tool to sell more of their products.

The last few years have seen the consolidation of a number of veterinary practices. These have stretched across state lines and represent a trend that I believe will continue. Efficient and effective delivery of veterinary services to an increasingly consolidated production system is important for pig health and welfare. Practices and veterinarians will look for creative and sustainable ways to provide the best care to clients and patients. As we see multi-state, regional practices develop, the question arises whether or not we will see true "national" practices develop with time.

The porcine epidemic diarrhea (PED) epidemic of 2013-2014 taught us valuable lessons about the illusions of biosecurity. As these lessons fade with time, it worries me that our diligence on controlling what goes onto a farm is also fading. Feed is the commodity that goes onto a farm in the largest quantity and highest frequency. Our understanding of the pathogens that can survive in feed, even from overseas, has improved. It still remains to be seen how much better we are doing in ensuring that the feed going to farms is not carrying some pathogen much worse than PED.

This is just my view from the hospital pen. While I do not recommend a hospital stay to others, I truly benefitted from having the experience, especially since I lived to tell the tale. Each of you has your own insights about veterinary medicine and raising pigs. I would love to hear each and every one!

Tom Burkgren, DVM
Executive Director

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Genres V2.0

This issue I would like to revisit the topic of genres. I wrote about manuscript genres in a previous editorial in July 2013,[1] but this is a topic I feel is worthy of another visit, Genres V2.0, so to speak. The term "genre" is applied to many things: music genre, literary genre, and of course scientific text genre. Interestingly, the word genre is derived from the French word "gender" meaning: "kind, sort, style, class or category.[2]"

When I research, or read up, on a topic, I often read many different types of scientific text genres: textbooks, scholarly publications (peer-reviewed), conference papers (sometimes peer-reviewed), government reports, theses (I read many), and sometimes grey literature. I think that most of us are familiar with the value that peer-reviewed papers, textbooks, conference proceedings, and theses provide. But let's not forget the grey literature either. Grey literature often contains data that may or may not have been through a peer review, and hence, some critics of grey literature will question the validity of such data. But it is important to note that the grey literature can also add value to our scientific knowledge. Often, the term "grey literature" refers to information (an article) that is not easily or readily discoverable through traditional database searches, eg, some government reports that are available only through specific channels may not be "discoverable" through a Google-like search.

"Not all manuscripts fit perfectly into one genre mold, and yet all can have valuable information to share with busy, practical practitioners such as yourself."

What are the genre families in peer-reviewed scholarly-academic writing and publications? To review, and in general, scholarly writing is information that results from an idea examined through a scientific method (quantitative or qualitative). Hence, scholarly publications present and use the evidence generated from that method to develop interpretations and conclusions. For the *Journal of Swine Health and Production* (JSHAP), the manuscript genre family includes a long list: original research, brief communication, production tool, literature review, peer-reviewed commentary, peer-reviewed diagnostic notes, peer-reviewed practice tip, case report, and case series. The author guidelines for JSHAP[3] provides a brief overview of what should make up each of these different manuscript genres, and all manuscript genres submitted to JSHAP are peer-reviewed. As an author, being aware of the genre your scientific work best falls into can help you to format and present your data-information-story in a manuscript genre which will ideally result in a successful peer review and subsequent publication.

Let's look at what is typically considered a "traditional" scientific manuscript which, for JSHAP, is the genre "original research." Put simply, an original research manuscript should contain the following sections: a summary, introduction, materials and methods, results, discussion, and implications. The data usually tests a hypothesis, may contain control subjects and blinded researchers (if the research is a clinical trial), is supported and designed on the basis of previous published data (unless of course, it is a pilot study), employs an appropriate study design that supports the research question and validity of the data generated, includes comprehensive statistical analysis considerations, and contains a discussion of interpretations and limitations of the data.

Why re-visit genres as a topic? Given that JSHAP has such a large genre family, I feel it important to remember myself, and to remind you as a reader, that genre is an important consideration when interpreting a paper. Interpretation and presentation of information in a manuscript can be different if the information is presented as original research versus a case report, for example. I encourage you to re-visit my previous editorial "Manuscript genres."[1] One of the great things I love about JSHAP is our long list of genre options. Not all manuscripts fit perfectly into one genre mold, and yet all can have valuable information to share with busy, practical practitioners such as yourself. The *Journal of Swine Health and Production* has broad options in which to present scientific information and yet maintains rigor by applying the peer-review process to all genre types. I feel fortunate that we (JSHAP enthusiasts) have these peer-reviewed genre options in which to present information that may otherwise not have been published outside of the grey literature.

I hope you enjoy this issue.

References

1. O'Sullivan T. Manuscript genres [editorial]. *J Swine Health Prod*. 2013;21:183.

2. English Oxford Online Dictionary. Available at **https://en.oxforddictionaries.com/definition/genre**. Accessed 30 December 2016.

3. *Journal of Swine Health and Production* Author Guidelines. Available at **https://www.aasv.org/shap/guidelines.pdf**. Accessed 30 December 2016.

Terri O'Sullivan, DVM, PhD
Executive Editor

Efficacy of three disinfectants against Senecavirus A on five surfaces and at two temperatures

Azad Singh, MVSc; Sunil K. Mor, PhD; Hamada Aboubakr, MSc; Fabio Vannucci, PhD; Devi P. Patnayak, PhD; Sagar M. Goyal, PhD

Summary

Objectives: To evaluate the virucidal efficacy of three commercial disinfectants against Senecavirus A (SVA) on five different surfaces at ~25°C and 4°C.

Materials and methods: Household bleach, a phenolic disinfectant, and a quaternary ammonium-aldehyde disinfectant were tested at manufacturer's recommended concentrations against a contemporary strain of SVA on aluminum, stainless steel, rubber, cement, and plastic surfaces at ~25°C and 4°C. Virus propagation and titration were performed on swine testicular cells. Viral titers were calculated before and after exposure to the disinfectant being tested.

Results: At ~25°C, household bleach at 1:20 dilution inactivated ≥ 99.99% of the virus within 10 to 15 minutes on aluminum, rubber, and plastic. On stainless steel and cured cement, it inactivated 99.97% and 99.98% of the virus, respectively. At 4°C, bleach inactivated ≥ 99.99% of the virus within 5 to15 minutes on all surfaces except rubber; on rubber, inactivation was 99.91% after 15 minutes. The phenolic disinfectant at the manufacturer's recommended concentration inactivated only ≤ 82.41% of the virus at either temperature and on any surface, even after a 60-minute contact time. Results for the quaternary ammonium disinfectant were intermediate: 78.12% to 99.81% of the virus was inactivated within 60 minutes at both temperatures and on all surfaces. To detect differences between disinfectants, paired Wilcoxon tests were performed. At 10- and 15-minute time points, efficacies of the three disinfectants differed significantly.

Implications: Significant variation exists in the antiviral efficacies of different disinfectants. Hence, they should be tested against various pathogens before use in the field.

Keywords: swine, Senecavirus A, disinfectant, virucidal, biosecurity.

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Resumen - Eficacia de tres desinfectantes contra el Senecavirus A en cinco superficies y a dos temperaturas

Objetivos: Evaluar la eficacia viricida de tres desinfectantes comerciales contra el Senecavirus A (SVA por sus siglas en inglés) en cinco superficies diferentes a ~25ºC y 4ºC.

Materiales y métodos: Se probaron un blanqueador casero, un desinfectante fenólico, y un desinfectante a base de cuaternarios de amonio y aldehído, en las concentraciones recomendadas por el fabricante contra una cepa contemporánea de SVA en superficies de aluminio, acero inoxidable, hule, cemento, y plástico a ~25ºC y 4ºC. La propagación y titulación del virus se realizó en células testiculares porcinas. Las cargas virales se calcularon antes y después de la exposición al desinfectante que se estaba probando.

Resultados: A ~25ºC, el blanqueador casero a una dilución de 1:20 desactivó ≥ 99.99% del virus en un periodo de 10 a 15 minutos en aluminio, hule, y plástico. En acero inoxidable y cemento curado, desactivó 99.97% y 99.98% del virus, respectivamente. A 4ºC, el blanqueador desactivó ≥ 99.99% del virus en un periodo de 5 a 15 minutes en todas las superficies excepto el hule; en hule, la desactivación fue de 99.91% después de 15 minutos. El desinfectante fenólico en la concentración recomendada por el fabricante desactivó solamente ≤ 82.41% del virus en ambas temperaturas y en cualquiera de las superficies, aún después de un tiempo de contacto de 60 minutos. Los resultados para el desinfectante a base de cuaternarios de amonio fueron intermedios: 78.12% a 99.81% del virus fue desactivado dentro de un periodo de 60 minutos en ambas temperaturas y en todas las superficies. Para detectar diferencias entre los desinfectantes, se realizó la prueba de Wilcoxon de pares iguales. La eficacia de los tres desinfectantes difirió significativamente en los puntos de tiempo de 10 y 15 minutos.

Implicaciones: Existe una variación significativa en la eficacia antiviral de diferentes desinfectantes. Por consiguiente, deberían probarse contra varios patógenos antes de utilizarse en el campo.

Résumé - Efficacité de trois désinfectants contre le Senecavirus A sur cinq surfaces et à deux températures

Objectifs: Évaluer l'efficacité virucide de trois désinfectants commerciaux contre le Senecavirus A (SVA) sur cinq surfaces différentes et à ~25ºC et 4°C.

Matériels et méthodes: De l'eau de javel domestique, un désinfectant phénolique, et un désinfectant d'aldéhyde d'ammonium quaternaire ont été testés aux concentrations recommandées par les manufacturiers contre une souche contemporaine de SVA sur des surfaces d'aluminium, d'acier inoxydable, de caoutchouc, de ciment, et de plastique à ~25ºC et 4°C. La propagation et la titration du virus ont été réalisées sur des cellules testiculaires de porc. Les titres viraux ont été calculés avant et après exposition au désinfectant testé.

Résultats: À ~25ºC, l'eau de javel diluée 1:20 a inactivé ≥ 99,99% des virus dans un délai de 10 à 15 minutes sur l'aluminium, le caoutchouc, et le plastique. Sur l'acier inoxydable et le ciment, l'inactivation du virus étaient

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

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de 99,97% et 99,98% respectivement. À 4°C, l'eau de javel a inactivé ≥ 99,99% des virus dans un délai de 5 à 15 minutes sur toutes les surfaces sauf le caoutchouc; sur le caoutchouc, l'inactivation du virus était de 99,91% après 15 minutes. Le désinfectant phénolique utilisé à la concentration recommandée par le manufacturier n'a inactivé que ≤ 82,41% des virus à l'une ou l'autre des températures, et sur n'importe laquelle des surfaces, et ce même après un temps de contact de 60 minutes. Les résultats pour le désinfectant ammonium quaternaire étaient intermédiaires: 78,12% à 99,81% des virus étaient inactivés dans un délai de 60 minutes aux deux températures et sur toutes les surfaces. Afin de détecter des différences entre les désinfectants, les résultats étaient comparés par le test pairé de Wilcoxon. Aux temps de contact de 10 et 15 minutes, l'efficacité des trois désinfectants différait de manière significative.

Implications: Des variations significatives existent dans l'efficacité antivirale de différents désinfectants. Ainsi, ils devraient être testés contre les différents agents pathogènes avant leur utilisation sur le terrain.

Senecavirus A (SVA) is a small, non-enveloped picorna virus having a single-stranded, positive-sense RNA genome.[1] It belongs to genus *Senecavirus*, which is closely related to the genus *Cardiovirus* in *Picornaviridae*.[2] The virus was initially identified as a cell-culture contaminant in PER.C6 cells,[3,4] but has now been reported in pigs from several countries including Australia, Canada, Italy, New Zealand, United States and recently Brazil.[3,5] In the United States, SVA has been detected in California, Illinois, Iowa, Louisiana, Minnesota, New Jersey, North Carolina, and South Dakota.[6]

Although Koch's postulates have not been fulfilled, pigs infected with SVA do exhibit fever, erosions on snout, and swelling of coronary bands, along with blanching and broken vesicles, sloughing of hooves and dewclaws, and eventually lameness.[4,7,8] Unfortunately, the clinical signs are indistinguishable from other vesicular diseases, including foot-and-mouth disease (FMD).[9] It is important, therefore, to confirm that the pigs are infected with SVA and not FMD virus (FMDV). A single case of FMD misdiagnosed as SVA will allow FMDV to take a foothold, resulting in huge economic losses in terms of control measures and loss of exports.[10]

The transmission routes of SVA are not well understood, but it can be safely assumed that SVA spreads, as in the case of FMDV, by direct contact with infected individuals or fomites, or exposure to aerosolized virus.[1] Detectable levels of infectious virus have been found in nasal secretions, sputum, blood, urine, and stool of human cancer patients treated with intravenous SVA in clinical trials for therapeutic use.[11] Animal houses can be contaminated via excretions of infected animals. Regular cleaning and disinfection of these premises is a cost-effective biosecurity measure to control and prevent viral diseases and to minimize their impact.

The effectiveness of disinfectants depends on many factors, such as chemical nature of the disinfectant, temperature at which it is used, type of contaminated surface, and physicochemical characteristics of the virus (eg, size and enveloped or non-enveloped). This makes it important to test a particular disinfectant against the target pathogen to ensure that it will be effective against the pathogen in question. This study was designed to evaluate the efficacies of three commercially available disinfectants against SVA at two different temperatures (~25°C and 4°C) using as carrier surfaces discs of aluminum, steel, rubber, plastic, and cured cement.

Materials and methods

Virus propagation

A field strain of SVA, isolated in September 2015 in the Veterinary Diagnostic Laboratory, University of Minnesota, was used. The virus was propagated and titrated in swine testicular (ST) cells. The titer of stock virus was $10^{6.2}$ median tissue culture infective doses ($TCID_{50}$) per mL.

Disinfectants

Three disinfectants, described in Table 1 and commonly used on swine farms in Minnesota, were evaluated in this study. Dilutions of disinfectants as recommended by their manufacturers were prepared in sterile distilled water.

Procedures

The experiments were performed at room temperature (~25°C) and at 4°C. Coupons of aluminum, stainless steel, rubber, and cured cement placed in individual wells of sterile 24-well cell culture plates (Corning, Kennebunk, Maine) were used as carrier surfaces for testing the disinfectant efficacy. The surface of the 24-well plate (without any coupon) was used as the plastic surface. Before use, the coupons were sterilized by autoclaving at 121°C for 15 minutes, and temperature-sensitive autoclave tape was used to confirm sterility. To each sterile coupon, 40 µL of SVA was applied. The coupon was then dried in a laminar flow hood for approximately 45 minutes. The inoculum volume of 40 µL was used with the intent to cover at least half of the coupon surface with the virus. A volume of 40 µL was found to be appropriate for this purpose. Disinfectant to be tested was then applied to the dried virus layer at 50 µL per coupon. The volume of 50 µL per coupon ensured that all of the virus inoculum came into contact with the disinfectant.

For negative control, 50 µL of minimum essential medium (MEM) was used instead of the disinfectant. Contact times were 1, 3, 5, 10, and 15 minutes for bleach and 10, 15, 30, and 60 minutes for Tek-Trol and Synergize. After various contact times, 400 µL of an eluent solution (3% beef extract in 0.05 M glycine solution; pH 7.5) was added to all wells. The eluent was repeatedly pipetted back and forth in each well to facilitate virus elution from the surface. Serial tenfold dilutions of elutes were prepared immediately in MEM followed by inoculation of all dilutions in monolayers of ST cells contained in 96-well microtiter plates, using three wells per dilution. Inoculated plates were incubated at 37°C and observed daily for up to 4 days for the appearance of virus-induced cytopathic effects. Virus titers were calculated by the method of Reed and Muench.[12] Virus titers in disinfectant-treated and MEM-treated (control) wells were compared to determine the amount of virus inactivated by the disinfectant. Efficacy of each disinfectant at each time point was analyzed in terms of per cent reduction of virus. All experiments were performed in triplicate.

Statistical analysis

To test for differences among the five surfaces, a permutation test using Friedman's test statistic[13] was used, treating each temperature and time combination as a block, with surface labels permuted within each temperature level. To test for differences between temperatures, the same technique was used, but with surface and time combinations as blocks and temperature labels permuted within each surface level. Tests were performed separately for each disinfectant. To test for differences between disinfectants, we examined time points 10 minutes and 15 minutes and performed pairwise Wilcoxon tests between the three disinfectants, paired by surface and temperature, with corrections

Table 1: Disinfectants and their dilutions used to inactivate Sencavirus A*

Disinfectant	Manufacturer	Disinfectant category	Active ingredient	Recommended dilution
Bleach	Champion Packaging and Distribution, Woodridge, Illinois	Chlorine	Sodium hypochlorite (5.25%)	1:20
Tek-Trol	Bio-Tek, a Division of ABC compounding, Atlanta, Georgia	Phenol	Ortho-phenylphenol (12%), Ortho-benzyl-para-chlorophenol (10%), Para-tertiary-amylphenol (4%)	1:250
Synergize	Preserve International, Reno, Nevada	Quaternary ammonium compounds + aldehyde	Alkyl dimethyl benzyl ammonium chloride (26%) glutaraldehyde (7%)	1:256

* Three types of disinfectants were tested, as described in the table.

for multiple corrections using the Bonferroni-Holm adjustment. A value of $P < .05$ was considered statistically significant.

Results

At 10- and 15-minute time points, all three disinfectants tested were significantly different ($P < .01$ at 10 minutes and $P < .05$ at 15 minutes). Household bleach at 1:20 dilution inactivated ≥ 99.99% of the virus within 10 to 15 minutes on aluminum, rubber, and plastic at room temperature (Table 2). Results obtained with bleach on stainless steel and cured cement were 99.97% and 99.98%, respectively. At 4°C, bleach inactivated ≥ 99.99% of the virus within 5 to 15 minutes on all surfaces except rubber. On rubber, bleach inactivated 99.91% of the virus after a contact period of 15 minutes.

Results for Synergize were intermediate between those obtained with bleach and Tek-Trol. Synergize inactivated 93.54% to 99.81% of the virus within 60 minutes at either temperature and on all surfaces tested (Table 2). The differences between surfaces were not significant for bleach, Tek-Trol, or Synergize ($P = .12$, $P = .55$, and $P = .44$, respectively), nor were differences between the temperatures ($P = 1.0$, $P = .25$, and $P = .13$, respectively).

Discussion

Each suspected case of SVA must be thoroughly investigated to rule out transboundary animal diseases such as FMD. The control strategy against SVA should include proper cleaning and disinfection of premises. Since SVA spreads very rapidly, the availability of an effective disinfectant is very important for disease control. In the present study, we tested three different disinfectants that are in common use on swine farms, including household bleach (sodium hypochlorite), Tek-Trol (phenolic compounds), and Synergize (quaternary ammonium compound and glutaraldehyde).

Although 4°C is not representative of conditions inside the barn, it does reflect outside conditions, especially during winters in the US Midwest. We emphasize that all experiments in this study were performed without any added organic matter (except for the small amount that is present in MEM). The presence of organic material, such as manure, reduces the efficacy of various disinfectants under field conditions.[14] We further emphasize that dry surfaces were used in this study, which is rarely the case in swine facilities. Whether the results of this study can be extended to apply to wet surfaces in the presence of organic matter remains to be seen. It is well known that no disinfectant is highly effective in the presence of organic matter, and hence cleaning of the facilities before the application of disinfectants is a prerequisite.[14]

Viral susceptibility to disinfectants depends on several factors, including virus type (enveloped or non-enveloped), size, morphology, and nucleic acid (single- or double-stranded).[15-17] In general, non-enveloped viruses such as enteroviruses are more resistant than enveloped viruses to the action of commonly used disinfectants such as 70% alcohol and 1% quaternary ammonium compounds.[18] In addition, non-enveloped viruses are more stable outside their hosts and have a greater potential to spread via contaminated environment.[17,19]

Disinfectants containing chlorine are recommended for inactivating a wide variety of viral and bacterial pathogens.[20] In the present study, 2500 ppm of household bleach was found to be the most effective; it inactivated > 4 $\log_{10}$ (≥ 99.99%) of SVA on at least three surfaces within 10 to 15 minutes. Harada et al[21] reported that sodium hypochlorite, in a suspension test, reduced the titer of FMDV by 99.5% within 30 seconds. It is well known that disinfectants are less effective on dry viruses than on wet viruses in suspension.[22] Hence, it is not surprising that it took only 10 to 15 minutes for sodium hypochlorite to inactivate 4 $\log_{10}$ (99.99%) of dried SVA on various surfaces. Our results are in agreement with previous studies on the sodium hypochlorite inactivation of coronavirus, human influenza virus, coxsackie B virus, adenovirus type 5, and rotavirus.[23,24] Although bleach was the most effective, it should be noted that it is corrosive and should be used with caution.

The phenolic homologue evaluated in our study (TekTrol) was not very effective in inactivating SVA even after a contact time of 60 minutes. In one of our experiments, double the recommended concentration of Tek-Trol was also ineffective against SVA (data not shown). Our findings are in agreement with those of other studies in which disinfectants with lipophilic properties (phenol homologues) were not active against small (20 to 30 nm), non-enveloped viruses belonging to Picornaviridae and Parvoviridae.[25-27]

Quaternary ammonium compounds (QAC) are reported to be less effective against hydrophilic, non-enveloped viruses, eg, feline calicivirus, canine parvovirus, and poliovirus.[23,28,29] In the present study, a combination of QAC and glutaraldehyde inactivated 93.54% to 99.81% of SVA, but only after a contact time of 60 minutes. Ineffectiveness of QAC against FMDV in a suspension test has been previously reported.[21]

Table 2: Inactivation of Senecavirus A by three disinfectants at two different temperatures and on five surfaces

Disinfectant (dilution)†	Time (minutes)‡	Percent inactivation of Senecavirus A on indicated surfaces and temperatures*									
		Aluminum		Stainless steel		Rubber		Cured cement		Plastic	
		4°C	25°C	4°C	25°C	4°C	25°C	4°C	25°C	4°C	25°C
Bleach (1:20)	1	99.53	99.70	98.86	96.52	99.53	99.77	90.60	76.56	99.85	99.96
	3	99.90	99.50	99.20	97.71	97.81	99.76	94.37	94.95	99.62	99.98
	5	99.95	96.43	≥ 99.99	99.96	99.18	99.74	99.33	92.53	99.92	99.98
	10	99.83	≥ 99.99	≥ 99.99	99.93	99.78	99.62	97.55	97.95	≥ 99.99	≥ 99.99
	15	≥ 99.99	≥ 99.99	≥ 99.99	99.97	99.91	≥ 99.99	≥ 99.99	99.98	≥ 99.99	≥ 99.99
Tek-Trol (1:250)	10	43.78	52.08	47.74	74.30	35.48	60.00	70.51	26.20	17.74	73.78
	15	82.08	36.19	00.00	18.10	17.74	36.19	43.78	26.20	56.20	52.08
	30	62.40	00.00	60.00	61.68	35.48	78.10	00.00	26.20	18.09	73.80
	60	26.04	77.74	82.41	61.52	79.90	56.20	17.74	18.10	18.09	47.74
Synergize (1:256)	10	91.77	90.00	96.15	86.20	78.62	90.00	96.61	78.62	78.12	86.20
	15	90.00	96.15	86.20	96.15	90.00	86.20	92.62	98.62	78.12	95.32
	30	95.32	98.62	97.80	97.81	82.41	92.62	99.17	90.41	97.37	97.81
	60	95.32	96.98	93.54	95.32	96.98	99.53	96.98	99.81	94.77	99.54

* Results shown are averages of three replicates. Reading indicates percent reduction of virus titer compared with control, with ≥ 99.99% corresponding to a 4 $\log_{10}$ titer reduction, which is desired at the recommended dilution of the disinfectant. Percent inactivation was calculated according to the following formula: (Amount of virus inactivated ÷ Amount of virus in control) × 100.

† Dilution recommended by the disinfectant manufacturer (manufacturer information shown in Table 1).

‡ Bleach, being the most effective disinfectant, was tested at contact times of 1, 3, 5, 10, and 15 minutes, while Tek-Trol and Synergize were tested at 10, 15, 30, and 60 minutes.

In this study, we did not use a neutralizer to neutralize the disinfectants. However, at each time point, we used 400 µL of an eluent solution to recover any surviving virus. The original amount of the applied virus was 40 µL per coupon, and elution of this amount of virus in 400 µL resulted in a 1:10 dilution of the eluate. Serial tenfold dilutions of this eluate were then made and inoculated in cell cultures, and hence the effective dilution of the eluate was 1:100. We relied on this 1:100 dilution to effectively reduce the continuing action of the disinfectant in the inoculated cells. In disinfectant testing, this is generally considered adequate.[19]

Our findings suggest that sodium hypochlorite at 2500 ppm is suitable for use as a virucide against SVA on various surfaces both at room temperature and at 4°C. Testing at 4°C is important because in the US Midwest climate, disinfectants are often used in both cold and warm atmospheric conditions. On the basis of these results, treatment of contaminated surfaces with sodium hypochlorite may reduce the viral load of contaminated surfaces and thereby reduce the risk of virus transmission during outbreaks. At both 10 and 15 minutes, efficacies of the three disinfectants were significantly different, indicating that such studies should be conducted with various disinfectant-virus-surface combinations to ensure that the chosen disinfectant is effective against the virus in question. The identification and evaluation of an optimal disinfectant against any pathogen is an essential and cost-effective way to control and prevent the spread of that pathogen.

Implications

- Under the conditions of this study, disinfectants commonly used in the swine industry have different anti-SVA efficacies.
- It is important to test various disinfectants against different viruses to ensure that they are effective against a given virus under the conditions of use.

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Conflict of interest

The authors declare that they have no conflict of interest.

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References

1. Alexandersen S, Knowles N, Dekker A, Belsham G, Zhang Z, Koenen F. Picornaviruses. In: Zimmerman J, Karriker L, Ramirez A, Schwartz K, Stevenson G, eds. *Diseases of Swine.* 10th ed. Ames, Iowa: John Wiley & Sons. 2012;587–620.

2. Adams MJ, Lefkowitz EJ, King AMQ, Bamford DH, Breitbart M, Davison AJ, Ghabrial SA, Gorbalenya AE, Knowles NJ, Krell P, Lavigne R, Prangishvili D, Sanfacon H, Siddell SG, Simmonds P, Carstens EB. Ratification vote on taxonomic proposals to the International Committee on Taxonomy of Viruses (2015). *Arch Virol.* 2015;160:1837–1850.

3. Hales LM, Knowles NJ, Reddy PS, Xu L, Hay C, Hallenbeck PL. Complete genome sequence analysis of Seneca Valley virus-001, a novel oncolytic picornavirus. *J Gen Virol.* 2008;89:265–275.

4. Pasma T, Davidson S, Shaw SL. Idiopathic vesicular disease in swine in Manitoba. *Can Vet J.* 2008;49:84–85.

5. Vannucci FA, Linhares DCL, Barcellos DESN, Lam HC, Collins J, Marthaler D. Identification and complete genome of Seneca Valley virus in vesicular fluid and sera of pigs affected with idiopathic vesicular disease, Brazil. *Transbound Emerg Dis.* 2015;626:589–593.

*6. Knowles NJ, Hales LM, Jones BH. Epidemiology of Seneca Valley virus: identification and characterization of isolates from pigs in the United States. *Northern Lights EUROPIC*. 2006.

7. Singh K, Corner S, Clark SG, Scherba G, Fredrickson R. Seneca Valley virus and vesicular lesions in a pig with idiopathic vesicular disease. *J Vet Sci Technol.* 2012;3:123. doi:10.4172/2157-7579.1000123.

8. Montiel N, Buckley A, Guo B, Kulshreshtha V, VanGeelen A, Hoang H, Rademacher C, Yoon KJ, Lager K. Vesicular disease in 9-week-old pigs experimentally infected with Senecavirus A. *Emerg Infect Dis.* 2016;22:7:1246–1248.

9. Yang M, van Bruggen R, Xu W. Generation and diagnostic application of monoclonal antibodies against Seneca Valley virus. *J Vet Diagn Invest.* 2012;24:42–50.

*10. Meyer S. Seneca Valley Virus could cost producers billions. *The National Hog Farmer*. September 21, 2015.

11. Rudin CM, Poirier JT, Senzer NN. Phase I clinical study of Seneca Valley virus (SVV-001), a replication-competent picornavirus, in advanced solid tumors with neuroendocrine features. *Clin Cancer Res.* 2011;17:888–895.

12. Reed LJ, Muench H. A simple method of estimating fifty percent end points. *Am J Hyg.* 1938;27:493–497.

13. Friedman M. The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *J Am Stat Assoc.* 1937;32:675–701.

*14. Russel AD, Russel NJ. Biocides: activity, action and resistance. *Symp Soc Gen Microbiol*. 1995;53:327–365.

15. Thurman RB, Gerba CP. Molecular mechanisms of viral inactivation by water disinfectants. *Adv Appl Microbiol.* 1988;33:75–105.

16. Maillard JY. Virus susceptibility to biocides: an understanding. *Rev Med Microbiol.* 2001;12:63–74.

17. Sattar SA. Hierarchy of susceptibility of viruses to environmental surface disinfectants: a predictor of activity against new and emerging viral pathogens. *J AOAC Int.* 2007;90:1655–1658.

18. Chan YF, Abu Bakar S. Virucidal activity of Virkon S on human enterovirus. *Med J Malaysia*. 2005;60:246–248.

19. Boone SA, Gerba CP. Significance of fomites in the spread of respiratory and enteric viral disease. *Appl Environ Microbiol.* 2007;73:1687–1696.

20. Weber DJ, Rutala WA. Uses of inorganic hypochlorite (bleach) in health-care facilities. *Clin Microbiol Rev*. 1997;10:597–610.

21. Harada Y, Lekcharoensuk P, Furuta T, Taniguchi T. Inactivation of foot-and-mouth disease virus by commercially available disinfectants and cleaners. *Biocontrol Sci*. 2015;20:205–208.

22. Springthorpe VS, Sattar SA. Carrier tests to assess microbicidal activities of chemical disinfectants for use on medical devices and environmental surfaces. *J AOAC Int.* 2005;88:182–201.

23. Sattar SA, Springthorpe VS, Karim Y, Loro P. Chemical disinfection of non-porous inanimate surfaces experimentally contaminated with four human pathogenic viruses. *Epidemiol Infect.*1989;102:493–505.

24. Sattar SA, Jacobsen H, Rahman H, Cusack TM, Rubino JR. Interruption of rotavirus spread through chemical disinfection. *Infect Control Hosp Epidemiol.*1994;15:751–756.

25. Noll H, Youngner JS. Virus-lipid interactions. The mechanism of adsorption of lipophilic viruses to water insoluble polar lipids. *Virology.* 1959;8:319–343.

26. Evans DH, Stuart P, Roberts DH. Disinfection of animal viruses. *Br Vet J.* 1977;133:356–359.

27. Maris P. Modes of action of disinfectants. *Rev Sci Tech Off Int Epiz.* 1995;14:47–55.

28. Kennedy MA. Virucidal efficacy of the newer quaternary ammonium compounds. *J Am Anim Hosp Assoc.* 1995;31:254–258.

29. Doultree JC, Druce D, Birch CJ, Bowden DS, Marshall JM. Inactivation of feline calicivirus, a Norwalk virus surrogate. *J Hosp Infect.* 1999;41:51–57.

* Non-refereed references.

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Brief communication

Weight of the evidence linking feed to an outbreak of porcine epidemic diarrhea in Canadian swine herds

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Summary

The weight of the evidence gathered during an outbreak of porcine epidemic diarrhea (PED) in Canada in January 2014 supports an association with feed containing spray-dried porcine plasma contaminated with the virus. Many questions remain regarding the importance of feed and (or) feed ingredients in the transmission of PED virus.

Keywords: swine, porcine epidemic diarrhea virus, infectious disease outbreaks, animal feed

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Resumen - Peso de la evidencia vinculando el alimento a un brote de diarrea epidémica porcina en hatos porcinos Canadienses

El peso de la evidencia reunido durante un brote de diarrea epidémica porcina (PED por sus siglas en inglés) en Canadá en Enero del 2014 apoya una asociación al alimento que contiene plasma porcino secado por aerosol contaminado con el virus. Aún quedan muchas preguntas con respecto a la importancia del alimento y (o) ingredientes del alimento en la transmisión del virus PED.

Résumé - Fardeau de la preuve liant l'aliment à une épidémie de diarrhée épidémique porcine dans des troupeaux porcins canadiens

Le fardeau de la preuve accumulé durant une épidémie de diarrhée épidémique porcine (DEP) au Canada en janvier 2014 supporte une association avec de l'aliment contenant du plasma porcin séché au jet contaminé par le virus. Plusieurs questions demeurent quant à l'importance de l'aliment et (ou) des ingrédients alimentaires dans la transmission du virus de la DEP.

Porcine epidemic diarrhea (PED) is a highly contagious disease of swine caused by the porcine epidemic diarrhea virus (PEDV), an Alphacoronavirus of the Coronaviridae family.[1] Swine enteric coronavirus diseases (SECDs) have been known for decades, but PEDV was reported for the first time in Canada in January 2014, nine months after it was first discovered in the United States in May 2013. Even though genetic and phylogenetic analyses of three US PEDV strains suggest that they likely originated from China,[2] the exact pathway for introduction has yet to be identified. A root cause investigation conducted by the United States Department of Agriculture Animal and Plant Health Inspection Services (USDA-APHIS) suggested that the use of flexible intermediate bulk containers, contaminated in the country of origin and reused in the United States for the transport of bulk feed or feed ingredients, could have been the source of introduction of SECD viruses into the United States, as well as contributing to their widespread introduction onto individual farms all over the country.[3]

In Canada, the initial investigation of the outbreak by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) led to the hypothesis that swine feed containing imported spray-dried porcine plasma (SDPP) was a possible route of introduction of PEDV in swine herds,[4] and polymerase chain reaction (PCR) testing revealed that the feed and SDPP both contained PEDV genetic material.[5] As part of its mandate to safeguard the food supply and the plant and animal resource base in Canada, including the assurance that livestock feed sold in Canada is safe and effective, the Canadian Food Inspection Agency (CFIA) conducted a feed investigation. The aim of the study presented here was to assess the weight of the evidence gathered during the feed investigation and to determine whether swine feed or feed ingredients were linked to cases of PED in Canadian swine herds.

Material and methods

A positive case herd was defined as a Canadian swine herd with laboratory confirmation of PEDV in pigs reported between January 22 and March 7, 2014. Secondary cases, which were attributed to a direct or indirect contact with another case farm, were excluded from the investigation.

Trace-back and trace-forward activities were conducted to determine the origin of the feed and its ingredients, to determine where the feed was distributed, and to ensure that

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other possibly contaminated products were identified. Case-herd owners were questioned on the feed or feed ingredients that were used on their farm during the 2 weeks prior to the onset of clinical disease. A distribution list was obtained from the distributor of the feed containing the imported PEDV-positive SDPP, and all farms that had received this feed were contacted. Additional lines of inquiry related to swine by-products, such as dried porcine solubles, spray-dried porcine red blood cells, and SDPP manufactured at other plants, as well as other feeds manufactured in the same time period as the feed containing the contaminated SDPP, were also investigated by the CFIA.

Confirmatory testing of the feed and SDPP was conducted at the National Centre for Foreign Animal Disease as described in Pasick et al.[6] Briefly, PEDV N gene real-time reverse transcription-polymerase chain reaction (RT-PCR), PEDV N and S gene conventional RT-PCR, and gene sequencing were conducted following nucleic acid extraction. In addition, naive piglets were inoculated with the samples in a swine bioassay experiment to determine whether the detection of genetic material corresponded with the presence of live virus.

The weight of the evidence linking the feed to cases of PED was assessed in a framework developed in Canada for the investigation of foodborne illness outbreaks.[7] The weight of the evidence gathered during the investigation was evaluated for the following criteria: consistency of the laboratory results with the epidemiological evidence, consistency of temporal and (or) spatial clustering of cases with the availability and distribution of the feed, temporal association between feed consumption and disease, strength of the statistical association between the feed and the disease, whether a single specific feed appeared to be the vehicle of infection, and whether the strength of the association increased with increasing consumption of the feed (dose response). A literature review was conducted to evaluate the plausibility that the feed pellets containing contaminated SDPP were the vehicle of infection. Finally, alternate explanations were considered. The proportion of positive cases exposed to the feed was compared, using exact probability testing, to the proportion expected to be exposed, on the basis of market-share estimates. Attack rates were computed as the number of cases divided by the size of the population exposed.

Results

This study covers the initial period of the 2014 Canadian outbreak of PED, which started in a swine herd in southwestern Ontario. During the period of the investigation, a total of 27 cases of PED were confirmed in Ontario, but spread to the rest of the country was limited. Only three cases were reported outside of the province: one case each in Manitoba, Prince Edward Island (PEI), and Quebec.

Laboratory evidence. It was discovered early on in the investigation of the outbreak by the OMAFRA that a single feed company delivered creep or nursery feeds to many of the case herds investigated. Samples from these feeds and from one lot of imported SDPP used as a feed ingredient were positive for PEDV on RT-PCR testing.[4] Confirmatory molecular diagnostic testing and swine bioassay studies demonstrated that the SDPP, but not the feed, did contain PEDV capable of infecting inoculated piglets, as well as transmitting the infection to contact piglets.[6]

Space and time consistency. Clinical signs at the index farm started on January 21, 2014, one week after the feed containing PEDV-positive SDPP was delivered to that facility. Pigs had consumed feed containing the PEDV-positive SDPP on 60% of the case herds (Ontario, n = 17; PEI, n = 1) (Figure 1).

Approximately 288 tonnes of the feed containing the PEDV-positive SDPP was distributed from January 3 to February 9, 2014, when it was voluntarily withdrawn from the market by the manufacturer. The SDPP was manufactured in the United States in November 2013, imported to Canada in December 2013, and used in the manufacture of three lines of pelleted swine nursery (piglet) feed by a third-party manufacturer in Canada. The feed contained no other ingredient of porcine origin. The feed was delivered to 84 farms, located primarily in Ontario (n = 75), but also in Alberta (n = 3), Manitoba (n = 5), and PEI (n = 1). For 20 of the farms it was not possible to confirm whether the feed had been consumed.

Strength of the association. The attack rate for the cohort of 84 exposed farms in which pigs presumably consumed the feed was 21.4% (18 of 84). Considering only farms where the consumption of feed was confirmed, the attack rate was 28.1% (18 of 64). The attack rate for unexposed farms was estimated at 0.17% (12 cases for approximately 7000 hog farms in Canada).

In Ontario, cases of PED were significantly more likely (exact binomial probability test; $P < .001$) to have been exposed to the feed (17 of 27; 63.0%) than expected from the 10% to 15% market share reported by the distributor.

Specificity. The attack rates were similar for the three different lines of feed that were manufactured using the PEDV-positive SDPP. Other products not containing SDPP were produced in the same feed mill during January and February 2014; these feeds were not linked to cases of PED.

Dose response. Each line of the feed was available in different SDPP concentrations. The attack rates were higher for the farms that received feed containing higher concentrations of SDPP (Figure 2). The risk of disease was significantly higher (relative risk = 9.0; 95% confidence interval 1.3-64.0) on farms that received feed containing high SDPP concentrations (3% to 6%) than on farms that received only feed containing low SDPP concentrations (1.0% to 1.5%). The PEI case farm was the only one of the nine exposed farms outside of Ontario that became infected; it was also the only farm outside of Ontario which received feed with an SDPP inclusion rate of 3% or more.

Alternate explanations. Investigation of the initial cases by the provincial authorities found no association with other exposures, such as feed transporters, service providers, a rendering company, or livestock haulers. Environmental contamination with PEDV was discovered at a major assembly yard in Ontario, but it was not possible to determine whether this contamination preceded the initial cases of PEDV infection in Ontario.[4]

Discussion

There was a good temporal and geographical correlation between cases and distribution of the feed; timing of the cases was also consistent with the incubation period of the disease. A single lot of SDPP was identified as the vehicle of infection, and the proportion of cases that were exposed to feed containing this SDPP was significantly higher than expected, based on market share. The attack rate calculated for the exposed farms was significantly higher than the attack rate estimated for unexposed farms. The strength

Figure1: Number of Canadian swine herds with confirmed cases of porcine epidemic diarrhea (PED) between 22 January and 7 March, 2014, by epidemiological week of onset of clinical signs (n = 30). Pigs in herds indicated in red consumed feed containing a specific lot of PEDV-positive (PEDV+) SDPP, whereas pigs in herds indicated in blue consumed feed that did not contain SDPP, or that contained PEDV-negative (PEDV-) SDPP. The feed containing the PEDV+ SDPP was voluntarily withdrawn from the market by the manufacturer on February 9, 2014. For nine of 15 farms that did not receive feed containing the specific SDPP lot, clinical signs were absent (n = 3) or the date of onset of clinical signs was missing (n = 6) and was replaced by the date of laboratory confirmation. PEDV = porcine epidemic diarrhea virus; SDPP = spray-dried porcine plasma; VMW = voluntary market withdrawal of the feed containing the specific lot of PEDV+ SDPP.

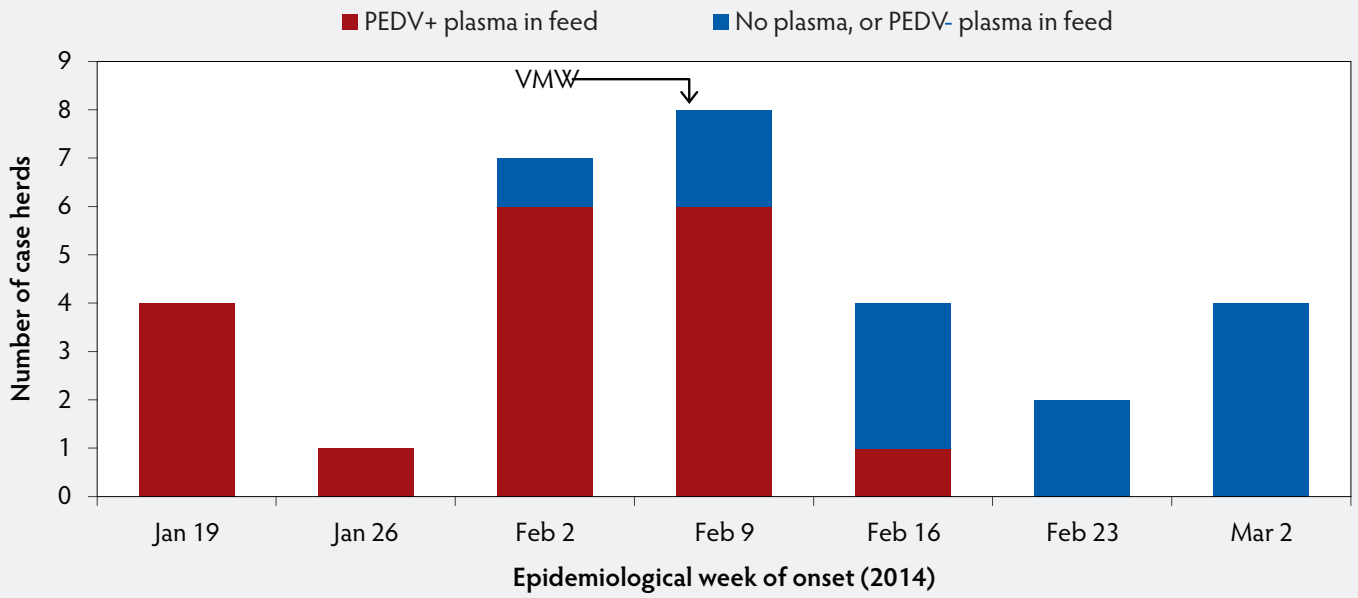
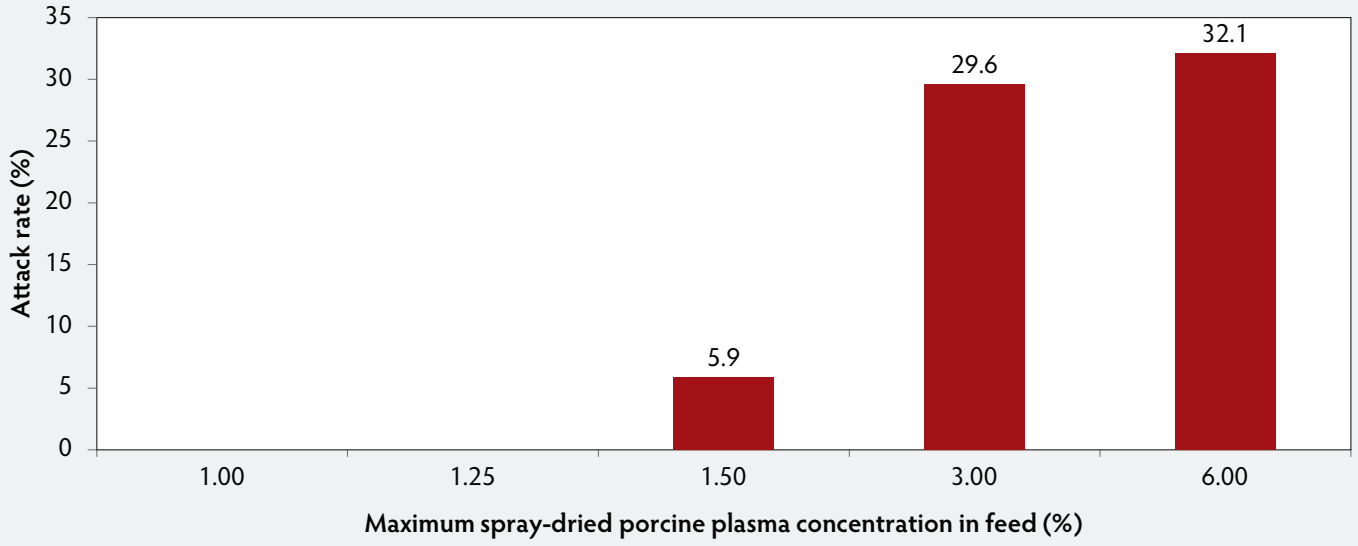


Figure 2: Attack rates for PED increased with increasing concentration of SDPP in feed for the cohort of 84 exposed Canadian swine herds. The risk of disease was significantly higher (RR = 9.0; 95% CI, 1.3-64.0) on farms that received feed containing high SDPP concentrations (3% to 6%; n = 55) compared to farms that received only feed containing low SDPP concentrations (1% to 1.5%; n = 29). 95% CI = 95% confidence interval; PED = porcine epidemic diarrhea ; RR = relative risk; SDPP = spray-dried porcine plasma.



of the association increased with increasing concentration of SDPP in feed, but this could have been confounded by the fact that the concentration of SDPP in nursery feed is typically higher for younger piglets, which are also more susceptible to PEDV infection than older pigs. The laboratory results confirmed the presence of live PEDV in the SDPP, but not in the feed.[6] This is compatible with infectious PEDV being present in the feed at very low concentrations, thereby causing infection on a few farms when fed to thousands of pigs for many consecutive days, but not in limited bioassay studies (low-dose, single-hit concept of infection; multiple repeated exposures).

On the other hand, there is evidence that the spray-drying process is effective at inactivating PEDV[8-10] as well as other viruses, such as the porcine reproductive and respiratory syndrome (PRRS) virus, pseudorabies virus,[11] and porcine circovirus (PCV2), which is one of the most resistant porcine viruses.[12,13] Good manufacturing practices, which include collection of blood only from animals fit for slaughter for human consumption, a closed system, cleaning and disinfection of holding tanks and equipment, and monitoring of the parameters of the spray-drying process, are in place to ensure that commercial SDPP is a safe product.[14] Nevertheless, a breach in good manufacturing practices and (or) biosecurity could potentially lead to cross-contamination during processing, and (or) post processing during packaging, storage, and (or) transportation.[15] A recent study[16] described outbreaks of PED that appeared to be linked to contaminated feed (not containing any animal by-products) on three different farms, and it provided proof of concept that feed can serve as a vehicle for PEDV infection of naive piglets. It is unknown whether contaminated flexible intermediate bulk containers could have played a role in this outbreak, but one would have then expected PED cases to be associated with a greater diversity of feed or feed ingredients, as appears to have been the case in the early cases the United States.[3]

While many questions remain regarding the plausibility or the importance of PEDV transmission through spray-dried porcine plasma or swine feed in the epidemiology of the disease, the weight of the evidence gathered during this outbreak supports that this first Canadian outbreak of PED was associated with swine feed containing a contaminated lot of SDPP.

The potential for PEDV contamination of SDPP or swine feed to occur at any point throughout the production and distribution chain needs to be investigated further in order to evaluate the importance of PEDV transmission via feed in the epidemiology of the disease.

Implications

- A systematic framework developed for the investigation of foodborne illness outbreaks can be used to assess the weight of evidence gathered during a feed investigation.
- It is possible for swine feed containing spray-dried porcine plasma (SDPP) contaminated with PEDV to be linked to clinical cases of porcine epidemic diarrhea, especially when the SDPP concentration in feed is ≥ 3%.
- Research is needed to elucidate the conditions under which swine feed or feed ingredients can become contaminated with PEDV and other swine pathogens, and potentially introduce new agents of disease into naive swine herds.

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Conflict of interest

None reported.

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References

1. Pensaert MB, Yeo S-G. Porcine epidemic diarrhea. In: Straw BE, Zimmerman JJ, D'Allaire S, Taylor DJ, eds. *Diseases of Swine*. Ames, Iowa: Wiley-Blackwell; 2006:367–372.

2. Huang Y-W, Dickerman AW, Piñeyro P, Li L, Fang L, Kiehne R, Opriessnig T, Meng X-J. Origin, evolution, and genotyping of emergent porcine epidemic diarrhea virus strains in the United States. *mBio.* 2013;4:e00737-00713.

3. Scott A, McCluskey B, Brown-Reid M, Grear D, Pitcher P, Ramos G, Spencer D, Singrey A. Porcine epidemic diarrhea virus introduction into the United States: Root cause investigation. *Prev Vet Med.* 2016;123:192–201.

4. Pasma T, Furness MC, Alves D, Aubry P. Outbreak investigation of porcine epidemic diarrhea in swine in Ontario. *Can Vet J.* 2016;57:84–89.

5. Kochhar HS. Canada: Porcine epidemic diarrhea in Canada: an emerging disease case study. *Can Vet J.* 2014;55:1048–1049.

6. Pasick J, Berhane Y, Ojkic D, Maxie G, Embury-Hyatt C, Swekla K, Handel K, Fairles J, Alexandersen S. Investigation into the role of potentially contaminated feed as a source of the first detected outbreaks of porcine epidemic diarrhea in Canada. *Transbound Emerg Dis.* 2014;61:397–410.

7. Health Canada. Weight of Evidence: Factors to Consider for Appropriate and Timely Action in a Foodborne Illness Outbreak Investigation. Ottawa, Ontario: Minister of Health; 2011.

8. Gerber PF, Xiao C-T, Chen Q, Zhang J, Halbur PG, Opriessnig T. The spray-drying process is sufficient to inactivate infectious porcine epidemic diarrhea virus in plasma. *Vet Microbiol.* 2014;174:86–92.

9. Opriessnig T, Xiao C-T, Gerber PF, Zhang J, Halbur PG. Porcine epidemic diarrhea virus RNA present in commercial spray-dried porcine plasma is not infectious to naïve pigs. *PLoS One.* 2014;9(8):e104766.

10. Pujols J, Segalés J. Survivability of porcine epidemic diarrhea virus (PEDV) in bovine plasma submitted to spray drying processing and held at different time by temperature storage conditions. *Vet Microbiol.* 2014;174:427–432.

11. Polo J, Quigley JD, Russell LE, Campbell JM, Pujols J, Lukert PD. Efficacy of spray-drying to reduce infectivity of pseudorabies and porcine reproductive and respiratory syndrome (PRRS) viruses and seroconversion in pigs fed diets containing spray-dried animal plasma. *J Anim Sci.* 2005;83:1933–1938.

12. Pujols J, López-Soria S, Segalés J, Fort M, Sibila M, Rosell R, Solanes D, Russell L, Campbell J, Crenshaw J, Weaver E, Polo J. Lack of transmission of porcine circovirus type 2 to weanling pigs by feeding them spray-dried porcine plasma. *Vet Rec.* 2008;163:536–538.

13. Shen HG, Schalk S, Halbur PG, Campbell JM, Russell LE, Opriessnig T. Commercially produced spray-dried porcine plasma contains increased concentrations of porcine circovirus type 2 DNA but does not transmit porcine circovirus type 2 when fed to naïve pigs. *J Anim Sci.* 2011;89:1930–1938.

14. Pérez-Bosque A, Polo J, Torrallardona D. Spray dried plasma as an alternative to antibiotics in piglet feeds, mode of action and biosafety. *Porcine Health Management*. 2016;2:16.

15. EA Panel. Scientific Opinion on porcine epidemic diarrhoea and emerging porcine deltacoronavirus. *EFSA Journal.* 2014;12:3877.

16. Dee S, Clement T, Schelkopf A, Nerem J, Knudsen D, Hennings J, Nelson E. An evaluation of contaminated complete feed as a vehicle for porcine epidemic diarrhea virus infection of naïve pigs following consumption via natural-feeding behavior: proof of concept. *BMC Vet Res.* 2014;10:176. doi: 10.1186/s12917-014-0176-9.

Peer reviewed

Practice tip

Fact sheet – Feed efficiency adjustments to compare group close-outs in finishing pigs

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FACT Sheet: Feed efficiency adjustments to compare group close-outs in finishing pigs

Feed efficiency adjustments in finishing close-outs

Initial and final body weight (BW) are major factors affecting feed-to-gain ratio (F:G), because fat deposition is less efficient than protein deposition, and the rate of fat deposition increases relative to protein deposition as BW increases.[1] A 1% increase in dietary net energy (NE) results in a 1% improvement in feed efficiency as long as NE loading values of the ingredients in the diet are correct.[2] This assumes dietary lysine is not limiting, according to NRC requirements.[1]

Equations accounting for factors affecting F:G

Equation (1)[3] accounts for initial and final BW:

> Adjusted F:G = observed F:G + [standardized initial BW (kg) – actual initial BW (kg)] × slope estimate + [standardized final BW (kg) – actual final BW (kg)] × slope estimate

Equation (2)[4] accounts for initial and final BW and energy level of the diet:

> Adjusted F:G = observed F:G + [standardized initial BW (kg) – actual initial BW (kg)] × slope estimate + [standardized final BW (kg) – actual final BW (kg)] × slope estimate – [(standardized energy level – actual energy level) ÷ standardized energy level) × observed F:G]

The slope estimate varies with energy level of the diet and genetic line,[5,6] and slope estimates per kg BW range from 0.007 to 0.011.[5,6] Use caution when applying these slope estimates to other genetic lines that have different body composition or growth curves.

Equation (3)[7] accounts for NE, average BW, and standardized ileal digestible (SID) lysine (Lys). This equation predicts F:G and then is modified to calculate an adjusted F:G that is based on the observed F:G.

> F:G prediction = 1 ÷ [(0.000004365 × NE) – (0.00162 × average BW) – (0.08023 × SID Lys) + (0.000094 × NE × SID Lys) + 0.3496]

> Adjusted F:G = (F:G from Equation 3 using standardized values) ÷ (F:G from Equation 3 using actual values) × observed F:G

where NE is the weighted average kcal of NE per kg. Average BW (kg) is the average of initial and final BW, and SID Lys (%) is the weighted average SID Lys. The NE and SID Lys are weighted on the basis of the amount of feed in each phase during the finishing period. This equation encompasses a range of BW from 20.8 to 138.2 kg. Information regarding NE of ingredients can be found in NRC's *Nutrient Requirements of Swine*.[1]

Other factors to consider when adjusting for F:G. The impact of mortality on F:G can be calculated by using the average day in which the mortality occurred in the close-out. If mortality is assumed to occur at the mid-point of the finishing phase, for every 1% increase in mortality, F:G will be poorer by 0.5% to 0.8%.[8] Pelleting improves F:G by about 4% to 6% for pelleted diets with less than 20% fines.[4] Feed efficiency will be poorer by 0.002857 for each 1% fines in the pelleted diet.[9] Grain particle size improves F:G by 1.0% to 1.2%[10] for each 100-micron reduction from 900 to 500 microns. Gilts have approximately 1.7% better F:G than mixed gender, whereas barrows have 1.7% poorer F:G than mixed gender.[1] Ractopamine fed for 21 days prior to market decreases finisher F:G by 1.8% for 5 ppm (5 g per tonne) inclusion and 3.4% for 10 ppm (10 g per tonne) inclusion, in a summary of 12 experiments.[11] In a meta-analysis of 10 studies,[12] F:G in immunocastrated barrows was 4% lower than in surgically castrated barrows for the whole finishing phase. The meta-analyses included only data from studies with animals slaughtered between 4 and 6 weeks after the second immunization (market weight, 107 to 110 kg). The F:G advantage would be expected to be less if animals were slaughtered more than 6 weeks after the second immunization.

Examples of differences in F:G adjustment that are based on the change of a single factor from the baseline system values are shown in Table 1, using a feed efficiency adjustment calculator. For example, when comparing two close-outs with similar observed F:G, if one was fed a diet with higher energy, the adjusted F:G would be poorer than the observed F:G, reflecting the way that group would have performed if the pigs had received diets containing the same amount of dietary energy as the lower energy group.

These adjustments are useful because they account for the various known factors that affect F:G and that are normally present in production systems. A feed efficiency adjustment calculator that accounts for these factors can be found at **http://www.asi.k-state.edu/research-and-extension/swine/calculators.html**.

Fast facts

Feed efficiency of group close-outs can be compared after adjusting for known factors that can influence it.

Body weight, dietary energy and lysine, grain particle size, immunocastration, mortality, pelleting, ractopamine, and gender are major factors affecting feed efficiency, and thus adjusting for them can produce more meaningful benchmark comparisons.

Feed efficiency is typically defined as feed-to-gain ratio (F:G). Feed-to-gain is not always related to profit, but is a useful metric in benchmarking group close-outs, especially within a production system. In order to evaluate F:G across group close-outs, adjustment factors can be used to account for known sources of variation.

Table 1: Feed efficiency adjustment simulations for different factors in a barn close-out, accounting for mortality and pelleting[7]

Parameters	Baseline	Entry weight	Final weight	Dietary energy	Mortality	Pelleting	Gender
Observed F:G	2.90	2.90	2.90	2.90	2.90	2.90	2.90
Initial weight (kg)	22	25	22	22	22	22	22
Final weight (kg)	130	130	135	130	130	130	130
Weighted SID Lys (%)	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Weighted energy (kcal) NE/kg	2527	2527	2527	2653	2527	2527	2527
Mortality (%)*	2.5	2.5	2.5	2.5	7.5	2.5	2.5
Average mortality (dpp)	60	60	60	60	60	60	60
Pelleting (Yes or No)†	No	No	No	No	No	Yes	No
If pelleted (% fines)†	0	0	0	0	0	20	0
Gender‡	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Barrows
Adjusted F:G§	NA	2.88	2.87	2.98	2.77	3.10	2.85

* Assumed impact of mortality over the baseline F:G.
† Assumed to reduce F:G by 5% when diets were in pellet form, increase F:G by 0.002857 for each 1% fines in the pelleted diet.
‡ Assumed that F:G in barrows is approximately 1.7% lower than mixed gender based on NRC[1] model.
§ Developed using Equation 3: 1 ÷ [(0.000004365 × NE) – (0.00162 × Average BW) – (0.08023 × SID Lys) + (0.000094 × NE × SID Lys) + 0.3496]. Then, adjusted F:G = (F:G from Equation 3 using standardized values) ÷ (F:G from Equation 3 using actual values) × observed F:G. The range of BW that this equation encompasses is 20.8 to 138.2 kg.
F:G = feed-to-gain ratio; SID Lys = standardized ileal digestible lysine; NE = net energy; dpp = days post placement; NA = not applicable.

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References

1. National Research Council. Models for estimating nutrient requirements of swine. In: *Nutrient Requirements of Swine*. 11th rev ed. Washington, DC: National Academy Press; 2012:127–156.

*2. Euken RM. Swine feed efficiency: Effect of dietary energy on feed efficiency. Kansas State Research and Extension. 2012. Available at **http://www.swinefeedefficiency.com/factsheets/IPIC25i%20SFE%20effect%20of%20dietary%20energy%20on%20efficiency.pdf**. Accessed 5 December 2016.

*3. Goodband RD, Tokach MD, Dritz SS, DeRouchey JM, Nelssen JL. Feeding and feeder management influences on feed efficiency. *Proc Allen D. Leman Swine Conf, Nutrition Workshop: Focus on Feeding Efficiency*. St Paul, Minnesota. 2008;20–27.

4. Gaines AM, Peterson BA, Mendoza OF. Herd management factors that influence whole herd feed efficiency. In: Patience J, ed. *Feed Efficiency in Swine*. Wageningen, The Netherlands: Wageningen Academic Publishers; 2012:15–39.

*5. Jungst S, Matthews N, Booher C, Fields B, Dreadin T, Tabor S, Anderson J, Martin J, Williams A, Jobin M, Sosnicki A, Wilson E. Growth curves for PIC327L sired pigs fed diets with differing energy levels. PIC Tech Memo. Hendersonville, Tennessee. 2010;ES50–344. Available at **http://www.pic.com/Images/Users/1/SalesPortal/ExcecutiveSummaries/ES050.pdf**. Accessed 14 December 2016.

*6. Jungst S, Matthews N, Booher C, Fields B, Dreadin T, Tabor S, Anderson J, Martin J, Williams A, Jobin M, Sosnicki A, Wilson E. Growth curves for commercial PIC337RG pigs fed high and low energy diets. PIC Tech Memo. Hendersonville, Tennessee. 2010;ES51–344. Available at **http://www.pic.com/Images/Users/1/SalesPortal/ExcecutiveSummaries/ES051.pdf**. Accessed 14 December 2016.

7. Nitikanchana S, Dritz SS, Tokach MD, DeRouchey JM, Goodband RD, White BJ. Regression analysis to predict growth performance from dietary net energy in growing-finishing pigs. *J Anim Sci.* 2015;93:2826–2839.

8. Tokach MD, Goodband RD, DeRouchey JM, Dritz SS, Nelssen JL. Feeding and barn management strategies that maximize feed efficiency. In: Patience J, ed. *Feed Efficiency in Swine*. Wageningen, The Netherlands: Wageningen Academic Publishers; 2012:41–62.

9. De Jong J. Swine. Calculators. Feed efficiency evaluator for finishing pigs. Available at **www.ksuswine.org**. Accessed 5 December 2016.

*10. Steinhart TL. Swine feed efficiency: Influence of particle size. 2012. Available at **http://www.swinefeedefficiency.com/factsheets/IPIC25d%20SFE%20Influence%20of%20Particle%20Size.pdf**. Accessed 5 December 2016.

*11. Kelly JA, Tokach MD, Dritz SS. Weekly growth and carcass response to feeding ractopamine (Paylean). *Proc AASV*. Orlando, Florida. 2003:51–58.

12. Dunshea FR, Allison JRD, Bertram M, Boler DD, Brossard L, Campbell R, Crane JP, Hennessy DP, Huber L, de Lange C, Ferguson N, Matzat P, McKeith F, Moraes PJU, Noblet J, Quiniou N, Tokach M. The effect of immunization against GnRF on nutrient requirements of male pigs: A review. *Animal.* 2013;7:1769–1778.

* Non-refereed references.

PRACTICE TIP

PEER REVIEWED

Fact sheet – Ingredient database management for swine: phosphorus

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FACT Sheet: Ingredient database management for swine: phosphorus

Phosphorus (P) is an inorganic element that is important for development and maintenance of the skeletal system.[1] Diets formulated with excess P can have a negative impact on the environment due to increased P excretion.[2] This fact sheet will briefly explain the different ways that P can be expressed, how to assign a phosphorus (P) value to an ingredient, and the effects of naturally occurring phytase and diet form on P digestibility. Phosphorus can be expressed as total or bioavailable.

Total P

Total P represents all P that the ingredient contains, including the non-available P, which is mostly bound in phytic acid and represents 60% to 75% of the total P in cereal grains and oilseed meals.[1,3] A limitation to using total P in diet formulation is that it provides no information on the amount of P that is available to the pig. Thus, the diet can appear to be adequate for total P, but may not actually meet the pig's requirement. Total P also does not place any value on exogenous or endogenous phytase.

Bioavailable P

Bioavailable P is the proportion of P that can be absorbed and available for use or storage.[4] The most common methods to estimate P bioavailability are the slope-ratio assay and digestibility experiments. The slope-ratio assay method theoretically estimates the digestible plus post-absorptive utilization of P at the tissue level and is known as available P (AvP), whereas digestibility experiments measure only digestible utilization, known as digestible P.[5]

Available P. In the slope-ratio assay method, linear regression is fitted to the response criterion (eg, growth performance or bone ash) for each set of titrated diets (new versus inorganic standard ingredient) and the slope of the equation from the ingredient is divided by the slope from the inorganic standard. The drawbacks of the slope-ratio assay method[1,5] are mainly assumption that the inorganic standard is 100% bioavailable, thus it is important to use the same standard for all ingredients; dependence on the response criterion used (bone ash versus P retention); and relatively high cost to perform. As there are no inorganic P sources that are 100% bioavailable, it is important to note that the values obtained using this methodology are relative bioavailability of the reference ingredients rather than true bioavailability. Thus, diets formulated on an available P basis may overestimate the true P being utilized.

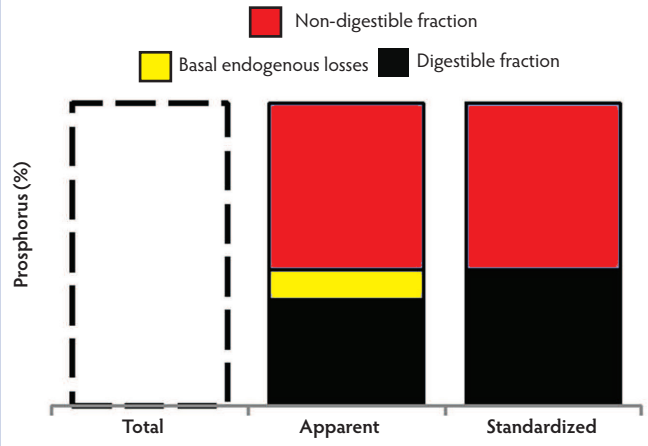
Digestible P. Digestible P can be expressed as apparent total tract digestible (ATTD) P or standardized total tract digestible (STTD) P. The difference between ATTD P and STTD P is that STTD P corrects for basal endogenous P losses (Figure 1). The concept of STTD P is similar to the concept of standardized ileal digestible amino acids, because there is no net P absorption or secretion in the large intestine.[1] The main drawback of the ATTD P method is that it underestimates the true amount of digestible P, because it does not account for basal endogenous losses. Basal endogenous losses account for approximately 25.6% of the animal's daily P requirement;[5] therefore, expressing P on an STTD basis is more accurate than expressing it on an ATTD basis. After correcting for basal endogenous losses, STTD is additive for diet formulation, resulting in a more appropriate estimation of the digestible P concentration in the diet.

Fast facts

Defining available phosphorus (P) for ingredients is expensive and requires a growth assay and bone-sample collection. An alternative, standardized total tract digestible (STTD) P, is less expensive to perform since it requires only feed- and fecal-sample evaluation for P.

Formulating diets on an STTD P basis is more accurate than using total tract digestible P because STTD P accounts for basal endogenous gastrointestinal tract losses. Thus, the STTD P is additive when combining different ingredients used for diet formulation.

Figure 1: Total, apparent digestible, and standardized digestible phosphorus (P) and their respective fractions.



How to assign P diet formulation values to a new ingredient

To assign or update a P ingredient value, two steps are needed.

Analyze the ingredient samples for total P. This step is simple and low cost and requires only a total P analysis of the ingredient.

Assign a digestibility value. Different databases in the literature express P on different bases (Table 1). One approach is to search for information in the scientific literature for estimates of a P digestibility. If the unknown new ingredient has similar characteristics, such as

Table 1: Comparison of phosphorus availability and digestibility percentages from different sources

	NRC (1998)[6]	NRC (2012)[1]		EvaPig[7]
Ingredient	Availability (%)	ATTD (%)	STTD (%)	ATTD (%)
Corn	14	26	34	28
Soybean meal	23	39	48	32

ATTD = apparent total tract digestibility; STTD = standardized total tract digestibility.

processing method or amount of phytate, this would be a reasonable starting point. Thus, for an unknown new ingredient, unless a digestibility trial is conducted, the nutritionist should use values from the most similar ingredient listed in published information. Another option would be to use the chemical analysis provided by the supplier. Finally, if no reference ingredient is available, one software program uses a default apparent P digestibility value of 20%.[7]

What is the impact of naturally occurring phytase and diet form on P digestibility?

Naturally occurring phytase (also known as endogenous dietary phytase) influences the P digestibility of some ingredients, such as wheat and wheat by-products.[1,6] However, pelleting can inactivate the naturally occurring phytase in these ingredients.[1,6] For example, apparent P digestibility in wheat middlings is 50% in mash diets, but only 25% in pelleted diets. Naturally occurring phytase is assumed to have an additive effect with exogenous phytase.[6] In pelleted diets, only exogenous phytase contributes to P release, assuming the exogenous phytase is heat stable or applied post pelleting.[6] EvaPig accounts for naturally occurring phytase and the impact of diet form on P digestibility.[7] Even though NRC (2012)[1] acknowledges the effects of naturally occurring phytase in wheat and its by-products and the negative effects of pelleting on endogenous dietary phytase, no adjustments are made in the ingredient values of NRC to account for these factors. Brief reviews about phytase and comparing different sources have been provided previously.[8,9]

Acknowledgement

Contribution no. 16-052-J from the Kansas Agricultural Experimental Station, Manhattan, KS 66506-0210.

References

1 . NRC. Minerals. In: *Nutrient Requirements of Swine*. 11th rev ed. Washington, DC: National Academy Press; 2012:74–103.

2. Kornegay ET, Harper AF. Environmental nutrition: Nutrient management strategies to reduce nutrient excretion of swine. *The Professional Animal Scientist*. 1997;13:99–111.

*3. Urriola PE, Shurson GC. Nutritional requirement for calcium, phosphorus, and vitamin D in pigs. *Proc Allen D. Leman Swine Conference*. St Paul, Minnesota. 2013;151–156.

4. Srinivasan VS. Bioavailability of nutrients: a practical approach to in vitro demonstration of the availability of nutrients in multivitamin-mineral combination products. *J Nutr*. 2001;131:1349–1350.

5. Shen Y, Fan MZ, Ajakaiye A, Archbold T. Use of the regression analysis technique to determine the true phosphorus digestibility and the endogenous phosphorus output associated with corn in growing pigs. *J Nutr*. 2002;132:1199–1206.

6. NRC. Minerals. In: *Nutrient Requirements of Swine*: 10th rev ed. Washington, DC: National Academy Press; 1998:47–70.

7. EvaPig. 2008. Evaluation of pigs feed. Reference manual. Available at **http://www.evapig.com/IMG/pdf/EvaPigManual-2.pdf**. Accessed 25 September 2016.

8. Gonçalves MAD, Dritz SS, Tokach MD, DeRouchey JM, Woodworth JC, Goodband RD. Fact sheets – comparing phytase sources for pigs and effects of superdosing phytase on growth performance of nursery and finishing pigs. *J Swine Health Prod*. 2016;24:97–101.

9. Jacela JY, DeRouchey JM, Tokach MD, Goodband RD, Nelssen JL, Renter DG, Dritz SS. Feed additives for swine: Fact sheets – high dietary levels of copper and zinc for young pigs, and phytase. *J Swine Health Prod*. 2010;18:87–91.

* Non-refereed reference.

Conversion tables

Weights and measures conversions

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

Temperature equivalents (approx)

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

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

Conversion chart, kg to lb (approx)

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

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

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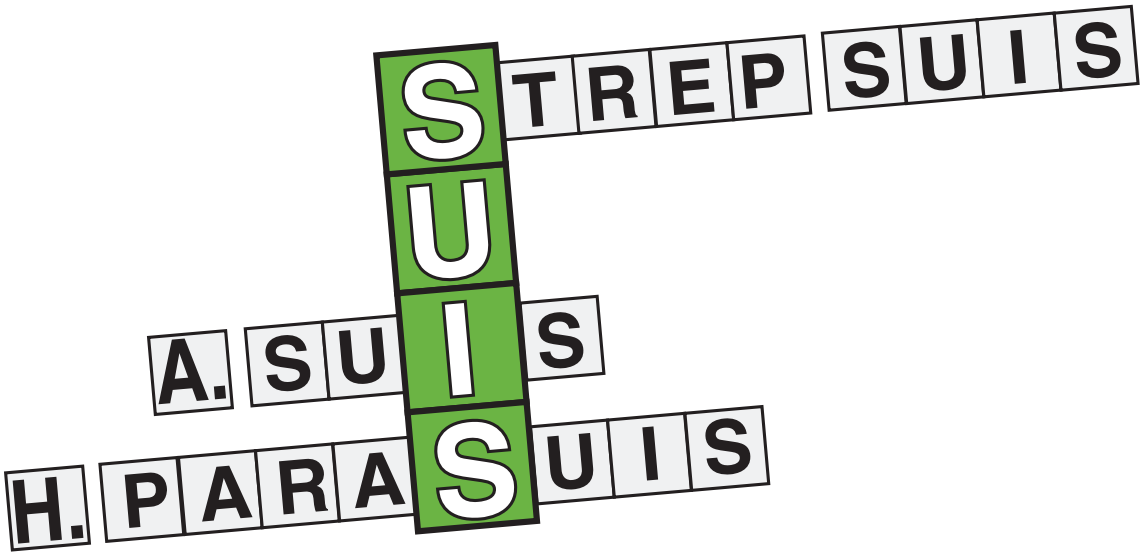

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Checkoff offers four educational modules to assist with the Common Swine Industry Audit

The Pork Checkoff is now offering four new educational modules to help producers prepare for the Common Swine Industry Audit and the PQA Plus Site Assessment. The modules are titled "Timely Euthanasia," "Standard Operating Procedures," "Willful Acts of Abuse," and "Medication and Treatment Records." Each module is about 10 minutes long and offers background information on the topic, goes over what auditors evaluate, and then asks producers to complete exercises to confirm their knowledge. Modules can be completed individually or as a series. The English-based modules are available on a flash drive, and the Spanish-based modules will be shortly, as well. Both are available via download at **www.pork.org/commonaudit**.

For more information, contact Jamee Amundsen at **JAmundsen@pork.org** or 515-223-3534.

Swine welfare symposium coming in November: Abstract-poster submission now open

The inaugural Pig Welfare Symposium will be held November 7 to 9, 2017, in Des Moines, Iowa. It will be a forum for sharing ideas, learning from other segments of the industry, and fostering dialogue on pig welfare-related issues. For those professionals and students interested in submitting abstracts for a technical poster presentation, please visit the symposium site at **www.pork.org/pws**. Students who submit also can chose to participate in a poster competition. All submissions are due by June 15, 2017.

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

Pig Welfare Symposium

Checkoff offers new Sow Housing Management Guides

Building upon its previous series on Sow Housing Options fact sheets, the Pork Checkoff has introduced a new series called "Sow Housing Management Guides." Six experts from various universities collectively wrote the six new booklets, each over 30 pages, which provide checklists and troubleshooting sections for in-depth practicality. The printed guides are in English and can be ordered free at **www.pork.org/porkstore**. The PDF versions are in English and Spanish and can be found at **www.pork.org/sowhousing**.

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

Protect your investment.

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

CAUTION: Federal law restricts medicated feed containing this veterinary feed directive (VFD) drug to use by or on the order of a licensed veterinarian.

The label contains complete use information, including cautions and warnings. Always read, understand and follow the label and use directions. Feeds containing tilmicosin must be withdrawn 7 days prior to slaughter.

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AASV NEWS

AASV Annual Meeting Proceedings online

As of February 13, the proceedings of the 2017 AASV Annual Meeting are available at **www.aasv.org/annmtg/proceedings** for members to download to their computers and mobile devices.

You'll find the proceedings available in the following formats:

- The "big book" of all the regular session papers in a single PDF file with a linked table of contents,
- Seminar booklets: a PDF file for each seminar,
- Offline Web app to provide searchable access to papers on your desktop, laptop, tablet, or other mobile device (similar format to the CD ROM we provided in the past),
- Individual papers in the Swine Information Library (**https://www.aasv.org/library/swineinfo/**).

To access, make sure your AASV membership has been renewed for 2017. You'll need your AASV Web site username and password to log in – if they're not handy, contact the AASV office or use the "Reset Password" link in the upper right of the AASV Web site (**www.aasv.org**) to have them e-mailed to you.

www.aasv.org/annmtg/proceedings

Understanding the VFD and potential liability risks

Any veterinarian who treats food animals must be familiar with the new Veterinary Feed Directive (VFD) rules and product labels. With these changes in marketing status, some veterinarians are concerned about potential liability. Widespread, significantly increased liability is not foreseen (source: AVMA PLIT Risk Awareness Alert, Fall 2016).

Veterinarians make therapeutic product selection decisions on a daily basis in their practices, and potential liability for such decision-making in a healthcare context is a fact of life. To reduce your risk, remember some of the basic risk- mitigation steps that are applicable any time a veterinarian is involved in the diagnosis and treatment of patients. Issue orders, prescriptions, or VFDs, in the context of a veterinarian-client-patient relationship (VCPR) as required by federal and (or) state authorities where you are licensed. Maintain clear and complete records supporting your diagnosis, treatment decisions, and the establishment of a VCPR. Fill out prescription or VFD orders correctly and accurately.

Because extra-label use of VFD drugs is not authorized under the Federal Food Drug and Cosmetic Act, VFDs must be in compliance with the product label. Using an electronic VFD service is a good way to reduce the potential for authorizing a VFD in a manner inconsistent with the label. Failure to write VFDs in compliance with the product label will weaken the defense of a veterinarian in litigation or before a state board of veterinary medicine. For those who treat minor species, FDA is aware of the paucity of available therapeutic drugs. The FDA is expected to provide a new Compliance Policy Guide (CPG) addressing the use of VFD drugs in minor species. Once this is finalized, veterinarians should follow the conditions set forth in the CPG when authorizing VFDs for minor species. The FDA issued this revised CPG on December 2, 2016, and it is available at **http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074659.htm**. For additional information about liability concerns with the VFD, visit the Fall 2016 issue of AVMA PLIT Risk Awareness Alert.

AASV news continued on page 85

AIVLOSIN®

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Now, **two routes** to ***Outstanding Results*** for the control of ileitis.

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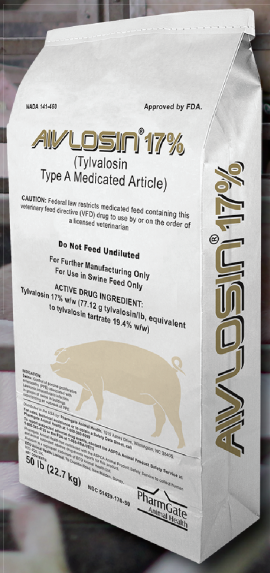

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*Judicious use per FDA *Guidance for Industry #209*, 2012.

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Important Safety Information: Available under VFD/prescription only. AIVLOSIN is indicated for the control of PPE caused by *Lawsonia intracellularis* in groups of swine in a house experiencing an outbreak of this disease. For use only in the drinking water or feed of pigs. Not for use in lactating or pregnant females, or males and females intended for breeding. People with known hypersensitivity to Tylvalosin Tartrate should avoid contact with this product. When used in accordance with label directions, no withdrawal period is required before slaughter for human consumption.

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PharmGate Animal Health

AASV news continued from page 83

VFD Accreditation Module posted

If it is time to renew your veterinary accreditation or you're just interested in learning a little more about the Veterinary Feed Directive (VFD), United States Department of Agriculture (USDA) recently posted online the 29th module of the USDA-Animal and Plant Health Inspection Service (APHIS) National Veterinary Accreditation Program (NVAP), entitled "Veterinary Feed Directive." This module was designed to familiarize accredited veterinarians with the recent updates to the VFD. The module can be found at the bottom of the NVAP page at **https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/nvap/ct_aast**. This training is targeted at the 65,000 US accredited veterinarians, but is free and available to anyone with internet access.

48th AASV Annual Meeting

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FOUNDATION NEWS

AASV Foundation announces new American College of Animal Welfare scholarship program

The AASV Foundation Board of Directors has approved a scholarship program for AASV members seeking Animal Welfare Board Certification from the American College of Animal Welfare (ACAW). The applicant must have either a DVM or VMD with at least 5 years of continuous membership in the AASV.

The applicant must provide a curriculum vitae, an ACAW-approved program plan, and three (3) letters of reference (one of which must come from the applicant's mentor). A selection committee will review and select awardees.

The scholarship will provide annual reimbursements for actual expenses related to the ACAW program. The expenses will include travel, course fees, and textbooks. Reimbursement will not cover lost income. Maximum amount of reimbursement will be $20,000. An incentive payment of $10,000 will be paid upon successful and timely completion of the ACAW Board Certification.

For more information, contact the AASV office: Tel: 515-465-5255; E-mail: **aasv@aasv.org**.

Swine externship grants available to veterinary students

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

Veterinary students who plan to complete an externship of at least 2 weeks' duration in a swine practice or a mixed practice with a considerable swine component may apply for the grant (university courses and paid internship programs do not qualify). Both the student and at least one member of the hosting practice must be members of the AASV.

In addition to student information, the grant application requests a letter from the hosting practice containing details of the planned externship. After the externship has been completed and the practice has confirmed the student's participation, the student submits a brief report of his or her experiences along with expense receipts to the AASV Foundation before the funds are disbursed.

The AASV maintains a searchable list of internship and externship opportunities for veterinary students at **https://www.aasv.org/internships/index.php**. Members who are willing to host veterinary students in their practice are encouraged to contact AASV with details.

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

AASV Foundation Fundraising AUCTION

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

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100 mg/mL Antimicrobial Injectable Solution

For Subcutaneous Use in Beef Cattle, Non-Lactating Dairy Cattle and Swine Only.
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.

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, Histophilus somni* and *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 *Histophilus somni* in beef and non-lactating dairy cattle.

Swine: Enroflox 100 is indicated for the treatment and control of swine respiratory disease (SRD) associated with *Actinobacillus pleuropneumoniae, Pasteurella multocida, Haemophilus parasuis* and *Streptococcus suis.*

RESIDUE WARNINGS:

Cattle: Animals intended for human consumption must not be slaughtered within 28 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 exposures. 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 1-866-591-5777.

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

ADVERSE REACTIONS: No adverse reactions were observed during clinical trials.

ANIMAL SAFETY:

In cattle safety studies, 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, inappetance 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. In swine safety studies, 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.

Norbrook Laboratories Limited,
Newry, BT35 6PU, Co. Down, Northern Ireland

I02 September 2016

Antibiotic use and stewardship

As you know, the new antibiotic use regulations governing Veterinary Feed Directive (VFD) drugs and water medications took effect on January 1. The US Food and Drug Administration (FDA) enacted these changes in the regulation to enhance the stewardship of antibiotic use in food-producing animals and place that use under the oversight of the veterinarian. This action will likely focus additional attention on veterinarians and their role in the antibiotic decision-making process.

The FDA worked with drug sponsors to eliminate uses for growth promotion that the agency deemed "injudicious." In addition, FDA modified the VFD as part of the agency's overall strategy to promote the judicious use of antimicrobials in food-producing animals. The modified VFD rule places the authorization of feed-grade antibiotics considered medically important in human medicine under the supervision of a licensed veterinarian. It is the goal of the FDA to restrict the use of these medications so that they are used only when medically necessary to ensure animal health.

With the removal of production claims from antibiotic labels, it is likely more scrutiny will be placed on prevention and control uses. The modified regulations place additional emphasis on the necessity of establishing and maintaining a valid veterinary-client-patient relationship. All of these efforts are an attempt to facilitate veterinary oversight and enhance the prudent use of antibiotics in food-producing animals. A key provision in the effort to promote antibiotic stewardship is our ability to justify the decision to use antibiotics, the products we choose, and the manner in which those drugs are used.

An important aspect of antibiotic stewardship is the ability to use injectable, water soluble, and human drugs in an extra-label manner. The Animal Medicinal Drug Use Clarification Act outlines the mechanism by which veterinarians can prescribe antibiotics for extra-label use. Under certain circumstances, veterinarians are allowed to use drugs in an extra-label manner. There are, however, some drugs for which extra-label use is further restricted or banned entirely. Two of these drugs approved for use in swine include the cephalosporins and fluoroquinolones (eg, ceftiofur and enrofloxacin, respectively).

"If we are to continue to be viewed as the appropriate stewards of antibiotic use, we must ensure that these drugs are used in a judicious manner for the prevention, control, and treatment of disease within the legal limitations placed on their use."

The extra-label use of the cephalosporins is limited to treating or controlling only those indications not included on the label. Cephalosporins may not be used for prevention of disease or in any manner (dose, duration, route of administration, etc) not specifically outlined on the label. The extra-label use of the fluoroquinolones is entirely prohibited. There is no legal justification for the extra-label use of fluoroquinolones. Also, remember, any extra-label use of feed-grade antibiotics remains illegal, even for veterinarians.

In addition to the extra-label use of antibiotics, veterinarians must ensure that all uses are necessary and justified to improve animal health, protect public health, and ensure food safety. If we are to continue to be viewed as the appropriate stewards of antibiotic use, we must ensure that these drugs are used in a judicious manner for the prevention, control, and treatment of disease within the legal limitations placed on their use.

Practices such as "routine use" and "pulse dosing" have come under additional scrutiny lately. The FDA responses to questions regarding these practices exhibit the agency's expectations that antibiotic use should be considered a temporary solution rather than a long-term fix. The agency has expressed its interpretation that routine use should be re-evaluated to determine the continued need for antibiotics and that pulse dosing may not meet the intent of product approvals and labeling. In addition, the agency has raised concerns regarding the duration of use of some products which may have no specified duration of use on the label or are labeled for "continuous" use. Additional restrictions may be placed on products regarding duration of use claims or the establishment of labels defining duration of use in cases where none currently exists.

Unfortunately, determining judicious use and differentiating prevention or control is often easier said than done. There is a large grey area open for interpretation in these terms. Thus, it comes down to veterinary experience and training – the so called "art of practice." First and foremost, veterinarians are the stewards of the health of the animals under our care and the promotion of public health.

Veterinarians are forced to balance animal health, public health, ethical use, economics, food safety, regulation, market challenges, and consumer perception. Having that many masters makes the task exceedingly difficult. The AASV continues to work with pork producers, researchers, allied veterinary organizations, drug sponsors, and the FDA to ensure the continued availability of antibiotics and to promote the appropriate and legal use of these products for animal health and public safety.

Harry Snelson, DVM
Director of Communications

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- Kills not only adult worms, but also the important larvae, including tunneling L2 and L3 whipworm and migrating L3 roundworm larvae.
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- Easy convenient individual sow daily dosing.
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F100012055 SAFE-GUARD® EZ-SCOOP® 1.8%
10 lb pail

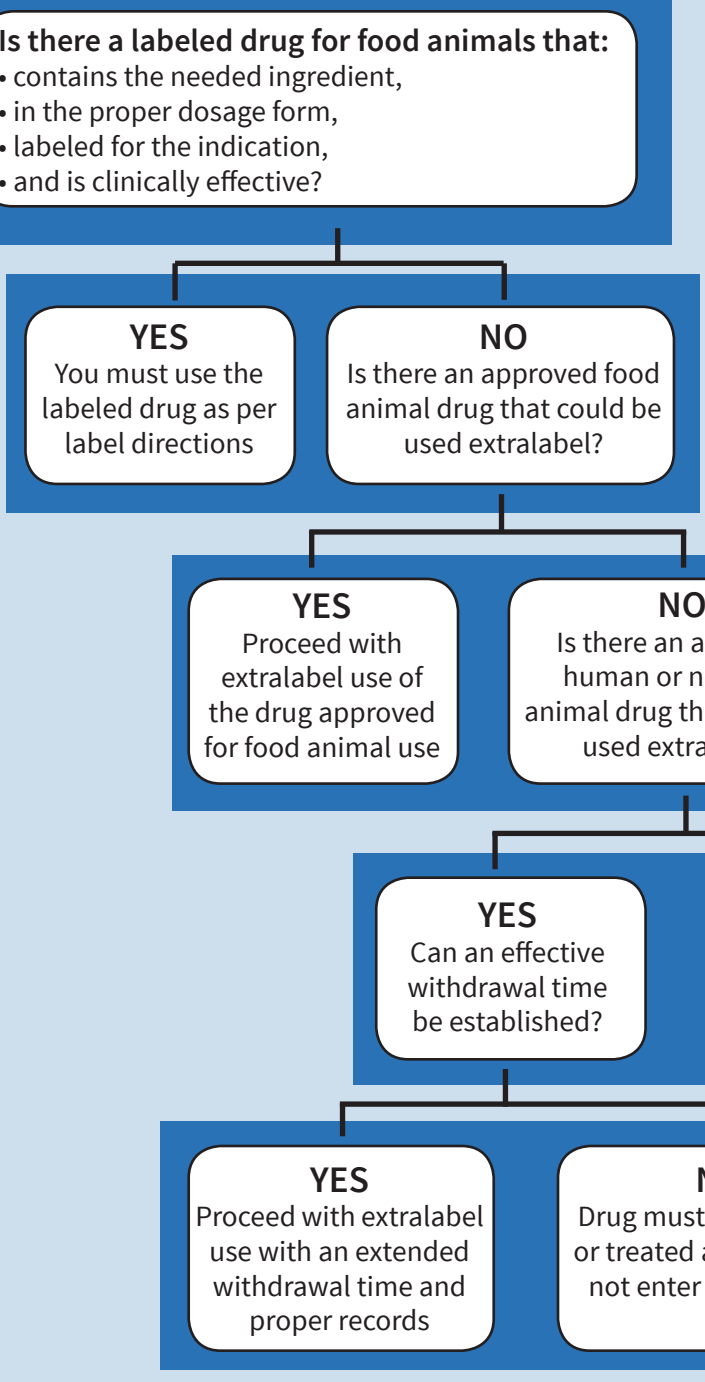
Consult your veterinarian for assistance in the diagnosis, treatment and control of parasitism.

EXTRALABEL DRUG USE IN SWINE

When using antibiotics in an extralabel manner, always ensure the use is judicious and complies with all state and federal regulations.

Remember that the extralabel use of cephalosporins and fluoroquinolones is restricted.**

Extralabel Drug Use Algorithm*



Cephalosporins (e.g., ceftiofur)

Extralabel use in food-producing animals is prohibited:

- for disease prevention purposes;
- at unapproved doses, frequencies, durations, or routes of administration; or
- if the drug is not approved for that species and production class.

Fluoroquinolones (e.g., Baytril®)

All extralabel use in food-producing animals is prohibited.

**Refer to FDA's AMDUCA regulations for a complete list of drugs prohibited for extralabel use in food-producing animals.

AMERICAN ASSOCIATION OF SWINE VETERINARIANS

* Adapted from the AVMA AMDUCA webpage (https://www.avma.org/KB/Resources/Reference/Pages/AMDUCA2.aspx)

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Upcoming meetings

American Association of Swine Veterinarians 48th Annual Meeting

February 25-28, 2017 (Sat-Tue)
Hyatt Regency Denver
Denver, Colorado

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

8th International Conference on Emerging Zoonoses

May 7-10, 2017 (Sun-Wed)
Manhattan, Kansas

For more information:
Target Conferences Ltd
65 Derech Menachem Begin
PO Box 51227
Tel Aviv, 6713818 ISRAEL
Tel: +972 3 5175150; Fax: +972 3 5175155
E-mail: zoo@target-conferences.com
Web: http://www.zoonoses-conferences.com/

UK-based series of workshops on conducting systematic reviews and meta-analysis

May 29-June 2, 2017 (Mon-Fri)
University of York
Heslington, York YO10 5DD.

Introduction to systematic reviews for food and feed related topics:
May 29-31, 2017

Meta-analysis in systematic reviews for food and feed related topics:
June 1-2, 2017

For more information and registration:

Annette O'Connor
Lloyd Vet Med Center Rm 2424
College of Veterinary Medicine
Iowa State University
1809 S Riverside Drive
Ames, Iowa, 50011-3619
Tel: 515-520-2376
E-mail: oconnor@iastate.edu
Web: http://www.yhec.co.uk/training/introduction-to-systematic-reviews-for-food-and-feed-related-topics/

World Pork Expo

June 7-9, 2017 (Wed-Fri)
Iowa State Fairgrounds
Des Moines, Iowa

Hosted by the National Pork Producers Council

For more information:
National Pork Producers Council
10676 Justin Drive
Urbandale, IA 50322
Web: http://www.worldpork.org

US-based series of workshops on conducting systematic reviews and meta-analysis

June 26-30, 2017 (Mon-Fri)
College of Veterinary Medicine, Iowa State University
Ames, Iowa

Introduction to systematic reviews in food and feed related topics:
June 26-28, 2017

Meta-analysis in systematic reviews in food and feed related topics:
June 29-30, 2017

For more information and registration:
Annette O'Connor
Lloyd Vet Med Center Rm 2424
College of Veterinary Medicine
Iowa State University
1809 S Riverside Drive
Ames, Iowa, 50011
Tel: 515-520-2376
E-mail: oconnor@iastate.edu
Web: http://register.extension.iastate.edu/systematic

25th International Pig Veterinary Society Congress

June 11-14, 2018 (Mon-Thu)
Chongqing, China

For more information:
Web: http://www.ipvs2018.net/

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

Photo Corner

Hampshire pigs at the University of Missouri

Photo courtesy of Tina Smith