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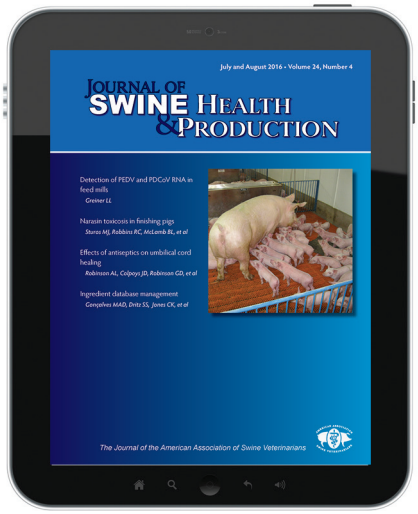

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So many piglets!

Photo courtesy of Dr Grant Allison

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Quoted from the Executive Editor's message, page 195

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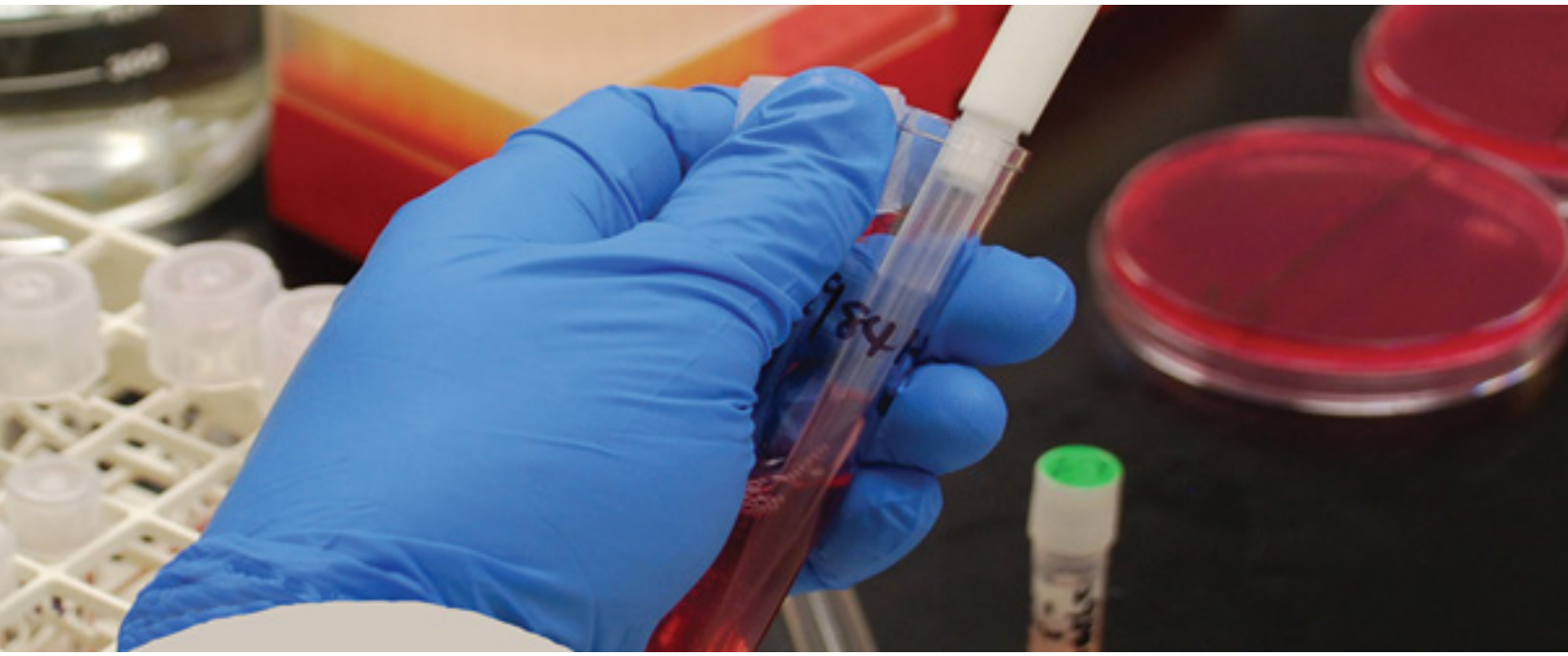

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Sustainability: Managing the moments of truth

Herbert "Herb" Stein was a free-market economist who was probably most famous as chairman of the Council of Economic Advisers under presidents Nixon and Ford. Mr Stein was also a journalist, comfortable commenting on a very broad range of topics. Whether he was supporting change in economic policy in the *Wall Street Journal* or penning a personal advice column under the pseudonym of "Dear Prudence," he did not let strict ideology stand in the way of common sense. He is probably best remembered for Herbert Stein's Law which stated "If something cannot go on forever, it will stop."[1] If nothing else, he was concise!

Sustainability is achieved by accommodating continual re-use of resources, and it is becoming increasingly important in promoting pork. While the notion of sustainability is important to all generations of consumers and policy makers, it is of particular importance to the Millennial generation. There are 75 million US Millennials, and this group wields significant consumer clout. Brand loyalty is much more fleeting in this group. Their purchasing decisions are more about social responsibility and sustainability than price. As food producers, we have some very serious challenges ahead of us. The Food and Agriculture Organization is predicting that if global population grows to 9.1 billion by 2050, then global food production will need to rise by 70%. Meat production alone will need to grow by 200 million tonnes to a total of 470 million tonnes. It should be no wonder that the Millennials and Generation Z are concerned about sustainability.

The US pork supply chain has stepped up to the plate in the past. The US pork supply has almost doubled over the past 50 years. At the same time, there has been a 78% decrease in the total amount of land required to produce pork. This gain has been associated with improved crop yields, feed milling, ration formulation, and increased by-product feed use (eg, dried distiller's grain solubles). Water consumption has dropped from 2.7 gallons to 1.6 gallons per pound of dressed carcass. On a pound-for-pound basis, the US pork industry's carbon footprint has been reduced from 3.8 kg per CO_{2e} to 2.5 kg per CO_{2e} per pound of dressed carcass.[2] We have a great track record in making better use of resources.

We need to communicate these and other good news stories, as well as our values, to our customers. The We Care Program jointly supported by the National Pork Board and the National Pork Producers Council acknowledges the responsibilities of producers and their supply-chain partners by affirming the responsibility to produce safe food, protect and promote animal well-being, ensure practices to protect public health, safeguard natural resources, and provide a safe work environment that is consistent with other ethical principles and contributes to a better quality of life in our communities. Consistently delivering on these responsibilities is a challenge.

In the early 1980's, Jan Carlzon was tasked with developing and executing a plan to turn around the money-losing Scandinavian Airlines System (SAS). Instead of instituting cost-cutting measures, he elected to improve the customer experience by focusing on what he called the "moments of truth." Carlzon explained, "Any time a customer comes into contact with any aspect of a business, however remote, is an opportunity to form an impression."[3] And these impressions would determine whether or not the customer would return. In Carlzon's eyes, it was the responsibility of everyone at SAS to deliver on the promises made by the company. These customer-service principles have stood the test of time.

In pork production, we are presented daily with many moments of truth. As veterinarians, we have an opportunity to influence the outcomes of many aspects of pork production that are important to the consumer. We assist with delivering food safety through PQA Plus. A One Health approach is important in protecting public health. Maintaining herd health allows for improved feed efficiency and welfare. As we work with farm staff we have an opportunity to lead by example in promoting workplace health and safety. Carlzon also said, "An individual without information can't take responsibility. An individual with information can't help but take responsibility."[3] Our work as educators is important for industry sustainability.

Herb Stein's Law probably works best as a reminder that we do not have the luxury of being complacent.[1] The reality is we will need to continue to adapt to a number of challenges in order to achieve sustainability. The AASV plays an important role in supporting the process. This support, however, could not be delivered without our great staff and dedicated AASV volunteers who give so willingly of their time. Thank you! As AASV members, we are woven into the fabric of the pork supply chain, and as such have an opportunity to influence outcomes. How will you respond to your next moment of truth?

References

1. Stein H. Herb Stein's Unfamiliar Quotations. *Slate* (magazine). The Slate Group. May 16, 1997. Available at www.slate.com/.../05/herb_steins_unfamiliar_quotations.single.html. Accessed 26 April 2016.

2. A 50 Year Comparison of the Carbon Footprint and Resource Use of the US Swine Herd: 1959 – 2009, http://research.pork.org/FileLibrary/ResearchDocuments/10-174-Boyd-Camco-final-5-22-12.pdf. Accessed 26 April 2016.

3. Jan Carlzon Quotes. A to Z Quotes. Available at http://www.azquotes.com/author/22935-Jan_Carlzon. Accessed 26 April 2016.

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Excellence

I have been training a bit lately in preparation for an upcoming amateur sporting event and have been enjoying the journey of preparation. I have been squeezing this into my already busy day and sometimes find myself wondering how to fit it all in. I am also in the midst of watching professional sports playoffs. As some of you may know, I am an avid hockey fan. Unfortunately, my favorite team (Blackhawks) is out of the playoffs (but I forgive them) and I am finding myself becoming a basketball fan as the Toronto Raptors are still in it! I watch the dedication of these professional athletes and the excellence that they demonstrate in their athletic skills. Watching these athletes and reflecting on my own general journey of constant improvement in both my professional and non-professional life has me thinking quite a bit, lately, about the pursuit of excellence in general. There is also quite a bit of talk in university communities about centers of excellence. There it is again – the word – "excellence"! What is excellence and how do elite athletes and centers of excellence do it – whatever "it" is?

As usual, I went to the dictionary to look up "excellence." In simple terms it means "the state, quality, or condition of excelling; superiority."[1] The definitions for "center of excellence" that I found are similar, but embody a team approach: "a center of excellence is a team, a shared facility or an entity that provides leadership, best practices, research, support and/or training for a focus area."[2]

"…swine veterinary clinics (all veterinary clinics) are in fact centers of excellence, each made up of a team of individuals whose shared goal is the pursuit of excellence in swine health."

Personally, I find the term "center of excellence" to be a bit haughty, but the term has stuck in universities and many other aspects of the business world. I do, however, think the general model of a center of excellence is sound and can be applied to swine health and more specifically to swine veterinary clinics. There are many models for the development and sustainability of a center of excellence, but generally the center should serve some basic needs. 1. Support – by way of providing experts for a subject matter (let's use swine health as an example); 2. Guidance – providing guidance in a subject area (swine herd health visits); 3. Shared Learning – encourage learning, training, skill assessment in subject area (mentoring a DVM student in swine health, producer training in swine welfare); 4. Measurements – demonstrate deliverables of results in a subject area (producer reports); and 5. Collaboration – promote collaboration and information sharing among other centers of excellence (AASV Annual Meeting presentation). Does any of this sound like what you do as a swine practitioner? I would argue that swine veterinary clinics (all veterinary clinics) are in fact centers of excellence, each made up of a team of individuals whose shared goal is the pursuit of excellence in swine health.

Currently in my world of work, research is a primary focus. I think what has struck me most about the pursuit of excellence in swine research is that a team approach is essential for success. This is not unlike the need for a team for the elite athlete, ie, coaches, doctors, trainers, teammates. This is also not unlike the need for a team approach to swine health, ie, researchers, practitioners, industry, and the teammates that make up those specific areas.

Professional sports teams and elite athletes seem to have embraced the team approach to achieving excellence (I know, there is a lot of money invested in professional sports). But I encourage you to think of who is your support network or team that helps you to achieve excellence, what is your role in your team's success or pursuit of excellence? And how do you fit excellence (or the pursuit of excellence) into your day repeatedly and consistently?

References

1. Collins Dictionary. Available at **http://www.collinsdictionary.com/dictionary/english/excellence**. Accessed 15 May 2016.

2. Cambridge Dictionary Online. Available at **http://dictionary.cambridge.org/us/dictionary/english/centre-of-excellence**. Accessed 15 May 2016.

Terri O'Sullivan, DVM, PhD
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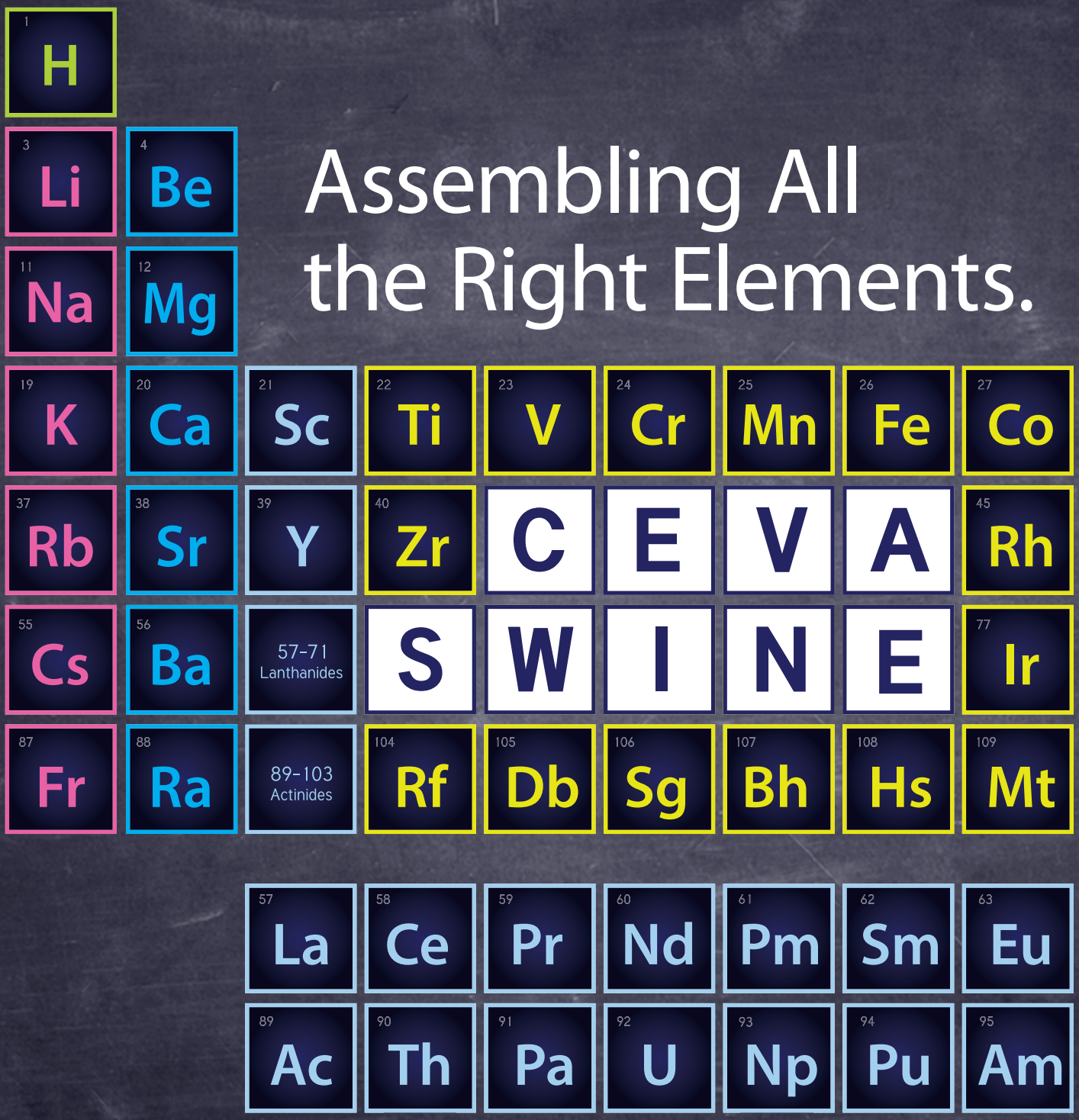

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Evaluation of the likelihood of detection of porcine epidemic diarrhea virus or porcine delta coronavirus ribonucleic acid in areas within feed mills

Laura L. Greiner, MS, PhD

Summary

Objective: To compare areas within feed mills to determine the likelihood of presence of either porcine epidemic diarrhea virus (PEDV) or porcine delta coronavirus (PDCoV).

Materials and methods: Twenty-four feed mills from various regions in the United States were evaluated. Swab samples (foot pedals of feed delivery trucks, bulk ingredient unloading pits, inside the mixer or pellet coolers, mill office floors, inside feed compartments on feed trucks and incoming bagged-ingredient trucks) were collected daily at each feed mill for up to 5 days. The samples were submitted for polymerase chain reaction testing for PEDV and PDCoV.

Results: Of the feed mills tested, 75% were supplying feed to known PEDV-positive herds, and 21% were supplying feed to known PDCoV-positive herds. No samples at any mill tested positive for PEDV ribonucleic acid (RNA), although 5% of the truck foot pedals and 1% of the bulk-ingredient pits tested suspect. Porcine delta coronavirus RNA was found on 3.4% of the foot pedals of the trucks, and 2.2% of the office floors tested suspect.

Implications: Porcine delta coronavirus RNA can be detected at different locations around feed mills. Feed mill biosecurity protocols need to be evaluated and maintained to minimize the probability of PEDV and PDCoV RNA presence.

Keywords: swine, feed mill, porcine epidemic diarrhea virus, sampling, probability assessment

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Resumen - Evaluación de la probabilidad de detección del ácido ribonucleico del virus de la diarrea epidémica porcina o del delta coronavirus porcino en áreas dentro de los molinos de alimento

Objetivo: Comparar áreas dentro de los molinos de alimento para determinar la probabilidad de la presencia del virus de la diarrea epidémica porcina (PEDV por sus siglas en inglés) o del delta coronavirus porcino (PDCoV por sus siglas en inglés).

Materiales y métodos: Se evaluaron veinticuatro molinos de alimento de diferentes regiones en los Estados Unidos. En todos los molinos, se recolectaron diariamente durante cinco días, muestras con hisopos (pedales de los camiones de entrega de alimento, pozos de descarga de ingredientes a granel, dentro de las mezcladoras o enfriadores de pellets, pisos de las oficinas del molino, dentro de los compartimientos de alimento en los camiones de alimento, y en los camiones que entregan ingredientes ensacados). Estas muestras fueron enviadas para ser analizadas con la prueba de reacción en cadena de polimerasa en busca de PEDV y PDCoV.

Resultados: De los molinos estudiados, 75% estaban supliendo alimento a hatos positivos al PEDV y 21% a hatos positivos al PDCoV. Ninguna muestra en ningún molino resultó positiva al ácido ribonucleico (RNA) de PEDV, sin embargo 5% de los pedales de camión y 1% de los pozos de ingredientes a granel resultaron sospechosos. El RNA del delta coronavirus porcino se encontró en 3.4% de los pedales de los camiones, y 2.2% de los pisos de oficina resultaron sospechosos.

Implicaciones: El RNA del delta coronavirus porcino puede ser detectado en diferentes localizaciones alrededor de los molinos de alimento. Los protocolos de bioseguridad de los molinos de alimento deben ser evaluados y mantenidos para minimizar la probabilidad de la presencia del RNA del PEDV y PDCoV.

Résumé - Évaluation de la possibilité de détecter de l'acide ribonucléique du virus de la diarrhée épidémique porcine ou du coronavirus delta porcin dans des sites à l'intérieur de meuneries

Objectif: Comparer des sites à l'intérieur de meuneries afin de déterminer la présence possible du virus de la diarrhée épidémique porcine (VDEP) ou du coronavirus delta porcin (CoVDP).

Matériels et méthodes: Vingt-quatre meuneries de différentes régions aux États-Unis ont été évaluées. Des écouvillonnages (pédales des camions de livraison de moulée, fosses de déchargement des ingrédients en vrac, intérieur du mélangeur ou refroidisseurs des granules, planchers des bureaux de la meunerie, intérieur des compartiments de moulée des camions de nourriture, camions amenant les ingrédients en sac) ont été faits quotidiennement jusqu'à 5 jours à chaque meunerie. Les échantillons ont été analysés par réaction d'amplification en chaîne par la polymérase pour détecter VDEP et CoVDP.

Résultats: Des différentes meuneries testées, 75% fournissaient de la moulée à des troupeaux connus pour être positifs au VDEP et 21% fournissaient de la moulée à des troupeaux connus pour être positifs au CoVDP. Aucun échantillon provenant des meuneries

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

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testées ne s'est avéré positif pour la présence d'acide ribonucléique (ARN) du VDEP, bien que les tests pour 5% des pédales des camions et 1% des fosses d'ingrédients en vrac fussent suspects. L'ARN du CoVDP fut trouvé sur 3,4% des pédales des camions, et 2,2% des planchers des bureaux donnaient un résultat suspect.

Implications: L'ARN du CoVDP peut être détecté dans différents sites autour des meuneries. Les protocoles de biosécurité des meuneries doivent être évalués et maintenus afin de minimiser la probabilité de la présence d'ARN du VDEP et du CoVDP.

Porcine epidemic diarrhea virus (PEDV) was first detected in the United States in the spring of 2013.[1] Porcine delta coronavirus (PDCoV) was first reported in the United States early in 2014; however, retrospective analysis of stored samples demonstrated that the virus was present in the fall of 2013.[2] In the retrospective analysis of PDCoV presence in the United States, a questionnaire was used to identify potential sources of introduction of the virus into the farms. Areas reviewed in the questionnaire included vehicles on the farm, as well as drivers and sources of feed.[2] With both feed trucks and staff returning from swine farms to the feed mill and incoming ingredient trucks delivering feedstuffs to the feed mill, an assessment was needed to determine the likelihood that, on any given day, viral ribonucleic acid (RNA) might be present in various areas of the mill and mill-associated fomites (eg, transport vehicles, footwear). Therefore, the goal of this study was to investigate the likelihood of detecting either PEDV or PDCoV RNA in selected areas within commercial feed mills.

Materials and methods

Twenty-four feed mills from eight states in the United States were evaluated in this study. The study was conducted from March 17 to September 1 of 2014. Six of the feed mills were providing feed to herds negative for PEDV. Feed mills were considered to be supplying feed to positive herds if one or more client farms were known to be positive for PEDV, PDCoV, or both viruses. The herd status information was reported from either the veterinarians that were involved with the feed mills or the feed mill managers to the individuals collecting the swab samples. The number of sites to which each mill delivered feed ranged from one to 173, with the median 32.5 sites. For up to 5 days, samples were collected daily at each feed mill to estimate the probability of a feed mill testing positive for PEDV or PDCoV. Sample areas included mill office floor, bulk ingredient unloading pit grate, incoming bagged-ingredient truck (inside of truck near site of off-loading), interior of either the mixer or pellet cooler, interior of one feed compartment on a feed truck, and both foot pedals of a feed delivery truck.

In brief, sample kits were prepared before the collection period at the mill, each including latex gloves; 50-mL tube containing 5 mL of sterile phosphate buffered saline (PBS); sealable plastic bag containing 25 mL of sterile PBS; and 10.16 cm × 10.16 cm sterile gauze. The sterile gauze was placed in the tube with the PBS and remained there until used. The collector changed gloves between samples. The gauze was removed from the 50-mL tube and wiped over the entire sample area (approximately 0.09 m^2). After each collection, the soiled gauze was placed in the sealable plastic bag and squeezed to express the fluid. Fluid was then drained from the bag into its original 50-mL tube and labeled accordingly (location within mill, mill identity, date). The tubes were then placed on ice in a cooler for transport. Samples were kept frozen in a -20°C freezer for the week prior to submission. Samples were tested for PEDV and PDCoV RNA via polymerase chain reaction (PCR) at the University of Minnesota (19 mills), Iowa State University (three mills), South Dakota State University (one mill), and a privately-owned laboratory (one mill). Each laboratory reported its respective cutoffs for a positive, negative, and suspect cycle threshold (Ct) value (University of Minnesota: < 35 positive, 35 to ≤ 40 suspect, > 40 negative; Iowa State University: < 36 positive, ≥ 36 negative; South Dakota State University: < 38 positive, ≥ 38 negative; private laboratory: ≤ 40 positive, > 40 negative), and those cutoffs were used in the analysis. All samples collected were tested for PEDV, and for 19 of the 24 mills, samples were also tested for PDCoV.

Polymerase chain reaction results were identified as positive, suspect, or negative on the basis of the respective diagnostic laboratory-designated cutoffs. Feed mills were assigned a letter identity for anonymity during analysis and reporting.

Data were analyzed to determine probability of PEDV or PDCoV RNA particle presence using the Bayesian model. Each sample was considered an experimental unit and was blocked both by location within the mill and health status of the site serviced by the mill. In addition, data was weighted on the basis of the percentage of mills that were supplying feed to either negative-status or positive-status herds. Data were summarized to indicate probabilities of detection in samples for each area being tested within the mills. In addition, probabilities of detection were calculated for the subset of mills that were known to be servicing positive herds.

Results

Seventy-five percent (18) of the feed mills tested were providing feed to PEDV-positive herds and 21% (five) of the feed mills were providing feed to PDCoV-positive herds. One third (eight) of the feed mills reported "unknown" concerning the PDCoV status of the herds that they were supplying with feed.

Raw means from the total samples collected per location within the mills for both PEDV and PDCoV are presented in Tables 1 and 2, respectively. No samples tested positive for PEDV. However, 5% of the truck foot pedals and 1% of the bulk ingredient pits tested suspect for PEDV. Porcine delta coronavirus RNA was found on 3.4% of the foot pedals of the trucks, and 2.2% of the office floors tested suspect. One mill that was currently not known to be supplying feed to PDCoV-positive herds did have a PDCoV suspect result on a sample from the office floor.

Tables 3 and 4 demonstrate the probability of negative results on the basis of the perceived health status of the herds to which the mills were supplying feed. In short, the areas that tested either positive or suspect had a lower probability of testing negative over time. Overall, mills that were supplying feed to at least one positive herd had a lower probability of testing negative.

Tables 5 and 6 further break down the probability of either PEDV or PDCoV positive or suspect results at the various locations tested within mills in relation to the perceived health status of the herds they supplied. As the number of sampling days increased, the probability of a positive or suspect result increased independently for the foot pedals, bulk ingredient pit, and the inside of the feed truck compartment for PEDV, and for the foot pedals and office floor for PDCoV.

Figures 1 and 2 demonstrate the probabilities of a mill testing positive on the basis of the number of days it has tested negative, with the percentage of mills supplying feed

Table 1: Proportions (%) of feed mill samples positive for porcine epidemic diarrhea virus (PEDV) ribonucleic acid by sampling site*

	Office floor	Bulk ingredient pit	Ingredient delivery truck	Mixer/cooler	Feed truck compartment	Foot pedal
			No. of samples			
Total	**100**	**100**	**74**	**99**	**100**	**100**
			Polymerase chain reaction results (%)			
Positive	0.0	0.0	0.0	0.0	0.0	0.0
Suspect	0.0	1.0	0.0	0.0	1.0	5.0
Negative	100.0	99.0	100.0	100.0	99.0	95.0

* Twenty-four feed mills from various regions in the United States were evaluated. Swab samples (foot pedals of feed delivery truck, bulk ingredient unloading pit, inside the mixer or pellet cooler, mill office floor, inside feed compartment on feed truck and incoming bagged-ingredient truck) were collected at each feed mill daily for up to 5 days. The samples were submitted for polymerase chain reaction testing for PEDV and porcine delta coronavirus. Cycle threshold (Ct) values varied depending on the analyzing laboratory. Each laboratory reported its respective cutoffs for a positive, negative, and suspect Ct value (University of Minnesota: < 35 positive, 35 to ≤ 40 suspect, > 40 negative; Iowa State University: < 36 positive, ≥ 36 negative; South Dakota State University: < 38 positive, ≥ 38 negative; private laboratory: ≤ 40 positive, > 40 negative). Data were analyzed using the Bayesian model to determine probability. Data were summarized to indicate probabilities of detection in samples for each area being tested within the mills. Probabilities of detection were calculated for the subset of mills that were known to be servicing PEDV-positive herds.

Table 2: Proportions (%) of feed mill samples positive for porcine delta coronavirus ribonucleic acid by sampling site*

	Office floor	Bulk ingredient pit	Ingredient delivery truck	Mixer/cooler	Feed truck compartment	Foot pedal
			No. of samples			
Total	**100**	**100**	**74**	**99**	**100**	**100**
			Polymerase chain reaction results (%)			
Positive	0.0	0.0	0.0	0.0	0.0	3.4
Suspect	2.2	0.0	0.0	0.0	0.0	1.1
Negative	97.8	100.0	100.0	100.0	100.0	95.5

* Study described in Table 1.

to positive herds included in the analysis.

Discussion

The areas of the feed mill and delivery trucks were purposively selected for testing due to the perceived potential for either cross-contamination by foot or truck traffic in the mill or farm or as an indirect measurement of the feed as a potential vector. For example, testing the foot pedals and office floor should reflect the potential for feed-mill staff or visitors to transfer contaminants from the farm to the mill or vice versa. Testing the incoming ingredient pit and delivery truck were chosen to evaluate the potential for the viruses to be transmitted into the feed mill with incoming ingredients. Finally, evaluation of the mixer and the inside of the feed truck allowed for assessment of the potential for the final feed product to be a source of viral transmission.

Other areas of the mill, such as the micronutrient intake point and ingredient bags or totes, could have also been tested. Recent data[3] demonstrated that PEDV in the feed would be widespread in a feed mill after manufacturing feed that contained PEDV. Therefore, testing the mixer and the inside of the feed delivery truck would provide information as to whether or not specific ingredients or the mixer intake points could serve as a source of viral introduction.

Although no samples tested positive for PEDV RNA, suspect results were seen in samples from the foot pedals of feed delivery trucks and mill office floors. However, PDCoV PCR-positive samples were found on feed truck foot pedals, and several PCR-suspect results were found in samples from the office floors of the tested feed mills. Mills currently feeding PEDV-positive or PDCoV-positive pigs had a higher chance of having a positive or suspect PCR test. However, the percentage of feed mills supplying feed to at least one PEDV-positive herd was higher than the percentage of those supplying at least one PDCoV-positive herd. As expected with sampling for low frequency events, repeated testing over time led to more mills yielding positive results. For example, after 1 day of negative test results on foot pedals, there was a one in 1.4 chance that the foot pedals would test positive for PEDV with additional days of testing.

One mill that was not supplying feed to any known PDCoV-positive herds at the time of testing did have a PDCoV-suspect result

Table 3: Average probability of negative porcine epidemic diarrhea virus (PEDV) polymerase chain reaction (PCR) test results on the basis of location and the PEDV status (positive or negative) of the herds being supplied with feed from the mill*

	Average (over five samples) probability of negative PCR test results					
	Office floor	Bulk ingredient pit	Ingredient truck	Mixer/cooler	Truck compartment	Foot pedal
Mills feeding PEDV-positive pigs						
Test ~+†	1.000	0.983	1.000	1.000	0.986	0.931
Test -‡	1.000	0.983	1.000	1.000	0.986	0.931
Mills feeding PEDV-negative pigs						
Test ~+	1.000	1.000	1.000	1.000	1.000	1.000
Test -	1.000	1.000	1.000	1.000	1.000	1.000
Total mills						
Test ~+	1.000	0.989	1.000	1.000	0.990	0.951
Test -	1.000	0.989	1.000	1.000	0.990	0.951

* Study described in Table 1.
† Test ~+: Either a positive or suspect result.
‡ Test -: Negative result.

Table 4: Average probability of negative porcine delta coronavirus (PDCoV) polymerase chain reaction (PCR) test results on the basis of location and the PDCoV status (positive or negative) of the herds being supplied with feed from the mill*

	Average (over five samples) probability of negative PCR test results					
	Office floor	Bulk ingredient pit	Ingredient truck	Mixer/cooler	Truck compartment	Foot pedal
Mills supplying feed for PDCoV-positive pigs						
Test +†	1.000	1.000	1.000	1.000	1.000	0.840
Test -‡	1.000	1.000	1.000	1.000	1.000	0.840
Mills supplying feed for pigs of unknown PDCoV status§						
Test +	0.967	1.000	1.000	1.000	1.000	1.000
Test -	0.967	1.000	1.000	1.000	1.000	1.000
Mills supplying feed for PDCoV-negative pigs						
Test +	0.967	1.000	1.000	1.000	1.000	1.000
Test -	0.967	1.000	1.000	1.000	1.000	1.000
Total mills						
Test +	0.982	1.000	1.000	1.000	1.000	0.923
Test -	0.982	1.000	1.000	1.000	1.000	0.923

* Study described in Table 1.
† Test +: Positive result
‡ Test -: Negative result
§ PDCoV status of herds being supplied with feed from the mills was not known at the time of the study, as PDCoV PCR was not a diagnostic test performed at that time for those sites.

Table 5: Probability of having a porcine epidemic diarrhea virus (PEDV) positive or suspect polymerase chain reaction (PCR) test result on the basis of the number of days tested and the PEDV status (positive or negative) of the herds being supplied with feed from the mill*

		Probability of any positive PCR test results by sample days					
	Sample days	Office floor	Bulk ingredient pit	Ingredient truck	Mixer/cooler	Truck compartment	Foot pedal
Mills supplying feed for PEDV-positive pigs							
Test ~+†	1	0.000	0.017	0.000	0.000	0.014	0.069
	2	0.000	0.033	0.000	0.000	0.028	0.133
	3	0.000	0.049	0.000	0.000	0.042	0.193
	4	0.000	0.065	0.000	0.000	0.056	0.248
	5	0.000	0.081	0.000	0.000	0.069	0.300
Mills supplying feed for PEDV-negative pigs							
Test ~+†	1	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.000	0.000	0.000	0.000	0.000	0.000
	5	0.000	0.000	0.000	0.000	0.000	0.000

* Study described in Table 1.
† Test ~+ : Either a positive or suspect result.

on a sample from the office floor, indicating that the health statuses of the herds being serviced by the mill are not the only potential sources that could lead to a positive or suspect PCR test. The status of the herd serviced by this mill was confirmed both before and after the study by the herd veterinarian.

Although this study did not determine if the suspect or positive PCR samples would result in creating a clinical disease in an animal, data from Thomas et al[4] demonstrates that 25% of the time, when PCR samples have a Ct value of > 45, samples may be infectious. Therefore, on the basis of this information, both positive and suspect samples in this study appear to have the potential to be infectious. Furthermore, the data from the current feed-mill study demonstrated that positive samples can be found in feed mill and delivery trucks, indicating that PEDV and PDCoV control practices should be in place at the feed mill.

Implications

- Under the conditions of this study, porcine delta coronavirus RNA can be detected at different locations around feed mills.
- Feed mill biosecurity protocols need to be evaluated and maintained to minimize the probability of PEDV and PDCoV RNA presence.

Acknowledgements

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References

1. Stevenson GW, Hoang H, Schwartz KJ, Burrough ER, Sun D, Madson D. Emergence of porcine epidemic diarrhea virus in the United States: clinical signs, lesions, and viral genomic sequences. *J Vet Diagn Invest*. 2013;25:649–654. doi: 10.1177/1040638713501675.

2. McCluskey BJ, Haley C, Rovira A, Main R, Zhang Y, Barder S. Retrospective testing and case series study of porcine delta coronavirus in US swine herds. *Prev Vet Med*. 2016;123:185–191. doi: 10.1016/j.prevetmed.2015.10.018.

*3. Schumacher LL, Cochrane RA, Evans CE, Kalivoda JR, Woodworth JC, Stark CR, Jones CK, Main RG, Zhang J, Dritz SS, Gauger PC. Evaluating the effect of manufacturing porcine epidemic diarrhea virus (PEDV)-contaminated feed on subsequent feed mill environmental surface contamination. *Kansas Agricultural Experiment Station Research Reports*. 2015;1:7.

4. Thomas JT, Chen Q, Gauger PC, Gimenez-Lirola LG, Sinha A, Harmon KM, Madson DM, Burrough ER, Magstadt DR, Salzbrenner HM, Welch MW, Yoon K, Zimmerman JJ, Zhang J. Effect of porcine epidemic diarrhea virus infectious doses on infection outcomes in naive conventional neonatal and weaned pigs. *PLoS One*. 2015;10(10):e0139266. doi:10.1371/journal.pone.0139266.

* Non-refereed reference.

Table 6: Probability of having a porcine delta coronavirus (PDCoV) positive or suspect polymerase chain reaction (PCR) test result on the basis of the number of days tested and the PDCoV status (positive or negative) of the herds being supplied with feed from the mill*

		Probability of any positive PCR test results by sample days					
	Sample days	Office floor	Bulk ingredient pit	Ingredient truck	Mixer/cooler	Truck compartment	Foot pedal
Mills feeding PDCoV-positive pigs							
Test+	1	0.000	0.000	0.000	0.000	0.000	0.160
	2	0.000	0.000	0.000	0.000	0.000	0.294
	3	0.000	0.000	0.000	0.000	0.000	0.407
	4	0.000	0.000	0.000	0.000	0.000	0.502
	5	0.000	0.000	0.000	0.000	0.000	0.582
Mills feeding pigs of unknown PDCoV status†							
Test+	1	0.033	0.000	0.000	0.000	0.000	0.000
	2	0.066	0.000	0.000	0.000	0.000	0.000
	3	0.097	0.000	0.000	0.000	0.000	0.000
	4	0.127	0.000	0.000	0.000	0.000	0.000
	5	0.156	0.000	0.000	0.000	0.000	0.000
Mills feeding PDCoV- negative pigs							
Test+	1	0.033	0.000	0.000	0.000	0.000	0.000
	2	0.066	0.000	0.000	0.000	0.000	0.000
	3	0.097	0.000	0.000	0.000	0.000	0.000
	4	0.127	0.000	0.000	0.000	0.000	0.000
	5	0.156	0.000	0.000	0.000	0.000	0.000

* Study described in Table 1.

† PDCoV status of herds being supplied with feed from the mills was not known at the time of the study, as PDCoV PCR was not a diagnostic test performed at that time for those sites.

Figure 1: Probability of detecting porcine epidemic diarrhea virus (PEDV) ribonucleic acid particles, determined by the number of sequential negative results on polymerase chain reaction (PCR) testing. Study described in Table 1.

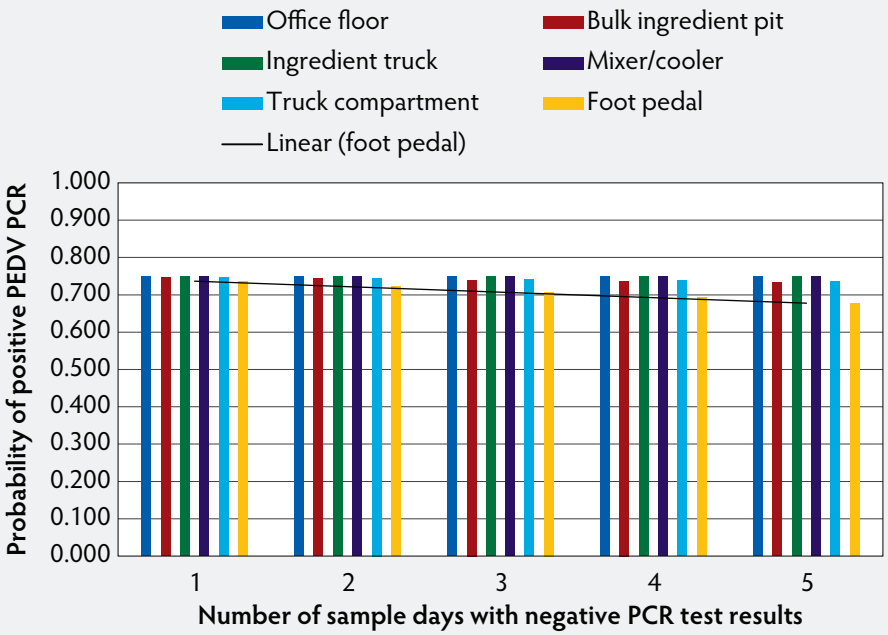
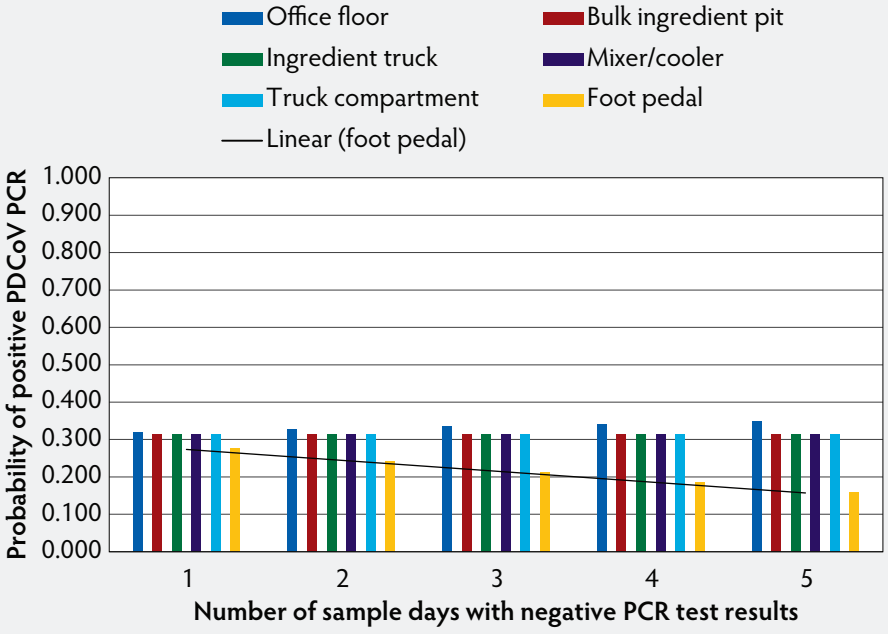


Figure 2: Probability of detecting porcine delta corona virus (PDCoV) ribonucleic acid particles, determined by the number of sequential negative results on polymerase chain reaction (PCR) testing. Study described in Table 1.



Peer reviewed

Case report

Narasin toxicosis in finishing pigs

Matthew J. Sturos, DVM; Rebecca C. Robbins, DVM; Roman Moreno, PhD; Brittany L. McLamb, DVM; Stephanie A. Rossow, DVM, PhD

Summary

This case report documents a clinical case of narasin toxicosis in a group of 19-week-old finisher pigs caused by accidental overdose of narasin in the feed at concentrations varying from 139 ppm (139 g per tonne) to 645 ppm (645 g per tonne). Affected pigs exhibited anorexia, pain (vocalization), skeletal muscle weakness, ataxia, recumbency, and dyspnea. Pathological lesions in the affected pigs examined were primarily restricted to skeletal muscle degeneration and necrosis. Skeletal muscles that were most severely affected included the diaphragm and outer muscularis layer of the proximal esophagus. Of the 3000 exposed pigs, 86 pigs died and 415 pigs were euthanized for animal welfare reasons. The overdose was caused by a broken load cell allowing undetected continuous leakage of narasin within the micro-ingredient batching system at the feed mill. Corrective action was implemented at the feed mill to prevent further episodes.

Keywords: swine, narasin, toxicity, finisher pigs

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Resumen - Toxicosis de narasina en cerdos de finalización

Este reporte documenta un caso clínico de toxicosis de narasina en un grupo de cerdos de finalización de 19 semanas de edad causada por una sobredosis accidental de narasina en el alimento en concentraciones variando de 139 ppm (139 gr por tonelada) a 645 ppm (645 gr por tonelada). Los cerdos afectados presentaron anorexia, dolor (vocalización), debilidad musculo esquelética, ataxia, recumbencia, y disnea. Las lesiones patológicas en los cerdos afectados examinados fueron principalmente restringidas a degeneración musculo esquelética y necrosis. Los músculos esqueléticos que fueron afectados más severamente incluyeron el diafragma y la capa muscular externa del esófago proximal. De los 3000 cerdos expuestos, 86 cerdos murieron y 415 cerdos fueron sacrificados por razones de bienestar animal. La sobredosis fue causada por una fuga continua, no detectada, de narasina dentro del sistema de procesamiento de micro ingredientes en el molino de alimento debido a un compartimiento de descarga roto. Se implementó una acción correctiva en el molino de alimento para prevenir episodios futuros.

Résumé - Toxicité du narasin chez des porcs en finition

Ce rapport de cas fait état d'un cas clinique d'intoxication au narasin chez un groupe de porcs en finition âgés de 19 semaines causée par une surdose de narasin dans l'alimentation à des concentrations variant de 139 ppm (139 g par tonne) à 645 ppm (645 g par tonne). Les porcs affectés présentaient de l'anorexie, de la douleur (vocalisation), faiblesse des muscles squelettiques, ataxie, décubitus, et dyspnée. Les lésions pathologiques chez les porcs affectés examinés étaient principalement limitées à de la dégénérescence des muscles squelettiques et de la nécrose. Les muscles squelettiques les plus sévèrement affectés incluaient le diaphragme et la musculeuse externe de l'œsophage proximal. Sur les 3000 porcs exposés, 86 sont morts et 415 ont été euthanasiés pour des raisons de bien-être animal. La surdose a été causée par un bris d'une cellule de chargement ce qui a entrainé une fuite continue non-détectée de narasin à l'intérieur du système de mélange des micro-ingrédients à la meunerie. Une action corrective a été mise en place à la meunerie afin de prévenir de nouveaux épisodes.

MJS, SAR: University of Minnesota, Veterinary Diagnostic Laboratory, St Paul, Minnesota.

RCR, RM: Seaboard Farms, Guymon, Oklahoma.

BLML: Banfield, Portland, Oregon.

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Ionophores are compounds that are capable of transporting charged molecules across biological membranes and have diverse uses in both human and veterinary medicine, to include artificial activation of human oocytes clinically,[1] inhibitors of human cancer stem cells experimentally,[2] well-established anticoccidial agents in poultry,[3] and approved for increased weight gain and feed efficiency in swine in Canada (Monteban 70; Elanco, Division of Eli Lilly Canada, Guelph, Ontario, Canada) and the United States (Skycis 100; Elanco Animal Health, Division of Eli Lilly and Company, Indianapolis, Indiana). Polyether ionophore antibiotics frequently used in veterinary medicine, such as monensin, lasalocid, salinomycin, and narasin, have the potential to cause toxicosis either by administration at levels above the recommended safe dosages[4] or by concurrent administration with known potentiating agents such as tiamulin.[5] Narasin is a monovalent polyether carboxylic ionophore antibiotic which is produced by a strain of the bacteria *Streptomyces aureofaciens.*[6,7] Narasin is currently used in swine in the United States as a feed additive, with label indications of increased rate of weight gain and improved feed efficiency in growing-finishing swine when fed at 15 g per tonne to 30 g per tonne for at least 4 weeks.[8] Narasin toxicosis in swine is a syndrome similar to that described for monensin and other ionophores, which is clinically characterized by anorexia, diarrhea, respiratory distress, ataxia, muscle weakness, lethargy, recumbency, and death.[9-12] These clinical signs are not pathognomonic for ionophore toxicosis and may be confused with some acute infectious

diseases (eg, disease caused by *Streptococcus suis*, *Hemophilus parasuis,* or F18-expressing *Escherichia coli*), selenium toxicosis, or water deprivation in older pigs. Gross lesions vary from none to pale pink, red, or white areas in either skeletal or cardiac muscle or both, and in cases of cardiac involvement, there have been reports of epicardial hemorrhage, pulmonary edema, pulmonary congestion, hydrothorax, and hydroabdomen. The defining microscopic feature is necrosis of striated muscle. Differential diagnoses to be considered with these gross and histological findings in either skeletal muscle or heart or both should also include gossypol toxicosis, nutritional myopathies, and porcine stress syndrome.[4]

Previously published reports of accidental narasin toxicosis in swine involve either contamination of pig feeds from unknown sources,[11] contamination of pig feeds in a facility also processing poultry feeds,[10] and contamination of pig feed containing tiamulin with narasin labeled for swine.[13] To the knowledge of the authors, this report describes the first documented case of narasin toxicosis in finishing pigs associated with inadvertent overdose of the ration with narasin labeled for swine, but not associated with concurrent administration of ionophore potentiators.

Herd description

This facility was under veterinary care and certified by Pork Quality Assurance (PQA; National Pork Board). The case herd was an 8000-finisher farm in the Oklahoma panhandle, composed of eight 1000-finisher tunnel-ventilated, curtain-sided barns, with 48 pens per barn. In July 2014, each barn housed 1000 nineteen-week-old, mixed-breed finisher pigs. Pigs were multi-sourced by site, single-sourced by barn, and managed all-in, all-out. In each pen, ad-libitum feed was available in a round feeder, with ad-libitum water available through water nipples mounted on a dual-head swinging water pipe. The pigs and their environment were monitored daily by caretakers.

Pigs were assigned a feed budget that consisted of six finishing rations formulated to meet or exceed the nutritional recommendations reported by the National Research Council.[14] The second finishing ration consisted of a corn and soybean-meal base containing 30 g per tonne narasin (Skycis 100; Elanco Animal Health). Pigs were fed 56.8 kg each of the second ration, which would last approximately 4 weeks.

Case description

At the case site, each of the eight barns received a delivery of the second finishing ration on July 17, 2014. It was estimated that pigs in Barn 3 started consuming the overdosed feed around July 25. On July 27, caretakers observed pigs nosing feed out of their feeders. At this time, caretakers started the barn on water-soluble potassium penicillin. On July 28, the caretaker contacted production management to report that the prevalence of gaunt pigs in Barn 3 had increased and now barns 4 and 5 were affected. In addition, the caretaker had noted pigs with signs of dyspnea and ataxia in each barn. Management discontinued administration of potassium penicillin in favor of water-soluble oxytetracycline and liquid aspirin for treatment of suspected pneumonia. Individual pigs exhibiting clinical signs of pneumonia were treated with injectable enrofloxacin (Baytril 100; Bayer HealthCare LLC, Animal Health Division, Shawnee Mission, Kansas). On July 28, two hundred and forty-nine pigs in Barn 3 and 95 pigs in Barn 4 were individually treated for suspected pneumonia. On July 29, the caretaker reported no improvement, and the production manager visited the farm and reported that over 50% of pigs in each barn appeared gaunt, ataxic, or dyspneic, or had tremors.

On July 29, the site veterinarian visited the farm and found clinical signs were confined to three barns, but varied in severity among barns. Barn 3 was most severely affected, with 20% of pigs dog-sitting or in lateral recumbency, while 10.0% and 8.5% of pigs were affected in barns 4 and 5, respectively. The veterinarian described a rapid onset of tremors and incoordination coinciding with vocalization that subsided when an affected pig sat back on its haunches or became recumbent. Affected pigs remained alert and responsive. Paddling, nystagmus, or other neurologic signs were not observed. In addition, all pigs that had received an enrofloxacin injection the day prior had a scab 2.5 cm to 4 cm in diameter at the site of injection. Because clinical signs were consistent with prior reports of ionophore toxicosis, the feed was removed from the affected barns and associated bins that day, and all antibiotic therapy was discontinued.

On July 30, the veterinarian reported improvement in the prevalence of affected pigs: 11.0%, 6.0%, and 2.5% in barns 3, 4, and 5, respectively. However, mortality increased over the next 7 days. In total, 86 pigs died and 415 pigs were euthanized when they became non-ambulatory, in accordance with the producer's animal welfare policy.

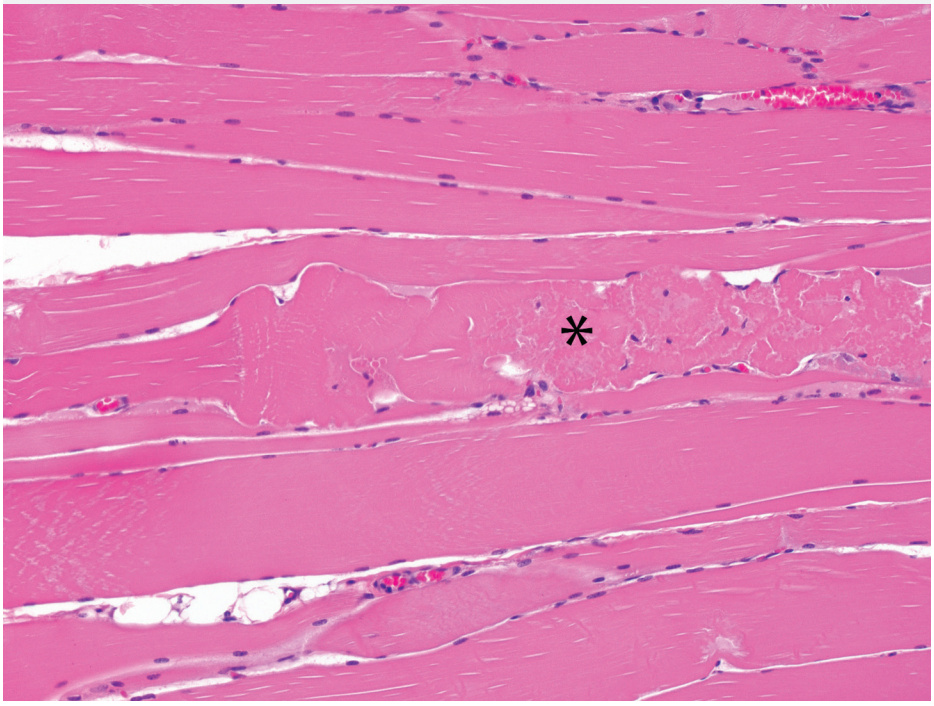
Laboratory findings

Two 19-week-old pigs (pigs #1 and #2) exhibiting ataxia and muscle tremors were euthanized on July 29, two days after the onset of clinical signs, and gross examination by the herd veterinarian found mild pneumonia and empty stomachs, but no other gross lesions or effusions. Feed samples, as well as fresh and formalin-fixed tissues including lung, liver, spleen, kidney, heart (ventricle), tonsil, lymph node, skeletal muscle, tongue, small intestine, and colon, were submitted to the University of Minnesota Veterinary Diagnostic Laboratory (UMN VDL, St Paul, Minnesota) for additional testing. Differential diagnoses included water deprivation, ionophore toxicosis, or unusual presentations of *Streptococcus suis*, *Hemophilus parasuis*, or Shiga-toxin-producing F18 *E coli* infections.

Microscopic examination of tissues revealed marked acute segmental skeletal muscle necrosis characterized by swollen myofibers with loss of cross-striations and myofibril distinction, homogeneous pale to deeply eosinophilic material (hyaline degeneration) or amorphous flocculent eosinophilic material replacing the normal sarcoplasmic tissue, and shrunken pyknotic nuclei at the periphery of the myofibers (Figure 1). In some areas, there was formation of linear bands of eosinophilic material (contraction bands) within the affected fibers. Necrotic myofibers were frequently clustered, and clusters of necrotic fibers were distributed throughout the muscle sections, often near the center of fascicles. In some sections, small numbers of macrophages infiltrated the affected fibers as well as the adjacent endomysium. All skeletal muscles submitted were affected, with the exception of the tongue, but the sectional area affected varied from 10% to 50% between sections. The submitted ventricular myocardium was unaffected. There were no significant microscopic lesions in other tissues.

Liver mineral values were analyzed by inductively coupled plasma mass spectrometry at Michigan State University Diagnostic Center for Population and Animal Health (MSU DCPAH; Lansing, Michigan) and were within normal limits. Liver samples tested by gas chromatography mass spectrometry performed at MSU DCPAH

Figure 1: Tissues from nine finisher pigs were examined histologically as part of the diagnostic investigation of a case of narasin toxicosis in finishing pigs. Pig #1, skeletal muscle, acute ionophore toxicosis. There is segmental acute degeneration and necrosis of a skeletal muscle fiber in the center of the image (*). Section stained with hematoxylin and eosin; ×10 magnification.



were negative for toxic organic compounds. Molecular diagnostics performed at UMN VDL were positive for porcine reproductive and respiratory syndrome virus (PRRSV) and *Mycoplasma hyorhinis,* and negative for porcine circovirus type 2, influenza virus, transmissible gastroenteritis virus, porcine epidemic diarrhea virus, swine delta coronavirus, and *Mycoplasma hyopneumoniae*.

Feed analysis at Covance Incorporated (Covance, Greenfield, Indiana) and MSU DCPAH indicated that the samples tested were positive for narasin. Covance analysis by liquid chromatography and post-column derivatization detected narasin concentrations of 645, 279, and 242 g per tonne in feed samples obtained from barns 3, 4, and 5, respectively. These samples were 21.5, 9.3, and 8.0 times higher than the expected as-fed, labeled concentration. The narasin-positive feed sample analyzed by MSU DCPAH was quantified by Iowa State University Veterinary Diagnostic Laboratory (ISU VDL; Ames, Iowa) by liquid chromatography and post-column derivatization; narasin was detected at 139 g per tonne, which was 4.6 times higher than the labeled concentration. The findings of marked necrosis of skeletal muscles and demonstration of elevated levels of narasin in the feed were consistent with the clinical diagnosis of suspected ionophore toxicosis.

On August 4, eight days after the onset of clinical signs, one 18-week-old pig (Pig #3) with clinical signs of ionophore toxicosis and a skin reaction at the site of the enrofloxacin injection was euthanized, and tissues were submitted to UMN VDL for testing. No gross lesions were noted at necropsy, other than the focal circular erythematous region around the injection site. Tissues submitted included skeletal muscle (loin [m longissimus lumborum], ham [m semimembranosus], tongue [m lingualis proprius]), heart (ventricle), and skin with subcutis. Microscopic evaluation revealed minimal acute skeletal muscle necrosis with numerous regenerating myofibers (small myofibers with increased sarcoplasmic basophilia, indistinct or absent cross-striations, and rows of centrally placed, large vesiculate nuclei) and moderate infiltration by macrophages, eosinophils, and non-degenerate neutrophils in response to the necrotic tissue (Figure 2). The tongue and ventricular myocardium were unaffected. Within the erythematous tissues from the injection site there was moderate localized acute inflammation in the dermis, subcutis, and muscles surrounding a central area of coagulative necrosis (loss of cellular detail with preservation of cellular outlines) in the superficial muscle. Bacteria were not observed within the affected tissues.

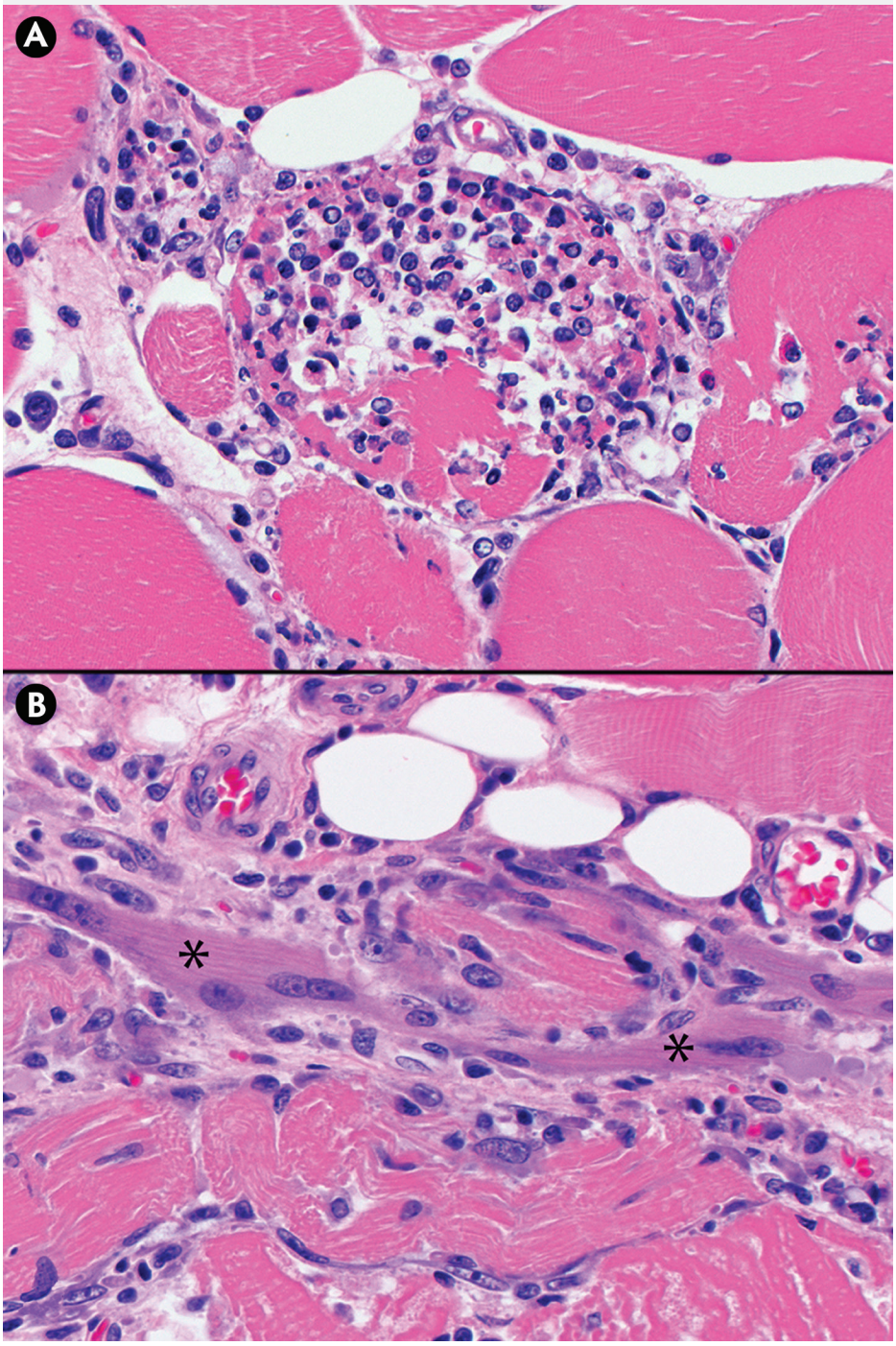
On August 7, eleven days after the onset of clinical signs, six 20-week-old pigs were submitted to assess the progression of the ionophore toxicosis. Three pigs (pigs #4, #5, and #6) which were clinically affected (off-feed, trembling, vocalizing), and three pigs (pigs #7, #8, and #9) from the same barn that were clinically unaffected, were euthanized and tissues harvested. At necropsy, all clinically affected pigs exhibited acute multifocal pneumonia. Clinically unaffected pigs exhibited no gross lesions at necropsy. Tissues submitted included formalin-fixed samples of the proximal esophagus, tongue, ham, shoulder (m deltoideus), loin, tenderloin (m psoas major), diaphragm, heart, spleen, kidney, small intestine, lung, liver, and colon in addition to serum and fresh samples of lung, liver, spleen, kidney, heart, small intestine, and colon.

All pigs were positive for PRRSV by polymerase chain reaction. The three clinically affected pigs had mild, multifocal acute pneumonia histologically. Ongoing acute skeletal muscle necrosis, characterized by amorphous to clumped eosinophilic material within the sarcoplasm, was minimal. All pigs had evidence of skeletal muscle regeneration with mild fibrosis in some areas. The clinically affected pigs also had moderate to large numbers of macrophages and small numbers of eosinophils and lymphocytes within the endomysium of some sections.

The severity of lesions varied among pigs and among muscles within the same pig. The severity and extent of muscle lesions in the clinically affected pigs was much greater than in the non-clinically affected pigs. Within the same pig, the severity of lesions between muscles followed the pattern of proximal esophagus (outer muscularis) ≥ diaphragm > shoulder > ham > tenderloin > loin (Figure 3). The tongue, inner muscularis of the proximal esophagus, and ventricular myocardium were unaffected.

Serum creatinine kinase (CK) concentrations were markedly elevated in clinically affected pigs (10,624 U per L, 20,899 U per L, and 6565 U per L in pigs #4, 5, and 6, respectively; institutional reference interval 24 to 225 U per L), and moderately elevated in non-clinically affected pigs (2270 U per L,

Figure 2: Case described in Figure 1. Pig #3, skeletal muscle, subacute ionophore toxicosis. Panel A: Macrophages are infiltrating necrotic muscle fibers and phagocytizing degenerate myofibrils. Panel B: Centrally there are regenerative muscle fibers (*) with large oval centrally placed nuclei and pale basophilic sarcoplasm. There is a normal muscle fiber in the upper right and variably degenerate muscle fibers in lower portions of image. All sections stained with hematoxylin and eosin; ×20 magnification.



9567 U per L, and 3622 U per L in pigs #7, #8, and #9, respectively).

Serum aspartate transferase (AST) concentrations in clinically affected pigs were 361 U per L, 586 U per L, and 391 U per L for pigs #4, #5, and #6, respectively; reference interval 32 to 84 U per L). Serum AST concentrations in non-clinically affected pigs were 34 U per L, 174 U per L, and 110 U per L for pigs #7, #8, and #9, respectively.

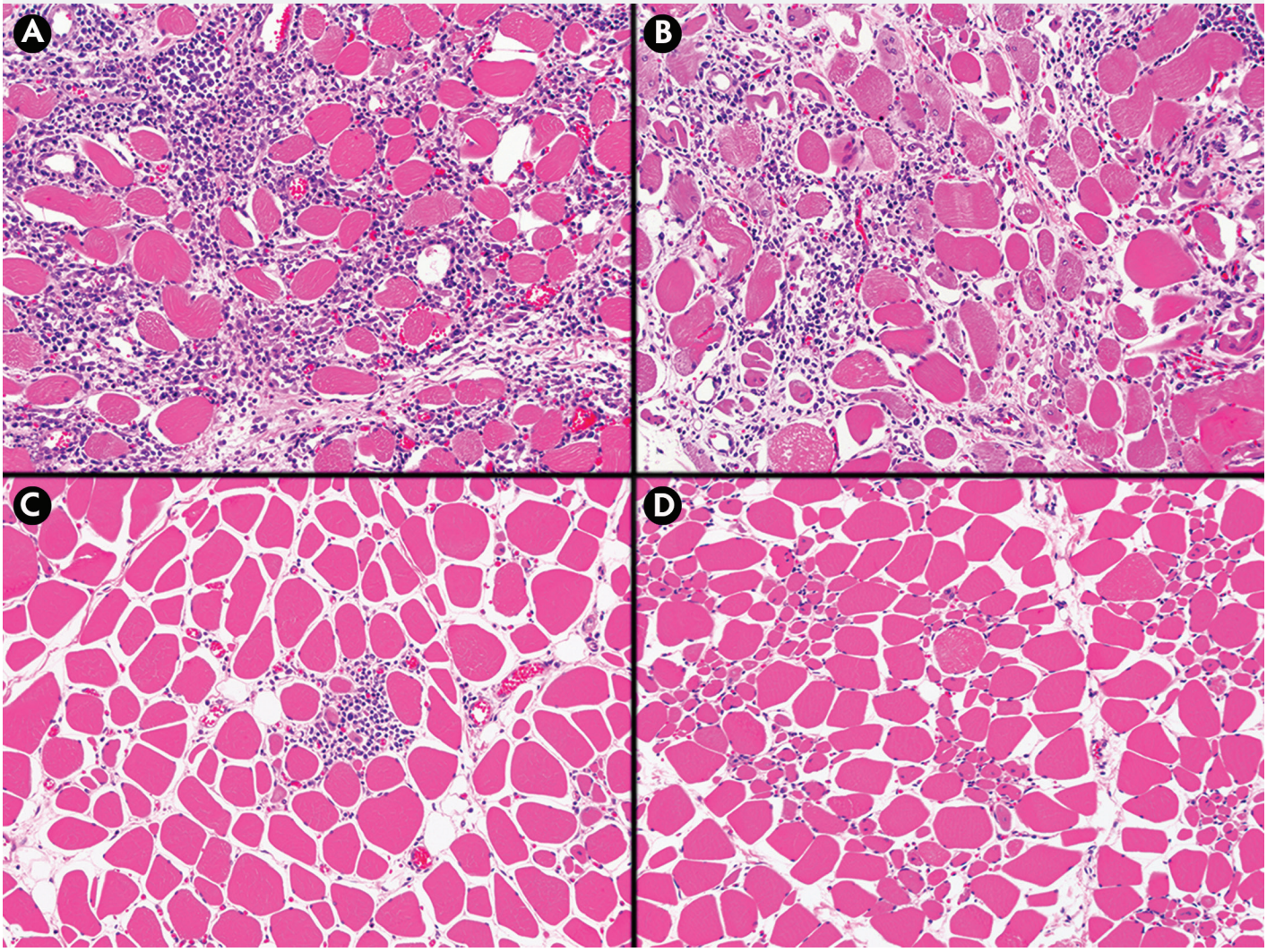
Serum potassium was markedly elevated in clinically affected pigs (12.6 mmol per L, 11.9 mmol per L, and 9.4 mmol per L for pigs #4, #5, and #6, respectively; reference interval 4.4 to 6.7 mmol per L), and within the reference intervals for all non-clinically affected pigs.

In one non-clinically affected pig (pig #8), there was also a mild elevation in serum sorbitol dehydrogenase (9 U per L; reference interval 1 to 6 U per L). There were no other significant changes in serum chemistry or electrolyte values for any of the tested pigs.

Treatment and outcome

Feed was immediately removed from affected barns' feeders and associated feed bins and disposed of. Non-medicated corn and soybean meal diets were fed throughout the remaining growing-finishing period. Immediately before the pigs had access to the overdosed feed, the average daily feed intake (ADFI) of barns 3, 4, and 5 had been 1.95 kg per day. During the time that the pigs had access to the overdosed feed, ADFI decreased to 0.72 kg per day. At the end of the growing-finishing period, pigs from barns 3, 4, and 5 were on average 4.0 kg lighter and had higher feed conversion (feed-to-gain ratio 2.4 versus 2.8) than pigs from barns 1, 2, 6, and 7. No water-soluble or injectable antibiotics were subsequently administered to pigs in barns that received the overdosed feed. Within 7 days of removing the contaminated feed, no new pigs were being found with clinical signs consistent with ionophore toxicosis, and 14 days after feed removal all pigs appeared clinically normal. In consultation with the Food Animal Residue Avoidance Databank (FARAD) and in light of the resolution of muscle lesions and absence of clinical signs, the three barns were marketed 9 weeks later. Of the 3000 exposed pigs, 86 pigs died and 415 pigs were euthanized for animal welfare reasons. Following an investigation, the manager of the farm-owned feed mill determined that

Figure 3: Case described in Figure 1. Pig #5. Skeletal muscle, subacute ionophore toxicosis. There is wide variation in the severity of lesions between skeletal muscle groups within the same pig. Panel A: esophagus, outer muscularis layer. Extensive infiltration of macrophages within affected myofibers and the endomysium. Panel B: diaphragm. Moderate infiltration by macrophages with occasional regenerative fibers. Panel C: ham. Mild infiltration by macrophages with numerous small regenerative fibers. Panel D: loin. Scant macrophage infiltrates with numerous small regenerative fibers. All sections stained with hematoxylin and eosin; ×10 magnification.



the problem arose in the micro-ingredient batching system, which resulted in the dosing error. The affected portion of the micro-ingredient batching system was dismantled and inspected, revealing that a broken load cell allowed product to continuously leak from the bin without detection. The load cell was repaired and, as an additional precaution, the producer immediately discontinued use of narasin in the affected mill.

Discussion

Multiple ionophores are available and labeled for use in animal feed, and these compounds are different in several ways, including the spectrum of molecules transported, the relative affinity for the ions transported, the comparative toxicity between ionophores, and the target organs affected between species. Monovalent carboxylic ionophores such as monensin and narasin are capable of transporting monovalent cations such as sodium (Na^+) and potassium (K^+) through biological membranes, including cell membranes and mitochondrial membranes, but do not directly transport divalent cations such as calcium (Ca^{++}). Other ionophores, such as lasalocid, are capable of directly transporting Ca^{++}. Ionophores also have differing affinities within the spectrum of ions transported; for example, narasin has been reported to preferentially transport K^+ over Na^+, while monensin preferentially transports Na^+ over K^+.[15,16] Each ionophore has varying toxicity, depending on the dosage at which no observable adverse effects occur, and the general relative toxicity between selected ionophores has been reported to be salinomycin < lasalocid ≤ narasin = monensin < maduramicin.[17] In general, striated muscles (skeletal and cardiac) are the target organs of ionophore toxicity, but between species the severity of skeletal versus cardiac muscle necrosis is variable. Horses are reported to have greater involvement of cardiac muscle with little skeletal muscle involvement; dogs and pigs are reported to have greater involvement of the skeletal muscle; and cattle, poultry, and rodents have equivalent involvement of skeletal and cardiac muscle.[4]

The definitive mechanism of ionophore toxicity has not been identified, but appears to converge on increased free cytoplasmic

calcium concentrations which activate cellular proteases, phospholipases, and caspases, as well as increasing mitochondrial permeability, resulting in cellular degradation, energy depletion, and cell death.[12,18] Free cytosolic calcium is also important in contraction of skeletal and cardiac muscle, which would hasten energy depletion.

Definitive diagnosis of ionophore toxicity requires demonstration of the presence of the compound in feed at an unsafe concentration for the species exposed, expression of clinical signs in the exposed animals, and demonstration of compatible gross and histopathologic lesions.[4] In this case, multiple samples of feed were quantitatively analyzed by two different laboratories (ISU VDL and Covance), with all samples markedly elevated beyond the recommended concentration. The marked difference in quantitative values demonstrates the need to collect multiple representative feed samples for toxicology testing, because the distribution of additives in feed may not be homogeneous. Safety studies in pigs demonstrated no adverse effects when narasin was administered at 45 g per tonne,[8] which is 1.5 times the recommended concentration. Pigs have been reported to show clinical signs (anorexia, dyspnea, depression, leg weakness, ataxia, and recumbency) when administered narasin at 82.5 and 137.5 g per tonne, or 2.8 and 4.6 times the recommended dosage, respectively.[13] The reported median lethal dose in 9-week-old pigs for a single oral dose is 8.9 mg per kg of body weight.[13] The estimated intake of narasin by pigs in this case was 1.8 to 8.6 mg per kg of body weight per day, determined by barn feed intake, narasin concentrations demonstrated in the feed, and an estimated average body weight of 52 kg.

Spontaneous narasin toxicosis has been previously reported in several species, which include pigs in South Africa,[10] Brazil,[11] and Canada,[13] rabbits in Brazil,[19] and dromedary camels.[20] Follow-up experimental reproduction of narasin toxicosis was performed and included in the published rabbit case and one published pig case report.[11,19] The pathological investigation in this case demonstrated extensive skeletal muscle involvement without ventricular myocardial involvement, which is similar to the spontaneous toxicity reported in conjunction with tiamulin in growing pigs in Canada[13] and in rabbits in Brazil,[19] as well as the experimentally induced narasin toxicosis in rabbits[19] and pigs[11] in Brazil. Interestingly, this is also similar to the reported findings in experimentally induced monensin toxicosis in pigs, in which there was extensive skeletal muscle involvement, but necrosis in the heart was inconsistent and affected only the atria (left atrium more frequently than the right).[9] In the cases of spontaneous narasin toxicosis in South African[10] and Brazilian pigs,[11] myocardial necrosis was reported in the ventricles and unspecified anatomical locations, respectively. The cause of the differences in the presence and distribution of cardiac involvement reported in spontaneous toxicoses, experimental toxicoses, and this case is unknown, but may be related to dose ingested, duration of access to contaminated feed, or other factors. Distribution of lesions in numerous skeletal muscles was reported for experimentally induced narasin toxicosis in Brazilian pigs, and the most severely affected muscle was reported to be the diaphragm, as in this case.

The area of cellulitis and dermatitis surrounding the locally extensive coagulative necrosis in pig #3 appears most consistent with a local ischemic event (eg, arterial infarction), which, given the location, was most likely related to the reported enrofloxacin injection. The relationship between the documented narasin toxicosis and the suspected injection-site reaction is unknown.

Implications

- Narasin toxicity should be considered in cases of sudden-onset anorexia or feed refusal with sudden death, painful or weak pigs, and muscle necrosis.
- Multiple samples of feed should be submitted for quantitative ionophore analysis and suspect feed should be replaced while test results are pending,
- Numerous skeletal muscle samples, including diaphragm and proximal esophagus, should be submitted for histopathologic evaluation in suspected cases. Pigs have been reported to occasionally have atrial-selective myocardial necrosis with ionophore toxicosis and both atrial and ventricular myocardium should be sampled.
- Serum CK, AST, and potassium concentrations are indirect measurements of muscle damage and may be useful in monitoring resolution of cases of ionophore toxicosis.
- Feed-mill management and maintenance are of utmost importance to ensure safe and accurate administration of feed additives or micronutrients with narrow safety margins.

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Conflict of interest

Dr Roman Moreno and Dr Rebecca C. Robbins are employed by Seaboard Foods, which owned the pigs described in this case report.

References

1. Ebner T, Montag M, on behalf of the Oocyte Activation Study Group. Live birth after artificial oocyte activation using a ready-to-use ionophore: A prospective multicentre study. *Repro BioMed Online*. 2015;30:359–365. doi:10.1016/j.rbmo.2014.11.012.

2. Gupta PB, Onder TT, Jiang G, Tao K, Kuperwasser C, Weinberg RA, Lander ES. Identification of selective inhibitors of cancer stem cells by high-throughput screening. *Cell*. 2009;138:645–659. doi: 10.1016/j.cell.2009.06.034.

3. Chapman HD, Jeffers TK, Williams RB. Forty years of monensin for the control of coccidiosis in poultry. *Poult Sci*. 2010;89:1788–1801. doi: 10.3382/ps.2010-00931.

4. Novilla MN. The veterinary importance of the toxic syndrome induced by ionophores. *Vet Hum Tox*. 1992;34:66–70.

5. Van Vleet JF, Runnels LJ, Cook JR Jr, Scheidt AB. Monensin toxicosis in swine: Potentiation by tiamulin administration and ameliorative effect of treatment with selenium and/or vitamin E. *Am J Vet Res*. 1987;48:1520–1524.

6. Berg DH, Hamill RL. The isolation and characterization of narasin, a new polyether antibiotic. *J Antibiot*. 1978;31:1–6.

7. Pressman BC, Fahim M. Pharmacology and toxicology of the monovalent carboxylic ionophores. *Annu Rev Pharmacol Toxicol*. 1982;22:465–490.

8. US Department of Health and Human Services, Food and Drug Administration. Freedom of information summary, Original new drug application, NADA 141-340, Skycis 100, Narasin. 2012. Available at **www.fda.gov/downloads/animalveterinary/products/approvedanimaldrugproducts/foiadrugsummaries/ucm326896.pdf**. Accessed 17 April 2016.

9. Van Vleet JF, Amstutz HE, Weirich WE, Rebar AH, Ferrans VJ. Clinical, clinicopathologic, and pathologic alterations of monensin toxicosis in swine. *Am J Vet Res*. 1983;44:1469–1475.

10. Van Halderen A, Bastianello SS, Fourie N, Zumpt IF. An outbreak of narasin poisoning in swine. *J S Afr Vet Assoc*. 1993;64:43–46.

11. Armién AG, Peixoto PV, Döbereiner J, Tokarnia CH. Surto de intoxicação por narasina em suínos [An outbreak of narasin poisoning in swine (in Portugese)]. *Pesq Vet Bras* [*Braz Vet Res*]. 1997;17:63–68.

12. Novilla MN. Ionophores. In: Gupta RC, ed. *Veterinary Toxicology: Basic and Clinical Principles*. 2nd ed. Waltham, Massachusetts: Academic Press; 2012:1281–1299.

13. Carpenter JA, Charbonneau G, Josephson G. Tiamulin and narasin toxicosis in nursery pigs. *J Swine Health Prod*. 2005;13:333–336.

14. Committee on Nutrient Requirements of Swine, Board on Agriculture and Natural Resources, Division on Earth and Life Studies, National Research Council. *Nutrient Requirements of Swine.* 11th rev ed. Washington, DC: National Academies Press; 2012.

15. Riddell FG, Arumugam S, Cox BG. The monensin-mediated transport of Na^+ and K^+ through phospholipid bilayers studied by ^{23}Na- and ^{39}K-NMR. *Biochim Biophys Acta - Biomembranes*. 1988;944:279–284.

16. Riddell FG, Tompsett SJ. The transport of Na^+ and K^+ ions through phospholipid bilayers mediated by the antibiotics salinomycin and narasin studied by ^{23}Na- and ^{39}K-NMR spectroscopy. *Biochim Biophys Acta - Biomembranes*. 1990;1024:193–197.

17. Oehme FW, Pickrell JA. An analysis of the chronic oral toxicity of polyether ionophore antibiotics in animals. *Vet Hum Toxicol*. 1999;41:251–257.

18. Dong Z, Saikumar P, Weinberg JM, Venkatachalam MA. Calcium in cell injury and death*. *Annu Rev Pathol Mech Dis*. 2006;1:405–434. doi: 10.1146/annurev.pathol.1.110304.100218.

19. Salles MS, Lombardo de Barros CS, Barros SS. Ionophore antibiotic (narasin) poisoning in rabbits. *Vet Hum Toxicol*. 1994;36:437–444.

20. Abu Damir H, Ali MA, Abbas T, Omer E, Al Fihail A. Narasin poisoning in the dromedary camel (*Camelus dromedarius*). *Comp Clin Path*. 2012:1–7.

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

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

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

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

Brief communication

Peer reviewed

The effect of antiseptic compounds on umbilical cord healing in piglets in a commercial facility

Amanda L. Robinson; Jessie D. Colpoys, PhD; Glenn D. Robinson; Elizabeth A. Hines, MS; Leo L. Timms, PhD; Erika M. Edwards; Ken J. Stalder, PhD; Anna K. Johnson, PhD; Howard D. Tyler, PhD

Summary

Four hundred and seventy piglets were assigned to four treatment groups: iodine, trisodium citrate, a dry dip created using nisin with talc, and no treatment. No treatment differences were noted on change in diameter or incidence of infection of the umbilical cord during the first 48 hours ($P > .05$).

Keywords: swine, antiseptic, healing, newborn, umbilical cord

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Resumen - El efecto de los compuestos antisépticos en la recuperación del cordón umbilical en lechones de un establecimiento comercial

Se asignaron cuatrocientos setente lechones a cuatro grupos de tratamiento: yodo, citrato de trisodio, un desinfectante seco a base de nisina con talco, y sin tratamiento. No hubo diferencia entre los tratamientos al evaluar el cambio en diámetro o incidencia de la infección del cordón umbilical durante las primeras 48 horas ($P > .05$).

Résumé - Effet de produits antiseptiques sur la guérison du cordon ombilical de porcelets provenant d'une entreprise commerciale

Quatre cent soixante porcelets furent assignés à quatre groupes de traitement: iode, citrate trisodique, un bain sec créé en utilisant de la nisine avec du talc, et aucun traitement. Aucune différence entre les traitements ne fut notée relativement au diamètre ou à l'incidence d'infection du cordon ombilical durant les premières 48 heures ($P > .05$).

The umbilical cord serves as a channel for the blood supply between the fetus and the placenta throughout pregnancy. During the birthing process, the umbilical cord ruptures, leaving it open-ended. This umbilical cord may become a potential route for pathogen entry into the newborn, increasing the risk of septicemia. Nielsen et al[1] reported that 2.1% of live-born piglets died from septicemia, which may result from umbilical infections, although there are several other common causes of this condition in piglets. Subclinical umbilical infections may prevent the abdominal wall musculature from healing completely, increasing the risk for umbilical hernias during the growing phase.[2] The prevalence rate of umbilical hernias in the swine industry is approximately 1%.[3] Preventing infections of the umbilical stump at birth through the use of antiseptic compounds is the most common approach for producers to attempt to decrease the prevalence of umbilical hernias,[1] and tincture of iodine is the most commonly used antiseptic for this purpose.[4] In 2007, the Drug Enforcement Administration listed iodine under the Controlled Substances Act. This regulation has made it difficult to obtain anything greater than 2% tincture of iodine.[5] Trisodium citrate is a component of a recently developed, commercially available umbilical dip (NavelShield Navel Dip; Zurex Pharmagra LLC, Middleton, Wisconsin). It is a non-iodine formulation that provides a wide spectrum of germicidal activity.[6] The nisin dry dip was developed in efforts to increase drying and healing time of umbilicus tissue. In pigs, nisin has effective antimicrobial activity against *Streptococcus suis*, a major worldwide swine pathogen associated with meningitis, arthritis, pneumonia, and septicaemia.[7] The nisin compound was mixed in a talc base because talc is relatively biologically inert and absorbs moisture without caking.[8]

The objective of this project was to compare three antiseptics (2% iodine, 10% trisodium citrate, and a nisin-based product) to no antiseptic treatment and determine their impact on umbilical healing and 24- and 48-hour infection rates in piglets in a field trial.

Materials and methods

This study was approved by the Iowa State University IACUC committee.

A total of 470 mixed-sex commercial piglets (PIC 1050 sow × Danbred 600 sire; average birth weight, 1.15 kg; standard error, 0.33 kg) from a breed-to-wean sow farm were enrolled in this study. Piglets received small ear tags that identified treatment groups. Sows were housed in farrowing stalls (2.1 m × 0.91 m). The piglet area was 0.6 m × 1.8 m on each side of the farrowing stall, with a heat lamp 0.7 m above the floor surface and one rubber mat on the floor underneath the lamp.

Piglets were randomly assigned by alternating the four treatments across birth order within a litter: 2% iodine (n = 116); 10% trisodium citrate (n = 119); a novel dry dip created using an antibacterial peptide (nisin) mixed with talc (formulation concentration = 3.105 g nisin per 100 g talc on a weight per weight basis (n = 117); and no treatment (n = 118). Piglet umbilical cords were dipped within 1 hour of birth using a small disposable cup filled with the antiseptic. Treatments were applied to the umbilical cord tissue and the

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umbilical stump for 5 seconds to ensure consistency of application between treatments and to ensure that the vulnerable opening of the cord was thoroughly disinfected.

At the end of the farrowing period, stall conditions of the farrowing area behind the sow and next to the sow on the rubber mat in each individual stall were evaluated on a wet-dry 3-point scale (1 = < 10% wet, 2 = 10% to 70% wet, and 3 = > 70% wet) and a clean-dirty 3-point scale (1 = < 10% dirty, 2 = 10% to 70% dirty, and 3 = > 70% dirty). Prior to initial dipping, diameter of each umbilical cord just distal to the abdomen, at the widest width of the cord, was determined using digital calipers (Mitutoyo 500-197-30 Absolute Digital Caliper, Aurora, Illinois) at birth and 24 ± 1 hours of age as an indicator of cord drying and healing. As a potential indicator of early umbilical infection, surface temperature of the umbilical stump (along with a reference point at the midpoint of the sternum) was measured using a dual laser infrared thermometer (Model 42570; Extech Instruments, Nashua, New Hampshire). The infrared temperature measurements were obtained at birth, at 24 ± 1 hours of age, and at 48 hours of age. In addition, redness and swelling of the umbilical stump were evaluated visually at both 24 and 48 hours. Redness was recorded as either being present or not present, while swelling was evaluated as either not present, minimal, or clinically significant. Piglets were available for this trial for only the first 48 hours of life.

All data were analyzed using the PROC UNIVARIATE procedure of SAS to determine normality of distribution. All data were further analyzed using mixed linear regression (PROC MIXED; SAS Version 9.3, SAS Institute Inc, Cary, North Carolina). All models included the fixed effects of umbilical diameter at birth, sex (female or male piglets), stall conditions, and treatment. Orthogonal contrasts were used to determine differences in the rate of healing and incidence of infection between piglets with untreated umbilical cords and those that were treated with antiseptics, as well as differences among the antiseptic treatments. All values reported are least squares means. Significance was declared at $P < .05$.

Results

Variations in stall conditions at birth in this study had no effect on healing of the umbilical stump or umbilical infection in the piglets ($P > .05$). Mean stall cleanliness score at farrowing was 2.1 ± 0.7, while mean stall dryness score at farrowing was 1.6 ± 0.6. Mean diameter of umbilical cords for all piglets was 6.60 mm at birth and decreased to a mean of 3.25 mm at 24 hours of age. Additionally, 32.6% of piglets had an umbilical cord that had healed to the point of separation from the body at 48 hours of age. There were no observed treatment differences ($P > .05$) for umbilical cord drying and healing (Table 1). There were no observed umbilical infections (as indicated by elevated umbilical stump surface temperatures) in piglets within the first 48 hours. In addition, no umbilical infections were observed (as indicated by redness and swelling measurements at 24 hours and 48 hours) in any of the piglets within the first 48 hours of life.

Discussion

Despite the perceived importance of umbilical cord care after birth for potentially reducing the incidence of umbilical infections and possible subsequent umbilical hernias, very few randomized trials have evaluated umbilical cord care and antiseptic use in production-animal settings. In one epidemiological study using dairy calves,[9] risk of calf mortality was significantly lower following use of chlorhexidine than after use of iodine or no cord care, while iodine tended to increase mortality risk. In a more recent study, Robinson et al[10] reported no differences between umbilical antiseptic treatments (7% iodine, 10% trisodium citrate, 4% chlorhexidine, and 1000 mmol per L chlorine) for enhancing healing or reducing the incidence of infection in Jersey calves in a clean, dry environment. However, an important consideration when comparing across species is that calves have a much larger umbilical cord than do piglets, which may affect both healing time and risk of infection.

However, the findings of this study with piglets indicated that appropriate antimicrobial solutions applied to the umbilical cord within 1 hour of birth did not affect umbilical infection rate in the first 48 hours of life. There were no observed differences between any of the treatments tested for decreasing the incidence of omphalitis in newborn piglets. In fact, there were no clinical umbilical infections observed in any piglets in this trial, whether they were treated with antiseptic or remained untreated. Umbilical infections often occur after 2 days of age; however, we were able to observe piglets only during the first 48 hours. These data suggest that dipping the piglet umbilical cord with an antiseptic within an hour of birth does not affect the incidence of umbilical infection or healing within the first 48 hours of life if piglets are kept in a clean, dry environment. Because no infections were observed during this time period, we were unable to validate the usefulness of surface temperature for detecting umbilical infections in newborn piglets. Validation of the infrared surface temperature thermometer for detecting infections has yielded mixed results in previous studies.[11,12]

Each antiseptic used in this trial has a different mode of action. Iodine rapidly penetrates into microorganisms and attacks key groups of proteins, nucleotides, and fatty acids, which culminates in cell death.[13] Trisodium citrate affects Mg^{2+} binding and removal of Ca^{2+} from the surrounding milieu of microorganisms that confers antimicrobial properties, as Ca^{2+} may regulate several genes responsible for growth and survival of microbes.[14] Nisin is generally more active on gram-positive than on gram-negative bacteria, and its bactericidal effect is exerted at the cytoplasmic membrane.[15] Nisin kills susceptible bacteria through a multi-step process that destabilizes the phospholipid bilayer of the cell and creates transient pores. Nisin is a small amphiphilic peptide that is cationic at neutral pH. It has been shown to adsorb to surfaces, maintain activity, and kill cells that have adhered in vitro.[16] Nisin is a safe chemical to use for food-animal treatment according to the FDA Code of Federal Regulation listing nisin as a Generally Recognized As Safe (GRAS) substance.[17] In addition, for the purposes of this trial, nisin was mixed with talc to absorb water and help increase the drying and necrosis time of the umbilicus tissue, thus decreasing the availability of a potential route for pathogen entry.

The current study also evaluated a potentially novel technique for assessing early signs of infection using the surface temperature of the umbilicus area compared to the sternal temperature (as determined using infrared technology). An increase in umbilical stump temperature when compared to the sternal temperature, combined with a tender umbilical stump, may indicate the presence of an infection. Similar approaches using infrared technology have been used to diagnose infection in human medical applications.[18] The application of this technology has the potential to be used in detecting subclinical umbilical infections, but could not be vali-

Table 1: Treatment effects on umbilical parameters in piglets during the first 48 hours*

	Treatment				Treatment effect†
Measure	2% iodine	10% trisodium citrate	Nisin dry dip	No treatment	*P*
Umbilical diameter at birth (mm)	6.4 ± 1.3	6.8 ± 1.3	6.7 ± 1.2	6.6 ± 1.1	> .05
Umbilical diameter at 24 hours (mm)	3.2 ± 1.2	3.4 ± 1.2	3.1 ± 1.2	3.3 ± 1.1	> .05
Stump temperature at birth (°C)	28.9 ± 3.1	29.1 ± 3.0	29.0 ± 3.0	29.1 ± 3.0	> .05
Sternal temperature at birth (°C)	30.1 ± 3.3	30.4 ± 3.1	30.1 ± 3.0	30.3 ± 3.3	> .05
Stump temperature at 24 hours (°C)	32.2 ± 2.8	32.5 ± 2.5	32.4 ± 2.6	32.4 ± 2.0	> .05
Sternal temperature at 24 hours (°C)	33.2 ± 2.0	33.4 ± 2.0	33.2 ± 2.0	33.2 ± 1.8	> .05
Stump temperature at 48 hours (°C)	35.0 ± 2.2	35.1 ± 1.9	34.6 ± 2.6	35.1 ± 2.3	> .05
Sternal temperature at 48 hours (°C)	35.4 ± 2.3	35.7 ± 1.8	35.3 ± 2.4	35.7 ± 2.4	> .05

* 470 piglets were assigned to four antiseptic treatment groups: iodine, trisodium citrate, a dry dip created using an antibacterial peptide (nisin) with talc, and no treatment. Piglet umbilical cords were dipped within 1 hour of birth, with treatments applied to the umbilical cord tissue and stump for 5 seconds. Diameter of the widest part of the umbilical cord, just distal to the abdomen, was determined using digital calipers at birth and 24 ± 1 hours of age. Surface temperature of the umbilical stump was measured at birth, at 24 ± 1 hours of age, and at approximately 48 hours of age of age using a dual laser infrared thermometer. Redness and swelling of the umbilical stump were evaluated visually at 24 and 48 hours.

† All data were analyzed using mixed linear regression and orthogonal contrasts. Significance was declared for values of $P < .05$.

dated in this study. Sternal temperature was used as a reference point for normal body temperature. Umbilical stump temperatures were lower than sternal temperatures at birth in all piglets (n = 470) due to decreased blood flow to that area associated with healing. This may have been because of low ambient temperature in the pen areas where the piglets were born, diverting blood flow away from non-essential areas and reducing umbilical stump temperature.

In addition, the use of digital calipers to measure the diameter of the umbilical cord may be useful to assess healing rate of the cord. A decrease in the diameter of the cord indicates that the umbilical cord is desiccating and the stump is healing.

In conclusion, there was no benefit to using an antiseptic treatment on piglet umbilical cords for improving healing or reducing the incidence of infections during the first 48 hours of life under the clean, dry stall conditions that were present in this study. Several management and environmental factors specific to this study may have affected the association between disinfectants, infection rate, and cord healing. Piglets in this study originated from a single farm, were born during the same season, and were housed in temperature-controlled facilities. In addition, piglets were removed from the study at 48 hours of age, and there may have been differences in infection rate after that time point.

Implication

Under the conditions of this study, none of the three dips tested differ from no treatment in preventing umbilical infections and permitting healing of the umbilical cord when used within 1 hour of birth.

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References

1. Nielsen NC, Riising HJ, Larsen, JL, Bille N, Svendsen J. Preweaning mortality in pigs. 5. Acute septicaemia. *Nord Vet Med.* 1975;27:129–139.

*2. Blackwell T, Hayes R, Charbonneau G. Umbilical hernias: problems for pigs, producers, and packers. *Pig Chat News Letter*. 2007;10:4. Available at http://devsouthwestvets.diligens.com/Portals/15/2007/PIGCHAT%200407.pdf. Accessed 30 March 2016.

3. Spicer EM. Preweaning mortality. In: Straw BE, Zimmerman JJ, D'Allaire S, Taylor DJ, eds. *Diseases of Swine.* 9th ed. Ames, Iowa: John Wiley and Sons; 2006:993–1009.

*4. Miller RF, Ingram R. Care and management. In: Farley JL, van Riet WJ, eds. *Swine Care Practices.* California Pork Industry Group and University of California Cooperative Extension. Available at http://www.vetmed.ucdavis.edu/vetext/local-assets/pdfs/pdfs_animal_welfare/swineCarePrax.pdf. Accessed 7 April 2016.

5. Drug Enforcement Administration (DEA). Changes in the Regulation of Iodine Crystals and Chemical Mixtures Containing Over 2.2 Percent Iodine. 2007. Available at http://www.deadiversion.usdoj.gov/fed_regs/rules/2007/fr0702.htm. Accessed 7 April 2016.

*6. Zurex Pharmagra Brochure. 2012. Available at http://zurexpharmagra.com/products/ZuraLac/. Accessed 7 April 2016.

7. LeBela G, Pichéa F, Frenettea M, Gottschalk M, Grenier D. Antimicrobial activity of nisin against the swine pathogen *Streptococcus suis* and its synergistic interaction with antibiotics. *Peptides.* 2013;50:19–23.

8. FDA. Food and Drug Administration. Talc. 2014. Available at http://www.fda.gov/Cosmetics/ProductsIngredients/Ingredients/ucm293184.htm. Accessed 26 April 2016.

9. Waltner-Toews D, Martin SW, Meek AH. Dairy calf management, morbidity and mortality in Ontario Holstein herds. IV. Association of management with mortality. *Prev Vet Med.* 1986;4:159–171.

10. Robinson AL, Timms LL, Stalder KJ, Tyler HD. Short communication: The effect of 4 antiseptic compounds on umbilical cord healing and infection rates in the first 24 hours in dairy calves from a commercial herd. *J Dairy Sci.* 2015;98:595–601.

11. Mufti A, Coutts P, Sibbald GR. Validation of commercially available infrared thermometers for measuring skin surface temperature associated with deep and surrounding wound infection. *Adv Skin Wound Care.* 2015;28:11–16.

12. David R, Kristin B, Martin LL. A comparative study of non-contact infrared and digital rectal thermometer measurements of body temperature in the horse. *J Equine Vet Sci.* 2011;31:191–193.

13. McDonnell G, Russell AD. Antiseptics and disinfectants: Activity, action, and resistance. *Clin Microbiol Rev.*1999;12:147–179

14. Weijmer MC, Debets-Ossenkopp YJ, van de Vondervoort FJ, ter Wee PM. Superior antimicrobial activity of trisodium citrate over heparin for catheter locking. *Nephrol Dial Transplant*. 2002;17:2189–2195.

15. Lubelski J, Rink R, Khusainov R, Moll GN, Kuipers OP. Biosynthesis, immunity, regulation, mode of action and engineering of the model antibiotic nisin. *Cell Mol Life Sci.* 2008;65:455–476.

16. Bower, CK, McGuire J, Daeschel MA. Suppression of *Listeria monocytogenes* colonization following adsorption of nisin onto silica surfaces. *Appl Enviro Microbiol* 1995;61:992–997.

17. FDA. Food and Drug Administration. Nisin GRAS Notice Information. 2000. Available at **http://www.fda.gov/ucm/groups/fdagov-public/@fdagov-foods-gen/documents/document/ucm266587.pdf**. Accessed 26 April 2016.

18. Fierheller M, Sibbald RG. A clinical investigation into the relationship between periwound skin temperature and local wound infection in patients with chronic leg ulcers. *Adv Skin Wound Care.* 2010;23:369–379.

* Non-refereed references.

PRACTICE TIP

PEER REVIEWED

Fact sheets – Ingredient database management: Part I, overview and sampling procedures and Part II, energy

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This practice tip includes fact sheets on sampling procedures for ingredients and assigning net energy values to ingredients.

Keywords: swine, energy, net energy, feeding value, feed sampling

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Conflict of interest

None reported.

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FACT Sheet: Ingredient database management. I. Overview and sampling procedures

Database management overview

A common best-practice for diet formulation ingredient database management is to start by selecting energy and nutrient values for ingredients from one or more sources, such as the National Research Council (NRC).[1] It should be noted that selecting values from different ingredient databases can be problematic, primarily concerning energy, fiber, and other components where quality control of assays is poor and different methods are utilized. It is generally best to select one database and use it to the maximum extent possible. Ingredient chemical analysis can be used to confirm or modify differences in nutrient profiles from reference sources, customizing to specific ingredient sources or local agronomic conditions. Additionally, as new alternative ingredients are available in the market, accurate estimations of their nutrient profiles are necessary. Therefore, a critical factor in obtaining accurate ingredient analysis is appropriate sampling.

Sampling procedures

The sampling procedures[2,3] are separated into four steps, shown below.

Steps in sampling feed ingredients

1. Define the number of samples to be collected;
2. Select the appropriate equipment for sampling;
3. Define the sampling location and size; and
4. Thoroughly mix subsamples and conduct a sample reduction (samples often must be blended and sample size reduced for analysis).

Number of samples

To determine the number of samples needed, one must have previous information from the standard deviation of the chemical analysis (ie, from NRC or farm-specific information). For example, if the goal is to collect the correct number of samples to estimate the crude protein of soybean meal within 0.5%, one can determine the number of samples by using the equation

$$n = \left(\frac{Z_{0.975} \times s}{0.5}\right)^2$$

where $z_{0.975}$ is 1.96 for a 95% confidence interval, s is the standard deviation of the sample, and n is the number of samples needed. If crude protein in soybean meal has a standard deviation of 0.99, then

$$n = \left(\frac{1.96 \times 0.99}{.05}\right)^2$$

Thus, n = 15 samples are needed.

If one is sampling from bagged or sacked products, the number of bags to sample may vary with the size of the load or shipment. For bagged shipments with multiple pallets, sample each pallet to reach the total number of samples required (ie, 15 samples total and three pallets: five samples should be collected from each pallet).

Fast facts

Maintaining an accurate ingredient database is important for predictable growth performance of pigs and economic optimization of the production system.

A standardized sampling procedure is key to manage a successful ingredient database.

Chemical analysis to verify ingredient database values is important for signaling the time when ingredient values should be updated. To maintain a consistent database, appropriate sampling procedure is needed.

For shipments involving different lots, obtain a sample from each lot and retain separately. If sampling from bulk products loaded into vehicles with multiple compartments, sample each compartment to reach the total number of samples required (ie, 15 samples total and three compartments: collect five samples from each compartment).

Sampling equipment

The correct selection of sampling equipment is necessary to obtain a representative sample. The most common sampling equipment is the slotted grain probe (Figures 1 and 2), which can be manual or automated.[2,3] Probes are available in a variety of sizes to appropriately sample the bag, container, or truck where a representative sample is being obtained. For trucks or railcars, the cylinder slotted or automatic probe should be long enough to reach the bottom of the vehicle to obtain samples. The slotted grain probe must be inserted in the closed position, and once in place, opened to obtain a representative sample. If this procedure is followed, the slotted grain probe has the advantage of obtaining a sample throughout the entire depth of the material.

Sampling location and size

Sampling patterns by probe should ensure that a representative sample is collected. For bulk grain, Figure 3 shows an example of locations for collection from a vehicle (truck or railcar). This pattern may be varied, but demonstrates product in two compartments being sampled. If only one probe is collected, particular care should be taken to vary the compartment and location within the compartment during sampling. Some automatic probes collect sample only from the end of the probe, as opposed to its entire length. If this is the case, take care to vary the depth of the probe.

While sampling by probe is the most common method, many mills instead either sample with a pelican sampler or with the catch method during unloading, ie, sampling from the moving stream of ingredient. Once again, as with probed samples, the number of samples collected is calculated on the basis of the ingredient's expected variability and the desired confidence interval of the estimate. However, multiple samples should be collected at regular intervals of time throughout the discharge of the lot to be sampled. These samples are then pooled and reduced. If this is the case, the samples should be

Figure 1: Manual slotted grain probe diagram. Reproduced with permission from Herrman.[3]

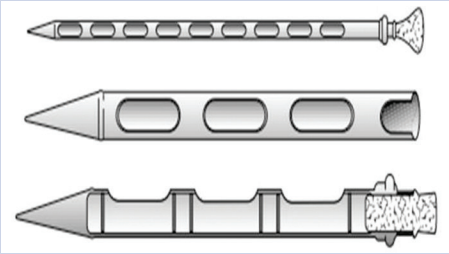
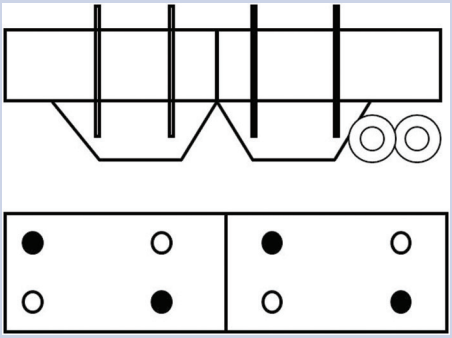


Figure 2: Manual slotted grain probe. Reproduced with permission from Herrman.[3]

Figure 3: Example of locations for sampling (lateral and top view in a hopper-bottom truck).



small collections. Regardless of the sampling method, the sample size for grain should not be less than 1 kg.[2]

When sampling bagged feeds and ingredients (Figure 4), insert the probe or bag trier diagonally, so that it reaches the opposite corner. Withdraw the probe and pour the sample into a container. Approximately 500 g should be collected from each bag. If the lot is 10 bags or fewer, sample each bag; if the lot is 11 bags or more, select 10 bags representative of varying locations in the lot to sample.

Liquid ingredients and fats. Sampling procedures for liquid ingredients and fats use the same principles as for sampling dry ingredients, but with modified liquid probes or collection devices that can be affixed to hoses to collect representative samples during unloading.[2]

Aseptic feed sampling. When sampling feeds or ingredients for analysis of biological hazards, use aseptic sampling.[4] Further information on aseptic sampling can be found at `https://www.youtube.com/watch?v=dXbBLn9WKGE&feature=youtu.be`.

Figure 4: Bagged-ingredient sampling

Figure 5: Riffle divider. Reproduced with permission from Herrman.[3]

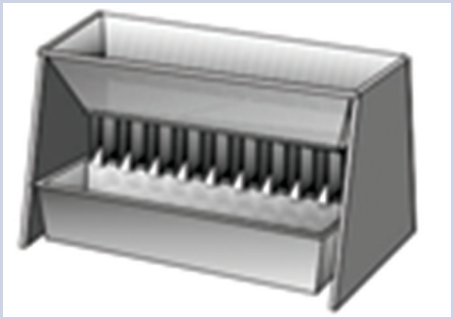
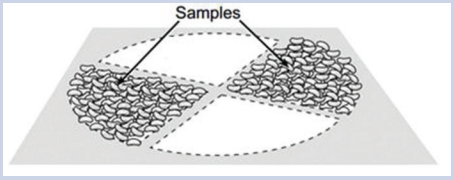


Figure 6: Quartering method. Reproduced with permission from Herrman.[3]



Sample reduction

If sample reduction is necessary, thoroughly mix subsamples. The samples can be split with a riffle divider[2] (Figure 5) or by the quartering method (Figure 6). For proper division using a riffle divider, pour the sample evenly over the divider, then combine the catch pans and pour the combined sample through the divider a second time. One of the pans can then be discarded and the process repeated to reduce sample size. The desirable end result will be two samples of approximately 500 g each: one that may be submitted for chemical analysis and a second that may be retained as a backup. Normally, the samples are retained until the livestock are slaughtered.

Implication

It is critical to obtain accurate nutrient values for all feed ingredients used in swine production by using a standardized sampling procedure to monitor chemical composition of incoming ingredients.

Acknowledgement

Contribution no. 16-049-J from the Kansas Agricultural Experiment Station, Manhattan, KS 66506-0210.

References

1. National Research Council. *Nutrient Requirements of Swine*. 11th rev ed. Washington, DC: National Academy Press; 2012:127–156.

2. National Grain and Feed Association. *Model Feed Quality Assurance Program Notebook*. 8th ed. Washington, DC. 2009:1–83.

*3. Herrman T. Sampling: Procedures for feed. 2001. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Available at http://www.ksre.k-state.edu/bookstore/pubs/mf2036.pdf. Accessed 25 January 2016.

4. Association of American Feed Control Officials. *Feed Inspector's Manual*. 5th ed. Champaign, Illinois: AAFCO. 2014. Available at http://www.aafco.org/Portals/0/SiteContent/Publications/AAFCO_Feed_Inspectors_Manual_5th_ed.pdf. Accessed 29 March 2016.

* Non-refereed reference.

FACT Sheet: Ingredient database management. II. Energy

Dietary energy is an important and expensive component of swine diet. The net energy (NE) system is the most correlated to performance[1] compared to systems based on digestible and metabolizable energy. The most common ingredient values are from the National Research Council (NRC)[2] and the French National Institute for Agricultural Research (INRA).[3] A well-founded energy system in formulation is especially important with the increasing use of alternative ingredients.

Fast facts

There are different methodologies for assigning a net energy value to an ingredient; however, consistently using the same methodology to assign energy values to ingredients is essential for developing a successful database.

Of equal importance is to use net energy values for ingredients that match the net energy values used for requirements estimates.

How to assign or update energy values in ingredient databases

Ingredients with different chemical profiles will generally have different energy concentrations. In order to assign or update an energy value for an ingredient, different approaches are possible.

Estimation and validation trials

These approaches use experiments conducted in commercial research barns to generate more information regarding the ingredient.

Estimation trial. This approach uses energy efficiency of gain (kcal of NE per kg of gain) to estimate the NE per kg of the ingredient.[4] After calculating the energy efficiency of gain, the researchers calculate what the energy content of the ingredient would be to provide the same energy efficiency as a standard corn-soybean-meal-based diet.

Validation trial. In this approach, the nutritionist assigns the estimated energy value and then conducts a trial with different inclusion rates of the ingredient compared to a standard corn-soybean-meal-based diet. The expectation is that any change in dietary energy will match performance across the different inclusion rates, as evaluated by the slope of the linear regression between feed efficiency and the ingredient inclusion rate.[5]

It must be noted that these approaches are not dynamic and do not take into account changes in chemical composition of the given ingredient over time.

NRC model equations

Different equations for predicting NE were presented by the NRC in 2012.[2] However, the equation from Noblet et al[6] was used in the NRC[2] publication to calculate NE content of feedstuffs because of the difficulty in acquiring some of the nutrients required by other equations (eg, sugar, digestibility values). The equation by Noblet et al[6] requires chemically analyzed values of crude protein (CP), acid detergent fiber (ADF), ether extract (EE), and starch values. Additionally, this equation requires a metabolizable energy (ME) value. Therefore, if no ME value is available for the ingredient, the ME equation presented in NRC[2] can be used to estimate a ME value using ash, CP, EE, and neutral detergent fiber (NDF).

INRA/EvaPig software

INRA/EvaPig software[3] (Saint-Gilles, France) integrates equations for several different classes of ingredients to predict a NE and nutrient profile. If the ingredient is biologically similar to any other ingredient family (cereals, cereal by-product, vegetable protein sources, dairy by-products, etc) one can use the most similar ingredient as reference. This method[3] is recommended rather than creating an ingredient profile from scratch, because the energy values of the ingredient will be calculated by using specific energy equations related to the reference ingredient. For example, creating a cereal by-product with 88% dry matter (DM), 9% CP, 12% NDF, 3% ADF, 2% ash, 3% crude fat, and 63% starch, and using corn as the reference ingredient in EvaPig, the ingredient is calculated with 2588 kcal of NE per kg for growing pigs, whereas corn in EvaPig is estimated at 2651 kcal of NE per kg.

If there is no available ingredient or family of ingredients to use as reference, then an ingredient can be created using equations in the software. To calculate the ME or NE value of the ingredient, the chemical analysis of DM, ash, CP, NDF or ADF, and either crude fat or gross energy, are mandatory. Analysis of starch is required to calculate ME and NE. Analysis of sugars adds precision to the calculations. The EvaPig software manual[3] has step-by-step instructions on this process. For example, the same cereal by-product described above is calculated as having 2580 kcal of NE per kg for growing pigs when using corn as the reference ingredient. When only the generic EvaPig equations are used, the estimate is slightly different (2580 kcal per kg). Additionally, this software accounts for differences in energy digestibility between the growing pigs and adult sows, while the NRC methods do not.[7] It is important to note that estimates using prediction equations should use input values that are within the range used to generate the prediction equations.

Supplier information

Some nutritionists use energy values provided by the ingredient supplier. It is important to have an understanding of the methodology used to derive those values and to gauge if they are logical, given the chemical composition. Another method is to use chemical analysis provided by the supplier and use either the NRC model equations[2] or INRA/Eva Pig software[3] to predict the energy value.

Calculate energy value relative to a reference ingredient

Some nutritionists have a high degree of confidence in the energy value they use for a reference ingredient such as corn. Thus, they will

use one of the methods described to generate an energy value for the unknown ingredient and use the same method to generate an energy value for their reference ingredient. If the generated value for the reference ingredient is different from the value in which they have a high degree of confidence, they adjust the calculated unknown ingredient value. The adjustment is made by multiplying the calculated unknown ingredient energy value by the ratio of the calculated reference ingredient value to the reference value in which they have a high degree of confidence. This method generates a relative value in which the ingredient is assigned an energy value relative to the nutritionist's reference ingredient in which they have a high degree of confidence, in the same ratio of the calculated unknown to calculated reference ingredient values. The nutritionist then uses the adjusted value in their database. For example, the new ingredient is calculated as having 2000 kcal of NE per kg, whereas corn has a calculated value of 2651 kcal per kg; therefore, the ratio is 2000 ÷ 2651 = 0.754. In the nutritionist's database, corn is valued at 2600 kcal NE per kg, so the new ingredient would be valued at 2600 × 0.754 = 1960 kcal NE per kg. If this approach is used, the reference ingredient must have a chemical profile (CP, NDF, EE, ash, starch) similar to the test ingredient. The energy values of common alternative ingredients presented as a ratio to corn are shown in Table 1.

It is important to emphasize that consistently using the same methodology to assign energy values to ingredients is essential for developing a successful database. Additionally, it is of equal importance to use NE values for ingredients that match the NE values used for requirement estimates. For example, if the requirement estimate is derived from NRC,[2] the NE ingredient values should be obtained from that source, not from the ingredient values in EvaPig.[3]

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References

1. 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.

2. NRC. Feed ingredient composition. In: *Nutrient Requirements of Swine*: 11th rev ed. Washington, DC: National Academy Press; 2012:239–242.

3. EvaPig. Evaluation of pig feeds. Reference manual. 2008. Available at: **http://www.evapig.com/**. Accessed 3 May 2016.

4. Hastad CW, Tokach MD, Goodband RD, Nelssen JL, Dritz SS, DeRouchey JM, Jones CL. Comparison of yellow dent and NutriDense corn hybrids in swine diets. *J Anim Sci*. 2005;83:2624–2631.

*5. Boyd RD, Zier-Rush CE, Fralick CE. Practical method for estimating productive energy (NE) of wheat middlings for growing pigs [abstract]. *J Anim Sci*. 2010;88:51.

6. Noblet J, Fortune H, Shi XS, Dubois S. Prediction of net energy value of feeds for growing pigs. *J Anim Sci*. 1994;72:344–354.

7. Le Goff G, Noblet J. Comparative total tract digestibility of dietary energy and nutrients in growing pigs and adult sows. *J Anim Sci*. 2001;79:2418–2427.

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

*Non-refereed reference.

Table 1: Energy value of feed ingredients related to that of corn for growing pigs

Ingredient	NRC[8]		EvaPig[3]	
	ME	NE	ME	NE
Corn	100	100	100	100
Corn DDGS (6%-9% oil)	100	88	101	78
Sorghum (milo)	104	104	100	99
Soybean meal, dehulled	97	78	99	75
Soybean hulls	57	37	56	38
Wheat middlings	87	79	77	69

DDGS = Dried distillers grains with solubles; ME = metabolizable energy; NE = net energy; NRC = National Research Council.

PQA Plus 3.0 launched at World Pork Expo

The new PQA Plus revision 3.0 was launched at the World Pork Expo in June. This version offers timely updates, greater convenience, and a stronger focus on the caretakers' role.

"PQA Plus revision 3.0 reflects pork producers' desire to continually improve and meet higher standards," said Bill Winkelman, vice president of producer and industry relations for the Pork Checkoff. "New research and better ways of presenting practical information are reflected in the latest version of PQA Plus."

Continuous improvement defines PQA Plus, which is revised every 3 years. "We incorporate feedback from producers, packers, PQA Plus advisors, and others to deliver a solid program," said Dinah Peebles, manager of certification programs for the Pork Checkoff. Revisions are reviewed by producers on several Pork Checkoff committees and are beta tested to make sure the information is useful to producers.

Three major enhancements in PQA Plus revision 3.0, include

1. Greater focus on caretakers,

2. New, interactive learning modules, and

3. Alignment of assessments, audits.

For more information, contact Dinah Peebles at DPeebles@pork.org or 515- 223-2795.

We Care plays key role in updated program

In the updated PQA Plus program, the We Care ethical principles now serve as the main chapter subjects, with the 10 Good Production Practices (GPP) restructured as subchapters.

Chapter 1: Food Safety

GPP 1: Establish a Herd Health Management Plan

GPP 2: Correctly Store and Administer Animal Health Products

GPP 3: Ensure Safe, Wholesome Pork Products

GPP 4: Follow Proper Feed Processing and Feed Biosecurity Protocols

Chapter 2: Animal Welfare

GPP 5: Provide Proper Care for the Pig

GPP 6: Provide Proper Care When Handling and Transporting the Pig

Chapter 3: Public Health

GPP 7: Protect Swine and Public Health

Chapter 4: Workplace Safety

GPP 8: Maintain Proper Workplace Safety

Chapter 5: Environment

GPP 9: Practice Good Environmental Stewardship

Chapter 6: Community

GPP 10: Participate In the Community

As of March 1, 2016, more than 64,000 individuals had achieved PQA Plus certification and 17,126 sites had been assessed.

Pork Checkoff announces 2016 Pork Industry Scholarship recipients

The Pork Checkoff has awarded 22 scholarships to college students around the United States as part of its strategy to develop the pork industry's future leaders. Successful applicants were selected from a pool of 35 applicants on the basis of scholastic merit, leadership activities, involvement in the pork production industry, and future plans for a career in pork production.

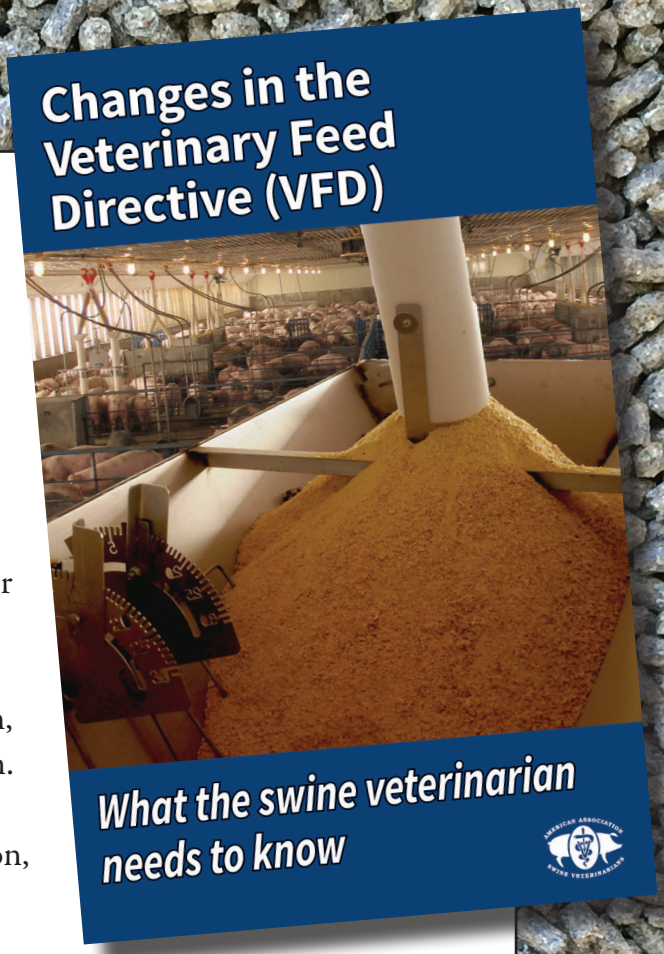
"The 2016 scholarship winners will positively impact the swine industry in the future," said National Pork Board President Derek Sleezer, a pork producer from Cherokee, Iowa. "We have an ongoing obligation to producers to help develop the next generation of pork producers. The goal is to ensure a sustainable source of leaders who will be ready to produce safe, wholesome food in a socially responsible way."

This year's top candidates were Taylor Homann and Kyle Anderson, who will receive $5000 and $3500 scholarships, respectively. Homann, a senior at the University of Minnesota, is majoring in animal science. She plans to continue her academic career by pursuing a doctor of veterinary medicine degree in the fall. Anderson, a junior at Kansas State University, has worked at the university's feed mill and would like to pursue a career as a mill manager after graduation. The remaining award recipients will receive $2000 each.

For more information, contact Chris Hostetler at CHostetler@pork.org or 515-223-2606.

NPB News continued on page 224

The US Veterinary Feed Directive (VFD) has changed



The new VFD regulation became effective October 1, 2015

The use of any feed-grade antimicrobial with a VFD label is now subject to the new regulation. This includes tilmicosin, florfenicol, and avilamycin, which are already VFD drugs labeled for use in swine.

Pharmaceutical manufacturers will transition other medically important, feed-grade antimicrobials to VFD labels by December 2016. Essentially all swine antibiotics will be affected, except bacitracin, carbadox, bambermycin, ionophores, and tiamulin. These antibiotics will remain available for growth promotion or over-the-counter (OTC) distribution, or both.

The AASV has prepared and mailed a brochure to all US members that highlights the responsibilities of the veterinarian issuing a VFD, the information required on a VFD, the need for a veterinary-client-patient relationship, and additional items of interest. The brochure is available online at **www.aasv.org/aasv/publications.htm**.

The AASV urges swine veterinarians to become familiar with the regulation, which is available – along with additional information and updates – on the FDA's Veterinary Feed Directive Web page: **http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/ucm071807.htm**.

Extra-label use of feed-grade antimicrobials remains ILLEGAL.

Questions about VFDs?

Contact:
AskCVM@fda.hhs.gov

NPB News continued from page 222

PQA Plus outlines paths to good swine health

Through its Pork Quality Assurance Plus (PQA Plus) program, the Pork Checkoff is reminding pork producers that antibiotics are just one tool in a producer's animal health plan, which includes proper nutrition, clean water, air ventilation, temperature management, animal housing maintenance, animal care, and even genetics.

Dr Jennifer Koeman, Pork Checkoff's director of producer and public health, says vaccinations are a key to keeping pigs healthy. "They must be used at the right time, on the right organisms," she said. "Along with heightened biosecurity measures to minimize the pathogens that animals encounter, this should go a long way to protecting pig health."

The PQA Plus program outlines steps for responsible antibiotic use, which can help minimize the potential risk of resistance developing within a herd. Here are points to consider:

- Use antibiotics for treatment only when there's an appropriate clinical diagnosis supported by clinical signs, necropsy, laboratory tests, herd history, and other factors.
- Identify factors that contribute to the cause of the disease, such as management, stressors, and pig flow, which are all a part of an accurate diagnosis.
- Consider herd-health history along with diagnostics that include culture and sensitivity tests to help in antibiotic selection.
- Consider group morbidity and mortality rates when deciding whether to initiate herd, group, or individual therapy.
- Limit antibiotic treatment to ill or at-risk animals, treating the fewest animals indicated.

As always, the National Pork Board advises producers to work with their veterinarian to select the most appropriate therapy for the specific situation, as well as any antibiotic-resistance implications for your farm and human health.

For more information, contact Jennifer Koeman at **JKoeman@pork.org** or 515-223-2633.

Webinars: Alternatives to antibiotics in swine feed

The Animal Science Committee of the National Pork Board is once again hosting their annual research Webinar series. The theme of this year's series is "Alternatives to Antibiotics in Swine Feed." As producers prepare for the reduced availability and flexibility of using feed-grade antibiotics due to the new FDA regulations, many are looking for suitable alternatives to keep their pigs healthy. This Webinar series will highlight the results of some of the Checkoff-funded research projects in the area of reproductive efficiency. The schedule and topics are as follows:

August 2: Dr Hans Stein – Management guide for reduced usage of antibiotics in swine production

- Pigs will have different management requirements when raised without antibiotics for growth promotion.

August 9: Dr Robin Anderson – Efficacy of thymol

- Thymol is a natural compound that has potent antimicrobial activity under laboratory conditions; however, will it work when fed to pigs?

August 16: Dr William Oliver – Feeding lysozyme to disease-challenged pigs

- These research results show that pigs fed lysozyme have performance comparable to that of pigs fed antibiotics.

August 23: Dr Crystal Levesque – Use of microbially-converted soybean meal in nursery diets

- Microbially-converted soybean meal may be used as a suitable replacement for fishmeal in nursery diets and supports gut health.

The Webinars will be held each Tuesday during the month of August at noon Central Time and are free to the public, but do require participants to pre-register. The link to register for these Webinars can be found at **www.pork.org/animalscience**.

For more information, contact Chris Hostetler at **CHostetler@pork.org** or 515-223-2606.

AASV NEWS

Board addresses antibiotic-free production

The American Association of Swine Veterinarians (AASV) Board of Directors addressed the issue of antibiotic-free production during their recent meeting in Perry, Iowa. Veterinarians serving on the association's pig welfare and pharmaceutical issues committees raised concerns regarding pig health and well-being in antibiotic-free production systems. The committees considered issues associated with concerns that animals requiring antibiotics may not receive timely treatment under certain antibiotic-free production strategies.

The timely treatment of sick animals is a standard of proper animal husbandry promoted by veterinarians and supported by America's swine farmers. Some antibiotic-free systems, however, do not provide marketing options for the animals that do need antibiotic treatment. This disincentive may lead to delayed treatment or the failure to treat altogether. Members of AASV consider this to be unacceptable from the standpoint of proper animal health and well-being.

Dr George Charbonneau, AASV president, commented that, "the AASV is committed to sustainable pork production. Maintaining the health and welfare of the pigs that are in our care is a top priority. We recognize there is a market for pork that is raised without antibiotics. It may be necessary, however, in any production system to provide timely and judicious antibiotic treatment in order to avoid animal suffering. Consequently, every antibiotic-free program should have the ability to sell antibiotic-treated pigs through an alternate market, following a safe withdrawal time."

In response to these concerns, the AASV board adopted an official position statement (see sidebar) regarding raising pigs without antibiotics.

> Any pork production system that is marketing pigs raised without the use of antibiotics should closely involve veterinarians in the management of herd health. If a pig is sick, or is at risk of getting sick, it is our responsibility as swine veterinarians to prevent or treat illness in a judicious manner to maintain animal health and welfare. Farmers should have an alternative marketing plan in place for pigs that need to be treated with an antibiotic.*,† It is important that the decision to treat or euthanize is made in a timely manner so as to minimize the pig's pain or distress.
>
> * If an animal has been treated with antibiotics and proper withdrawal times are followed, the meat is safe for consumption.
>
> † Marketing programs should not prevent a farmer from treating or preventing illness.

Call for submissions – Industrial Partners

The American Association of Swine Veterinarians invites submissions for the Industrial Partners portion of the 48th AASV Annual Meeting, to be held February 25 to 28, 2017, in Denver, Colorado. This is an opportunity for commercial companies to make brief presentations of a technical, educational nature to members of the AASV.

As in the past, the oral sessions will consist of a series of 15-minute presentations scheduled from 1:00 to 5:00 PM on Sunday afternoon, February 26. A poster session will take place on the same day. Poster authors will be required to be stationed with their poster from 12:00 noon until 1:00 PM, and the posters will remain on display throughout the afternoon and the following day for viewing by meeting attendees.

Restricted program space necessitates a limit on the number of presentations per company. Companies that are members of the *Journal of Swine Health and Production* Industry Support Council (listed on the back cover of each issue of the journal) may submit two topics for oral presentation. All other companies may submit one topic for oral presentation. Sponsors of the AASV e-Letter may submit an additional topic for oral presentation. In addition, every company may submit one topic for poster presentation (poster topics must not duplicate oral presentations). All topics must represent information not previously presented at the AASV annual meeting or published in the meeting proceedings.

To participate, send 1) company name, 2) presentation title, 3) a brief description of the presentation content, and 4) contact information for the presenter (name, mailing address, telephone number, and e-mail address) to AASV by **September 30, 2016**. Please identify whether the submission is intended for oral or poster presentation. Send submissions to **aasv@aasv.org**.

Presenters will be notified of their acceptance by October 14, 2016, and must submit a paper for publication in the meeting proceedings by November 15, 2016. Companies failing to submit papers in a timely manner may not be eligible for future participation in these sessions.

There is no charge for participation in the Industrial Partners sessions, but all presenters are required to register for the meeting (nonmember participants may register at the AASV regular member rate). The AASV does not provide a speaking stipend or travel reimbursement to Industrial Partners presenters.

AASV news continued on page 227

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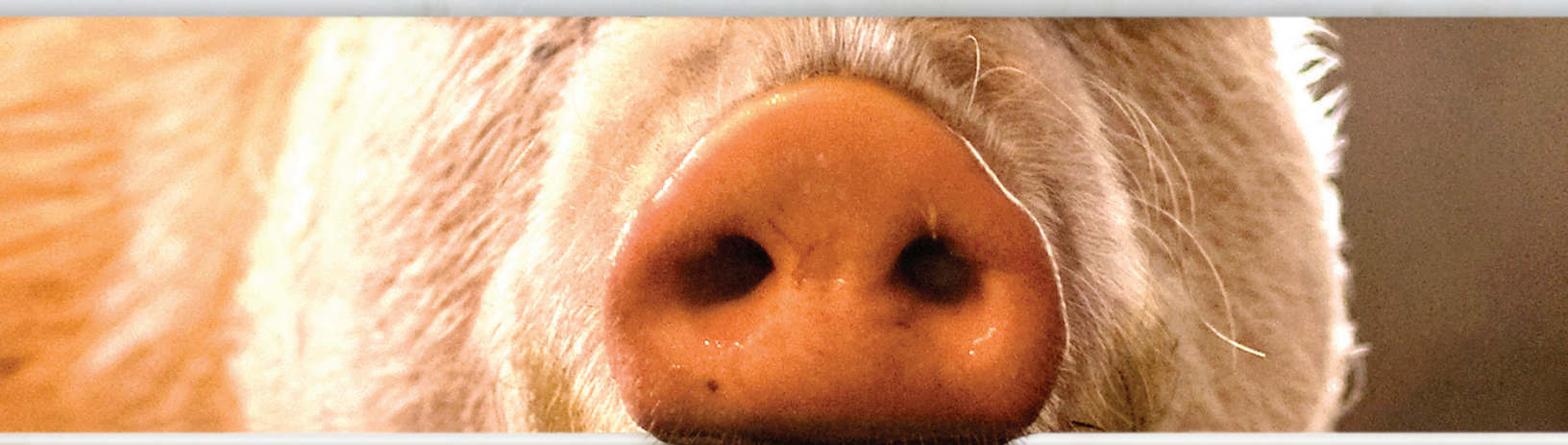

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AASV news continued from page 225

Call for papers – AASV 2017 Student Seminar

The American Association of Swine Veterinarians announces an opportunity for veterinary students to make a scientific presentation during the Student Seminar at the AASV Annual Meeting in Denver, Colorado, on Sunday, February 26, 2017. Interested students are invited to submit a one-page abstract of a research paper, clinical case study, or literature review for consideration. The submitting student must be a current (2016-2017) student member of the AASV at the time of submission and must not have graduated from veterinary school prior to February 26, 2017. Submissions are limited to one (1) abstract per student.

Abstracts and supplementary materials must be received by Dr Maria Pieters (**pieters@aasv.org**) by 11:59 PM Central Daylight Time on Wednesday, September 21, 2016 (firm deadline). All material must be submitted electronically. Late abstracts will not be considered. Students will receive an e-mail confirming the receipt of their submission. If they do not receive this confirmation e-mail, they must contact Dr Maria Pieters (**pieters@aasv.org**) by Friday, September 23, 2016, with supporting evidence that the submission was made in time; otherwise, the submission will not be considered for judging. The abstracts will be reviewed by an unbiased professional panel consisting of a private practitioner, an academician, and an industry veterinarian. Fifteen abstracts will be selected for oral presentation in the Student Seminar at the AASV Annual Meeting. Students will be notified by October 14, 2016, and those selected to participate will be expected to provide the complete paper or abstract, reformatted for publication, by November 15, 2016.

As sponsor of the Student Seminar, Zoetis provides a total of $20,000 in support to fund travel stipends and the Top Student Presenter scholarship. The student presenter of each paper selected for oral presentation receives a $750 stipend to help defray the costs of attending the AASV meeting.

Veterinary Student Scholarships

Each veterinary student whose paper is selected for oral presentation competes for one of several veterinary student scholarships awarded through the AASV Foundation. The oral presentations will be judged to determine the amount of the scholarship awarded. Zoetis funds the $5000 scholarship for the student whose paper, oral presentation, and supporting information are judged best overall. Elanco Animal Health provides $20,000 in additional funding, enabling the AASV Foundation to award $2500 each for 2nd through 5th place, $1500 each for 6th through 10th place, and $500 each for 11th through 15th place.

Abstracts that are not selected for oral presentation in the Student Seminar will be considered for participation in a poster session at the annual meeting. Zoetis and the AASV fund a stipend of $250 for each student who is selected and participates in the poster presentation. In addition, the presenters of the top 15 poster abstracts compete for awards ranging from $200 to $500 in the Veterinary Student Poster Competition sponsored by Newport Laboratories.

Complete information for preparing and submitting abstracts is available on the AASV Web site at **www.aasv.org/annmtg/2017/studentseminar.htm**. Please note: the rules for submission should be followed carefully. For more information, contact the AASV office (Tel: 515-465-5255; Fax: 515-465-3832; E-mail: **aasv@aasv.org**).

Call for abstracts – Research Topics session

Plans are underway for the 48th annual meeting of the American Association of Swine Veterinarians (AASV), to take place February 25 to 28, 2017, in Denver, Colorado. As part of the meeting, there will be a session highlighting research projects related to swine health and production. Abstracts are now being accepted for potential presentation during the Research Topics session.

Those interested in making a 15-minute oral presentation should submit a one-page abstract on applied research related to swine health and production issues (virology, bacteriology, parasitology, environment, food safety, odor, welfare, etc) to **aasv@aasv.org** by **August 15, 2016.** Include the presenting author's name, mailing address, phone number, and e-mail address with each submission.

Abstracts not selected for oral presentation will be considered for poster presentation. All submitting authors will be notified of the selection results in September. Authors of abstracts selected for oral or poster presentation must provide their paper, formatted for publication in the meeting proceedings, by November 15, 2016.

PLEASE NOTE: Participation in the Research Topics oral and poster session is at the presenter's expense. The presenting author is required to register for the meeting (nonmember participants may register at the AASV regular member rate). No speaking stipend or travel expense reimbursement is paid by the AASV.

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FOUNDATION NEWS

Are you a Leman Fellow? You should be!

More than 20 years after the inception of the Leman Fellow program, foundation leaders have re-opened the popular giving program and are calling upon a new generation of AASV members to "ensure our future... create a legacy" for swine veterinarians.

Conceived in 1995 and named in honor of the late industry leader and AASV past president Dr Allen D Leman, the program established an endowment to ensure the foundation's long-term financial stability. Foundation leaders at that time challenged AASV members to demonstrate their commitment to the profession by making a $1000 contribution to the foundation, with the assurance that the contributions would be invested to provide a perpetual source of income for foundation programs and activities. More than 120 AASV members and supporters answered the challenge by enrolling as Leman Fellows.

Over the years, fundraising events and additional giving programs (Heritage, Legacy) have added to the foundation's endowment, which now approaches the noteworthy benchmark of $1 million. Concurrently, the number of programs funded by the foundation has also increased, leading the foundation board to set the ambitious goal of achieving a $2 million endowment by the AASV's 50th annual meeting in 2019. To help reach this goal, the foundation once again challenges each member of the swine veterinary community to make a personal investment in the future of the profession by becoming a Leman Fellow.

A contribution of $1000 entitles the giver to the Leman Fellow designation and lapel pin, along with recognition on the foundation Web site and an invitation to the annual AASV Foundation Luncheon. Perhaps most importantly, Leman Fellows receive the satisfaction of knowing that their contributions will be invested to provide income for lasting support of foundation programs, including scholarships, research grants, AASV keynote lectures, student travel stipends, SMEC tuition grants, AASV Heritage videos, and more!

It's easy to become a member of this prestigious group of foundation donors: simply make a $1000 contribution to the AASV Foundation, directed to the Leman Fellow program. Leman Fellow contributions may be made in a single contribution or divided into installments to be paid over a period of up to 4 years. Leman Fellows who later decide to take their giving to the next stage may apply their Leman Fellow contributions towards the Heritage ($5000) and Legacy ($50,000) giving levels.

Mail contributions to Leman Fellow Program, AASV Foundation, 830 26th Street, Perry, IA 50220-2328, or submit credit card payment online at `http://ecom.aasv.org/misc`.

The 121 Leman Fellows on the list that follows have each made a personal commitment to the future of the swine veterinary profession. Is your name on the list? It should be!

AASV Foundation Leman Fellows

Matthew A. Ackerman
Roberta Alvarez
Sandy Amass
Jack L. Anderson
Paul J. Armbrecht
John E. Baker
Steven A. Bales
David A. Baumert
Angela K. Baysinger
Tim Blackwell
Paul Blotkamp
R. L. Brodersen
Wayne W. Brown
Thomas J. Burkgren
John A. (Randy) Bush
Brian Caldwell
Cary Christensen
L. Kirk Clark
Jack L. Coleman
James E. Collins
Richard D. Collins
Richard Conger
Joseph F. Connor
John M. Cunningham
Bernard J. Curran
G. Michael Daniel
Dean Dau
David D. Davis
Scott Dee
John Deen
James E. Dick
Dennis D. DiPietre
R. C. Ebert
Mark J. Engle
Robert W. Evelsizer
Steve Feuerbach
Lawrence D. Firkins
James Fleck
Wayne R. Freese
Jerome Geiger
Thomas G. Gillespie
Robert Graybill
Patrick G. Halbur
D. L. Hank Harris
Peggy Anne Hawkins
Dale Hendrickson
Howard T. Hill
Alex Hogg
J. Tyler Holck
William Hollis
Derald Holtkamp
Thayer C. Hoover
Jeffrey Husa
Rodney G. Johnson
Randy Jones
Kerry Keffaber
Kent Kislingbury
Darrel A. Kraayenbrink
Michael J. Kuhn
Elizabeth A. Lautner
Tim J. Loula
James Lowe
David P. Madsen
Thomas A. Marsteller
Paul E. Mleziva
Robert B. Morrison
Gene Nemechek
Daryl Olsen
Duane Pankratz
Craig W. Pfeifer
James D. Pillen
William E. Plummer
David Pyburn
Tracy Ann Raef
David E. Reeves
Larry G. Robison
Max T. Rodibaugh
Brian D. Roggow
Lawrence R. Rueff
Paul Ruen
Anthony R. Scheiber
Alan B. Scheidt
Russell L. Schelkopf
Richard H. Schlueter
Conrad B. Schmidt
Rodger Schneck
Jan Schuiteman
Gary Schultz
Roy A. Schultz
Leann Schulz-Thomas
Michael Senn
Richard L. Sibbel
Ludwig Simmet
Rebekah Simmet
Randy Simonson
Harry Snelson
Steve A. Sornsen
Gordon D. Spronk
William A. Starke
Douglas Stine
James W. Temple
Michael D. Terrill
Brad Thacker
Eileen Thacker
Robert Thompson
Harold Tilstra
Lisa Tokach
Timothy P. Trayer
Roderick C. Tubbs
Eldon K. Uhlenhopp
Melissa Fleck Veenhuizen
Ralph A. Vinson
John Waddell
Elizabeth A. Wagstrom
Thomas L. Wetzell
Ron D. White
Warren D. Wilson
Nathan L Winkelman
Kurt Wohlgemuth
Kenneth T. Wright
Paul E. Yeske

Continued on page 231

AASV Foundation continued from page 229

Foundation golf outing returns to Ames, Iowa

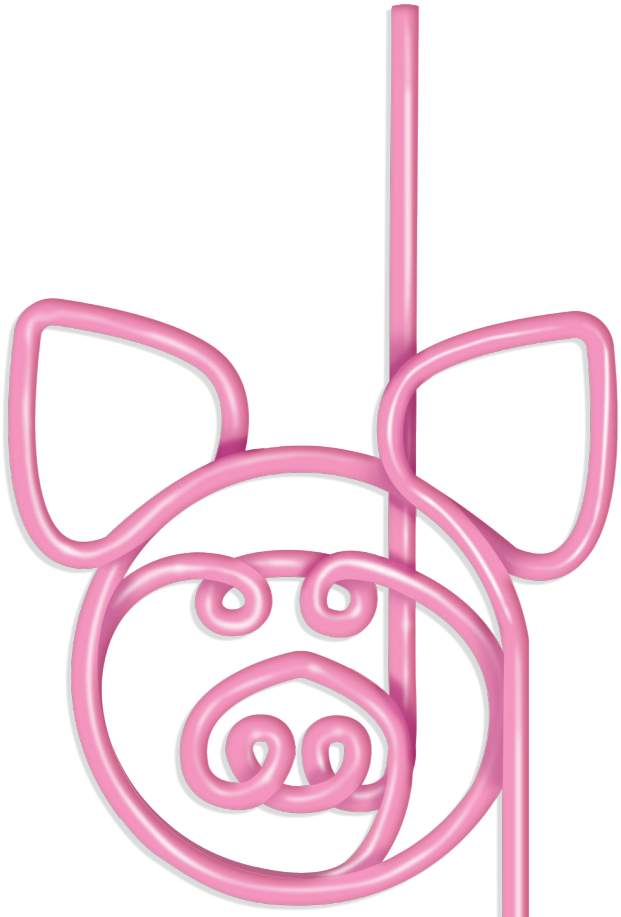
Registration is now open for the popular AASV Foundation Golf Outing, to be held at the Veenker Memorial Golf Course on **Thursday, August 25,** in Ames, Iowa. Previous foundation outings held at this championship golf facility on the Iowa State University campus have enjoyed record attendance.

Members of AASV, family, staff, clients, friends, producers, and other industry stakeholders are all welcome to register a four-person team for this friendly 18-hole best-ball tournament. Individuals and couples may also register and will be assigned to a team. Golfers will test their combined skills against the challenges of the course and compete in individual contests along the way.

Golfer check-in begins at 11:00 AM the day of the event, with the driving range and practice balls available for warm-up before the contest begins. The four-person team, best-ball competition gets underway at 12:00 noon with a shotgun start. Box lunches and beverages will be provided. Following the golfing, team and individual contest winners will be recognized during a pork dinner.

The registration fee includes 18 holes of "best-ball" golf, cart rental, lunch, beverages, awards dinner, and prizes. Proceeds from the outing provide support for the AASV Foundation as it seeks to "ensure our future...create a legacy" for swine veterinarians. Income generated by the event helps fund foundation programs such as swine externship grants for veterinary students, travel stipends for students attending the AASV Annual Meeting, research funding, Swine Medicine Education Center tuition grants, heritage member videos, and more.

For a sneak preview of the golf course, visit **http://www.veenkergolf.com**. For more information about the outing, contact AASV: Tel: 515-465-5255; E-mail: **aasv@aasv.org**.



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Raising pigs without antibiotics

The American Association of Swine Veterinarians (AASV) Board of Directors addressed the issue of antibiotic-free production during their recent meeting in Perry, Iowa. Veterinarians serving on the association's pig welfare and pharmaceutical issues committees raised concerns regarding pig health and well-being in antibiotic-free production systems. The committees considered issues associated with concerns that animals requiring antibiotics may not receive timely treatment under certain antibiotic-free production strategies.

Dr John Baker, a private practitioner from Indiana, brought the issue before the committees in a letter raising concerns about production practices he was observing in the field that risked animal health and well-being. A market for pork raised without antibiotics has arisen in response to retail perceptions indicating a consumer demand. It is becoming increasingly common to see restaurants and retailers touting products "raised without antibiotics." As a result, some processors are offering an economic incentive to farmers to raise pigs without the use of antibiotics in the hopes of filling this demand. Consumers are often misinformed regarding the use of antibiotics on the farm and any risk that they may pose to human health from eating pork.

There was not much debate within the committees. Although accepted that, under certain circumstances, it is possible to raise pigs without antibiotics and that antibiotics must be used judiciously, the members stressed that animals that need to receive antibiotics to prevent or treat disease should be treated. The timely treatment of sick animals is a standard of proper animal husbandry promoted by veterinarians and supported by America's swine farmers. Some antibiotic-free systems, however, do not provide marketing options for the animals that do need antibiotic treatment. This disincentive may lead to delayed treatment or the failure to treat altogether. Members of AASV consider this to be unacceptable from the standpoint of proper animal health and well-being.

"The timely treatment of sick animals is a standard of proper animal husbandry promoted by veterinarians and supported by America's swine farmers."

Dr George Charbonneau, AASV president, commented that, "the AASV is committed to sustainable pork production. Maintaining the health and welfare of the pigs that are in our care is a top priority. We recognize there is a market for pork that is raised without antibiotics. It may be necessary, however, in any production system to provide timely and judicious antibiotic treatment in order to avoid animal suffering. Consequently, every antibiotic-free program should have the ability to sell antibiotic-treated pigs through an alternate market after a safe withdrawal time."

First and foremost, swine veterinarians speak for the health and well-being of the pig and the promotion of public health. While consumers may request that pigs be raised a certain way, that doesn't necessarily mean it's in the best interest of the pig or even food safety and public health. It is important that we reinforce the basic tenets of livestock production that are paramount to animal health and well-being, particularly when those tenets are ignored for reasons of economic gain and market access. Accepting increased morbidity and mortality, delaying or withholding necessary treatment, or failing to perform timely euthanasia are unacceptable.

In response to these concerns, the AASV board has adopted a position statement regarding raising pigs without antibiotics. The position statement is shown in the box below:

> Any pork production system that is marketing pigs raised without the use of antibiotics should closely involve veterinarians in the management of herd health. If a pig is sick, or is at risk of getting sick, it is our responsibility as swine veterinarians to prevent or treat illness in a judicious manner to maintain animal health and welfare. Farmers should have an alternative marketing plan in place for pigs that need to be treated with an antibiotic.*,† It is important that the decision to treat or euthanize is made in a timely manner so as to minimize the pig's pain or distress.
>
> *If an animal has been treated with antibiotics and proper withdrawal times are followed, the meat is safe for consumption.
>
> † Marketing programs should not prevent a farmer from treating or preventing illness.

As Dr Baker put it in his letter, "swine veterinarians should promote responsible antibiotic use in pork production and lead the pork industry in educating the public. To do otherwise means we have failed in our responsibility to lead the industry on matters of animal health and welfare and have failed the animals in our care."

Harry Snelson, DVM
Director of Communications

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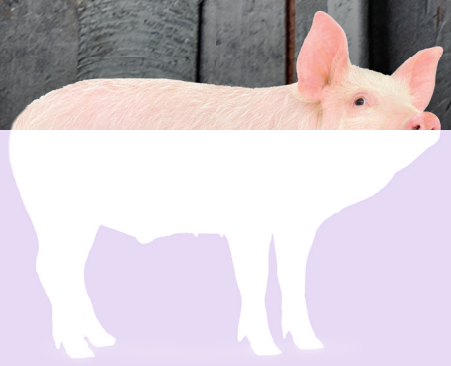

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Upcoming meetings

Passion for Pigs 2016 Seminar & Trade Show Tour

August 23-December 6, 2016

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August 23 (Tues)
VMC Management
Cedar Rapids, Iowa

September 8 (Thurs)
Bush Stadium
St Louis, Missouri

September 15 (Thurs)
Orange City Veterinary Clinic
Orange City, Iowa

November 17 (Thurs)
Minnesota Swine Reproduction Center
Mankato, Minnesota

November 29 (Tues)
North Central Veterinary Services
Ohio

December 6 (Tues)
Passion for Pigs
Columbia, Missouri

For more information:
Julie Lolli, Executive Coordinator
Tel: 660-651-0570
E-mail: julie.nevets@nevetsrv.com
Web: http://www.passionforpigs.com

2016 Allen D. Leman Swine Conference

September 17-20, 2016 (Sat-Tue)
St Paul RiverCentre, St Paul, Minnesota

For more information:
University of Minnesota
Veterinary Continuing Education
1365 Gortner Avenue
St Paul, MN 55108
Web: http://www.cvm.umn.edu/vetmedce/events/adl/home.html

Leman China Swine Conference

October 16-18, 2016 (Sun-Tue)
Nanjing, China

For more information:
Frank Liu
University of Minnesota
St Paul, Minnesota
Tel: 612-625-2267
E-mail: liuxx0b3@umn.edu
Web: http://www.cvm.umn.edu/lemanchina/

2016 ISU James D. McKean Swine Disease Conference

November 3-4, 2016 (Thu-Fri)
Hosted by Iowa State University
Ames, Iowa

For more information:
E-mail: registrations@iastate.edu
Web: http://www.extension.iastate.edu/registration/events/conferences/swine/
Dr Chris Rademacher, Conference Chair
Iowa State University
E-mail: cjrdvm@iastate.edu

2016 North American PRRS Symposium (NA-PRRS) Emerging and Foreign Animal Diseases

December 3-4, 2016 (Sat-Sun)
Intercontinental Hotel and Downtown Marriott
Magnificent Mile in Chicago, Illinois

For more information:
Web: http://www.vet.k-state.edu/na-prrs/index.html

Banff Pork Seminar

January 10-12, 2017 (Tue-Thu)
Banff, Alberta, Canada

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

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

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

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Spring day on a farm in Iowa

Photo courtesy of Dr Grant Allison

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