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Journal of Swine Health & Production

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Vitamin A and iron for piglet anemia
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AASV
902 1st Avenue
Perry, IA 50220-1703
Tel: 515-465-5255; Fax: 515-465-3832
E-mail: **aasv@aasv.org**

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

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

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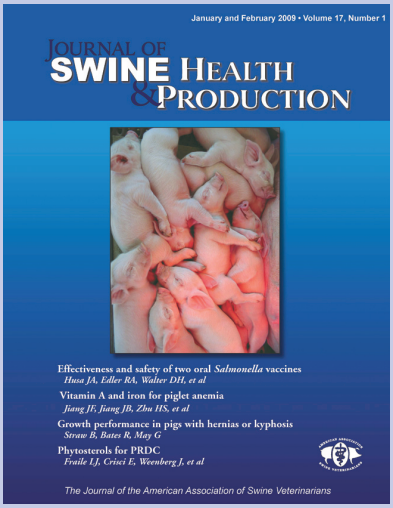

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Table of contents

President's message 5
From the Executive Director 7
From the Executive Editor 9
A comparison of the safety, cross-protection, and serologic response associated with two commercial oral *Salmonella* vaccines in swine 10
Husa JA, Edler RA, Walter DH, et al

Combined treatment with vitamin A and iron to prevent piglet anemia 22
Jiang JF, Jiang JB, Zhu HS, et al

Anatomical abnormalities in a group of finishing pigs: prevalence and pig performance 28
Straw B, Bates R, May G

Effect of treatment with phytosterols in three herds with porcine respiratory disease complex 32
Fraile LJ, Crisci E, Weenberg J, et al

Conversion tables 41
News from the National Pork Board 43
AASV news 47
AASV Foundation news 51
Advocacy in action 54
Straight talk 59
Vice-presidential candidates 60, 61
Author guidelines 62
Upcoming meetings 63

"In this day and age of large systems with large numbers of employees, it is not simple to make sure everyone is doing the right thing. It is not simple, but it is imperative."

quoted from the Executive Director's message on page 7

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President's message

Tipping point?

Kerry Keffaber, DVM

This message is being written as election results are being reported. I am always intrigued by the process and the media and political maneuverings. Looking at how and why individuals make their decisions, trying to understand human and group behavior, would be great entertainment if the results were not so impacting. While it is interesting to hear the variation in experts' analysis of the reasons behind the results, of even more insight are the responses I receive listening to regular Joes such as cab drivers, gas-station attendants, shopping clerks, or business travelers, scattered in different locales with varied backgrounds.

On reviewing what I heard the last several months, I have become more convinced that the actual facts do not matter when looking at trends and social behavior. To repeat the often repeated quote, "Perception is reality." Even deeper, looking at my recent data points, voting decisions are not made on data but feelings. People vote and take action with their hearts versus their heads. Behavior is more driven by emotion than by fact or science. This is not to say the decisions are wrong, or that because the recent election trend was counter to mine, all other voters must be stupid or did not think (I will let you and time determine the intelligence of the results). My point is, if we want to have influence, focusing on emotion will yield larger results if the world is casting a vote either in an election box or a grocery store cash register. These are the two arenas that can change the way we raise livestock.

This is really tough for me to admit, because as veterinarians, we are scientists and believe facts are king and will win eventually every time. Wrong. The most reinforcing example is the approval of Proposition 2 in California – an action that will eliminate egg production in the state, raise costs for consumers, and, it can be argued, lower food safety. Science was strongly on our side, but that argument did not gain any traction. While the science must always be right, it is foolish to debate the masses on anything but an emotional-component basis.

The recent happenings have reminded me of a book I read several years ago, *The Tipping Point: How Little Things Can Make a Big Difference,* by Malcom Gladwell.[1] The idea behind the book is very simple. The best way to understand the changes that mark everyday life is to think of them as epidemics. Ideas and products and messages and behaviors spread just like viruses. Items that become trends have three characteristics: one, contagiousness; two, the fact that little causes can have big effects; and three, change happens not gradually but at one dramatic moment. The "tipping point" is that magic moment when an idea, trend, or social behavior crosses a threshold, tips, and spreads like wildfire. That is the dramatic moment when everything can change all at once. The examples and documentations in the book were paradigm-shifting for me. Post reading, I now evaluate happenings under a totally different light. To give the book true justice, one must read for more depth than this simple explanation and learn the three rules of the tipping point: the Law of the Few, the Stickiness Factor, and the Power of Context.

Looking at the national presidential election, what was the tipping point? Was it the economic crash, with John McCain's quote "The fundamentals of the economy are sound"? Was it having his VP's credibility implode through Saturday Night Live parodies or from reports of her clothes-shopping spree? Or was it the emotion, trust, and hope generated by a man with humble beginnings on the verge of a new frontier when Barack Obama stated "I can no more disown him than I can disown the black community," defending Reverend Wright in his landmark speech on US race relations. They all match the criteria. The ideas created were contagious and "stuck" with many; the specific acts were narrow and minor compared to the broad magnitude of the future job; and the change occurred dramatically and quickly.

Is the passage of Proposition 2 the tipping point in animal welfare? Yes, but the direction is yet to be determined. It could and is highly likely to lead to a state-by-state referendum to eliminate one choice of humane options for livestock production. However, if we focus on the *emotion* of small businessmen going out of business, loss of jobs, young mothers and retirees unable to afford higher-priced eggs, lowered food safety, and more imports from outside the United States, Proposition 2 passage could be the tipping point for many to feel the unintended consequences of similar actions. Time will tell. I am just not sure if my emotions will be happy with either outcome.

Reference

1. Gladwell M. *The Tipping Point: How Little Things Can Make a Big Difference.* Boston, Massachusetts: Little, Brown & Company; 2000.

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From the Executive Director

Who's watching now?

Tom Burkgren, DVM

I own five televisions – all of which are of the analog persuasion (one is even black-and-white). Very soon now these will cease to work without a digital converter box. This is just another reminder that we live in a digital world that is overflowing with technological advancements. The possibilities created through these advancements are having an impact on almost every part of our daily life.

For the most part, these advancements are beneficial in some way. I marvel at how a video of my son's basketball game can be digitally recorded, then stored and played back on my home computer. However, there are occasions when perhaps we wish technology was not so advanced or pervasively applied. We were given a stark reminder of that in 2008 when an undercover video was recorded in a sow unit in Iowa, documenting alleged animal abuse. Much to the delight of PETA (the instigators of the undercover operation), this video created a stir in the industry.

There have been other undercover videos of swine as well as other species. However, this particular video struck close to home for several reasons. Geographically it was less than 30 miles from the AASV office. In addition, the sow unit had close ties, both past and current, to veterinarians who are members of the AASV. Lastly, I was thrust into the role of a spokesperson for the industry. It was an up close and personal experience with several aspects of the news media.

The good news was that for the most part, the media personnel were friendly and not prejudicial in their questions or their reporting. Ultimately, the story persisted for only a couple of days, despite PETA's attempts to keep it in the news. However, it did make it into the national news and into the consuming public's view. It faded from public view due to other more pressing news, such as the economic and financial crisis. The video definitely raised the issue of how pigs are treated on the farm, and it brought certain production practices into question.

Animal handling, euthanasia, and castration are all seen on the video. PETA presented everything on the video as abuse and produced the video in a manner to depict it that way. We all know there are better and more humane ways of moving animals than beating them with gate rods. The language and verbal abuse recorded on the video were perhaps more damaging than the recorded actions. However, the PETA depiction of routine production practices as abuse is intellectually and scientifically dishonest.

When done properly, euthanasia of baby piglets by blunt-force trauma is humane. It results in rapid insensibility and consistent death. The training of personnel in proper application is essential. It is not aesthetically pleasing to perform or watch, and because of this, the veterinary profession must be constantly looking for and researching other humane methods of euthanasia for all sizes and ages of pigs. One interesting aspect of the video was the euthanasia of a sow which was done correctly. It was presented as part of the alleged abuse, but the euthanasia itself could not have been done any better. In an instance like this, we have to step up and point out the inconsistency and purposeful lies aimed at harming the industry.

Castration of piglets without anesthesia is another issue that is going to be brought up again in future campaigns against the pork industry. The science has shown us that rapidly performing the procedure and use of minimal handling decrease the stress on the animal. So far, the science has not shown any advantage to the use of anesthesia or analgesics in piglets. Once again, proper training of personnel and skill development can go a long way in the humane processing of pigs. We must staunchly defend the scientific truth that supports certain practices utilized in pork production.

Undercover videos and investigations are common tactics of anti-animal-agriculture groups such as PETA and HSUS. Unfortunately, these tactics are an effective means of casting doubt as to the care and handling of animals on farms. As much as we would like to ignore them, we cannot. The digital technology that makes this all possible is here to stay and will most likely become more advanced in the future. Short of requiring all personnel to work in the nude, I don't believe we can ever be assured that undercover video is not being recorded.

When we accept that undercover video is a brutal fact for hog production today, our strategy becomes very straightforward. If we assume that at any given time someone may be watching how we handle and care for our animals, then we make sure that we are doing the right thing. If we have nothing to hide, then we will not care who is videotaping. Please notice that I said straightforward, not simple. In this day and age of large systems with large numbers of employees, it is not simple to make sure everyone is doing the right thing. It is not simple, but it is imperative.

Every video that is recorded, released, and celebrated by our opponents will have a cumulative effect over time. Our opponents count on this as part of their strategy to gradually wear down animal agriculture and give the public the perception that abuse is common and pervasive. It is up to us to not give them anything of interest to video record. It is up to us to make sure that everyone in the barn, and I do mean everyone, is doing the right thing at all times. We have to keep asking ourselves: Who's watching now?

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From the Executive Editor

KTT in Kenya = Capacity building

Cate Dewey, DVM, MSc, PhD

The latest buzz phrase is KTT or "knowledge translation and transfer." KTT means taking new research findings and translating them into useful information that veterinarians and producers can put into practice. Our implication statements assist with that process and help you to carry the information to producers in the field. KTT is also accomplished through writing articles for producer magazines and speaking at veterinary and producer meetings, an essential role of researchers. Research is relevant when the new knowledge improves what is done in our industry.

In developing countries, KTT is called "capacity building." It, too, provides veterinary technicians and pig farmers with information relevant to their industry. It aims to give them the opportunity to improve how they manage pigs in direct response to our research findings.

Veterinarians Without Borders, Canada, funded the capacity-building component of my work in Kenya. We put on 1-day workshops for government employees who work directly with subsistence pig farmers. These employees included veterinary, livestock, and public-health technicians, veterinarians, adult-education specialists, and social workers whose role is to provide advice to farmers' groups. We then facilitated the government workers to train the farmers. This is a "train the trainers" model of education. Most farmer workshops took place in a farmer's yard, under a mango tree.

This capacity building did improve management and the level of farmer knowledge. We asked the farmers what they implemented after our research farm visits and workshops. The management changes and the proportion of farmers who implemented each change are as follows: fed the pig more and a wider variety of feed (58%), estimated the pig's weight prior to sale (49%), housed the pig (34%), gave the pig medication (29%), and bred the sows two times versus one time per estrus (17%). Farmers were 2.8 times more likely to know about *Taenia solium*, the tapeworm that causes epilepsy due to neurocysticercosis, after the workshop than before and were 3.6 times more likely to know about it after the workshop plus one-on-one training at their farm ($P < .001$). However, people who had personally attended the workshop were 4.6 times more likely to know about the disease than people who lived on a farm where someone else attended ($P < .001$). If this association is transferable to North America, we need to encourage multiple people from each farm to attend workshops. We cannot rely on those who attend to spread the knowledge.

At the end of one training day, a pig farmer approached me, smiling from ear to ear and showing me her finger. Loosely translated from Swahili, she said, "Do you remember me? You cured my finger and now my hand is without pain." When I met her in November 2006, she owned two beautiful long brown sows that were nursing 14 piglets. Her right hand was pulsing with pain from an infected finger. The distal third of the finger had turned black. She had no means of getting medical attention. I suggested she soak her hand in hot salt water three times a day. Either because of me or in spite of me, her finger is now fully functional. Like so many of the farmers we interact with, it is these personal encounters that add extra meaning to our work. The Kenyan farmers, like pig farmers in North America, are genuinely good people, hard-working and dedicated to doing the best for their pigs. I feel a real connection to these farmers and the whole community, where the charity I started, Children of Bukati, is supporting the education of AIDS orphans.

In 2006, there were 150 AIDS orphans at the local elementary school and many more who were staying at home. Today, the charity is supporting the education of 514 orphans. All orphans in the community are being educated. With the help of our donors, the children are eating lunch 3 days a week. Altogether, they consume 140 kg of beans and 140 kg of corn each day. The school is working towards sustaining the education of the orphans without financial help from the charity, beginning in 2013. They have rented 7 acres of land to grow maize, beans, and kale. Our long-term goal is to purchase 10 acres of land. We built a corn grist mill for the local women to grind their corn to make ugali, the staple food in this region. Women pay a small fee for this service. The profits from the mill purchased a dairy cow for the school. There is a good local market for the milk. The school's three sows have produced piglets that were sold at weaning, and the livestock enterprise now includes three sheep. The school also sells eggs and breeding birds from their chicken enterprise. More information about this project can be found at **www.childrenofbukati.com**.

KTT or capacity building brings researchers in contact with the world outside the university. It enables our work to effect change in the industries we serve. It puts a name and a face to the people whose lives can be improved by the work we do. This makes our work so much more worth the effort.

A comparison of the safety, cross-protection, and serologic response associated with two commercial oral *Salmonella* vaccines in swine

Jeffrey A. Husa, DVM; Roy A. Edler, MS; Donald H. Walter, DVM; J. Tyler Holck, DVM, MS, MBA; Ryan J. Saltzman, DVM

Summary

Objectives: To compare safety, cross-protection, and serologic response associated with two *Salmonella* serovar Choleraesuis vaccines.

Materials and methods: Eighty 4-week-old pigs, seronegative and culture-negative for *Salmonella*, were assigned to four groups of 20. The nonvaccinated challenged control group (NVC) was inoculated with virulent *Salmonella* serovar Typhimurium. Two groups received either Enterisol SC-54 (SC-54; Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) or Argus SC/ST (Argus; Intervet Inc, Millsboro, Delaware) avirulent live *Salmonella* serovar Choleraesuis vaccines (Day 0) and were challenged (Day 43) with *Salmonella* serovar Typhimurium. The strict control group (NVNC) was nonvaccinated and nonchallenged. Individual body weights, clinical scores, rectal temperatures, and necropsy observations were recorded. *Salmonella* serum antibodies were measured using an indirect ELISA (Idexx Laboratories, Westbrook, Maine).

Results: After vaccination, the Argus group showed more severe and frequent pyrexia and lower average daily gain (ADG) and Day 43 body weights than the SC-54 and NVC groups ($P < .05$). Vaccinates demonstrated cross-protection against *Salmonella* Typhimurium, with less severe and frequent pyrexia and lower individual clinical scores ($P < .05$). Prevalence of enteric lesions and total clinical scores were lower with SC-54 ($P < .05$). Vaccinal seroconversion was not detected pre-challenge, despite demonstrated cross-protection. By Day 52, 95% to 100% of all challenged pigs seroconverted.

Implications: Enterisol SC-54 causes no adverse effects. Argus SC/ST induces significant deleterious responses. Both vaccines confer *Salmonella* Typhimurium cross-protection, with greater cross-protection by SC-54. As vaccinal seroconversion is not detected, monitoring programs using this ELISA are unlikely to be confounded by vaccination.

Keywords: swine, *Salmonella* serovar Typhimurium, vaccine, safety, efficacy

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Resumen - Comparación de la seguridad, protección cruzada, y respuesta serológica asociada a dos vacunas comerciales orales de *Salmonella* en cerdos

Objetivos: Comparar la seguridad, protección cruzada, y repuesta serológica asociada con dos vacunas de *Salmonella* serovar Choleraesuis.

Materiales y métodos: Ochenta cerdos de 4 semanas de edad, seronegativos y negativos al cultivo de *Salmonella*, se asignaron a cuatro grupos de 20. El grupo control retado, no vacunado (NVC por sus siglas en inglés) fue inoculado con *Salmonella* serovar Typhimurium virulenta. Dos grupos recibieron vacunas contra *Salmonella* Choleraesuis viva, no virulenta ya fuera Enterisol SC-54 (SC-54; Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) ó Argus SC/ST (Argus; Intervet Inc, Millsboro, Delaware) (Día 0) y se retaron con *Salmonella* Typhimurium (Día 43). El grupo control negativo (NVNC por sus siglas en inglés) no fue vacunado ni retado. Se registraron los pesos individuales, evaluación clínica, temperatura rectal, y observaciones a la necropsia. Se midieron los anticuerpos en suero contra *Salmonella* utilizando una ELISA indirecta (Idexx Laboratories, Westbrook, Maine).

Resultados: Después de la vacunación, el grupo Argus presentó una pirexia más severa y frecuente y menor ganancia diaria (ADG pos sus siglas en inglés) y peso corporal en el Día 43 que los grupos vacunados con la SC-54 y NVC ($P < .05$). Los cerdos vacunados demostraron una protección cruzada contra *Salmonella* Typhimurium, con una pirexia menos severa y frecuente y una mejor evaluación clínica individual ($P < .05$). La prevalencia de lesiones entéricas fue menor y la evaluación clínica fue mejor con la vacuna SC-54 ($P < .05$). No se detectó serconversión contra la vacuna antes del reto, a pesar de que se demostró la protección cruzada. Para el Día 52, 95% a 100% de los cerdos retados seroconvirtieron.

Implicaciones: La vacuna Enterisol SC-54 no causa efectos adversos. Argus SC/ST induce reacciones deletéreas significativas. Ambas vacunas confieren protección cruzada contra *Salmonella* Typhimurium, con una mayor protección cruzada de la SC-54.

JAH, RAE, DHW, JTH: Boehringer Ingelheim Vetmedica, Inc, Ames, Iowa.

RJS: Veterinary Resources, Inc, Ames, Iowa.

Corresponding author: Dr Jeff Husa, PO Box 50, Sioux Center, IA 51250; Tel: 712-722-8711; Fax: 712-722-8701; E-mail: jeff.husa@boehringer-ingelheim.com.

Dr Husa, Roy Edler, and Drs Walter and Holck were employed by Boehringer Ingelheim Vetmedica, Inc, while this study was being conducted.

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

Husa JA, Edler RA, Walter DH, et al. A comparison of the safety, cross-protection, and serologic response associated with two commercial oral S*almonella* vaccines in swine. *J Swine Health Prod.* 2009;17(1):10–21.

Al no detectarse la seroconversión contra la vacuna, es poco probable que la vacunación confunda los programas de monitoreo utilizando la prueba de ELISA.

Résumé - Comparaison de l'innocuité, de la protection croisée, et de la réponse sérologique associées à deux vaccins commerciaux oraux contre *Salmonella* **chez le porc**

Objectifs: Comparer l'innocuité, la protection croisée, et la réponse sérologique associées avec deux vaccins contenant *Salmonella* serovar Cholerasuis.

Matériels et méthodes: Quatre-vingts porcs âgés de 4 semaines, négatifs pour *Salmonella* par culture et par sérologie, ont été assignés à quatre groupes de 20 porcs. Le groupe témoin non-vacciné infecté (NVC) a été inoculé avec une souche virulente de *Salmonella* serovar Typhimurium. Deux groupes ont été vaccinés (Jour 0) soit avec Enterisol SC-54 (SC-54; Boehringer Ingelheim Vetmedica Inc, St-Joseph, Missouri) ou Argus SC/ST (Argus; Intervet Inc, Millsboro, Delaware), des vaccins constitués d'une souche vivante avirulente de *Salmonella* Cholerasuis, et inoculés (Jour 43) avec *Salmonella* Typhimurium. Le groupe témoin négatif (NVNC) était non-vacciné et non-inoculé. Des données individuelles sur le poids corporel, les pointages cliniques, la température rectale, et les observations à la nécropsie ont été notées. Les anticorps anti-*Salmonella* ont été mesurés à l'aide d'une épreuve ELISA indirecte (Idexx Laboratories, Westbrook, Maine).

Résultats: Après la vaccination, les animaux du groupe Argus ont montré une pyrexie plus sévère et plus fréquente ainsi qu'un plus faible gain journalier moyen (ADG) et poids corporel au Jour 43 que ceux des groupes SC-54 et NVC ($P < .05$). Une protection croisée envers *Salmonella* Typhimurium, manifestée par une pyrexie moins sévère et fréquente ainsi que par des pointages cliniques individuels plus bas, a été observée chez les animaux vaccinés ($P < .05$). La prévalence des lésions entériques et les pointages cliniques totaux étaient plus faibles avec SC-54 ($P < .05$). Une séroconversion vaccinale n'a pas été détectée avant l'inoculation défi, malgré l'évidence d'une protection croisée. Au Jour 52, 95% à 100% de tous les animaux soumis à une infection défi ont présenté une séroconversion.

Implications: Le vaccin Enterisol-54 n'a pas causé d'effets adverses. Le vaccin Argus SC/ST a induit de sérieuses réactions adverses. Les deux vaccins confèrent une protection croisée contre *Salmonella* Typhimurium, avec une meilleure protection croisée associée à SC-54. Étant donné qu'une séroconversion vaccinale n'est pas détectée, les programmes de surveillance utilisant cet ELISA ne sont pas sujets à être confondus par la vaccination.

Salmonella enterica has been recognized as a disease threat to animals since the late 1800s, when Dr D. E. Salmon and others initially investigated this bacterium as the suspected cause of hog cholera.[1-7] Salmonellosis significantly reduces swine performance due to clinical and subclinical disease, and farms with 15% seroprevalence or higher have been shown to produce 7.3 kg less pork per square meter of building floor space per year.[5,7-10] Studies cite prevalence as high as 62.6% on an individual pig basis, with up to 94% of herds found positive.[11-15] Veterinary diagnostic laboratories continue to report *Salmonella* as a primary cause of enteritis and septicemia, and recently as a cofactor in porcine circovirus associated disease.[6,16-18]

Salmonellae can also infect humans, and may be passed between animals and man as a zoonosis.[19-26] Numerous human cases are reported globally, of which 95% are estimated to be food-borne.[27] In 2005, the US Centers for Disease Control reported 36,184 *Salmonella* isolates from human sources.[28] Annual socio-economic costs attributed to food-borne salmonellosis are estimated at $2.3 billion to $12.8 billion in the United States, and more specifically, at $81.53 million for cases associated with pork.[27,29] The threat of food-borne illness has prompted the adoption of national *Salmonella* reduction programs in countries such as Denmark, Great Britain, and the United States. These programs rely on effective control measures and reliable monitoring methods from pre-harvest through post-harvest.[30-35]

Pre-harvest control of *Salmonella enterica* serovars can be achieved through vaccination, sanitation, medication, and management of known risk factors.[4,5,7,9,10,36-75] Several vaccines are licensed for control of *Salmonella* in swine. Before these licenses were granted, the manufacturers were required to prove acceptable safety in pigs.[7,40,59,71] The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service defines "safe" as "freedom from properties causing undue local or systemic reactions when used as recommended or suggested by the manufacturer."[76] These pre-licensure evaluations are commonly based upon clinical appearance and growth performance. Vaccines may employ a wide variety of immunity-stimulating mechanisms with varying safety attributes and risks. Inactivated (killed) vaccines commonly include adjuvants to augment an immune response. Avirulent live culture vaccines consist of altered bacteria or virus populations that interact with the pig's immune system. The variety of materials or methods used in manufacturing vaccines may result in different levels of safety or side-effects. Highly reactive vaccines may reduce animal performance as a result of stress, hypersensitivity, and other reactions.[74] If, for instance, vaccines are administered to unhealthy pigs or are administered incorrectly, they may induce undesirable side-effects. In some studies, reactive *Salmonella* vaccines have even caused pig death.[77]

Few swine vaccines have documented effectiveness against multiple *Salmonella* serovars.[7,39-41,58,59,71,78] Of the more than 2500 serovars recognized, *Salmonella* Choleraesuis and *Salmonella* Typhimurium are the ones most commonly associated with disease in swine.[5,6,11,17,36,47,73,79]

Various diagnostic tools are available to evaluate *Salmonella* control measures and to monitor food safety assurance programs. Ante-mortem serum antibody tests are available which provide insights into *Salmonella* exposure, prevalence, and onset of infection.[8,9,80-85] To allow control-program monitoring while utilizing vaccine, these tests are most useful when they differentiate vaccine-induced antibody from that generated by natural infection.

For maximum benefit, *Salmonella* control measures, including vaccines, should cause minimal negative effects and should be effective against multiple serovars and compatible with monitoring and reduction initiatives. To assess the compatibility of two commercial swine *Salmonella* vaccines using these criteria, this study was conducted to compare the safety, cross-protection, and serologic response associated with Enterisol SC-54 (Boehringer Ingelheim Vetmedica, Inc, St Joseph, Missouri) and Argus SC/ST (Intervet Inc, Millsboro, Delaware).

Materials and methods

Animals

Eighty pigs were randomly assigned to four treatment groups at 28 ± 3 days of age

(n = 20 per group; Table 1). All pigs were both negative for *Salmonella* by fecal culture (Iowa State University Veterinary Diagnostic Laboratory, Ames, Iowa)[86] and seronegative by the HerdChek Swine *Salmonella* Antibody Test Kit (Idexx Laboratories, Inc, Westbrook, Maine), an indirect ELISA test which detects a broad range of *Salmonella* serogroups, with a negative test defined as a sample:positive ratio < 0.25. The size of each treatment group was based upon the maximum number of pigs that Veterinary Resources, Inc (VRI; Ames, Iowa) could house in accordance with their Institutional Animal Care and Use Committee (IACUC) and biosecurity standard operating procedures. As this was the first published study to compare swine *Salmonella* vaccines in a controlled challenge, reference data was not available and no pre-study power calculation could be performed. Commercial, crossbred, mixed-sex pigs weighing 9.13 ± 0.28 kg (95% CI; Table 2) were used in this study.

Housing, biosecurity, feeding

Pigs were housed and managed by an independent research firm (VRI). Internal and external site biosecurity was maintained according to VRI standard operating procedures, with an emphasis on *Salmonella* transmission control. All pigs were housed by treatment group in solid-walled plastic tubs designed to minimize the risk of lateral transmission of *Salmonella* vaccine or challenge organisms via fecal-oral or nose-to-nose transfer (Figure 1). Each tub held five pigs, with a raised, fenestrated plastic floor (1.2 m by 1.5 m) above a self-contained waste pit. Water and feed containers were dedicated to each tub for the duration of the study. Tub walls were 1.07 m in height above the raised deck. Additional measures against cross-contamination between treatments included housing the nonvaccinated nonchallenged controls (NVNC) in a separate building; separation of the nonvaccinated controls (NVC) by a solid wall and door from the SC-54 and Argus groups; separation of the SC-54 and Argus groups within the same room by a distance of more than 5.7 m; waste handling equipment, rectal thermometer, snare, and other tools required daily dedicated by treatment group; and requirements for all personnel to wash hands and change boots, coveralls, and gloves prior to any movement between treatment groups. Figure 2 shows the site diagram.

Table 1: Treatment groups and event timeline for groups of pigs vaccinated or not vaccinated with live avirulent *Salmonella* serovar Choleraesuis vaccines on Day 0 and challenged or not challenged with virulent *Salmonella* serovar Typhimurium on Day 43

			Vaccination safety phase†		Cross-protection phase‡	
Group	Treatment*	n	Day 0	Day 43	Day 57	Day 71
1	NVC	20	NT	C	N_1	N_2
2	SC-54	20	V	C	N_1	N_2
3	Argus	20	V	C	N_1	N_2
4	NVNC	20	NT	NT	N_1	N_2

* NVC = Nonvaccinated controls, not vaccinated on Day 0 (33 ± 3 days of age), challenged Day 43; SC-54 = Vaccinated with Enterisol SC-54 (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) on Day 0, challenged Day 43; Argus = Vaccinated with Argus SC/ST (Intervet Inc, Millsboro, Delaware) on Day 0, challenged Day 43; NVNC = Nonvaccinated nonchallenged controls (biosecurity sentinels).

† NT = no treatment; V = vaccinated; C = challenged with virulent *Salmonella* Typhimurium.

‡ N_1 = one-half of pigs in each treatment group necropsied; N_2 = remaining pigs in each treatment group necropsied.

Table 2: Mean body weight and ADG (± SE) and CVs of body weight and ADG during the vaccination safety phase (Days 0 through 43)* of a study in which nursery pigs were either vaccinated or not vaccinated Day 0 with live avirulent *Salmonella* serovar Choleraesuis vaccine and challenged or not challenged Day 43 with virulent *Salmonella* serovar Typhimurium

Parameter	NVC	SC-54	Argus
Day 0			
Body weight (kg)	9.16 ± 0.29	9.08 ± 0.29	9.10 ± 0.29
CV (%)	13.8	14.3	14.3
Day 43			
Body weight (kg)	34.58 ± 0.75[a]	33.00 ± 0.73[a]	29.72 ± 0.73[b]
CV (%)	9.4	9.9	11.0
Days 1 through 43			
ADG ± SE (kg)	0.59 ± 0.02[a]	0.56 ± 0.02[a]	0.48 ± 0.02[b]
CV (%)	14.8	13.5	18.6

* Treatment groups and timeline described in Table 1. Least squares means reported.

SE = standard error; CV = coefficient of variation; ADG = average daily gain.

[ab] Values within a row with different superscripts differ significantly (Tukey honestly significant difference test; $P < .05$)

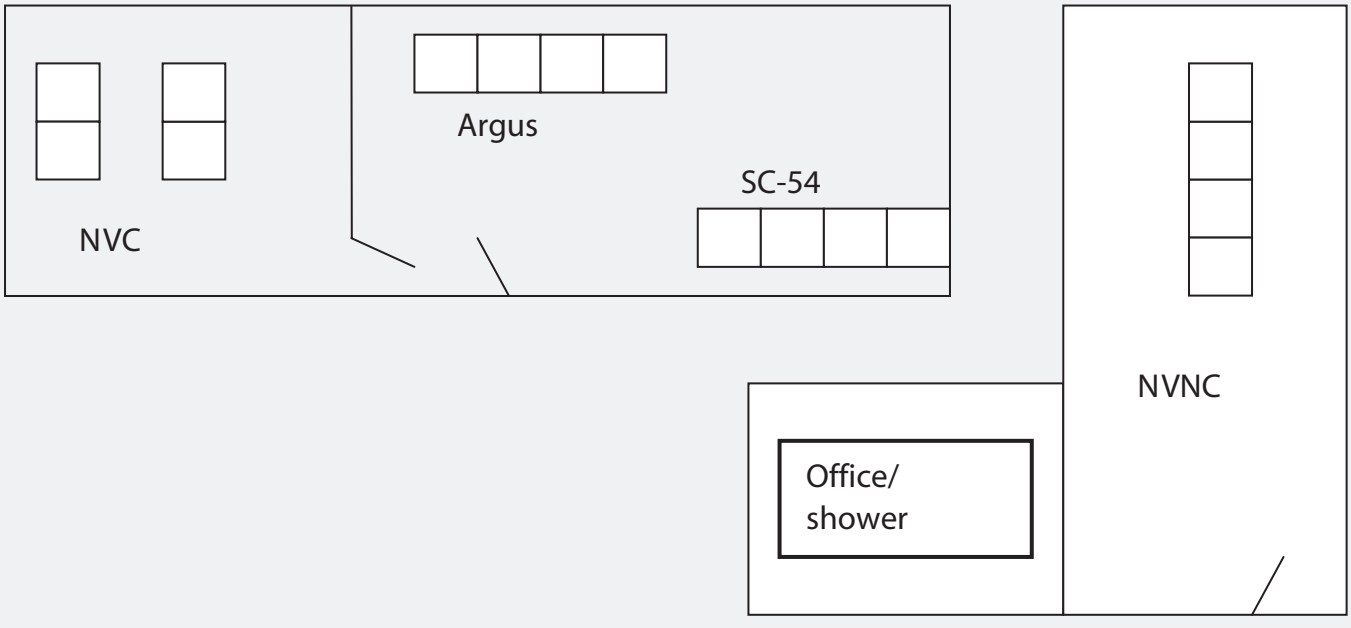
Feed and water rations provided throughout this trial were suitable for the size, age, and condition of the test animals according to acceptable industry standards. As an additional safeguard against inadvertent *Salmonella* exposure, all groups of pigs were fed a ration including 55 g per tonne of carbadox (Mecadox; Phibro Animal Health Corporation, Ridgefield Park, New Jersey) from Day -10 through Day -4. All feed and water available from Day -3 through study termination were free of antimicrobials. Animal care and euthanasia during this study were conducted in accordance with VRI's IACUC guidelines. This IACUC maintains compliance with all standards set forth in the USDA Code of Federal Regulations (9 CFR 2 Subpart C)[76] and the 2000 Report of the American Veterinary Medical Association Panel on Euthanasia.[87]

Figure 1: Cohort housing for nursery-age pigs (five pigs per unit), designed to minimize risk of lateral *Salmonella* transmission between treatment groups.

Study design

On Day -5, pigs were assigned a uniquely numbered identification tag (ID) and then individually weighed. The resulting list of pigs was next sorted by sex and by weight, and a random number was generated and assigned to each animal (Microsoft Excel; Microsoft Corporation, Redmond, Washington). The list of pigs was then blocked by sex and weight, and treatment group (1 through 4) was assigned from lowest to highest random number within block. Pigs were allocated to pen location by sorting the list by ascending treatment, and assigning pen such that pens 1 through 4 contained pigs in Treatment Group 1, pens 5 through 8 contained pigs in Treatment Group 2, pens 9 through 12 contained pigs in Treatment Group 3, and pens 13 through 16 contained pigs in Treatment Group 4. This method succeeded in achieving uniform starting weights among groups (Table 2) and ensured unbiased pen allocation. Treatments were assigned to groups as described in Table 1. By convention, where there are two sets of controls,

Figure 2: Site diagram of a facility used to house nursery-age pigs in a *Salmonella* vaccine study. Distances and barriers were designed to minimize risk of lateral *Salmonella* transmission among treatments. Pigs were either vaccinated or not on Day 0 (approximately 33 days of age) and either challenged or not on Day 43. Vaccines were oral avirulent live culture *Salmonella* serovar Choleraesuis: Enterisol SC-54 (Boehringer Ingelheim Vetmedica Inc, St Joseph, Missouri) and Argus SC/ST (Intervet Inc, Millsboro, Delaware). The challenge organism was virulent *Salmonella* serovar Typhimurium. NVC = Nonvaccinated challenged controls; SC-54 = Vaccinated with Enterisol SC-54, challenged; Argus = Vaccinated with Argus SC/ST, challenged; NVNC = Nonvaccinated nonchallenged controls (biosecurity sentinels).



our protocols utilize the nonvaccinated challenged controls for data comparisons, and the nonvaccinated nonchallenged controls to verify a lack of uncontrolled field infection. In this study, the NVNC group acted as sentinels to validate the controlled challenge model, and their data is not included in comparative analyses.

This trial was divided into two consecutive phases: a vaccination safety phase followed by a heterologous cross-protection phase (Table 1). On Day 0, the SC-54 and Argus groups were vaccinated by oral drench (study initiation). Administration of virulent *Salmonella* Typhimurium (heterologous challenge) on Day 43 marked the delineation between the vaccination safety phase and the cross-protection phase (Table 1).

To eliminate bias, the investigator making clinical and necropsy observations was blinded to treatment by his absence during pen allocation and treatment administration. Rectal temperatures were measured on Days -2, -1, 0, 1 through 21, 28, and 43 through 58. Additionally, rectal temperatures were measured on Day 0 at 0, 4, 8, and 12 hours after vaccination. Pigs in all groups were individually weighed on Days -5, 0, 2, 7, 14, 21, 28, 35, 43, 50, 57, 64, and 71. Serum samples were collected from all pigs on Days 0, 7, 14, 21, 28, 35, 43, 52, 57, 64, and 70. All sera were tested for *Salmonella* antibodies using the Idexx HerdChek Swine *Salmonella* Antibody Test Kit.[82]

On Day 57, one-half of the pigs in each treatment group were randomly selected for euthanasia. To make these selections, a random number was assigned to each pig using Microsoft Excel. Pigs were then sorted by this number within pen, and pigs with the lower one-half of these numbers were euthanized. On Day 71, all remaining animals were euthanized.

Clinical observation scoring

Observations were made on Days -2 through 7, 14, 21, 28, 35, 43 through 58, 61, 63, 65, 68, and 70, as well as at 0, 4, 8, and 12 hours post vaccination. Clinical observations were recorded using qualitative scoring with a numeric grading scale (Figure 3). A daily summation of individual parameter scores was calculated for each pig, with normal being a score of 9 and a maximum total score possible of 29.

Challenge

On Day 43, 2 mL of virulent *Salmonella* Typhimurium (strain BIVI 02-04) was administered intranasally to the SC-54, Argus, and NVC groups. Each challenge dose contained 1.22×10^{10} colony forming units. This high-dose inoculum was chosen for its documented ability to cause clinical signs and lesions.[78]

Off-test procedures

At necropsy, the investigator blindly assessed all pigs for gross enteric lesions consistent with *Salmonella* Typhimurium infection. Post-mortem samples of tonsil, lung, liver, spleen, ileum, cecum, mesenteric lymph node, and ileocecal lymph node were collected from each animal and submitted to the Iowa State University Veterinary Diagnostic Laboratory for qualitative *Salmonella* culture.

Calculations and statistical analysis

The experimental unit in this study was the individual pig. All statistical analyses were performed using JMP 6.0 (SAS, Cary, North Carolina). Rectal temperatures of the SC-54, Argus, and NVC treatment groups for the time periods from 4 hours post vaccination through Day 43 (vaccination safety phase) and Days 44 through 58 (cross-protection phase) were analyzed using parametric and nonparametric methods. Parametric analyses included multivariate analysis of variance (ANOVA), with time as the repeated measure. One-way ANOVA was used as a second parametric analysis to compare differences among the three treatment groups. Tukey honestly significant difference (HSD) test was used to determine the response by treatment differences for mean rectal temperature. Nonparametric analysis was also performed using Fisher's exact test to compare the number of nor-

Figure 3: Clinical observations record sheet for the study described in Table 1. A separate record sheet was completed each observation day. Each pig's score for each parameter was circled according to the scale shown at the bottom of the form: normal individual parameter score 1, normal total daily score, 9.

Pig ID	Rectal temp	Stools	Behavior	Appetite	Body condition	Hydration	Ambulation	Hair coat	Skin	Respiration	Additional notes
		1234	1234	123	123	123	123	123	123	123	
		1234	1234	123	123	123	123	123	123	123	
		1234	1234	123	123	123	123	123	123	123	
		1234	1234	123	123	123	123	123	123	123	

Stool consistency
1. normal
2. semi-formed
3. diarrhea
4. diarrhea with blood or tissue

Behavior
1. normal
2. lethargic
3. huddled
4. moribund

Appetite
1. normal
2. diminished
3. anorexic

Body condition
1. normal
2. gaunt
3. thin

Hydration
1. normal
2. slight dehydration
3. severe dehydration

Ambulation
1. normal
2. lame
3. down

Hair coat
1. normal
2. rough
3. bristled

Skin
1. normal
2. urticaria/ hyperemia
3. cyanosis

Pulmonary
1. normal
2. rapid
3. labored

mal versus abnormal rectal temperatures by treatment group. The minimum value for fever (abnormal temperature) for each study phase was determined using methods described by Vincent et al.[88] Abnormal temperature for the vaccination safety phase was calculated to be ≥ 40.77°C, based upon two standard deviations above the mean rectal temperature for all pigs in the three challenged groups on Day -2, Day -1, and Day 0 prior to vaccination. For the cross-protection phase, these calculations determined an abnormal temperature to be ≥ 40.37°C, based upon mean rectal temperature for all challenged pigs on Days 21, 28, and 43. For the vaccination safety phase, average daily gain (ADG) comparisons among the SC-54, Argus, and NVC groups during the period from Day 0 through 43, and the Day 43 body weights, were analyzed using one-way analysis of covariance (ANCOVA), with Day 0 body weight as a covariate. Day 0 body weight comparisons used one-way ANOVA. For the cross-protection phase, Day 57 and 71 body weights, Days 44 through 57 ADG, and Days 58 through 71 ADG, ANCOVA calculations used Day 43 body weight as a covariate to account for weight-gain differences arising after vaccination and prior to challenge. Multiple comparisons among means were tested using Tukey HSD. Clinical observation scores, segregated by vaccination safety phase or cross-protection phase, were analyzed using Kruskal-Wallis rank sums test. Rank sums were compared among treatment groups using Tukey HSD. Nonparametric analysis was also performed using Fisher's exact test to compare the number of normal versus abnormal clinical observations by treatment group. An abnormal binomial was assigned for any score above baseline (ie, above individual parameter score 1 or total score 9). The proportion of pigs exhibiting gross enteric lesions consistent with *Salmonella* Typhimurium infection at necropsy was compared among groups using Fisher's exact test.

Results

Prior to challenge administration, one pig from the NVC group and one from the NVNC group died due to causes unrelated to treatments.

Vaccination safety phase

During Days 1 to 43, both frequency of abnormally elevated rectal temperatures and mean rectal temperature were significantly higher in pigs vaccinated with Argus than in the SC-54 and NVC pigs ($P < .05$; Table 3). No significant differences in rectal temperature measurements were observed between the SC-54 vaccinates and the nonvaccinated controls.

No significant difference in ADG was detected between the SC-54 and NVC groups, but ADG was significantly lower in the Argus group than in the SC-54 and NVC groups ($P < .05$, Table 2). Mean body weights were not significantly different for the SC-54 group than for the NVC group (Figure 4). However, at some data points, mean body weights were significantly lower in the Argus group than the SC-54 and NVC groups (Figure 4). On Day 43, Argus pigs were 3.28 kg lighter than SC-54 vaccinates and 4.86 kg lighter than NVC pigs (Figure 4).

The influence of vaccination on group pig weights and ADG variability was also assessed by calculation of the coefficient of variation (CV) for these parameters within each group. Less individual ADG variation was exhibited in the SC-54 group than in the NVC or Argus groups (Table 2). Day 43 body-weight variation was also less for the SC-54 group than for the Argus group (Table 2).

Differences in clinical observation scores included significantly lower total rank sums and frequency of abnormal total scores in the SC-54 group than in the NVC and Argus groups ($P < .05$; Table 4). Lower hair-coat rank sums and frequency of abnormal hair-coat scores were observed in SC-54 pigs than in NVC pigs. Lower appetite, hair-coat rank sums, and frequency of abnormal total scores were observed in SC-54 and Argus groups than in the NVC group ($P < .05$; Table 4). No statistical differences among groups were found in other clinical parameters. Throughout the study, no abnormal scores or differences among groups were found for hydration, ambulation, or skin condition (data not shown).

Cross-protection phase

Both *Salmonella* Choleraesuis vaccines conferred varying degrees of protection against *Salmonella* Typhimurium challenge during the post-challenge period (Days 44 through 71). Both frequency of abnormally elevated rectal temperatures and mean rectal temperature were significantly lower after inoculation with *Salmonella* Typhimurium in the SC-54 and Argus groups than in the NVC group ($P < .05$; Table 5).

No significant ADG or body-weight differences were detected among groups during the post-challenge period (Table 6). The ANCOVA for ADG from Day 44 to 57, and mean body weight on Day 57, suggest a difference between means (probability of obtaining greater F statistic, $P = .04$) for vaccinates versus the NVC group. However, when the data was assessed using Tukey HSD at $\alpha = .05$, no pair-wise differences between groups were detected (Table 6).

Clinical observation scores also showed evidence of challenge effectiveness and vaccine-induced heterologous protection. Total rank sums and frequency of abnormal

Table 3: Rectal temperature results for vaccination safety phase (Days 0 through 43)* in a study in which nursery pigs were either vaccinated or not vaccinated Day 0 with live avirulent *Salmonella* serovar Choleraesuis vaccine and challenged or not challenged Day 43 with virulent *Salmonella* serovar Typhimurium

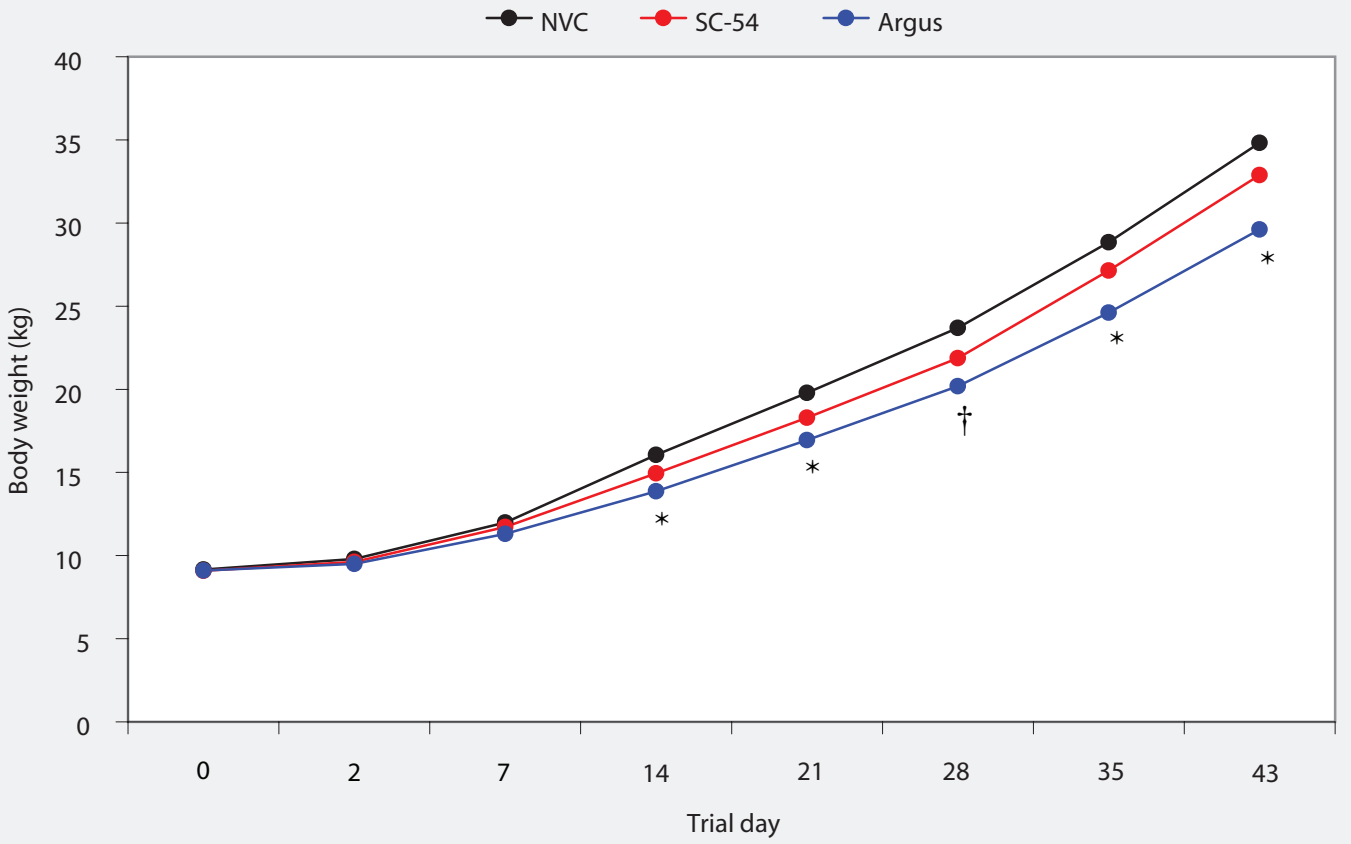
Parameter	NVC	SC-54	Argus
Frequency of abnormal rectal temperature	14/503[a]	7/520[a]	32/520[b]
Mean rectal temperature (range 95% CI) (°C)	39.89[c] (39.86-39.92)	39.93[c] (39.91-39.96)	39.99[d] (39.96-40.03)

* Treatment groups and timeline described in Table 1. Abnormal rectal temperature defined as ≥ 40.77°C.

[ab] Values within a row with different superscripts differ significantly (Fisher's exact test; $P < .05$).

[cd] Values within a row with different superscripts differ significantly (Tukey honestly significant difference test; $P < .05$).

Figure 4: Mean group body weights during the vaccination safety phase of the study described in Table 1. The symbol * indicates time point when mean body weights for SC-54 and NVC groups differed from those for the Argus group (ANCOVA; $P < .05$); † indicates time point when mean body weight for the Argus group differed from that of the NVC group (ANCOVA; $P < .05$).



total scores were significantly lower in the SC-54 group than in the NVC and Argus groups ($P < .05$; Table 7). Rank sums and frequency of abnormal stool and respiration scores were significantly lower in the SC-54 and Argus groups than in the NVC group ($P < .05$; Table 7). Behavior rank sums, frequency of abnormal behavior, and frequency of abnormal body condition scores were significantly lower in the SC-54 and NVC groups than in the Argus groups ($P < .05$; Table 7).

A significantly lower proportion of pigs with enteric lesions consistent with *Salmonella* Typhimurium infection was found in the SC-54 group than in the NVC group ($P < .05$), but this proportion did not differ between the Argus and NVC groups (Table 7). Gross lesions noted included microabscesses at the ileocecal junction, inflammation of ileum, cecum, and large intestine, adhesions, and thickening of intestinal tissues. Qualitative *Salmonella* Typhimurium isolation rate did not differ among the three challenged groups, as expected due to the high challenge dose. *Salmonella* isolates recovered after challenge inoculation were confirmed to be serogroup B by the Iowa State University Veterinary Diagnostic Laboratory.

No abnormal clinical signs or positive *Salmonella* cultures were observed in the NVNC group.

Serologic response

One animal from each vaccinated group (5% per group) seroconverted immediately prior to challenge. Following challenge with virulent *Salmonella* Typhimurium, high rates of seroconversion were observed in all challenged groups by 9 days post challenge (Day 52: seroconversion in 100% of NVC and SC-54 groups and 90% of the Argus group). By Day 70, 100% of the pigs in the three challenged groups were seropositive. *Salmonella* seroconversion was never observed in the NVNC group.

Discussion

During the vaccination safety phase of this study, differences in post-vaccination pyrexia, growth rates, and clinical scores significantly favored the safety of Enterisol SC-54 over that of Argus SC/ST. Both vaccines contain attenuated live culture *Salmonella* Choleraesuis isolates, but the methods of attenuation used to create them were distinctly different. Repeated passage in neutrophils caused natural deletion of the 50-kb plasmid from the Enterisol SC-54 isolate. This *Salmonella* Choleraesuis plasmid is important for virulence and intestinal invasiveness.[89] Argus SC/ST is an isogenic Δ*cya* Δ*crp* derivative from *Salmonella* Choleraesuis, using transposon-mediated deletion mutagenesis.[57,77] These differences in attenuation methods may account for the significant differences in safety of the two vaccines observed in this study.

As demonstrated in previous clinical and field studies, Enterisol SC-54 [39,58,61,62,78] and Argus SC/ST [41] confer heterologous protection against *Salmonella* Typhimurium. In the cross-protection phase of this study, both frequency of abnormally elevated rectal temperature and mean rectal temperature after challenge were lower in vaccinated pigs than in nonvaccinated controls. Clinically, stool and respiratory scores of both vaccinated groups were significantly lower than

Table 4: Clinical observation results for vaccination safety phase (Days 0-43)* of a study in which nursery pigs were either vaccinated or not vaccinated Day 0 with live avirulent *Salmonella* serovar Choleraesuis vaccine and challenged or not challenged Day 43 with virulent *Salmonella* serovar Typhimurium

Parameter	NVC	SC-54	Argus
Total score (rank sums)	457.76[a]	431.38[b]	453.57[a]
Frequency of abnormal total scores (> 9.00)	21/275[c]	4/280[d]	19/280[c]
Mean total score (range 95% CI)	9.18 (9.09-9.27)	9.02 (9.00-9.03)	9.09 (9.05-9.14)
Stool score (rank sums)	453.68	442.99	445.95
Frequency of abnormal stool scores (> 1.00)	9/294	2/300	4/300
Mean stool score (range 95% CI)	1.04 (1.01-1.07)	1.01 (1.00-1.02)	1.02 (1.00-1.03)
Behavior score (rank sums)	453.18	442.48	446.95
Frequency of abnormal behavior scores (> 1.00)	9/294	2/300	5/300
Mean behaviour score (range 95% CI)	1.03 (1.01-1.05)	1.01 (1.00-1.02)	1.02 (1.00-1.03)
Body condition score (rank sums)	453.18	442.48	446.95
Frequency of abnormal body condition scores (> 1.00)	9/294	2/300	5/300
Mean body condition score (range 95% CI)	1.03 (1.02-1.05)	1.01 (0.99-1.02)	1.02 (1.00-1.03)
Hair-coat score (rank sums)	456.72[a]	440.00[b]	445.96[ab]
Frequency of abnormal hair-coat scores (> 1.00)	11/294[c]	0/300[d]	4/300[cd]
Mean hair-coat score (range 95% CI)	1.04 (1.02-1.05)	1.00 (0.99-1.01)	1.01 (1.00-1.03)
Respiration score (rank sums)	447.52	446.00	448.98
Frequency of abnormal respiration scores (> 1.00)	1/294	3/300	2/300
Mean respiration score (range 95% CI)	1.00 (1.00-1.01)	1.00 (1.00-1.00)	1.01 (1.00-1.02)
Appetite score (rank sums)	452.60[a]	445.00[b]	445.00[b]
Frequency of abnormal appetite scores (> 1.00)	5/294[c]	0/300[d]	0/300[d]
Mean appetite score (range 95% CI)	1.02 (1.00-1.04)	1.00 (1.00-1.00)	1.00 (1.00-1.00)

* Treatment groups and timeline described in Table 1. Clinical observation scoring described in Figure 3: normal individual parameter score = 1.00, normal total daily score = 9.00.

[ab] Values within a row with no common superscript differ significantly (Tukey honestly significant difference test; $P < .05$).

[cd] Values within a row with no common superscript differ significantly (Fisher's exact test; $P < .05$).

Table 5: Rectal temperature for cross-protection phase (Days 44-71)* of a study in which nursery pigs were either vaccinated or not vaccinated Day 0 with live avirulent *Salmonella* serovar Choleraesuis vaccine and challenged or not challenged Day 43 with virulent *Salmonella* serovar Typhimurium

Parameter	NVC	SC-54	Argus
Frequency of abnormal rectal temperature	29/275[a]	16/290[b]	16/290[b]
Mean rectal temperature, (range 95% CI) (°C)	39.84[c] (39.79-39.88)	39.74[d] (39.69-39.78)	39.72[d] (39.68-39.76)

* Treatment groups described in Table 1. Rectal temperatures measured through Trial Day 58, with abnormal temperature defined as ≥ 40.37°C.

[ab] Values within a row with no common superscript differ significantly (Fisher's exact test; $P < .05$).

[cd] Values within a row with no common superscript differ significantly (Tukey honestly significant difference test; $P < .05$)

those of the NVC group, while total observation scores and enteric-lesion prevalence were significantly lower only in the SC-54 group. In the ANOVA model, ADG Days 44 to 57 and mean body weight on Day 57 were significantly greater in the vaccinated groups than in the NVC group. However, assessment of the data using Tukey HSD at $\alpha = .05$ detected no pairwise differences between groups. A retrospective power calculation suggests that at least 30 pigs were needed in each of the challenged groups (NVC, SC-54, and Argus) in order to achieve $P < .05$ at 80% power, and to clarify the potential significance of these post-challenge differences in ADG. A larger field or clinical study is needed to investigate this trend.

Table 6: Body weight and ADG results for cross-protection phase (Days 44-71)* of a study in which nursery pigs were either vaccinated or not vaccinated Day 0 with live avirulent *Salmonella* serovar Choleraesuis vaccine and challenged or not challenged Day 43 with virulent *Salmonella* serovar Typhimurium

Parameter	NVC	SC-54	Argus
Days 44-57 ADG ± SE (kg)†	0.47 ± 0.05	0.61 ± 0.04	0.61 ± 0.05
CV (%)	42.5	31.3	33.3
Day 57 body weight ± SE (kg)†	38.91 ± 0.64	40.92 ± 0.60	41.00 ± 0.64
CV (%)	7.2	6.6	7.0
Days 58-71 ADG ± SE (kg)†	0.90 ± 0.05	0.91 ± 0.04	0.83 ± 0.04
CV (%)	15.8	13.8	16.3
Day 71 body weight ± SE (kg)†	51.99 ± 1.10	53.68 ± 0.92	53.47 ± 0.99
CV (%)	6.3	5.4	5.9

* Treatment groups and timeline described in Table 1.

† Least squares means reported.

Table 7: Clinical observation and enteric lesion results for cross-protection phase (Days 44-71)* of a study in which nursery pigs were either vaccinated or not vaccinated Day 0 with live avirulent *Salmonella* serovar Choleraesuis vaccine and challenged or not challenged Day 43 with virulent *Salmonella* serovar Typhimurium

Parameter	NVC	SC-54	Argus
Total score (rank sums)	563.03[a]	496.44[b]	542.18[a]
Frequency of abnormal total scores (> 9.00)	60/346[c]	17/360[d]	48/360[c]
Mean total score (range 95% CI)	9.28 (9.21-9.36)	9.08 (9.04-9.12)	9.21 (9.15-9.27)
Stool score (rank sums)	538.00[a]	479.47[b]	495.84[b]
Frequency of abnormal stool scores (> 1.00)	51/327[c]	13/340[d]	24/340[d]
Mean stool score (range 95% CI)	1.22 (1.16-1.28)	1.06 (1.03-1.10)	1.11 (1.07-1.16)
Behavior score (rank sums)	491.58[a]	497.39[a]	522.56[b]
Frequency of abnormal behavior scores (> 1.00)	2/327[c]	6/340[c]	23/340[d]
Mean behavior score (range 95% CI)	1.01 (1.00-1.01)	1.02 (1.00-1.03)	1.07 (1.04-1.09)
Body condition score (rank sums)	491.58[a]	497.39[a]	522.56[b]
Frequency of abnormal body condition scores (> 1.00)	2/327[c]	6/340[c]	23/340[d]
Mean body condition score (range 95% CI)	1.01 (0.99-1.02)	1.02 (1.00-1.04)	1.07 (1.05-1.09)
Hair-coat score (rank sums)	503.50	503.50	504.98
Frequency of abnormal hair-coat scores (> 1.00)	0/327	0/340	1/340
Mean hair-coat score (range 95% CI)	1.01 (1.00-1.02)	1.00 (1.00-1.00)	1.00 (1.00-1.01)
Respiration score (rank sums)	508.16[a]	502.00[b]	502.00[b]
Frequency of abnormal respiration scores (> 1.00)	4/327[c]	0/340[d]	0/340[d]
Mean respiration score (range 95% CI)	1.02 (1.00-1.04)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Appetite score (rank sums)	505.04	503.50	503.50
Frequency of abnormal appetite scores (> 1.00)	1/327	0/340	0/340
Mean appetite score (range 95% CI)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (1.00-1.00)
Pigs with enteric lesions at necropsy	9/19[c]	3/20[d]	6/20[cd]

* Treatment groups described in Table 1. Clinical observation scoring described in Figure 3: normal individual parameter score = 1.00; normal total daily score = 9.00.

[ab] Values within a row with no common superscript differ significantly (Tukey honestly significant difference test; $P < .05$).

[cd] Values within a row with no common superscript differ significantly (Fisher's exact test; $P < .05$).

Bacterial culture for this study was limited to qualitative methods (positive-negative) and was not designed to evaluate a difference in tissue colonization as reported in earlier studies.[9,39,41,58,59,61,71,78] In all parameters measured in this study, protection induced against *Salmonella* Typhimurium challenge by the SC-54 vaccine was equal to or greater than that induced by the Argus vaccine.

The Idexx HerdChek Swine *Salmonella* Antibody Test Kit clearly differentiated *Salmonella* Typhimurium-exposed pigs from non-exposed pigs regardless of vaccination status with either SC-54 or Argus. Only one animal in each of the vaccinated groups seroconverted after vaccination and prior to challenge. These singleton results fall within reported false-positive (specificity) test-performance characteristics.[82] At 9 days after challenge, all groups inoculated with virulent *Salmonella* Typhimurium (NVC, SC-54, and Argus groups) demonstrated 95% to 100% group seroconversion. The differential capability of this assay could allow pre-harvest *Salmonella* control programs to utilize these *Salmonella* vaccines without confounding the interpretation of serologic monitoring. When applied as part of a regularly scheduled audit, this assay could be used to monitor the effect of *Salmonella* reduction programs in clinically and subclinically affected herds.

It is notable that vaccinates demonstrated significant protective immunity without producing detectable levels of ELISA antibodies. This implies that ELISA antibodies are not indicative of protection, and that this test is not suitable as a vaccination compliance-monitoring tool.

An additional application for this *Salmonella* serum ELISA can be inferred from these results. The seroconversion of > 95% of pigs within 9 days after *Salmonella* Typhimurium challenge indicates rapid antibody detection after the onset of infection. This enables practitioners to serologically profile herds and then schedule preventive vaccination at an appropriate interval before wild-type *Salmonella* exposure. Thus, adequate time may be provided for onset of vaccinal immunity prior to exposure. The onset of immunity from SC-54 vaccination has been demonstrated within 14 days, and this vaccine has a proven duration of immunity of at least 20 weeks.[39,59,71] Accounting for farm-to-farm variation in transmission factors, the authors recommend administration of this vaccine at least 4 weeks prior to the onset of group seroconversion (2 weeks prior to the onset of exposure).

Implications

- Under the conditions of this study, vaccination with Enterisol SC-54 does not adversely affect pig growth and clinical appearance, but vaccination with Argus SC/ST does induce significant deleterious biologic responses.
- In pigs infected with virulent *Salmonella* Typhimurium, pyrexia is less frequent and less severe, and stool and respiration scores are lower, in pigs previously vaccinated with either Enterisol SC-54 or Argus SC/ST.
- In pigs infected with virulent *Salmonella* Typhimurium, the prevalence of enteric lesions is lower in pigs previously vaccinated with Enterisol SC-54 than in non-vaccinated controls, and the magnitude of total observation scores is lower in pigs previously vaccinated with Enterisol SC-54 than in Argus SC/ST vaccinates and nonvaccinated controls.
- As the indirect *Salmonella* ELISA assay used in this study (Idexx HerdChek) differentiates pigs exposed to wild-type *Salmonella* Typhimurium from non-exposed pigs regardless of vaccination status, this test can be used together with vaccination in *Salmonella* control and monitoring programs.
- Seroconversion as measured using the Idexx HerdChek Swine *Salmonella* ELISA is not a suitable indicator of vaccination compliance or protection.

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Combined treatment with vitamin A and iron to prevent piglet anemia

JunFang Jiang, PhD; JunBing Jiang, PhD; HuiSen Zhu, MAgr; YongQing Jiang, MAgr

Summary

Objective: To determine if vitamin A enhances the effect of iron in preventing piglet anemia.

Materials and methods: Neonatal pigs (n = 96) from crossbred sows were assigned to three treatments, with four replicates per treatment. Treatments consisted of control (no iron), 200 mg injectable iron (iron dextran) at 2 days of age (Day 2), and 200 mg injectable iron (iron dextran) with 2000 IU oral vitamin A (vitamin A palmitate) on Day 2. The study was continued until Day 21. Blood samples were collected on Days 1, 7, 14, and 21, and liver and spleen samples were collected on Day 21. Hemoglobin concentration, hematocrit, total iron-binding capacity, and iron concentration were measured in plasma, liver, and spleen samples. Body weight was recorded on Days 0 and 21. Deaths were recorded through the study.

Results: Weight gain and mortality did not differ significantly between pigs treated with iron alone and pigs treated with both iron and vitamin A ($P > .05$). Hemoglobin concentration, hematocrit, and iron concentration in plasma, liver, and spleen samples in pigs treated with both iron and vitamin A were higher, and total iron-binding capacity was lower, than in pigs treated with iron alone ($P < .05$).

Implications: Iron nutrition status is better in piglets provided with both iron and vitamin A than in piglets treated with iron alone. The combination of vitamin A and iron is more effective than iron alone in preventing piglet anemia.

Keywords: swine, piglet anemia, vitamin A, iron

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Resumen - Tratamiento combinado de vitamina A y hierro para prevenir la anemia de lechón

Objetivo: Determinar si la vitamina A mejora el efecto del hierro en la prevención de la anemia de lechón.

Materiales y métodos: Se asignaron cerdos recién nacidos (n = 96) de hembras híbridas a tres tratamientos, con cuatro repeticiones por tratamiento. Los tratamientos fueron control (sin hierro), 200 mg de hierro inyectable (hierro dextrán) a los 2 días de edad (Día 2), y 200 mg de hierro inyectable (hierro dextrán) con 2000 IU de vitamina A oral (palmitato de vitamina A) en el Día 2. El estudio se continuó hasta el Día 21. Se recolectaron muestras de sangre en los Días 1, 7, 14, y 21, y se recolectaron muestras de hígado y bazo en el Día 21. Se midió la concentración de hemoglobina, hematocrito, capacidad total de fijación de hierro, y la concentración de hierro en muestras de plasma, hígado, y bazo. El peso corporal se registró los Días 0 y 21. La mortalidad se registró durante del estudio.

Resultados: La ganancia de peso y la mortalidad no difirieron significativamente entre cerdos tratados solamente con hierro y cerdos tratados con hierro y vitamina A ($P > .05$). La concentración de hemoglobina, hematocrito, y la concentración de hierro en muestras de plasma, hígado, y bazo de cerdos tratados con hierro y vitamina A fueron más altos, y la capacidad total de fijación de hierro fue más baja, que en cerdos tratados solamente con hierro ($P < .05$).

Implicaciones: El estatus de nutrición de hierro es mejor en los lechones a lo que se les trató con hierro y vitamina A que en los lechones tratados solamente con hierro. La combinación de vitamina A y hierro es más efectiva que el hierro solo en la prevención de anemia de lechón.

Résumé - Traitement combiné de vitamine A et de fer afin de prévenir l'anémie chez les porcelets

Objectif: Déterminer si la vitamine A augmente l'effet du fer pour prévenir l'anémie chez les porcelets.

Matériels et méthodes: Des porcelets nouveau-nés (n = 96) issus de truies croisées ont été assignés à trois groupes de traitement, avec quatre réplications par traitement. Les groupes étaient: témoin (aucun fer), 200 mg de fer injectable (fer dextran) à 2 jours d'âge (Jour 2), et 200 mg de fer injectable (fer dextran) avec 2000 UI de vitamine A (palmitate de vitamine A) au Jour 2. L'étude s'est poursuivie jusqu'au Jour 21. Des échantillons sanguins ont été prélevés aux Jours 1, 7, 14, et 21, et des échantillons de foie et de rate obtenus au Jour 21. La concentration d'hémoglobine, l'hématocrite, la capacité totale de liaison

JFJ, YQJ: Institute of Animal Husbandry and Veterinary Science, Zhejiang Academy of Agricultural Sciences, Hangzhou, 310021, China.

JBJ, HSZ: College of Animal Science and Technology, Shanxi Agricultural University, Taigu, 030801, China.

Corresponding author: YongQing Jiang, Institute of Animal Husbandry and Veterinary Science, Zhejiang Academy of Agricultural Sciences, No.145 Shiqiao Road, Hangzhou, 310021, China; Tel: 86-0571-8640465; Fax: 86-0571-86400836; E-mail: jiang_junfang@sohu.com.

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du fer, et la concentration de fer ont été mesurés dans le plasma, le foie, et la rate. Le poids corporel a été enregistré aux Jours 0 et 21. Les mortalités ont été notées tout au long de l'étude.

Résultats: Le gain de poids et les mortalités n'étaient pas significativement différents entre les porcs traités avec le fer seul et ceux traités avec le fer et la vitamine A ($P > .05$). La concentration d'hémoglobine, l'hématocrite, et la concentration de fer dans le plasma et les échantillons de foie et de rate étaient plus élevés chez les porcs traités avec le fer et la vitamine A, et la capacité totale de liaison du fer était plus basse, que celle notée chez les porcs traités avec le fer seul ($P < .05$).

Implications: Le statut nutritionnel du fer est meilleur chez les porcelets ayant reçu du fer et de la vitamine A que chez les porcelets n'ayant reçu que seulement du fer. La combinaison de vitamine A et de fer est plus efficace que le fer seul pour prévenir l'anémie chez les porcelets.

Anemia is the most prevalent nutritional deficiency in the world.[1] Both iron and vitamin A deficiencies were independent risk factors for anemia among Marshall Islands preschool children.[2] Attempts to improve iron status have been thwarted by deficiency of and adverse interaction with other micronutrients.[1] Confinement-reared pigs develop iron deficiency anemia (hypochromic, microcytic anemia) early in life. Anemia occurs because piglets are born with unusually small iron stores, milk contains low levels of iron, and pigs have a very rapid growth rate.[3] Anemia interferes with growth, and affected pigs are listless and more susceptible to infectious diseases than are normal pigs.

Supplemental vitamin A increased hemoglobin levels and packed cell volume (PCV) in pregnant women with deficient iron status or marginally deficient or deficient vitamin A status.[4] Vitamin A supplementation thereby contributed to control of nutritional anemia, and there was a synergistic interaction between vitamin A and iron in combined therapy. Vitamin A supplementation of pregnant women was associated with higher birth weight and lower prevalence of anemia among their infants.[5] Vitamin A deficiency appears to be related to the pathogenesis of anemia by several biological mechanisms, eg, improvement of growth and differentiation of erythrocyte progenitor cells, promotion of immunity to infection, less severe anemia of infection, and mobilization of iron stores from tissues.[6,7]

Concomitant supplemental vitamin A and ferrous sulfate promoted the hematopoietic effect of iron supplementation in young male rats.[8] Concomitant supplementation of vitamin A enhanced the response to weekly supplementation of iron and folic acid in anemic teenagers in urban Bangladesh.[9] A relationship between vitamin A and iron may have relevance in the treatment of nutritional anemia, and some studies suggest that supplementation with both vitamin A and iron is superior to iron alone in treating nutritional anemia in humans and rats.[10] The aim of this study was to evaluate combined treatment with iron and vitamin A in preventing piglet anemia.

Materials and methods

Study animals

Ninety-six piglets (Duroc × Large White × Landrace), born to eight crossbred multiparous sows (third or fourth parturition; Large White × Landrace) inseminated with semen from the same boar, were used in this study. All experimental procedures, care, and handling of animals were conducted according to guidelines on the care and use of animals for scientific purposes.[11] All animal experiments were approved by the Local Ethics Committee of Animal Research (permit no. C 16/6).

Experimental design

Piglets were assigned to eight blocks (12 piglets per block) on Day 0 (the day of birth) according to the following criteria: litter, gender, and weight. Each animal in a block was randomly allotted to one of 12 groups which comprised three treatments (four replicates per treatment). Treatments consisted of the control (no supplemental iron; n = 32); intramuscular (IM) injection of 200 mg iron as iron dextran (Bestar Laboratories Ltd, Shanghai, China) on Day 2 (n = 32); and IM injection of 200 mg iron as iron dextran plus oral administration of 2000 IU vitamin A as vitamin A palmitate (Beijing Zhongnongjianuo Technology Co Ltd, Beijing, China) on Day 2 (n = 32).

Immediately after birth, all piglets were encouraged to suckle to ensure ingestion of colostrum, then litter size was equalized to 12 by cross-fostering. Within 12 hours after birth, piglets in each litter were stratified according to weight and randomly assigned by weight to treatment groups. Piglets within each litter were equally allotted to the 12 groups; thus, each sow nursed piglets belonging to each of the 12 groups. Piglets were individually identified with ear tags.

Twelve pigs (four randomly selected pigs from each treatment) were euthanized by electrocution on Day 21. Applying the electrodes to the head of pigs for a minimum of 5 seconds resulted in instantaneous loss of consciousness (collapse, immediate mydriasis, no vocalization), and subsequently applying the electrodes to the thorax of pigs for a minimum of 15 seconds caused cardiac arrest within 1 minute. Death was confirmed and electrodes were removed from the thorax. The liver and spleen were removed as soon as possible after euthanasia and stored at -20°C until iron analysis 10 days later.

Housing and feeding

The farrowing barn housed piglets and their sows in farrowing crates with thermostatically controlled creep boxes and plastic-coated slatted floors. Air temperature of the farrowing pens was maintained at approximately 18°C through the experiment. Temperature in the creep boxes was maintained at approximately 32°C using a 250-watt electric heat lamp from Day 0 to Day 6. Temperature in the creep area was reduced to 30.5°C, 29°C, 27°C, and 25°C on Days 7, 11, 15, and 19 by changing to bulbs of 240, 225, 210, and 195 watts, respectively. On Day 1, all piglets were processed according to standard commercial practices, including teeth clipping, tail docking, and ear notching. During the previous gestation and lactation, the dams of the experimental pigs were fed a corn-soybean meal-based diet formulated to meet National Research Council[12] nutrient requirement estimates (Table 1). During the study, sows and piglets had ad libitum access to feed and water.

Parameters measured

Piglets were individually weighed on an electronic scale accurate to 0.1 kg within 12 hours after birth and on Day 21. Blood samples collected in EDTA tubes were obtained via vena cava puncture on Days 1, 7, 14, and 21. One portion of the blood from each pig was immediately prepared for hemoglobin and hematocrit determination. The second EDTA tube of blood from each pig was chilled to 4°C and centrifuged at 2000*g*. Plasma was harvested and stored at -20°C until iron and total iron-binding capacity were determined 2 days later.

Table 1: Composition of diets for gestating and lactating sows in a study on the effects of supplementing piglets with both iron and vitamin A to prevent anemia

Ingredient	Basal diet	
	Gestating sows	Lactating sows
Corn (%)	61	57
Wheat bran (%)	15	12
Barley (%)	9	0
Soybean meal (%)	11	22.5
Soybean oil (%)	0	2
Fish meal (%)	0	3
Limestone (%)	0.95	1.2
Dicalcium phosphate (%)	1.8	0.9
Salt (%)	0.25	0.25
L-lysine HCl (%)	0	0.15
Trace and vitamin premix (%)*	1.0	1.0
Total (%)	100	100
Calculated composition		
Digestible energy (MJ/kg)	12.75	13.26
Crude protein (%)	13.23	18.22
Lysine (%)	0.55	1.08
Methionine + Cystine (%)	0.46	0.61
Calcium (%)	0.83	0.81
Available phosphorus (%)	0.5	0.4

* Premix for gestating sows provided, for each kg of complete diet, vitamin A, 8000 IU; vitamin D_3, 1200 IU; vitamin E, 44.7 IU; vitamin K_3, 1.5 mg; vitamin B_{12}, 15 μg; thiamine, 1 mg; riboflavin, 3.8 mg; pantothenic acid, 12 mg; niacin, 10 mg; pyridoxine, 1 mg; biotin, 0.2 mg; folic acid, 1.1 mg; choline, 1 g; copper, 8 mg; iodine, 0.13 mg; iron, 80 mg; manganese, 30 mg; selenium, 0.15 mg; and zinc, 70 mg. For lactating sows, the premix provided, for each kg of complete diet, vitamin A, 6000 IU; vitamin D_3, 1200 IU; vitamin E, 44.7 IU; vitamin K_3, 1.5 mg; vitamin B_{12}, 15 μg; thiamine, 1 mg; riboflavin, 3.8 mg; pantothenic acid, 12 mg; niacin, 10 mg; pyridoxine, 1 mg; biotin, 0.2 mg; folic acid, 1.3 mg; choline, 1 g; copper, 8 mg; iodine, 0.15 mg; iron, 90 mg; manganese, 35 mg; selenium, 0.15 mg; and zinc, 70 mg.

Iron was measured in plasma, liver, and spleen using atomic absorption spectrophotometry. Liver and spleen samples were prepared for iron analysis by blotting dry, drying in a forced-air oven at 100°C, then wet-ashing with nitric acid in a microwave oven as described by Kegley et al.[3] Hemoglobin and total iron-binding capacity were measured by using commercially available test kits (Sigma Chemical Co, St Louis, Missouri). Hematocrit was measured using microcapillary tubes as described by Kegley et al.[3]

Deaths were recorded in each group. Mortality for each group was calculated as the total number of pigs at the beginning of the experiment minus the number of dead piglets at the end of the experiment, expressed as a percentage of the total number of pigs.

Data analysis

Data were analyzed by analysis of variance (ANOVA) using PROC MIXED of SAS (SAS 9.0, SAS Institute Inc, Cary, North Carolina). Variables included weight gain, mortality, iron concentrations in the liver and spleen, hematocrit, hemoglobin concentration, plasma iron concentration, and total iron-binding capacity. The model for weight gain, mortality, and iron concentrations in the liver and spleen included treatment and litter as fixed effects. The model for hematocrit, hemoglobin concentration, plasma iron concentration, and total iron-binding capacity included treatment, litter, day, and the interaction of treatment and day as fixed effects. When treatment effect was a significant source of variation, differences were determined using the DIFF option of SAS. Least squares means were calculated for each independent variable. Statistical significance was set at $P < .05$ for all statistical tests.

Results

Weight gains during the study were greater ($P < .05$) for pigs treated either with iron alone or with iron and vitamin A than for the controls (Table 2). Weight gains did not differ significantly between pigs treated with iron alone and pigs treated with both iron and vitamin A ($P > .05$).

Mortality during the study was higher in the control group ($P < .05$) than in the treated groups (Table 2). Mortality did not differ significantly between pigs treated with iron alone and pigs treated with both iron and vitamin A ($P > .05$).

On Day 21, iron concentrations in liver and spleen samples from pigs that received no iron were lower ($P < .05$) than concentrations in pigs treated with iron (Table 2). Concentration of iron in the liver was 10% higher in pigs treated with both iron and vitamin A than in pigs treated with iron alone ($P < .05$; Table 2). Concentration of iron in the spleen did not differ significantly between pigs that were treated with iron alone and pigs treated with both iron and vitamin A ($P > .05$; Table 2).

Hematocrits did not differ significantly on Day 1 (Table 3). On Days 7, 14, and 21, hematocrits were lower in control pigs than in either group of pigs treated with iron ($P < .05$). On Day 7, hematocrits were 10.3% higher ($P < .05$) in pigs treated with both iron and vitamin A than in pigs treated with iron alone. On Days 14 and 21, hematocrits did not differ significantly between pigs treated with iron alone and pigs treated with both iron and vitamin A ($P > .05$).

Hemoglobin concentrations did not differ significantly on Day 1 (Table 4). On Days 7, 14, and 21, hemoglobin concentrations were lower in control pigs ($P < .05$) than in either group of pigs treated with iron. On Days 7, 14, and 21, hemoglobin concentrations were 11.2%, 10.6%, and 10.7% higher, respectively, in pigs treated with both iron and vitamin A than in pigs treated with iron alone ($P < .05$).

Plasma iron concentrations did not differ significantly on Day 1 (Table 5). Plasma iron concentrations were lower in controls than in pigs treated with iron on Days 7, 14 and 21 ($P < .05$). On Days 7 and 14,

Table 2: Effects of treatments with iron and iron plus vitamin A* on least squares means for growth, mortality, and iron concentrations in the liver and spleen in 21-day-old pigs†

Treatment	Body weight (kg)			Mortality (%)	Iron (mg/kg)‡	
	Day 0	Day 21	Gain		Liver	Spleen
Control	1.32	5.04	3.72[a]	12.5[a]	97[c]	375[c]
Iron	1.34	5.73	4.39[b]	3.13[b]	594[d]	903[d]
Iron with vitamin A	1.30	5.82	4.52[b]	3.13[b]	652[e]	974[d]
SE	0.04	0.25	0.06	0.59	10.37	13.18

* Pigs born Day 0 were treated on Day 2 with iron dextran (200 mg intramuscularly) or with the same dose of iron dextran plus oral vitamin A (2000 IU), or no treatment (control).

† Ninety-six piglets from eight litters were used in the study, with four replicates per treatment for a total of 12 treatment groups. Litters were adjusted at birth on Day 0 by cross-fostering to 12 pigs per litter, with each pig in a litter randomly assigned to one of the 12 treatment groups. Means for Days 1, 7, and 14 represent eight pigs per treatment. Liver and spleen samples were collected from only four pigs per treatment on Day 21; thus, means for iron concentration in liver and spleen represent four pigs per treatment.

‡ Dry matter basis.

[ab] Means within a column with no common superscript are significantly different (ANOVA; $P < .05$).

[cde] Means within a column with no common superscript are significantly different (ANOVA; $P < .01$).

Table 3: Effects of treatments with iron, iron plus vitamin A, or no treatment* on Day 2 on mean hematocrit in pigs on Days 7,14, and 21

Treatment	Hematocrit (L/L)†			
	Day 1	Day 7	Day 14	Day 21
Control	31.2	23.8[a]	21.3[a]	20.4[a]
Iron	30.7	31.1[b]	35.7[b]	37.6[b]
Iron with Vitamin A	30.3	35.4[c]	38.5[b]	39.1[b]

* Ninety-six piglets from eight litters were used in the study, with four replicates per treatment (litters adjusted by cross-fostering to 12 pigs per litter at birth on Day 0). Means for Days 1, 7, and 14 represent eight pigs per treatment. Blood samples for hematocrit were collected from only four pigs per treatment group on Day 21; thus, means represent four pigs per treatment.

† Least squares means. In the ANOVA model, there were significant effects of treatment (SE, 0.41; $P < .001$) and day (SE 0.39; $P < .01$), and the treatment × day interaction was significant (SE, 0.67; $P < .01$).

[abc] Means within a column with no common superscript are significantly different (ANOVA; $P < .05$).

plasma iron concentrations in pigs treated with both iron and vitamin A were higher ($P < .05$) than those in pigs treated with iron alone. On Day 21, plasma iron concentrations did not differ significantly between pigs treated with iron alone and pigs treated with both iron and vitamin A ($P > .05$).

Total iron-binding capacity was higher ($P < .05$) in control pigs than in pigs treated with iron on Days 7, 14, and 21 (Table 6).

On Day 7, total iron-binding capacity did not differ significantly between pigs treated with iron alone and pigs treated with both iron and vitamin A. On Days 14 and 21, total iron-binding capacity was lower in pigs treated with both iron and vitamin A than in pigs treated with iron alone ($P < .05$).

The effect of day on hematocrit, hemoglobin concentration, plasma iron concentration, and total iron-binding capacity was significant ($P < .05$). The treatment × day interaction was significant for hematocrit and plasma iron concentration ($P < .05$), but not for hemoglobin concentration and total iron-binding capacity ($P > .05$).

Discussion

Iron deficiency is the main cause of piglet anemia.[13] Many researchers have proved that newborn pigs need supplemental iron, and administration of iron to the neonatal pig has been a standard practice in many parts of the world for many years. In the present study, weight gains between Day 0 and Day 21 were higher in pigs that were treated with iron on Day 2 than in pigs not treated with iron. Measures of iron nutrition, including hemoglobin concentration, hematocrit, plasma iron concentration, total iron-binding capacity, and concentrations of iron in liver and spleen were all significantly better in pigs that were treated with iron than in pigs not treated with iron, in agreement with other studies.[3,14,15]

Intramuscular injection of iron in newborn pigs is effective in preventing piglet anemia in practice. In this study, intramuscular injection of iron combined with oral vitamin A was more effective than treatment with iron alone. Hemoglobin and hematocrits levels are sensitive criteria for evaluating body biological response to iron. Plasma iron concentration is the indicator of iron deficiency, and total iron-binding capacity is the important index in iron metabolism, representing the ability of transferrin to carry iron in the blood.[16] In this study, hemoglobin concentration, hematocrit, plasma iron concentration, and iron concentrations in liver and spleen were higher and total iron-binding capacity was lower in pigs treated with both iron and vitamin A than in pigs treated with iron alone, showing that body iron status was better when piglets were treated with both iron and vitamin A. These data suggest that a combination of iron and vitamin A is more effective than iron alone in preventing piglet anemia. To the authors' knowledge, there are no previously published reports concerning the combination of iron and vitamin A in preventing anemia in pigs.

In a study in humans with low vitamin A status or deficient iron status, supplemental vitamin A was associated with higher hemoglobin level and hematocrit, thereby contributing to control of nutritional anemia, and there was a synergistic interaction between vitamin A and iron in combined

Table 4: Effects of treatments with iron, iron plus vitamin A, or no treatment* on Day 2 on mean hemoglobin in pigs on Days 7, 14, and 21

Treatment	Hemoglobin (g/L)†			
	Day 1	Day 7	Day 14	Day 21
Control	97.5	71.4[a]	57.5[a]	1.1[a]
Iron	96.6	103.3[b]	110.8[b]	21.6[b]
Iron with Vitamin A	96.5	114.9[c]	122.6[c]	29.9[c]

* Ninety-six piglets from eight litters were used in the study, with four replicates per treatment (litters adjusted by cross-fostering to 12 pigs per litter at birth on Day 0). Means for Days 1, 7, and 14 represent eight pigs per treatment. Blood samples for hemoglobin were collected from only four pigs per treatment group on Day 21; thus, means represent four pigs per treatment.

† Least squares means. In the ANOVA model, there were significant effects of treatment (SE, 4.77; $P < .05$) and day (SE 3.87; $P < .001$), but the treatment × day interaction was not significant (SE, 0.20; $P = 6.69$).

[abc] Means within a column with no common superscript are significantly different (ANOVA; $P < .05$).

Table 5: Effects of treatments with iron, iron plus vitamin A, or no treatment* on Day 2 on mean plasma iron concentrations in pigs on Days 7, 14, and 21

Treatment	Plasma iron (μmol/L)†			
	Day 1	Day 7	Day 14	Day 21
Control	12.31	11.66[a]	11.57[a]	11.14[a]
Iron	12.47	13.12[b]	13.43[b]	13.62[b]
Iron with Vitamin A	12.11	13.69[c]	14.37[c]	14.17[b]

* Ninety-six piglets from eight litters were used in the study, with four replicates per treatment (litters adjusted by cross-fostering to 12 pigs per litter at birth on Day 0). Means for Days 1, 7, and 14 represent eight pigs per treatment. Blood samples for plasma iron were collected from only four pigs per treatment group on Day 21; thus, means represent four pigs per treatment.

† Least squares means. In the ANOVA model, there were significant effects of treatment (SE, 0.15; $P < .001$) and day (SE 0.14; $P < .01$), and the treatment × day interaction was significant (SE, 0.25; $P < .001$).

[abc] Means within a column with no common superscript are significantly different (ANOVA; $P < .05$).

Table 6: Effects of treatments with iron, iron plus vitamin A, or no treatment* on Day 2 on mean total iron-binding capacity in pigs on Days 7, 14, and 21

Treatment	Total iron-binding capacity (μmol/L)†			
	Day 1	Day 7	Day 14	Day 21
Control	126	125[a]	123[a]	124[a]
Iron	123	120[b]	118[b]	117[b]
Iron with vitamin A	125	117[b]	113[c]	112[c]

* Ninety-six piglets from eight litters were used in the study, with four replicates per treatment (litters adjusted by cross-fostering to 12 pigs per litter at birth on Day 0). Means for Days 1, 7, and 14 represent eight pigs per treatment. Blood samples for total iron-binding capacity were collected from only four pigs per treatment group on Day 21; thus, means represent four pigs per treatment.

† Least squares means. In the ANOVA model, there were significant effects of treatment (SE, 1.15; $P < .001$) and day (SE 0.79; $P < .001$), but the treatment × day interaction was not significant (SE, 0.36; $P = 1.37$).

[abc] Means within a column with no common superscripts are significantly different (ANOVA; $P < .05$).

therapy.[4] Iron in combination with vitamin A was more effective than iron alone in treating low iron status in rats that had lower blood hemoglobin concentration, hematocrit, and erythrocyte count after being fed a diet deficient in both iron and retinol.[8] Mwanri et al[17] conducted a randomized controlled trial to study the effects of dietary supplements on anemic children, using vitamin A alone, iron and vitamin A, iron alone, or placebo, administered in a double-blind design for 3 months. All supplements were administered in corn-based gruel. Results showed that after 3 months, mean hemoglobin concentration was higher by 13.5 g per L in children receiving vitamin A alone, compared with 3.5 g per L in the placebo treatment group ($P < .0001$). In addition, after 3 months, the mean body weight of children receiving vitamin A alone was higher by 0.6 kg, compared with 0.2 kg for the placebo treatment ($P < .0001$), and mean height for children receiving vitamin A alone was higher by 0.4 cm compared with 0.1 cm for the placebo treatment ($P = .0009$). However, in the group of children who received both vitamin A and iron supplementation, mean change from baseline was better in all indicators compared with the placebo treatment (mean change in hemoglobin 18.5 g per L, $P < .0001$; mean change in body weight 0.7 kg, $P < .0001$; and mean change in height 0.4 cm, $P < .0001$). The authors concluded that, in developing countries, vitamin A supplementation may have a useful role in combating anemia, as well as in improving children's growth.

Zhang et al[18] found that in broiler chickens, iron concentration in liver decreased and iron concentration in serum increased with an increase in dietary supplemental vitamin A. Duodenum iron concentration, tibia iron concentration, and erythrocyte count increased significantly with higher dietary supplemental vitamin A ($P < .01$), indicating that vitamin A can enhance iron metabolism.

The mechanism by which vitamin A alleviates iron deficiency anemia is not clear. There are several hypotheses. Vitamin A may form a complex with iron, maintaining its solubility in the intestinal lumen and preventing the inhibitory effects of phytates and polyphenols on iron absorption,[19,20] but Sajedianfard et al[21] concluded that the therapeutic effect of vitamin A in iron-deficiency anemia is probably not associated with its influence on iron absorption from the

gastrointestinal tract. The study of Amine et al[22] showed that vitamin A deficiency impairs erythropoiesis, but Roodenburg et al[23] found no evidence that vitamin A deficiency affected erythropoiesis and erythrocyte turnover. Transcription of the transferrin gene in vitro is stimulated by vitamin A,[24,25] suggesting that vitamin A is involved in synthesis of the glycosyl moieties of the transferrin molecule.

Vitamin A seems to be related to the pathogenesis of anemia by various biological mechanisms, such as enhancing the growth and differentiation of erythrocyte progenitor cells, potentiating immunity to infection and reducing the anemia of infection, and mobilizing iron stores from tissues.[7]

There was a significant positive correlation between plasma retinol and plasma iron in pregnant women.[26] By measuring plasma retinol concentrations of piglets before and after suckling, Hakansson et al[27] established that piglets were born with low levels of retinol (0.07 mg per L), that transfer of vitamin A via the placenta appeared to be limited, and that colostrum was a major means of retinol transfer to the young piglet. Davila et al[28] reported that, in rats, vitamin A concentration in colostrum on day 1 of lactation did not vary with maternal vitamin A intake during pregnancy; however, the concentration of vitamin A in milk increased with increasing maternal vitamin A intake during lactation. In swine, the highest mean concentrations of retinol were found in colostrum, while retinol concentration in sow milk decreased by 71% during the first week postpartum and remained relatively stable thereafter.[27] These results[17,27,28] indicate that transfer of vitamin A via the placenta is limited, that piglets are born with small vitamin A stores, that colostrum is the main source of vitamin A for newborn piglets, that colostrum vitamin A concentration is not affected by maternal vitamin A intake during pregnancy, and that the vitamin A status of piglets is influenced by maternal vitamin A intake during lactation.

Implications

- Piglets have better iron nutrition status when provided with both iron and vitamin A than when treated with iron alone.
- Vitamin A may promote the role of iron in preventing piglet anemia.
- Under the conditions of this study, a combination of vitamin A and iron is more effective than iron alone in preventing piglet anemia.

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Anatomical abnormalities in a group of finishing pigs: prevalence and pig performance

Barbara Straw, DVM, PhD; Ronald Bates, MS, PhD; Gerald May, MS

Summary

Growth rate and mortality during the first 80 days in a commercial finisher were documented in pigs with scrotal or umbilical hernias or kyphosis. Umbilical hernias were classified by size. Scrotal hernias and kyphosis were not subclassified. Descriptive statistics were performed for prevalence of defects. Prevalence, gender, and mortality in affected and non-affected pigs were compared using chi-squared tests. Gain in the first 80 days was compared by ANOVA in pigs with umbilical hernias of various sizes. Prevalence and mortality rate for umbilical hernias did not differ by gender ($P > .05$), but kyphosis occurred more frequently in barrows ($P < .05$). Mortality rates were higher among affected pigs, but did not increase with umbilical-hernia score ($P = .30$). Pigs that died spent considerable time in the finisher, with probable compromise of their welfare during this time. Welfare and economic considerations may make euthanasia preferable to placing pigs with hernias or kyphosis in the finisher.

Keywords: swine, scrotal hernia, umbilical hernia, kyphosis, performance

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Resumen - Anormalidades anatómicas en un grupo de cerdos de finalización: prevalencia y desempeño del cerdo

Se documentó el índice de crecimiento y mortalidad durante los primeros 80 días en una engorda comercial en cerdos con hernias umbilicales ó escrotales ó cifosis. Las hernias umbilicales se clasificaron por tamaño. Las hernias escrotales y cifosis no se subclasificaron. Se realizaron análisis de estadística descriptiva para la prevalencia de defectos. Se comparó la prevalencia, género, y mortalidad en cerdos afectados y no afectados utilizando la prueba de xi cuadrada. La ganancia en los primeros 80 días se comparó utilizando ANOVA en cerdos con hernias umbilicales de varios tamaños. Los índices de prevalencia y mortalidad de hernias umbilicales no difirieron por género ($P > .05$), pero la cifosis ocurrió más frecuentemente en machos castrados ($P < .05$). La mortalidad fue más altos en los cerdos afectados, pero no aumentó con la calificación de hernias umbilicales ($P = .30$). Los cerdos que murieron pasaron un tiempo considerable en la engorda, probablemente afectando su bienestar durante este tiempo. Las consideraciones de bienestar y económicas pueden justificar que la eutanasia sea preferible a aceptar cerdos con hernias ó cifosis en el área de finalización.

Résumé - Anomalies anatomiques dans un groupe de porcs en finition: prévalence et performances zootechniques

Le taux de croissance et les mortalités durant les premiers 80 jours d'élevage dans un troupeau de finition commercial ont été documentés pour des porcs ayant des hernies scrotales ou ombilicales ou de la cyphose. Les hernies ombilicales ont été classées en fonction de leur taille. Aucune sous-classification n'a été faite pour les hernies scrotales et la cyphose. Des statistiques descriptives ont été effectuées pour la prévalence des anomalies. La prévalence, le sexe, et les mortalités chez les porcs affectés et non-affectés ont été comparés à l'aide de tests de chi-carré. Le gain de poids dans les premiers 80 jours a été comparé par ANOVA chez les porcs avec hernies ombilicales de tailles différentes. La prévalence et le taux de mortalité pour les hernies ombilicales n'étaient pas différents en fonction du sexe ($P > .05$), mais la cyphose était plus fréquente chez les mâles castrés ($P < .05$). Les taux de mortalité étaient plus élevés par les porcs affectés, mais n'a pas augmenté en fonction du pointage de l'hernie ombilicale ($P = .30$). Les porcs qui moururent passèrent considérablement plus de temps en finition, avec fort probablement une atteinte à leur bien-être durant cette période. Pour des considérations économiques et de bien-être, l'euthanasie pourrait être préférable à l'entrée en finition pour des porcs avec hernies ou cyphose.

Congenital defects occur in pigs at a prevalence estimated by different authors as 0.11% to 4.96%.[1] Umbilical and inguinal hernias have been reported by one source as occurring in 0.4% to 1.5% of pigs.[2] An Ontario study[1] reported a prevalence of 0.39% for all types of hernias, but a higher prevalence (1.7% to 6.7%) has been reported.[3] For umbilical hernias specifically, prevalence has been reported as 0.4% to 1.2%.[4] For scrotal hernias, prevalence has been reported as 2% (Germany),[5] 5%,[6] 1% to 5% (Thailand),[5] 1.35% and 0.22% to 0.54% (Netherlands),[7] and 0.6%, 1.0%, and 1.5% for the Duroc, Landrace, and Yorkshire breeds, respectively.[8]

Pigs with kyphosis and lordosis are referred to in the industry as humpy-back pigs (Figure 1). In most affected animals, the condition is not apparent at birth, but

BS: Department of Large Animal Clinical Sciences, College of Veterinary Medicine, Michigan State University, East Lansing, Michigan.

RB: Department of Animal Sciences, Michigan State University, East Lansing, Michigan.

GM: Michigan State University Extension, Ithaca, Michigan.

Corresponding author: Dr Barbara Straw, Large Animal Clinical Sciences, A203 Veterinary Medical Center, Michigan State University, East Lansing, MI 48824; Tel: 517-432-5199; Fax: 517-432-3450; E-mail: straw@cvm.msu.edu.

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Figure 1: Kyphosis in two pigs at placement in a commercial finisher.

becomes recognizable at 8 to 16 weeks of age, and sometimes as early as 3 weeks of age.[9] The prevalence of kyphosis has been reported as 2.5% (Denmark),[10] 4% (England),[11] and 6.3% to 11.4% (Sweden),[12] with outbreaks affecting up to 30% of pigs.[9]

Identification of scrotal hernias, umbilical hernias, and kyphosis creates a dilemma for producers, as welfare and economic considerations may make euthanasia preferable to placing affected pigs in the finisher. The objective of this study was to assess growth rate and mortality of pigs with scrotal or umbilical hernias or kyphosis in a commercial finisher.

Data collection

The selected finishing site included eight 1000-head, curtain-sided, tunnel-ventilated Hog Slat barns (Hog Slat, Inc, Newton Grove, North Carolina) with totally slatted floors. Pigs were placed in the finisher at approximately 27 to 32 kg and were usually sold at 126 to 131 kg. In this observational study, approval of the study protocol by the animal care and use committee was not required. This farm employed PQA Plus® guidelines[13] in care of finishing pigs.

Pigs were weighed as a group at transfer to the finisher, and average weight was calculated. When the site was filled, all pigs were examined for scrotal and umbilical hernias and kyphosis, and affected pigs were individually weighed and ear-tagged, distinguishing them from the nonaffected pigs, which were not ear-tagged. Defects were assessed by a veterinarian and a group of veterinary students. Umbilical hernias were subjectively classified into three categories by approximate size: small (approximately golf-ball size), medium (approximately baseball size), and large (approximately melon size). Scrotal hernias and kyphosis were identified without further classification. Eighty days post placement, non-tagged pigs were weighed as a group and ear-tagged pigs were individually weighed. Throughout the finishing period, mortality in the tagged pigs was recorded and gross necropsies were performed on-site on all tagged and non-tagged pigs that died. Hernia contents were not cultured. Kill sheets from the packing plant were used to record mean age and individual weights of non-tagged pigs at market.

Data analysis

Descriptive statistics (prevalence of defects) and comparisons of prevalence, mortality, and gender in affected and nonaffected pigs were performed in Minitab (Minitab Inc, State College, Pennsylvania) using a chi-square test. Comparison of 80-day weight in affected and nonaffected pigs, and among pigs with small, medium, or large umbilical hernias, were performed using least squares analysis of variance (ANOVA) in SAS (SAS Institute, Cary, North Carolina). For all comparisons, the group of nonaffected pigs included only normal, healthy pigs that had not been diagnosed or treated for any diseases. For all analyses, $P < .05$ was considered statistically significant.

Results

No tagged pigs were euthanized during the study. No non-tagged pigs developed hernias or kyphosis after initial evaluation of the herd. Mortality rates were higher among pigs with any of the three anatomical defects than among unaffected pigs ($P < .05$) (Table 1). Tagged pigs that died spent up to 80 days in the finisher. Necropsy findings in pigs with hernias were characterized by peritonitis with strangulated gut. The common lesion in pigs with kyphosis was pneumonia, which was the major cause of death in this production site. Pneumonic lesions were not cultured.

Kyphosis occurred more frequently in barrows (22) than in gilts (11) ($P < .05$). Among pigs with umbilical hernias, neither prevalence of the defect ($P = .19$) nor mortality rate ($P = .41$) differed between gilts (n = 36) and barrows (n = 33). No inguinal hernias were identified in gilts.

Hernias in necropsied pigs were not reducible, with some degree of fibrin adhesions evident in all cases. While the presence of an umbilical hernia was associated with slower growth rate, ADG in pigs with the largest umbilical hernias (ADG 912.0 ± 53 g) did not differ from ADG in either pigs with medium umbilical hernias (ADG 832.6 ± 30 g) or pigs with small umbilical hernias (ADG 857.9 ± 34 g; $P = .43$). Mortality rates were 4.0%, 3.1%, and 8.3% for pigs with umbilical hernias scored as small, medium, and large, respectively ($P = .30$). As the tagged pigs in this study were processed through the cull market, which provides no kill sheet, no estimate of condemnation rate was available for these pigs.

Discussion

A variety of genetic and environmental factors contribute to the formation of umbilical hernias,[4] which occur when weakened supportive muscles around the umbilical stump or navel area interfere with closure of the umbilical opening, allowing intestines to protrude through the abdominal wall. The genetic control of umbilical hernias is not known. A heritable cause has been suggested,[4] and progeny testing of single-sire lines showed that the odds of finding a pig with an umbilical hernia were greater for some genetic lines. However, specific genes have never been reported and umbilical hernias are not the result of simple inheritance.[14] Environmental conditions that interfere with closure of the umbilical cord contribute to development of hernias, for example, abnormal stretching of the umbilical cord during farrowing, placing navel clips too close to the skin, and infection of the umbilical stump.[7] Genetic variability may have an effect on the musculature of the navel, and pigs with weaker navel muscles in a poor environment may be particularly susceptible to herniation. Proper sanitation and hygiene may be more likely to reduce the incidence of umbilical hernias than eliminating certain boars or dams.

Inguinal hernias may affect both genders, although they are rare in females and usually associated with intersexuality.[15] It is thought that scrotal hernias are caused by failed obliteration of the process vaginalis after descent of the testis,[16] or from failed involution at the internal inguinal ring.[17] In either case, the inguinal ring does not close off properly after descent of the testes, allowing the distal jejunum and ileum to drop into the scrotum. The mode of inheritance for susceptibility to inguinal and scrotal hernias is likely to be polygenic.[7] In a study of breeding and performance records for an 8-year period, Vogt and Ellersieck[8] identified breed differences in the prevalence of scrotal hernia in the progeny of Yorkshire, Duroc, and Landrace boars, and a greater prevalence of scrotal hernias among male full siblings of affected pigs than among male full siblings in the general population. Vogt and Ellersieck[8] concluded that susceptibility to this defect is inherited via genes at multiple loci. Using a genome scan for markers associated with inguinal and scrotal hernias, Grindflek et al[18] identified genomic areas associated with susceptibility to both types of hernias in pigs.

Table 1: Prevalence of defects (umbilical and scrotal hernias and kyphosis) and growth rate and mortality in affected and unaffected finisher pigs*

	No. affected	80-day weight (kg)(n)†	Prevalence (%)	Mortality (%)	Days until death (range)‡
Umbilical hernia					
Small	25	85.00 (22)			
Medium	32	90.38 (27)	69 (0.86)	5/69 (7.2)[a]	58.0 ± 22.6 (30-80)
Large	12	93.54 (10)			
Scrotal hernia	56	83.41 (42)	56 (0.70)	14/56 (25.0)[b]	17.4 ± 17.1 (1-70)
Kyphosis	34	83.13 (30)	34 (0.42)	4/34 (11.8)[c]	48.5 ± 31.5 (5-75)
Unaffected	7863	99.48 (7627)	NA	236/7863 (3.0)	NA

* The 8022 pigs in the finisher were weighed as a group at placement (approximately 27 to 32 kg); 80 days later, nonaffected pigs were weighed as group, and affected pigs were individually weighed. Affected pigs were ear-tagged at placement when assessed for defects. Umbilical hernias were classified as small (approximately golf-ball size), medium (approximately baseball size), and large (approximately melon size).

† Pigs not weighed at 80 days included those that died (1, 2, and 2 in the small, medium, and large umbilical hernia groups, respectively) and those that had lost their ear tags.

‡ Mean ± SD. Days until death was recorded only for pigs with hernias or kyphosis.

[a] Differed from mortality of nonaffected pigs (chi-square analysis; $P = .048$).

[b] Differed from mortality of nonaffected pigs (chi-square analysis; $P < .001$).

[c] Differed from mortality of nonaffected pigs (chi-square analysis; $P < .01$).

NA: not applicable.

All types of hernias are classified as direct if intestines directly contact the skin, and indirect if intestinal loops outside the abdominal wall are covered by peritoneum or vaginal tunic.[18] Direct contact of intestines with skin stimulates formation of adhesions that can cause partial bowel obstruction, with subsequently poor growth performance.[2] The welfare of severely affected animals may be at stake if the intestine becomes completely obstructed or if the hernial sac is injured or abscessed.[2] Moderate adhesions may not severely diminish performance, and the carcass values of affected and unaffected pigs should be similar. However, peritonitis interferes with evisceration at slaughter, necessitating trim loss for small hernias and, at some abattoirs, condemnation of > 50% of pigs with large hernias.[2] Handling animals with hernias requires extra labor during processing, as intestinal adhesions cannot be distinguished from infectious peritonitis. Adhesions predispose to rupture of the intestines during the slaughter process, contamination of the carcass with intestinal content, and subsequent condemnation. Pigs with hernias may be marketed through specialty harvest facilities that can accommodate and slaughter them with minimal risk of carcass condemnation, as was the case in the herd observed in this study, with the caveat that special handling reduces the value of the animals.

Pigs with kyphosis may grow poorly and fail to reach slaughter weight.[19] Primary vertebral lesions caused by physical or metabolic abnormalities, intrauterine infections, early onset of puberty in male pigs, stress on the lumbar spine caused by painful musculoskeletal conditions, and genetic background have all been suggested as possible causes of kyphosis,[4] but no confirmatory studies have been reported. Three variants of this defect are reported. First, there may be no gross or histological vertebral changes.[10] Second, kyphosis may be the result of failure of vascularization of the ventral centers or ossification in the lumbar vertebrae, with subsequent development of ventral hemivertebrae.[10] Finally, outbreaks in some herds may be associated with vasculitis affecting both the lumbar vertebrae and other tissues, as described in Canadian herds.[19] An association with infectious agents such as porcine circovirus type 2 is suspected in these cases.[19] Kyphosis has also been associated with lesions of osteochondrosis,[10] specifically affecting intervertebral synovial joints and femorotibial joints.[20] It has been suspected that osteoarthorisis and osteochondrosis may be initiated by infectious agents.[21] This may include agents such as porcine reproductive and respiratory syndrome (PRRS) virus that can cross the placental barrier and infect piglets in utero.[22] It has been suggested that endemic PRRS may be associated with prevalence of kyphosis in finisher pigs.[9]

Producers can estimate the profitability of retaining pigs with hernias or kyphosis by calculating growth performance, mortality rate, and condemnation rate for affected pigs in their herds. Welfare is an important consideration in decisions made concerning the care of these pigs. In this study, pigs with hernias not only consumed feed and occupied space in the finisher during the 3 to 4 weeks before they died, but also were likely to have experienced abdominal discomfort. Approximately 15% of pigs with hernias died during the 80-day period of observation, and previous research[2] suggests that up to 50% of the survivors might have been condemned for peritonitis. Depending on availability and quality of individual-pig observation, euthanasia of affected animals when they are identified might be a better option than placing them in the finisher.

Implications

- Under the conditions of this study, mortality rates are higher in finisher pigs with umbilical or scrotal hernias or kyphosis than in unaffected animals.
- Growth rate is slower in pigs with umbilical hernias, scrotal hernias, and kyphosis than in unaffected pigs.
- Neither growth rate nor mortality rate vary with the size of an umbilical hernia.

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Effect of treatment with phytosterols in three herds with porcine respiratory disease complex

Lorenzo J. Fraile, DVM, PhD; Elisa Crisci, DVM; Joan Weenberg, DVM; Montse Armadans, DVM; Lorenzo Mendoza, DVM; Lara Ruiz, DVM; Santi Bernaus, DVM; María Montoya, MSc, PhD

Summary

This case study includes three pig production systems belonging to two companies in Spain. Mortality, percent culls, average daily gain (ADG), and feed efficiency in Production Systems One and Two were incorporated into a database program and analyzed using statistical process control (SPC) techniques to assess changes in performance before and after phytosterols, natural substances that act as immunomodulators, were added to the feed. Inmunicin Maymo (Maymo Laboratories SA, Barcelona, Spain), a commercial phytosterol product, was administered in feed during the nursery and finishing periods, from 4 weeks before until 4 weeks after the predicted date of an outbreak of porcine respiratory disease complex (PRDC). In Production System Three, data obtained for batches treated or not treated with Inmunicin Maymo were compared using a one-way ANOVA, with the level of significance set at .05. In all three production systems, finisher mortality and percent culls were lower and production parameters were best when the immunomodulator was applied. Differences were statistically significant for all parameters evaluated, except feed conversion ratio, when assessed using SPC criteria in Systems One and Two and one-way ANOVA in System Three. Phytosterols may be useful to control endemic PRDC under field conditions.

Keywords: swine, phytosterols, porcine respiratory disease complex, inmunomodulation, statistical process control

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Resumen - Efecto del tratamiento con fitoesteroles en tres hatos con complejo respiratorio porcino

Este estudio de casos incluye tres sistemas de producción de cerdos que pertenecen a dos compañías en España. En un programa de base de datos se integraron la mortalidad, el porcentaje de desechado, ganancia diaria promedio (ADG por sus siglas en inglés), y eficiencia alimenticia de los Sistemas de Producción Uno y Dos y se analizaron utilizando la técnica de control estadístico del proceso (SPC por sus siglas en inglés) para evaluar cambios en el desempeño antes y después de que los fitoesteroles, sustancias naturales que actúan como inmunomoduladores, se añadieran al alimento. Inmunicin Maymo (Laboratorios Maymo SA, Barcelona, España) un producto comercial a base de fitoesteroles, se administró en el alimento durante los periodos de destete y finalización, desde 4 semanas antes hasta 4 semanas después de la fecha predicha de un brote de complejo respiratorio porcino (PRDC por sus siglas en inglés). En el Sistema de Producción Tres, la información obtenida de grupos tratados y no tratados con el Inmunicin Maymo se comparó utilizando un ANOVA de una vía, con un nivel de significancia establecido a .05. En los tres sistemas de producción, la mortalidad en las engordas y el porcentaje de desechos fueron más bajos y los parámetros de producción fueron mejores cuando se aplicó el inmunomodulador. Las diferencias fueron estadísticamente significativas en todos los parámetros evaluados, excepto en el índice de conversión alimenticia, cuando se evaluaron utilizando los criterios del SPC en los Sistemas Uno y Dos y la ANOVA de una vía en el Sistema Tres. Los fitoesteroles pueden ser útiles para controlar el PRDC endémico bajo condiciones de campo.

Résumé - Effet d'un traitement aux phytostérols dans trois troupeaux aux prises avec le complexe des maladies respiratoires porcines

La présente étude de cas inclus trois systèmes de production appartenant à deux compagnies en Espagne. Les donnés sur les mortalités, le pourcentage de réforme, le gain quotidien moyen (ADG), et l'efficacité alimentaire pour les Systèmes de Production Un et Deux ont été incorporées dans un programme de base de données et analysées à l'aide de techniques utilisant un processus de contrôle statistique (SPC) afin d'évaluer les changements dans les performances avant et après que des phytostérols, substances naturelles qui agissent comme des immunomodulateurs, aient été ajoutés aux aliments. Immunicin Maymo (Maymo Laboratories SA, Barcelone, Espagne), un produit phytostérol commercial, a été administré dans l'alimentation durant les périodes en pouponnière et en finition, d'une période allant de 4 semaines avant à 4 semaines après la date prévue d'une éclosion du complexe des maladies respiratoires porcines (PRDC). Dans le Système de Production Trois, les données obtenues

LJF, EC, MM: Centre de Reçerca en Sanitat Animal (CReSA), Edifici V, Universitat Autónoma de Barcelona, Bellaterra, Spain.

LJF, MM: Institut de Recerca i Tecnologies Agroalimentaries (IRTA), Barcelona, Spain.

JW, MA, LM, LR: Pinsos Baucells, Seu central Tona, Barcelona, Spain.

SB: Avinguda Alcalde Rovira Roure, 110, Lleida, Spain.

Corresponding author: Dr Lorenzo J. Fraile, CReSA, Edifici V, Universitat Autónoma de Barcelona, 08193 Bellaterra, Spain; Tel: +34 93 581 44 95; Fax: +34 93 581 44 90; E-mail: lorenzo.fraile@cresa.uab.es.

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pour les lots traités ou non-traités avec Immunicin Maymo ont été comparées à l'aide d'une analyse de variance univariée (ANOVA), avec un seuil significatif établi à .05. Dans les trois systèmes de production, la mortalité chez les finisseurs et le pourcentage d'animaux réformés étaient plus faibles et les paramètres de production étaient meilleurs lorsque l'immunomodulateur était appliqué. Les différences étaient statistiquement significatives pour tous les paramètres évalués, sauf le taux de conversion alimentaire, en utilisant les critères SPC dans les Systèmes Un et Deux et une ANOVA univariée dans le Système Trois. Les phytostérols pourraient être utiles pour maîtriser les PRDC endémiques dans des conditions de terrain.

Porcine respiratory disease complex (PRDC) seems to have evolved with modern swine production. It is characterized clinically by dyspnea, coughing, acute depression, anorexia, fever, and nasal discharge, most often affecting growing to finishing pigs.[1] The interaction of multiple factors contributes to PRDC. Both viral and bacterial organisms play a role, as well as environmental conditions and various management practices. In the right combination, these factors can compromise respiratory defense mechanisms sufficiently to cause severe respiratory disease.[2]

The most common viral pathogens associated with PRDC are porcine reproductive and respiratory syndrome virus (PRRSV), swine influenza virus (SIV), and porcine circovirus type 2 (PCV2).[3] The most commonly associated bacterial pathogens include *Mycoplasma hyopneumoniae, Actinobacillus pleuropneumoniae, Bordetella bronchiseptica, Pasteurella multocida, Haemophilus parasuis,* and *Streptococcus suis*.

Measures used to cope with PRDC include strict management policies, environmental monitoring, pig flow changes, implementation of strategic vaccination programs focused mainly on viral infectious agents (PRRSV, PCV2, and SIV), and antibiotic medication.[4] Antibiotics are used as prevention, therapeutic treatment, or both in swine medicine. This use has been associated with a significant increase in the resistance pattern of some microorganisms to antibiotics used in human and veterinary medicine.[4] For this reason, many alternatives to antibiotic use have been considered by the swine industry, including natural substances (immunomodulators) that may modulate the immune system, helping to overcome common infectious diseases. Many categories of immunomodulators have been investigated in animals, but only a few have been licensed for use in food animals, both in the United States and Europe.[5] However, this is an active field of research, not only with the goals of enhancing survival and clinical parameters for common infectious diseases, but also for improving the response to vaccines in many species.[6-12] Use of immunomodulators as an alternative to antibiotic use in livestock is highly supported by the European Commission's Seventh Framework Programme for research and technical development.[13]

Use of immunomodulators might be a useful approach to enhance immune responses after vaccination with PRRSV modified live vaccines or to overcome infectious diseases in swine. Recently, Inmunicin Maymo (Maymo Laboratories SA, Barcelona, Spain), a product containing plant phytosterols with immunomodulating activity,[14] has become commercially available in Spain. Its exact composition is protected under European patent, but the main component is beta-sitosterol (BSS). In animals, BSS and its glucoside have exhibited anti-inflammatory, antineoplastic, antipyretic, and immune-modulating activity[15] in a number of studies, including in vitro studies, animal models, and human clinical trials.[16] This phytosterol complex seems to target specific T-helper lymphocytes, increasing Th1 activity and resulting in improved T-lymphocyte and natural killer cell activity.[17] Taking into account the pathogenic mechanisms of PRRSV, SIV, and PCV2 infections, it is possible that an increase in Th1 activity would improve the immune response, helping to minimize the negative production consequences in herds where PRDC occurs endemically.[18-20]

Porcine respiratory disease complex causes immune dysfunction in affected animals, interfering with the capacity to overcome infectious challenges.[21] Our laboratory has preliminary experimental data on the use of a phytosterol mixture administered to pigs in feed to treat respiratory diseases that cause immune dysfunction.[22] This case study describes growth-production results in three production systems when phytosterols were administered in feed during the period when herd records showed that an outbreak of PRDC was likely to occur.

Production systems

The three pig-production systems described in this study belonged to two companies located in northeastern Spain. All animals were fed, housed, and handled with due concern for their welfare. The three facilities operated under the guidelines of the animal care and use committee of the Universidad Autónoma de Barcelona. No specific authorization was required for this study as Inmunicin is an authorized product in Spain (ie, it is not an experimental product).

Production System One

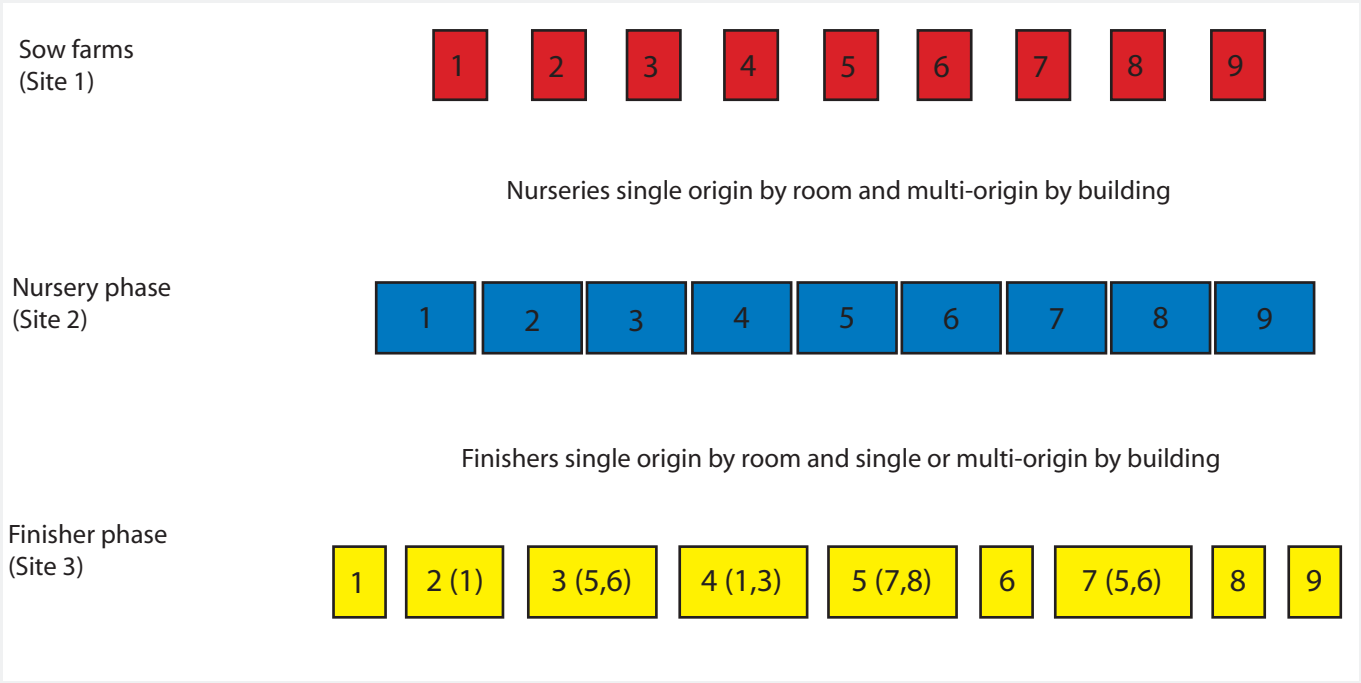
This 7000-sow multi-site production system included nine sow farms. Pig flow is shown in Figure 1. Briefly, pigs born in different sow farms were weaned at 21 days of age and moved to nurseries (Site 2) that were multi-origin by site and single origin by room. Nurseries were managed all-in, all-out by room. Pigs moved from the nurseries to the finishing units (Site 3) at 8 to 10 weeks of age. Finisher buildings 1, 6, 8, and 9 were single-origin ie, housed only pigs from sow farms 1, 6, 8, and 9, respectively. Finisher buildings 2, 3, 4, 5, and 7 were multi-origin, with pigs from two to three farms of origin per building. All finisher buildings were managed all-in, all-out and housed approximately 1000 pigs each.

During 2005, this system experienced > 10% mortality in late nursery pigs, early finishing pigs, or both, despite treatment with broad-spectrum antibiotics in feed and water and by injection (data from 108,000 pigs). During 2006, clinical signs compatible with PRDC were less severe and mortality decreased, but data from 120,000 pigs compared unfavorably with average finisher mortality for pigs in Spain (6.1%) during the same year (J. Font, SIP Consultors, oral communication, 2007). Both in 2005 and 2006, clinical signs compatible with PRDC were observed in pigs 8 to 9 weeks of age. For this reason, the company decided to use Inmunicin Maymo to improve performance in the system. This product was administered to pigs 4 to 12 weeks of age (end of the nursery period to the early finishing period) beginning in March 2006. Pigs in finishing closeouts beginning in August 2006 received this treatment (data for 120,000 pigs).

Production System Two

This multi-site production system included 1000 sows in a 3-week batch system. Pigs were moved to a nursery at a weaning age of 21 days. The nursery was single-origin by site, single-aged by room, and managed all-in, all-out by room. The finishing units were filled with pigs from this nursery (9 weeks

Figure 1: Pig flow for Production System One, a 7000-sow multi-site system in Spain. Finisher buildings 1, 6, 8, and 9 housed only pigs from sow farms 1, 6, 8, and 9, respectively. Finisher buildings 2, 3, 4, 5, and 7 each housed pigs from two to three farms of origin. Numbers in parentheses represent additional sow farms of origin. All finisher buildings were managed all-in, all-out (approximately 1000 pigs per barn).



of age) and were managed all-in, all-out by building (between 1000 and 1500 pigs per barn). Each closeout was from one finisher barn.

During 2005, the system experienced > 10% mortality in the finishing period (data from 21,589 pigs in 21 barns) and clinical signs compatible with PRDC were observed when pigs were 13 weeks of age. Mortality did not improve significantly during 2006 (data from 11,922 pigs in eight barns). For this reason, the company decided to use Inmunicin Maymo to improve performance in pigs 9 to 17 weeks of age, with treatment beginning in January 2006. Pigs in finishing closeouts beginning in May 2006 (batch 29) received this treatment (data from 16,694 pigs in 14 barns).

Production System Three

This 2135-sow multi-site production system included three farms, with 500 to 900 sows per farm. Pigs born in different sow farms were moved to nurseries (Site 2) at a weaning age of 21 days. Nurseries were multi-origin by site and single origin by room, and were managed all-in, all-out by room. The finishing units (1350 to 4220 pigs per barn) were filled with pigs from these nurseries (8 to 10 weeks of age) and were managed all-in, all-out by building.

During 2006, the system experienced high mortality in the finishing period because of PRRS outbreaks in some sow farms. Clinical signs characteristic of PRDC were observed when pigs were 13 weeks of age. The company decided to use Inmunicin Maymo to improve performance, with treatment administered to pigs 9 to 17 weeks of age in some finisher batches beginning in June 2006. Others batches were not treated (controls). Control and treated batches originating from the same sow herd included closeouts of 28,252 and 12,902 pigs from 10 and four finisher farms, respectively.

Treatment with Inmunicin Maymo

In each production system, Inmunicin Maymo was administered according to the label instructions (2 kg of Inmunicin Maymo per tonne of feed) during the period from 4 weeks before until 4 weeks after the predicted date of a PRDC outbreak, according to clinical experience in that system. No changes in gilt acclimation, genetic background, vaccinations, semen extenders, boar management, or weaning age of pigs were made during the treatment period.

Parameters evaluated

Criteria evaluated included average daily gain (ADG), feed efficiency, mortality, and percent culls during the finisher phase. Average daily gain was calculated as the difference between final weight at closeout and initial weight of all pigs, divided by the length of the finisher period. Mortality was calculated as the number of pigs that had died by closeout divided by the number of pigs that had entered the finisher. Percent culls was calculated as the number of culls at closeout divided by the number of pigs that had entered the finisher. Feed efficiency was calculated by dividing feed consumption (including feed wastage) at barn level during the finisher period by the difference between final weight at closeout and initial weight of all pigs that had entered the finisher in the three production systems.

Diagnostic testing

Diagnostic testing was performed in each production system at several time points. Blood samples from 12 animals that exhibited signs of PRDC (dyspnea, coughing, anorexia, and fever) were collected and tested for PRRSV genomes by reverse transcriptase polymerase chain reaction (RT-PCR).[23] Samples were collected on the day when clinical signs were first noticed (Day 0) and from the same ear-tagged animals 21

days later (Day 21). Extraction and amplification of PRRSV DNA was performed on pools of Day 0 samples (four samples per pool). Day 0 and Day 21 sera were tested for PRRSV antibodies by ELISA (HerdChek PRRS 2XR; Idexx Laboratories, Barcelona, Spain).

Necropsies were performed by the herd veterinarian during the PRDC outbreak. To avoid misinterpretation of pathological findings, only fresh specimens (ie, no autolyzed carcasses) were examined. The main purpose of necropsy was to determine whether or not postweaning multisystemic wasting syndrome (PMWS) was a significant contributor to disease and mortality. Tissue samples (lung, superficial inguinal lymph node, spleen, kidney, and liver) were submitted to the histopathology department, Universidad Autonoma de Barcelona (Barcelona, Spain), for histopathology and testing for PCV2 infection by in situ hybridization.[24]

No microbiological isolation was attempted, as many animals were being treated with antimicrobials prophylactically or therapeutically during the PRDC outbreak. Pigs were treated with tiamulin (200 g per tonne) and chlortetracycline (400 g per tonne) in the feed at the end of the nursery period and early in the finishing period (5 weeks total).

Statistical analyses

Data from Systems One and Two were incorporated into a database program and analyzed using statistical process control (SPC) techniques[25] to assess changes in performance before and after addition of the immunomodulator to the feed. If the process remained in control, future measurements would continue to follow the same probability distribution as previously. All analyses were performed with the QI Macros2007 SPC for Excel (KnowWare international Inc; `www.excel-spc-software.com/excel-spc-software.html`). System changes were considered significant if one or several of the following conditions existed: one single point more than 3 σ away from the mean; at least two of three successive points 2 σ away and on the same side of the mean; at least nine successive points on the same side of the mean; at least four of five successive points 1 σ away and on the same side of the mean.

A control chart was constructed for each analyzed parameter and the control limit, upper control limit, and lower control limit were calculated from the inherent variation using the software described. The chart was selected according to the type of analyzed data and whether or not the data was normally distributed.[25]

Production parameters (ADG, feed efficiency, and mortality) of control and treated batches in System Three were compared in a one-way ANOVA, as data for controls and treated groups were generated concurrently rather than in successive groups as in Systems One and Two. Level of significance was established at < .05. All analyses were performed in NCSS 2004 and PASS 2005 (NCSS, Kavysville, Utah).

Results of diagnostic testing

Diagnostic results are described in Table 1. Infections with both PRRSV and PCV2 were diagnosed in System One, while PMWS alone was diagnosed in System Two and PRRS alone was diagnosed in System Three on a single occasion. Diagnostic testing for PMWS was not performed in System Three. In Production Systems One and Two there was a clinical diagnosis of PRDC (respiratory signs as described) and a laboratory diagnosis of PRRSV infection, PCV2 infection, or both during the Unstable, Stable, and Stable with immunomodulator periods (defined in Table 2 and described in Figure 2). No additional diagnostic testing was performed for other pathogens.

Mortality, percent culls, and production parameters

The mean values of the studied parameters in Systems One and Two are represented in the XmedianR charts (Figures 2, 3, 4, and 5). This chart was chosen because the mean values for the studied parameters were normally distributed (NCSS 2004 and PASS 2005 software). From these mean values, in both production systems, three periods could be clearly defined: Unstable, Stable, and Stable with immunomodulator. The dates of the beginning and end of each period are shown in Table 2. Highest mortality and percent culls and worst production parameters were observed during the first period (Unstable) in both production systems, which corresponded with the epidemic phase of PRRS, PMWS, or both in each production system. In both systems, the outbreak of PRDC was first noticed during this period, and treatment with antimicrobials began. It was not possible to calculate chart limit values during the Unstable period, because SPC may be applied only in a stable situation.[26] During the following period (Stable), all studied parameters improved.

This stable phase was associated with the endemic phase of PRRS, PMWS, or both, but production parameters were always inferior to those accepted as average in Spain (J. Font, SIP consultors [`www.sip-consultors.com`], oral communication, 2007). During the stable period, natural variation inherent in a process is expected

Table 1: Results of diagnostic testing for two agents associated with porcine respiratory disease complex in finisher pigs in three production systems in Spain

	PRRSV*		
Production system	PCR-positive	Seroconversion	PMWS †
One	Yes	Yes	Yes
Two	No	No	Yes
Three	Yes	Yes	ND

* Blood samples were collected from the same 12 animals on Day 0 (first observation of dyspnea, coughing, anorexia, and fever) and Day 21. Day 0 samples were tested for PRRSV by reverse-transcriptase PCR. Day 0, and Day 21 samples were tested for PRRSV antibodies by ELISA (HerdChek PRRS 2XR; Idexx Laboratories, Barcelona, Spain), defining a positive result as sample:positive ratio (S:P) > 0.4. Seroconversion was defined as an S:P in the Day 21 sample that was at least three times that of the Day 0 sample.

† PMWS was diagnosed using fresh specimens and internationally accepted criteria[19] for clinical signs and histopathology lesions, and porcine circovirus type 2 was detected by in situ hybridization.

PRRSV = porcine reproductive and respiratory syndrome virus; PCR = polymerase chain reaction; PMWS = postweaning multisystemic wasting syndrome; ND = not done.

Table 2: Beginning and ending dates for periods when parameters analyzed using statistical process control methods were clearly different in two production systems with endemic PRDC treated by administration of an immunomodulator*

Period of time	Beginning date	End date
System One		
Unstable	January 2005	September 2005
Stable	October 2005	July 2006
Stable with immunomodulator	August 2006	June 2007
System Two		
Unstable	January 2005 (Batch 1)	August 2005 (Batch 13)
Stable	September 2005 (Batch 14)	May 2006 (Batch 29)
Stable with immunomodulator	May 2006 (Batch 30)	January 2007 (Batch 43)

* The Unstable time period corresponds to an outbreak of PRDC (epidemic phase of PRRS, PCV2, or both), when the highest levels of mortality and percent culls, and worst production parameters, were observed, and treatment with antimicrobials began. The Stable period was associated with the endemic phase of PRRS, PCV2, or both. During the third period (Stable with immunomodulator), 4 weeks before until 4 weeks after the predicted date of a PRDC outbreak, the immunomodulator Inmunicin Maymo (Maymo Laboratories SA, Barcelona, Spain) was administered (2 kg per tonne of feed).
PRDC = porcine respiratory disease complex; PRRS = porcine reproductive and respiratory syndrome; PCV2 = porcine circovirus type 2.

Figure 2: Finisher mortality in Production System One. Each monthly average represents closeouts of 12 finisher barns (approximately 1000 pigs per barn). Unstable, Stable, and Stable with immunolmodulator periods described and defined in Table 2. The blue line represents the average value for finisher mortality in pigs in Spain (J. Font, SIP Consultors, oral communication, 2007).

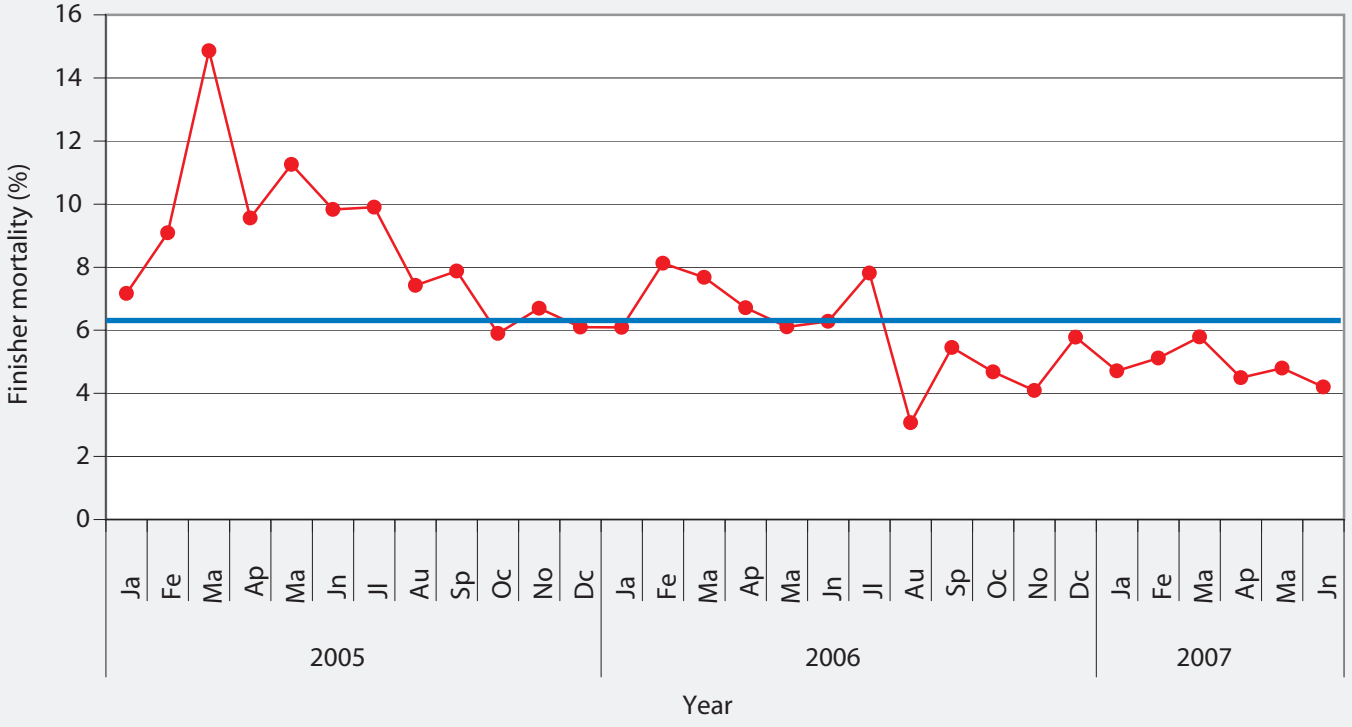
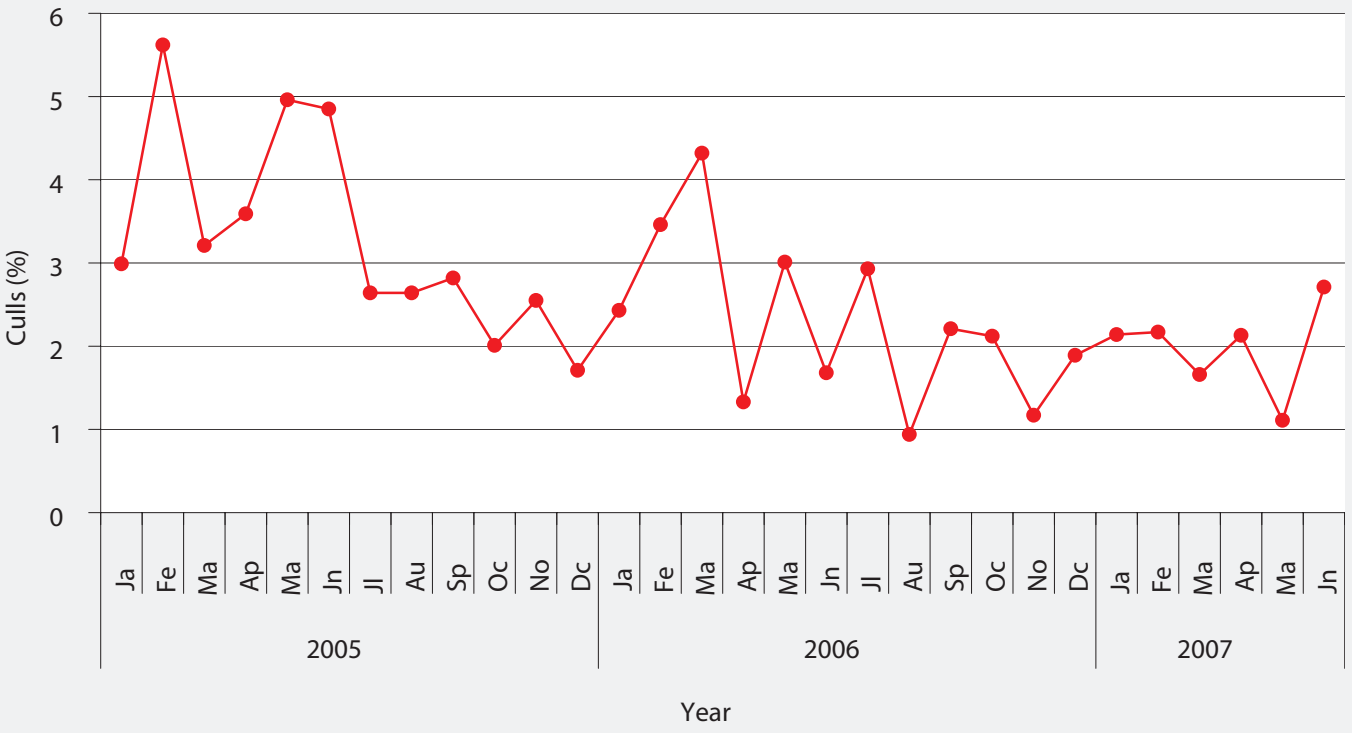


Figure 3: Percent culls in Production System One (described in Figure 1). Each monthly average represents closeouts of 12 finisher barns (12,000 pigs). Unstable, Stable, and Stable with immunomodulator periods are described in Figure 2.



to occur according to the underlying statistical distribution. Production parameters in both production systems were best during the period when the immunomodulator was administered (Figures 2, 3, 4, and 5). Moreover, in both production systems, according to SPC criteria, the changes in the system were statistically significant for all parameters except feed efficiency (Table 3).

System Three experienced high mortality in the finisher during 2006 because of PRRS outbreaks in some sow farms. The immunomodulator was administered to pigs from 9 to 17 weeks of age in some batches, and other batches were not treated. Lower mortality and better production parameters were observed in the group treated with the immunomodulator (Table 4). These differences were statistically significant ($P < .05$) for all studied parameters except feed efficiency.

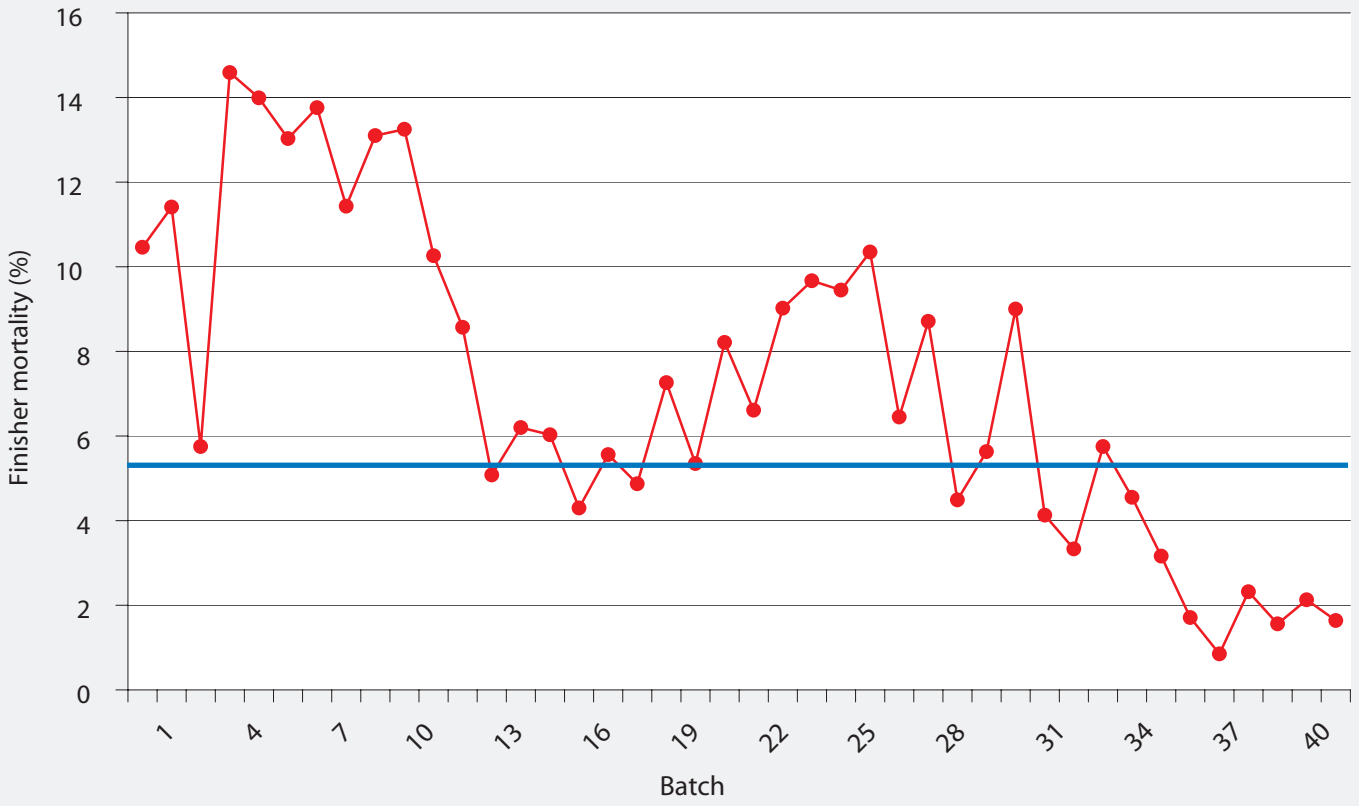
Discussion

The objective of immunomodulation in food-producing animals is to control an immune response for the benefit of the animal and for production efficiency. Substances that exert this control are called immunomodulators.[5] Broad categories of immunomodulators include cytokines, pharmaceuticals, microbial products, nutraceuticals, and traditional medicinal plants. Many categories of immunomodulators have been investigated in food-producing animals, but only a few have been licensed for use in food animals by regulatory authorities, not only in the United States, but also in Europe. Many authorized products were licensed after clinical studies demonstrated efficacy of the products by measuring improvements in clinical or production parameters or both.[27] In the three production systems described in this study, growth-production parameters, mortality, and percent culls were examined to assess whether a phytosterol mixture administered in the feed could aid in control of endemic PRDC under field conditions.

Formal studies are designed to determine the efficacy of a product to treat a disease or disease complex. These studies are usually performed using a small number of animals under experimental conditions. Extrapolation of results to practical situations has been extensively discussed.[28,29] Using a formal study with concurrent control and treated groups, Pearson et al[10] showed that low-dose dietary supplementation with ginseng (a traditional medicinal plant) may be a useful adjunct to vaccination against equid herpesvirus 1 in horses. A simpler approach than a formal trial may be performed under field conditions. For example, it is possible to compare the performance of a process by using statistical process control to examine data collected before and after a change has been introduced. This tool has been widely used in pig production to assess the efficacy of vaccine protocols and feed additives under field conditions, where formal studies (using concurrent control and treated groups) were not suitable.[30-32]

Immunomodulators licenced in Europe for use in swine are usually administered by the parenteral route, either alone or combined with vaccines.[33-35] However, when the objective is to administer a product to a large population, the oral route is much more practical. For this reason, it is very easy to understand that nutraceuticals are the fastest growing category of immunomodulators.[5] A nutraceutical is a food that provides medical or health benefits, including prevention or treatment of disease.[36] The oral route has been used to administer immunomodulators to fish. For example, Kumari and Sahoo[8] showed that the introduction of β-1,3 glucan, levamisole, lactoferrin, and vitamin C (pharmaceutical and nutraceutical immunomodulators) into the diet of fish grown in farms under immunosuppressive or stressful conditions enhances protection against infection and offers economic benefits.

Figure 4: Finisher mortality in Production System Two, a 1000-sow multi-site system working in a 3-week batch system. Each closeout is from one finisher barn (1000 to 1500 pigs per barn). The Unstable (data from 21 barns), Stable (data from 8 barns), and Stable with immunomodulator (data from 14 barns) periods are described in Figure 2. The blue line represents the average value for finisher mortality in pigs in Spain (J. Font, SIP Consultors, oral communication, 2007).



The mechanisms of action of phytosterols in swine remain elusive. Few reports in the literature describe the mechanisms of action of immunomodulators. Schierack et al[11] showed that feed supplementation with the probiotic *Bacillus cereus* var *toyoi* (a microbial product) improved the outcome of vaccination against *Mycoplasma hyopneumoniae* and influenza virus by modulating the composition and activities of blood immune cells in treated piglets. Data reported by Yuk et al[37] suggest that beta-sitosterol, the main component of Inmunicin Maymo, may be a potential therapeutic molecule in asthma because in this respiratory disease, Th1/Th2 balance is switched towards Th2 (antibody production).[38] Beta-sitosterol seems to target specific T-helper lymphocytes, increasing Th1 activity and resulting in improved T-lymphocyte and natural killer cell activity (cellular immunity).[17] Recently, Lee et al[39] showed that daucosterol, a beta-sitosterol glycoside, has an immunomodulating activity that mediates induction of Th1-dominant cytokine production from activated CD4+ T-cells. This Th-1 response is involved in protection of mice against disseminated candidiasis. In this disease, the dominance of Th2 responses correlates with severity of the fungal infection, and Th1-type dominance can reduce severity.[39] Unpublished data from our laboratory agree with these results, showing that beta-sitosterol treatment enhanced immune responses in pigs. Lymphocyte function, assessed as ability to proliferate in the presence of different concentrations of phytohemagglutinin (PHA), was measured in porcine blood mononuclear cells 2 days after vaccination with an MLV PRRS vaccine. Surprisingly, PRRS MLV vaccination induced a decrease in PHA proliferation responses during the first 2 days after vaccination in animals fed a standard diet. In contrast, when treatment with Inmunicin Maymo was administered in the diet, PHA proliferation responses were normal. In addition, when IL-6 levels were measured to evaluate tissue damage during the acquired phase of the immune response, 33 days post administration of the PRRS MLV vaccine, levels were generally lower in pigs fed phytosterols than in pigs fed a standard diet. These results suggest that immunomodulation was apparent not only 2 days after vaccination with a PRRS MLV (innate phase of the immune response), but also during the acquired phase of the immune response such that these responses might aid in control of infectious diseases that contribute to PRDC.[22]

In this study, lower finisher mortality and percent culls and the best production parameters were observed in all three production systems when the inmunomodulator was applied. These system changes were statistically significant for all parameters except feed efficiency, according to SPC criteria for Systems One and Two and ANOVA criteria for System Three. Feed efficiency depends on feed consumption and weight gain during a period of time. The mortality observed in Systems One and Two occurred during the first month of the finisher phase, so the impact on feed efficiency might be minimal, as observed in this case.

It can be argued that the observed improvement in most of the studied parameters during the third period in Systems One and Two is a direct consequence of the natural

Figure 5: Average daily gain (ADG) in Production System Two. The Unstable (data from 21 barns), Stable (data from 8 barns), and Stable with immunomodulator (data from 14 barns) periods are described in Table 2. Each value is calculated from closeouts of each finisher barn (1000 to 1500 pigs per barn).

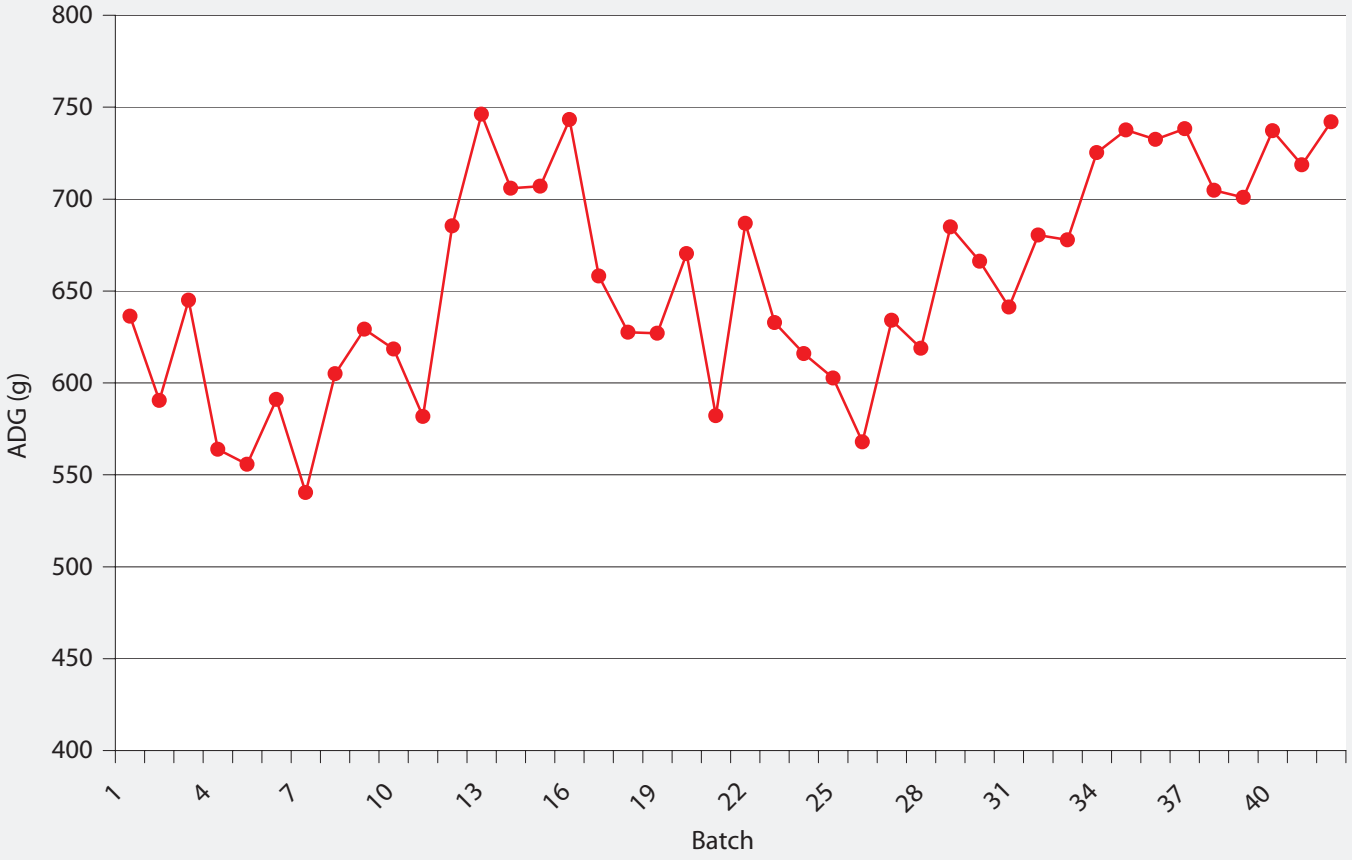


Table 3: Chart limits for two production systems in Spain* calculated applying statistical process control

Parameter	Period 2 (Stable)†			Period 3 (Stable with immunomodulator)†		
	Control limit	Upper control limit	Lower control limit	Control limit	Upper control limit	Lower control limit
Production System One						
Culls (%)‡	2.5	4.9	0.2	1.9	3.0	0.7
Feed efficiency§	2.68	2.84	2.52	2.63	2.71	2.55
Mortality (%)¶	6.7	8.2	5.2	4.9	6.9	2.9
Production System Two						
ADG (g/day)**	632.3	705.0	559.4	706.0	745.0	666.4
Feed efficiency§	2.55	2.77	2.32	2.42	2.52	2.32
Mortality (%)¶	7.1	10.0	4.2	3.7	6.6	0.8

* Production System One (described in Figure 1) and Production System Two in which endemic porcine respiratory disease complex was treated by administration of an immunomodulator. In Production System Two, nurseries were single-origin by site and managed all-in, all-out, and finishing units were filled from a single nursery and managed all-in, all-out by building. Average daily gain (ADG) for System One and percent culls for System Two were not analyzed because of missing values.

† Process control periods described in Figure 2.

‡ Percent culls = (number of culls at closeout ÷ number of pigs that entered the finisher) × 100.

§ Feed efficiency at barn level = feed consumption during the finishing period ÷ (final weight of all pigs at closeout – initial weight of all pigs that entered the finisher).

¶ Mortality = (number of dead pigs at closeout ÷ number of pigs that entered the finisher) × 100.

** Average daily gain (ADG) = (final weight of all pigs at closeout -- initial weight of all pigs that entered the finisher) ÷ length of the finishing period.

Table 4: Means (± standard deviation) for ADG, feed efficiency, and mortality in Production System Three for batches of finishers either treated with an immunomodulator* or not treated (Controls)

Parameter	Controls	Treated	*P* †
ADG (g/day)‡	601.6 (43.6)	664.7 (29.8)	< .05
Feed efficiency§	2.55 (0.1)	2.49 (0.07)	> .05
Mortality (%)¶	7.5 (1.8)	4.5 (0.5)	< .01

* Inmunicin Maymo (Maymo Laboratories SA, Barcelona, Spain) administered in feed to pigs 9 to 17 weeks of age in some finisher batches beginning in June 2006. Control and treated batches originating from the same sow herd included closeouts of 28,252 and 12,902 pigs from 10 and four finisher farms, respectively.

† Variables compared using one-way ANOVA.

‡ Average daily gain (ADG) = (final weight of all pigs at closeout – initial weight of all pigs that entered the finisher) ÷ length of the finishing period.

§ Feed efficiency at barn level = feed consumption during the finishing period ÷ (final weight of all pigs at closeout – initial weight of all pigs that entered the finisher).

¶ Mortality = (number of dead pigs at closeout ÷ number of pigs that entered the finisher) × 100.

evolution of the PRRSV and PCV2 outbreak, with development of herd level active immunity against these agents,[19,40] and not a result of treatment with the immunomodulator. A similar argument could be used for Production System Three, because each finisher batch was not divided into immunomodulator-treated and control groups, although consecutive batches were divided into treated and untreated groups. Thus, it is not clear whether treatment with the immunomodulator was linked to the better production measures observed in the three studied pig-production systems, because there were no controls within each batch. Nevertheless, similar results were observed in three different production systems belonging to two different pig-production companies, involving a large number of animals in a long follow-up study. It is unlikely that these results are explained by "natural evolution" or chance in all three cases. Therefore, the observed enhancement of production values was most probably linked with the use of the immunomodulator.

Implications

- Statistical process control may be used to assess the efficacy of products in pig production when formal studies are not feasible.
- Phytosterols are immunomodulators that may reduce the negative impact of PRDC under field conditions.

Acknowledgements

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Conversion tables

Weights and measures conversions

Common (US)	Metric	To convert	Multiply by
1 oz	28.35 g	oz to g	28
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	0.6
1 sq in	6.5 cm^2	sq in to cm^2	6.5
0.15 sq in	1 cm^2	cm^2 to sq in	0.15
1 sq ft	0.09 m^2	sq ft to m^2	0.09
11.11 sq ft	1 m^2	m^2 to sq ft	11
1 cu ft	0.03 m^3	cu ft to m^3	0.03
35.32 cu ft	1 m^3	m^3 to cu ft	35
1 c (cup)	0.24 L	c to L	0.24
4.1667 c	1 L	L to c	4.2
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
33.8138 oz	1 L	L to qt	1.1

Temperature equivalents

°F = (°C × 9/5) + 32

°C = (°F - 32) × 5/9

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

Conversion chart, kg to lb

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

1 tonne = 1000 kg

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

1 ppm = 1 mg/L

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An introduction to the National Pork Board's new Chief Executive Officer

The National Pork Board's new Chief Executive Officer (CEO), Chris Novak, started on October 1, 2008. Novak's experience includes being executive director of the Indiana Soybean Alliance and Indiana's corn organizations. He led the merger of two soybean organizations and helped build partnerships between Indiana's soybean, corn, and livestock commodity organizations.

"This is like coming home for me," said Novak, who grew up on a diversified farm near Marion, Iowa, and who worked for the National Pork Producers Council (NPPC) early in his career. "I look forward to building on the grassroots tradition of serving both the producers who invest in the Pork Checkoff and those who hold a stake in the success of the US pork industry."

"Pork producers have a long history of leadership in caring for their animals, nurturing the environment, and meeting the needs of their communities and their customers. The board's responsible pork initiative is a great example of putting that commitment into action. I am honored to be able to return to this great segment of American agriculture and to be able to help chart its future."

Novak replaces Steve Murphy, who announced his resignation in January 2008 and who continued to serve as CEO while the board searched for his replacement, and as an advisor through the end of 2008. Murphy became the National Pork Board's first CEO in October 2002. Prior to that time, the National Pork Board's Checkoff-funded programs were handled under a contract with NPPC.

Novak has a bachelor's degree from Iowa State University, a law degree from the University of Iowa, and an executive master's degree in business administration from Purdue University. He began his professional career as a legislative assistant to US Senator Charles Grassley of Iowa and joined NPPC in 1990 as director of public policy. In 1992, he became NPPC's first director of environmental services. Novak also has been executive director of the Terrene Institute, a nonprofit environmental education organization. He served as an executive of the American Soybean Association, and he was science communication manager for Syngenta, where he directed biotechnology communication activities.

2008 Pork Industry Environmental Stewards to be honored at the Pork Industry Forum

Four pork-production operations were selected to represent the industry as the 2008 recipients of Pork Industry Environmental Steward Awards in September 2008. The Pork Checkoff and its co-sponsor, *National Hog Farmer* magazine, award this honor yearly to four US pork-producing operations that demonstrate a firm commitment to safeguarding the environment and the communities that surround them. The 2008 award recipients were:

1. Enterprise Nurseries of Madrid, Nebraska, represented by Dr Scott Burroughs;
2. Oetting Farms of Concordia, Missouri, represented by Sharon and Steve Oetting;
3. O'Neel Farms of Friend, Nebraska, represented by Terry and Diane O'Neel; and
4. Veldkamp Farms of Jasper, Minnesota, represented by Jim and JoAnn Veldkamp.

The 2008 Pork Industry Environmental Steward Award winners will be honored at the 2009 Pork Industry Forum in Dallas, Texas, in March 2009.

The Environmental Steward Award winners were selected by judges drawn from pork producers and environmental organizations. The judges reviewed the applications of pork producers committed to minimizing the pork industry's footprint on the environment. Their operations were evaluated on their manure-management systems, water and soil conservation practices, odor-control strategies, farm aesthetics and neighbor relations, wildlife habitat promotion, innovative ideas used to protect the environment, and an essay on the meaning of environmental stewardship.

Nutritional Efficiency Consortium update

The Missouri Soybean Merchandising Council has joined the Pork Checkoff's Nutritional Efficiency Consortium, a group of organizations addressing the increasing cost of producing pork through research.

Today, the 26 consortium members include the Pork Checkoff, state pork associations, state and national corn grower associations, the Missouri Soybean Merchandising Council, and several allied industry organizations.

Since its inception, the Nutritional Efficiency Consortium has funded over $1.3 million ($US) in research. An additional $500,000 was provided in cooperative funding from the Illinois Corn Marketing

Board. Research priorities have included a review of alternative feed ingredients for swine rations; the use of co-products, such as distillers dried grains with solubles, in swine rations; the estimation of net energy for feedstuffs; a study into the physiology of nutrient utilization by pigs; and the effects of co-product use on pork quality.

Pending approval of the 2009 budget by the US Department of Agriculture's Agricultural Marketing Service, the consortium will have approximately $400,000 for funding. The Illinois Corn Marketing Board has pledged $500,000 in cooperative funding for the next fiscal year as well.

The consortium's Web site at **www.pork.org/PorkScience/NutritionalEfficiency.aspx?c=Home** has more information about the group's activities, research priorities, funded research, and fund allocation.

Pork Checkoff recommends producers and their employees get the "flu shot"

In what has become an annual communication to the industry, the Pork Checkoff reminded producers, farm personnel, veterinarians, and others who have contact with pigs to get the flu shot in anticipation of the 2008–2009 flu season. The season starts as early as October and can last through May.

This season's flu shot contains two type A viruses and one type B virus. While the A viruses may spread between people and pigs, the B virus is not of concern to the health of the animals. Humans will develop antibodies that will protect them against infection with the flu virus 2 weeks after taking the flu shot, according to Liz Wagstrom, assistant vice president of the Pork Checkoff's Science and Technology Department.

Wagstrom recommends other practices to reduce the spread of infection among workers and pigs with human influenza viruses. Among them is modifying sick-leave policies to encourage workers to stay away from the farm if they are suffering from acute respiratory infections. Good building ventilation and good hygiene also will reduce transmission of the flu viruses.

Wagstrom added that to protect pigs and humans from other species' influenza viruses, producers also should look at bird-proofing their buildings, protecting feed from birds, and enforcing biosecurity practices, such as the use of farm-specific clothing and footwear. She suggested chlorinating the water used on the farm, especially if it is surface or pond water, since migrating fowl and other wildlife may spread different viruses.

The Centers for Disease Control and Prevention (CDC) have more information on this season's flu vaccine. The CDC's Web site is **www.cdc.gov**.

A Pork Checkoff's fact sheet titled "Influenza: Pigs, People and Public Health" is available online at **www.pork.org/PorkScience/PublicHealth.aspx?c=Factsheets**.

Pork Checkoff participates in development of Trichinae Certification Program

In November 2008, the voluntary Trichinae Certification Program for US pork was made effective. The program certifies pork-production sites that follow prescribed good production practices that reduce, eliminate, or avoid the risk of exposure to *Trichinella*. The program was formalized with an announcement in the Federal Register. This announcement is available online at **http://edocket.access.gpo.gov/2008/pdf/E8-23678.pdf**.

The US Department of Agriculture's program is meant to facilitate access of domestic pork products to foreign markets, and may also increase the sales and marketability of fresh pork products destined for those markets. It targets markets requiring imported pork products to be trichinae free, including the European Union and the Russian Federation.

The program was developed as a cooperative effort with the National Pork Board and the pork-processing industry. Participation in this program is voluntary, and because of the need to control potential trichinae exposure, it will be limited to those producers who house and feed swine in confinement units and who do not utilize waste that contains meat in their feeding regimen.

Qualified accredited veterinarians and qualified veterinary medical officers will be accredited to perform site audits of production facilities enrolled in the voluntary program. Qualified accredited veterinarians are accredited veterinarians who have been granted an accreditation specialization by the Animal and Plant Health Inspection Service (APHIS), based on completion of an APHIS-approved training program in good production practices in swine management, and will be authorized by APHIS to perform site audits and other specified program services.

Qualified accredited veterinarians will be responsible for the cost of periodic training to perform this activity. At least initially, APHIS' National Trichinae Coordinator will provide this special training to accredited veterinarians, charging an amount sufficient to recover costs. Qualified accredited veterinarians will need requalification training, but this will not occur more than once every 2 years, and the accredited veterinarians will again be charged a fee to recover costs.

Qualified veterinary medical officers of the state or federal government are trained in good production practices and are authorized by APHIS to perform site audits, spot audits, and other specified program services.

Once a producer is accepted into the certification program, the USDA will award the production site Stage I enrolled status. This stage signifies that a qualified accredited veterinarian or qualified veterinary medical officer has performed a site audit of

the facility and found it to adhere to the good production practices in the rule, as well as other recordkeeping and program requirements and that APHIS has received the producer's completed audit form. A producer awarded Stage I status is acknowledged to be participating in the certification program, but will not be allowed to identify pigs or hogs originating from his or her site as certified products from a certified production site.

Stage II certified status can be obtained upon APHIS approval of a site audit of a Stage I enrolled site; and Stage III certified status is obtained upon APHIS approval of a site audit of a Stage II certified site and maintained upon APHIS approval of subsequent site audits for renewal of Stage III certified status.

Stage II and Stage III sites that have passed subsequent site audits can identify their products as certified products from a certified production site. Without such identification, pork products from the site may not undergo process verification testing at a participating slaughter facility, and a certificate of export identifying the products as being from the Trichinae Certification Program may not be issued. The regulations also dictate requirements for the monitoring and testing of pork products that originate from certified sites at harvest facilities. Only harvest facilities that are under continuous inspection by the Food Safety and Inspection Service (FSIS), or under state inspection that FSIS has recognized as equivalent to federal inspection, may participate in the program.

Harvest facilities that purchase swine from certified production sites are required to carry out certain functions relating to verification, segregation, testing, and recordkeeping of certified swine under their control. Testing at the slaughter facility entails taking tissue, blood, or meat juice specimens from a sample of the certified swine population processed at the facility in order to determine the *Trichinella* species infection status of the tested animals and to verify that the trichinae management practices at the production level are adequate.

The USDA has committed to drafting program standards to help producers better understand and participate in the program, as well as an auditor's handbook.

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AASV NEWS

AASV discusses cephalosporin ban with FDA

Veterinarians representing the AASV met with Food and Drug Administration (FDA) officials on October 8 to discuss the agency's proposed ban on the extra-label use of cephalosporins. The FDA issued an order effective November 30 that would ban the extra-label use of the cephalosporin class of antimicrobials in food-producing animals. This ban would not affect the approved uses as described on the label. Swine veterinarians, along with other veterinary groups, have expressed multiple concerns with the ban, which prompted swine veterinarians to join the AASV leadership in a meeting at FDA headquarters in Rockville, Maryland.

The group met with Dr Bernadette Dunham, director of the FDA Center for Veterinary Medicine (CVM), and other CVM officials to discuss the agency's rationale for issuing the order and to express the concerns of swine veterinarians. The CVM is responsible for approval and regulation of veterinary antimicrobials. The Animal Medicinal Drug Use Clarification Act (AMDUCA) governs the extra-label use of antimicrobials and authorizes FDA to restrict such use if the agency determines it to be a threat to public health.

During discussions, the agency reiterated its support for the ban, citing their interpretation of data collected through the National Antimicrobial Resistance Monitoring System (NARMS), results of published studies, and the findings of FDA investigations, along with a healthy dose of precautionary principle. The regulators stated that they considered the cephalosporin class of antimicrobials to be similar to that of the fluoroquinolones with regard to potential importance to human health. They indicated that they had considered banning the extra-label use of cephalosporins by generation rather than the entire class, but determined that would be too cumbersome and was not well defined. The agency did, however, agree to review all comments received during the comment period and left the door open to possibly modifying the order on the basis of the issues brought forth in the comments.

The AASV representatives explained the process swine veterinarians undertake to determine effective treatment regimens for the conditions affecting the food animals they treat. Emphasizing the importance of AMDUCA, they expressed concern regarding the lack of availability of approved products effective in the treatment of a number of conditions encountered on the farm and thus the need for extra-label use in some situations. The veterinarians described the collection and laboratory analysis of diagnostic samples used to establish a therapeutic protocol. They emphasized reliance on their training and understanding of pharmacokinetic properties to properly utilize antimicrobials in a responsible manner, recognizing the public-health concerns as well as the necessity to relieve animal suffering and disease.

The group also questioned the validity of the data used to support the proposed ban. There have long been questions regarding the design and interpretation of the NARMS project, for instance. The NARMS data for pork indicates that the incidence of *Salmonella* is extremely low and found no cephalosporin resistance in *Salmonella* isolates from 2004 or 2005. Likewise, the data also showed an extremely low incidence of cephalosporin-resistant *Escherichia coli* isolates in 2002-2005. In addition, a number of studies have identified the presence of cephalosporin resistance in animals that never received cephalosporins or, in some cases, any antimicrobials at all.

The veterinarians questioned why CVM considers the extra-label use of an approved product for non-labeled indications in the approved species at the approved dosage and route of administration to be a greater risk for development of resistance than the approved labeled use. The response of CVM representatives was that they do not have information regarding the pharmacokinetic profile and safety data for bacteria not approved on the label. It seems, however, that given the fact that antimicrobials affect all susceptible bacteria in the animal being treated, whether or not that bacteria is on the approved label, the more rational approach would be to use an approved product for the species being treated rather than a product labeled for a different species. We have much more information about the pharmacokinetics, tissue distribution, and withdrawal times for products approved for use in a particular species.

The AASV has submitted comments in response to the proposed order and will continue to communicate the concerns of our members to FDA. The original order banning the extra-label use of cephalosporins is available online for review at **www.fda.gov/OHRMS/DOCKETS/98fr/E8-15052.htm**.

Breaking news: FDA to rescind order

The FDA has announced that it will rescind the order banning the extra-label use of the cephalosporin class of antimicrobials in food-producing animals. The FDA has decided to withdraw the order pending a complete review of the comments received and is planning to re-examine the data upon which the agency based the decision regarding the extra-label use of cephalosporins in food animals. Following this review, the agency may choose to re-issue the order in a full or modified version.

30-day health rule resolved? Finally!

It appears we have finally reached a suitable solution to the issue involving the issuance of Certificates of Veterinary Inspection (CVIs) to weaned pigs born into a herd participating in a herd-health plan that requires an accredited veterinarian to inspect the health status of the herd every 30 days. As you recall, a federal Area Veterinarian in Charge (AVIC) had questioned the practice of issuing a CVI for interstate shipment of weaned pigs moving out of a production flow without actually inspecting the individual pigs, even though the herd participated in a herd-health plan as described in the Code of Federal Regulation.

After much discussion, Dr John Clifford, Deputy Administrator, USDA-APHIS, issued a Veterinary Services Notice in August instructing the AVICs to allow accredited veterinarians to issue a CVI to weaned pigs born into a herd participating in a recognized herd-health plan without further inspection after the third routine 30-day herd-health visit. The Veterinary Services Notice, however, also pointed out that the CVI must accurately reflect the actions of the veterinarian. Most CVIs contain a printed statement that implies or indicates that the animals referenced on the CVI have actually been inspected by the accredited veterinarian. This represents an inconsistency with the policy recognized by USDA: signing a false form would be grounds for regulatory action.

To address the issue of issuing a CVI that accurately reflects the actions of the veterinarian, AASV went before the National Assembly of State Animal Health Officials during their annual meeting on October 25 in Greensboro, North Carolina, to make them aware of this situation. The AASV representatives requested that the assembly consider allowing accredited veterinarians to write an additional statement on the CVI that would explain that the herd, but not necessarily the weaned pigs referenced on the CVI, was inspected within the last 30 days. The assembly members unanimously approved this request.

The assembly did not suggest any official wording, but the intent is to inform the receiving state animal-health officials and recipients of the pigs about the actual inspection procedures. I would suggest the following wording or something similar: "The herd from which these pigs originated was inspected within the last 30 days. The weaned pigs referenced on the CVI were either resident in the herd at the time of the herd inspection or were born since the last inspection to dams which were resident in the herd at the time of the last visit and would thus have been inspected."

As a reminder, this issue involves only pigs shipped outside an established production flow as defined in the Code of Federal Regulation. Pigs moving within a production flow or in compliance with an Interstate Movement Report are not affected by this interpretation. An Interstate Movement Report is an agreement between the state animal-health officials involved and the producer to allow for the routine movement of pigs within an established production flow. The shipment and record-keeping requirements are negotiated between the parties involved and normally allow for the ongoing shipment of pigs without the issuance of a CVI.

The AASV wishes to thank Dr Sam Holland, president of the National Assembly of State Animal Health Officials, and Dr John Clifford for their willingness to consider a resolution to this important issue.

Applicants sought for Alternate Student Delegate on AASV Board of Directors

The AASV Student Recruitment Committee is accepting applications for veterinary students interested in serving as the Alternate Student Delegate on the AASV Board of Directors. This student will represent student interests and serve as a non-voting member of the AASV board.

The alternate student delegate and student delegate are required to attend the AASV board's two meetings each year: the spring meeting held during the AASV Annual Meeting, and the fall meeting, which is usually held in Kansas City each October. The student delegate presents a summary of board activities to the student membership at the student breakfast during the AASV Annual Meeting, and re-emphasizes all student opportunities in AASV to the AASV student members at that time. In addition, the delegate and alternate delegate are voting members of the AASV Student Recruitment Committee, and are invited to participate in committee conference calls and meetings. The delegates receive reimbursement to cover travel and lodging expenses for the fall board meeting and transportation expenses for the spring meeting.

Interested students must be members of AASV in their freshman, sophomore, or junior year. Applicants are required to submit the following documentation to the AASV (902 1st Avenue, Perry, IA 50220–1703; E-mail: **aasv@aasv.org**):

1. An introductory letter, not to exceed one page, explaining why they want to serve as the alternate student delegate for AASV, and their level of interest and background in swine medicine.
2. A one-page resume featuring the student's interest and experience in production medicine, particularly swine medicine.
3. A statement of recommendation from the student's AASV faculty advisor.

The deadline for submission of necessary documentation is **January 31, 2009**.

The delegate will be chosen by members of the AASV Student Recruitment Committee following review of the submitted materials. The Student Recruitment Committee may seek additional comment from other AASV members, including the AASV Collegiate Activities Committee.

The term of service is 2 years, beginning at the AASV Annual Meeting. During the first year, the student will serve as the alternate student delegate. The alternate delegate will automatically succeed as student delegate, beginning at the annual meeting the following year. The alternate delegate will serve in the capacity of delegate if the selected student delegate is unable to carry out his or her duties. Each year, a new alternate delegate will be selected by the AASV Student Recruitment Committee.

AASV news continued on page 50

ADVERTISEMENT #6
COMPANY: Bayer
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AD CAPTION: “New to the team. Veteran of the game.””
Rerun ad form the Nov/Dec issue
1 1/3 pages

AASV news continued from page 48

AASV districts merge, conduct elections

Change is coming soon for two AASV districts. The AASV Board of Directors passed a motion to amend the bylaws and merge District 7 (Kansas, Oklahoma, and Texas) with District 10 (western United States). The combined geographic area will be considered District 7, and a new director will be elected to represent the members in the enlarged district. The primary impetus for the change is the shrinking membership in the western states. The change will be effective in March 2009 at the conclusion of the spring board meeting.

Current District 7 and 10 directors Drs Scanlon Daniels and Don Davidson will represent their districts at the spring board meeting, but their terms will expire at the conclusion of the meeting. Nominations for a new District 7 board representative will be requested in January, with elections to follow. The procedure for nominations is as follows: all eligible voters in the combined district will receive a nomination form and may nominate a current AASV member in the district for the position. The two members who receive the most nominations (and confirm their willingness to serve if elected) will be placed on the ballot and district members will vote to elect their new board representative.

Two other AASV districts, District 1 (northeastern United States), and District 4 (Indiana and Michigan) will also be conducting elections for board representatives. In District 1, the current director, Dr Bill Minton, has served one 3-year term and is eligible to be nominated for a second term. The same is true in District 4, where Dr John Baker has served one term as director and is eligible for a second term.

The directors represent their district members on the AASV Board of Directors, which is the primary governing body of the association. The board meets during the AASV annual meeting in March and again in the fall to set policies and oversee the activities of the association. Candidates for the position of district director must be active (veterinary) AASV members residing in the district to be represented. The term of office is 3 years, with a limit of two consecutive terms. For more information, please contact the AASV: Tel: 515-465-5255; E-mail: **aasv@aasv.org**.

AASV to conduct NAIS outreach

The AASV has received funding from the National Pork Board to conduct an educational outreach program, targeting swine veterinarians, about the veterinarian's role in the USDA's National Animal Identification System (NAIS) and to encourage premises registration.

The AASV Board of Directors supports premises registration and urges swine veterinarians to register their clinic and livestock premises as part of the NAIS effort. The board also encourages veterinarians to work with their clients to register their premises as well.

Throughout 2009, the AASV will be conducting a campaign to educate our members about the NAIS and the key role veterinarians play as an integral part of the system. Premises registration, while voluntary, is a key component of the system and facilitates the rapid response necessary during an animal health emergency. Obtaining a Premises Identification Number, or PIN, is an easy process conducted by the state animal health official within each state. In the future, PINs will likely be required on Certificates of Veterinary Inspection and laboratory submissions. It is also likely that packers and livestock markets will begin requiring PINs on animal shipments.

So, watch for advertisements in the *Journal of Swine Health and Production* and e-Letter, as well as signage at the AASV Annual Meeting and individual outreach efforts to get the word out about premises registration and your role in the NAIS. Even though it's voluntary, AASV supports the effort and it's the right thing to do for animal agriculture.

AASV FOUNDATION NEWS

Biddin' large in Texas

The AASV Foundation is planning an XL auction for the association's 40th (XL in Roman numerals) anniversary in Dallas, Texas, where everything is XL! In commemoration of the anniversary and to build on last year's record-setting effort, the auction committee has challenged the membership to raise $80,000 at the 2009 Foundation Auction.

You may be wondering what the foundation does with the funds it collects. Well, below are some examples of the programs your donations funded in 2008.

The AASV Foundation is funding three research proposals in 2008. The funding – in the amount of $6000 per proposal – supports research efforts at four Midwest universities.

- At the University of Minnesota, work is underway to develop a real-time PCR for detection of *Actinobacillus suis*. The AASV Foundation support for this project will enable primary investigator Dr Simone Oliveira to employ a veterinary student to participate in the research effort and submit the results for publication and presentation during the AASV annual meeting.
- Drs Locke Karriker and Alex Ramirez at Iowa State University are leading a project to create a swine medicine field manual. The foundation funds will assist with the peer review and publication of the first edition of the manual, which consists of a compilation of field diagnostic techniques for swine veterinarians and students. The manual will be produced in electronic as well as print format.
- The third project funded by the AASV Foundation involves a joint effort by researchers at Kansas State University and Michigan State University and private practitioners. The proposal, submitted by Dr Megan Potter at Kansas State, will explore the use of PCV2 vaccine as a tool in the elimination of PCV2 from infected swine herds. The foundation contribution will support the diagnostic testing needed to complete the third phase of the study.

Also in 2008, the foundation funded a systematic literature review in support of the AASV Pig Welfare Committee's update of the Swine Euthanasia Guidelines. This thorough review of the pertinent literature associated with humane euthanasia techniques was also forwarded to the AVMA to provide a scientific basis to guide a similar review of AVMA's guidelines.

The AASV Foundation supports the Swine Externship Grant Program which provides grants of $200 to $500 to veterinary students who complete an externship of at least 2 weeks in a swine practice or a mixed practice with a considerable swine component. The actual amount of the grant is dependent on the costs of the externship and approval of the foundation. Any AASV student member in veterinary school who fulfills the requirements is eligible to apply. Grants are limited to one per student.

Co-sponsoring with Newport Laboratories, the foundation provides travel stipends for veterinary students to attend the AASV annual meeting.

AASV Foundation Mission

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

Enhancing the image of the swine veterinary profession,

Supporting the development and scholarship of students and veterinarians interested in the swine industry,

Addressing long-range issues of the profession,

Supporting faculty and promoting excellence in the teaching of swine health and production, and

Funding research with direct application to the profession.

"Ensuring our future... creating a legacy"

The foundation has sponsored financial-planning seminars at the AASV annual meeting and oversees the administration of the Howard Dunne Lecture and the Alex Hogg Memorial Lecture.

Be sure to visit the AASV Foundation Web site to view the wide variety of items donated by our members and allied industries. We look forward to seeing you at the 2009 AASV Foundation Auction on Monday night March 9 in Dallas, Texas. Bring your XL wallet or purse (cowboy boots and 10-gallon hats optional)! It's up to you to make this auction the most successful ever!!

Swine veterinarians invited to apply for Hogg Scholarship

The American Association of Swine Veterinarians Foundation is pleased to offer the Hogg Scholarship, established to honor the memory of longtime AASV member and swine industry leader Dr Alex Hogg. Applications for the $10,000 scholarship will be accepted until February 2, 2009, and the scholarship recipient will be announced on March 8 during the Foundation Luncheon at the AASV 2009 Annual Meeting in Dallas.

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

Dr Alex Hogg's career serves as the ideal model for successful applicants. After 20

AASV Foundation news continued on page 53

ADVERTISEMENT #7
COMPANY: BI
PRODUCT: Ingelvac CircoFlex
AD CAPTION: "Don't get burned by Cirovirus"
Rerun ad from Nov/Dec

AAAV Foundation news continued from page 51

years in mixed-animal practice, Dr Hogg pursued a master's degree in veterinary pathology. He subsequently became Nebraska swine extension veterinarian and professor at the University of Nebraska. Upon "retirement," Dr Hogg capped off his career with his work for MVP Laboratories. Always an enthusiastic learner, at age 75 he graduated from the Executive Veterinary Program offered at the University of Illinois.

The scholarship application requirements are outlined to the right and on the AASV Web site at **http://www.aasv.org/foundation/hoggscholarship.htm**.

Hogg Scholarship application requirements

An applicant for the Hogg Scholarship shall have:

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

Each applicant is required to submit the following for consideration as a Hogg Scholar:

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

Applications and requests for information may be addressed to the AASV Foundation, 902 1st Avenue, Perry, IA 50220-1703; Tel: 515-465-5255; E-mail: **aasv@aasv.org**.

AASV Foundation requests research proposals

As part of its mission to fund research with direct application to the profession, the AASV Foundation seeks research proposals for funding in 2009. Proposals are due January 31, 2009, and may request a maximum of $6000 (US$) per project. The selection and announcement of projects for funding will take place in March.

Proposed research must fit into one of the five action areas stated in the AASV Foundation mission (see side bar on page 51).

Proposals must also contain the following:

1. Identification of the issue
2. Background information
3. Description of the project
4. Timeline
5. Budget
6. Plan to apply results for maximum return to swine veterinarians, veterinary students, or both

No project timeline is to exceed 12 months. A final report will be due within 60 days of stated project completion. For more information, or to submit a proposal, contact:

AASV Foundation
902 1st Avenue
Perry, IA 50220-1703
Tel: 515-465-5255; Fax: 515-465-3832
E-mail: **aasv@aasv.org**

Six students to receive NPIF veterinary internship stipends

The AASV Foundation is pleased to announce the recipients of the inaugural National Pork Industry Foundation (NPIF) veterinary internship stipends. Six first- and second-year veterinary students were selected from a pool of 64 applicants to receive the $3300 stipends. The recipients are: Jennifer Arnall, University of California-Davis; Abbey Canon, Iowa State University; Jeremy DiBari, Cornell University; Kathleen Elstrott, Louisiana State University; Rachael Gately, Texas A&M University; and Jamie Gosch, Iowa State University.

The NPIF Veterinary Internship Stipend Program links each recipient with a swine practitioner-mentor with whom they will spend a 1-month internship during the summer of 2009. The NPIF stipend of $3300 per student defrays the cost of travel, lodging, and compensation during the 1-month internship. Additionally, the interns are encouraged to utilize their practitioner-mentor as a resource throughout the year, and to attend the AASV Annual Meeting and Leman Swine Conference in an effort to increase their knowledge and exposure to swine medicine. A written report and evaluation are required upon completion of the program.

The AASV Student Recruitment Committee developed the NPIF Veterinary Internship Stipend Program in an effort to attract veterinary students to swine medicine and to provide interested students with exposure to the life for a swine veterinarian. Funding for the program – $20,000 per year for 3 years – was provided by the National Pork Industry Foundation, a charitable corporation that promotes activities in the swine industry related to research and education. The funds are administered by the AASV Foundation.

Advocacy in action

2008 in review

Harry Snelson, DVM

The January-February issue of *JSHAP* is always a good opportunity to reflect on the challenges and accomplishments of the previous year. Following is an update on a number of the issues AASV addressed during 2008.

30-day health rule

I'm sure you are as tired of hearing about this issue as I am about talking about it. However, it appears we have finally reached an acceptable solution to this problem, which involves the issuance of Certificates of Veterinary Inspection (CVIs) for weaned pigs moving outside of an established production flow. Veterinarians had routinely interpreted the regulations to allow for the issuance of a CVI to weaned pigs originating from a herd participating in a herd-health program without having to revisit that herd between 30-day health inspections.

In early 2007, a USDA Area Veterinarian in Charge (AVIC) challenged that interpretation, suggesting that the regulation actually required the veterinarian to inspect the individual animals referenced on the CVI. The AASV argued that that was not the intent of the regulation and was eventually successful in convincing USDA to issue a Veterinary Services Notice informing the AVICs that veterinarians issuing a CVI referencing weaned pigs born into a herd in compliance with the 30-day rule did not have to individually inspect the pigs, providing the CVI accurately reflected the actions taken by the veterinarian. The AASV then requested that the National Assembly of State Animal Health Officials agree to allow the veterinarian to add a statement on the CVI that would explain the actions undertaken, thus allowing the veterinarian to sign an accurate official form. The assembly agreed unanimously. For a more detailed discussion of this issue, please read the news article in the AASV News section of this issue of *JSHAP*.

Pharmaceutical issues

Extra-label drug use – The ability of veterinarians to utilize antimicrobials in an extra-label manner was a hot topic for most of the second half of 2008. With the approval of Baytril in swine (in spite of the continued prohibition on the extra-label use of the fluoroquinolones) and FDA's issuance of an order prohibiting the extra-label use of the cephalosporin class of drugs, AASV began an educational effort to inform our membership about the regulations governing the extra-label use of antimicrobials. The AASV Executive Committee visited with FDA leadership in Washington, DC, in June to discuss antimicrobial-use issues, including growth promotants, Veterinary Feed Directives, and antimicrobial resistance. The order banning the extra-label use of cephalosporins was announced approximately 2 weeks later, although FDA did not mention the impending ban during our visit. A group of AASV staff and practitioners again visited with FDA officials on October 8 to specifically discuss the cephalosporin ban and subsequently submitted comments questioning the assertions made by FDA regarding the impact on public health and requesting modifications to allow for the continued extra-label use in approved species. The FDA has decided to withdraw the order pending a complete review of the comments received and is planning to re-examine the data upon which the decision regarding the extra-label use of cephalosporins in food animals was based.

Antimicrobial use in livestock – This continues to be a significant issue both at the national level, with proposed legislation to further restrict or ban some uses, and within AVMA (a resolution was brought before the House of Delegates to restrict "non-therapeutic" use in livestock). The AASV remains active on both fronts to emphasize that antimicrobial access should be based on sound science and a thorough risk assessment analyzing the impact on both animal and human health.

Injectable iron – The AASV worked closely with FDA to facilitate the importation of injectable iron products during a recent shortage resulting from manufacturing shortfalls. Dr Tom Burkgren was instrumental in explaining to FDA the importance of these products to swine producers and veterinarians and the potential animal health and welfare impacts resulting from the lack of injectable iron. The FDA agreed to allow the importation of product from Canada until adequate domestic supplies could resume.

FARAD – The AASV has joined with AVMA and other allied veterinary and producer groups to secure funding to support the Food Animal Residue Avoidance Databank (FARAD). This unique program, residing at NC State University, UC Davis, and the University of Florida, collects residue-avoidance information about pharmaceuticals, chemicals, and pesticides. Since its inception in 1982, the program has never been adequately funded. For the first time, veterinary and producer groups were successful in getting FARAD authorized in the 2008 Farm Bill. Unfortunately, Congress adjourned before appropriating the necessary funding, and FARAD may have to shut down unless emergency funds can be located to support the program until Congress can act. The AASV continues to work with other stakeholder groups to secure the needed funding for this vital and unique program.

Animal welfare

Euthanasia – The AASV Pig Welfare Committee, in collaboration with the National Pork Board's Welfare Committee, has undertaken an evaluation of the current swine euthanasia guidelines. As part of this effort, the AASV Foundation funded a systematic literature review to support a revision of the guidelines and offer scientific basis for recommendations to AVMA as they undertake a similar review of their guidelines as well. The revised guidelines were presented to the AASV Board of

Advocacy in action continued on page 56

ADVERTISEMENT # 8

COMPANY: Pfizer

Product: Draxxin

AD CAPTION: “How much hog are you really helping”

Rerun from Nov/Dec-

1/3 COMPLIANCE AD WILL BE NEW AD

Advocacy in action continued from page 54

Directors during their fall meeting and approved for distribution.

PETA video – The AASV responded to the recent welfare abuses highlighted in a PETA video captured at a sow farm in Iowa. The AASV publically denounced the abuses observed on the video and worked with the National Pork Board to educate consumers and the media about efforts to insure proper husbandry practices that enhance animal well-being.
Welfare issues continue to be significant topics at the national and state levels and within the AVMA.

Diseases

Pig high fever disease in China – The AASV and the National Pork Board supported a team of veterinarians during a visit to mainland China in late 2007 to investigate pig high fever disease and to offer assistance with further diagnostics. Chinese researchers identified a PRRSV variant that they believe is contributing to the elevated mortality observed. Samples were submitted to Plum Island for analysis, and Plum Island researchers also isolated a PRRSV, which they have forwarded to the National Veterinary Services Laboratory for further analysis and genetic sequencing.

Classical swine fever – The USDA again funded an educational outreach effort to remind veterinarians and veterinary students about the impact of classical swine fever. Through this effort, we were able to conduct multiple presentations to veterinary association meetings, including AASV, AVMA, Indiana Veterinary Medical Association, Leman Swine Conference, United States Animal Health Association, Iowa State University Swine Disease Conference, and the Ohio Swine Health Conference. Student presentations are being planned at a number of veterinary colleges as well.

National Animal Identification System (NAIS) – The AASV has obtained a grant from the National Pork Board to utilize USDA funding to promote premises registration to AASV members and provide educational information regarding the veterinarian's role in the NAIS. This is an effort to promote the AASV's position in support of the premises registration phase of the NAIS.

These are just a few of the issues we addressed in 2008. As we begin to work with a new administration and a new congress in the face of a struggling economy and rising production costs in the pork sector, 2009 will likely be a very interesting year. Efforts to ban gestation stalls and curtail the use of antibiotics in livestock production will likely continue to be significant topics of discussion for our membership. The issues of welfare and antimicrobial use will continue to take on ever-increasing significance on the world stage as international groups such as the World Organization for Animal Health begin to address international standards. We'll do our best to keep you informed regarding issues that significantly impact the swine industry or that may affect your ability to practice your profession.

ARE YOU PREPARED FOR AN ANIMAL HEALTH EMERGENCY?

A rapid response to an animal health emergency requires that officials know where animals and resources are located.

Premises registration is the first phase of USDA's National Animal Identification System (NAIS)

The AASV urges veterinarians to register their clinic premises and encourages them to work to ensure their clients register their livestock premises as well. Registering your clinic insures that officials can contact you with important information during an animal health emergency. Registration is voluntary and the information collected is confidential. Following registration, each individual premises will be assigned an official Premises Identification Number or PIN.

WHY IS PREMISES REGISTRATION IMPORTANT?

1. Hastens locating veterinary clinics and livestock facilities during an animal health emergency.
2. Enables rapid communication to veterinarians and livestock owners during an animal health emergency.
3. A PIN will likely be required on official forms including Certificates of Veterinary Inspection (Health Certificates) and laboratory submissions.
4. Packers and livestock markets will likely begin requiring a PIN on shipments of incoming animals.

To learn more about premises registration in your state, contact your state animal health official or visit the USDA's NAIS web site at **www.usda.gov/nais**.

Premises registration is voluntary and it's the right thing to do!

ADVERTISEMENT #9

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AD CAPTION: "Once you figure in all the variables, choosing the right circovirus vaccine is simple"

Rerun ad from Nov/Dec issue

AASV STRAIGHT TALK

Annual meeting memories

Members of the association would all agree that the annual meeting is the single most valuable benefit of being a member for a variety of different reasons. Members were asked to describe a favorite memory of a past annual meeting. Below are some responses.

From Simone Oliveira

"AASV annual meetings have been part of my past and present, and it is my goal to make them an important part of my students' futures. I have presented at the AASV as a student and as a professional, and now I feel very proud to pass the torch to my own students. Since I became an assistant clinical professor at the University of Minnesota, I have always encouraged students to develop a small project over the summer and submit it for presentation at the student seminar section. They work so hard! They are so dedicated! And I am so proud to see them presenting their work! So this is, and will always be, the most memorable moment for me: the moment that I realize that I have helped a new student to develop a passion for research in swine medicine!"

From Alex Ramirez

"There are many great memories I have from past annual meetings. It is hard to think of a single one, so I just have to talk briefly about two of them that I truly believe represent what our organization is really about: its members.

Roy Shultz's presentation during the general session at the 2006 annual meeting in Kansas City was very motivating. Listening to Roy talk about 'Founders' message: Successes and failures in swine veterinary medicine – What have we learned?' was a great speech. This was a reminder that swine veterinary medicine has in fact changed significantly over the years, yet our members continue to be science-driven, honest, hard-working individuals. There have been many times through the years where challenges and uncertainty might have painted a grim picture for the future of our profession, but thanks to the audacity, dedication, and creativity of many, new frontiers have been opened. Swine veterinarians have found more and more ways that we can help serve our industry and continue to improve the health and welfare of pigs. Roy's talk was motivational and he made us proud to be swine veterinarians.

How can one forget last year's auction in San Diego? Once again, members of our organization demonstrated their true colors when many joined together to bid on the handmade quilt presented by Mary Ann Curran in memory of her husband Bernie. The real story was not the large amount of money that this quilt brought into the foundation, but rather that a group of many, and I mean *many* members, had pooled their funds together to purchase the quilt so it could be returned to its proper place, Bernie's family. This was a very emotional event for many of us. Once again, reminders of who we are as an organization and the love and respect we have for so many of our members who have dedicated their lives to improve the knowledge, health, and welfare of swine worldwide. Our organization came together to recognize the respect and gratitude we have to those who serve the industry. This moment was an inspirational moment and a great reminder of how proud I am to be part of the AASV!"

From Mark Hammer

"It is always exciting to attend the AASV meetings for several reasons … the opportunity to travel to a different place but always seeing familiar people. Our meetings are a time to hear new information, catch up with friends, and change your paradigm. A favorite memory is difficult because most of my memories are insightful. Discussing the clinical aspects of swine practice with colleagues or the newest scientific findings with our research colleagues are all memories which I cherish. We have an eclectic group of some of the best veterinary practitioners and scientists I know. It is always reassuring that we are gathered to learn about improving pig health, share ideas, and change our paradigms, which ultimately lead to more affordable pig meat for the world."

From Paul Sundberg

"One of the most interesting things to watch during the AASV meetings through the years is the transition from the old guard to the new practitioners that takes place each year, over the years. There is a wealth of talent that is coming into the industry.

But I think one of the most unique meetings was the 1997 one in Quebec City. It was March and it was Quebec. Riding the shuttle in from the airport, we passed houses that had a trail dug through the snow that was 6 feet or better on each side. You could only see snow – the front of the house was completely hidden. Orlando was a long way away. During one of the outings, we were bussed somewhere into the woods to sample the maple sugar and syrup products. The combination of adult beverages and concentrated, concentrated sugar was a unique experience that was remembered well for quite a few days after."

From Harry Snelson

"I suppose the single moment that stands out in my mind as one of my best memories actually occurred at last year's meeting in San Diego when a group of AASV members banded together to purchase the quilt for Bernie Curran's wife and family. That symbolized to me the great caring and respect that our members have for each other. It is a moment that I will always remember. But, there are memorable moments at every annual meeting and those usually occur in the hallways between sessions. That's when I get a chance to renew old friendships and catch up with folks that I don't get the chance to interact with on a frequent basis. It's also the time when I get to mingle with students and recent graduates and hear about their experiences and plans for the future, as well as those folks that helped shape my career. While I always enjoy the high quality scientific sessions at every meeting, it's the hallway encounters that provide the personality that is AASV."

Tracy Ann Raef

Vice-presidential candidate

Scanlon Daniels

Scanlon Daniels

The AASV has had a tremendous impact on me from the time I became a student member to now. I always look forward to the annual meeting for the opportunity to learn and interact with fellow members. I am humbled and deeply honored to be nominated for the position of vice president. The AASV is very special to me and I would very much appreciate your support and vote.

I grew up on a family farm in central Iowa. After graduation from high school, I ventured a whole 32 miles from home to attend Iowa State University. While there, I met my wife, Angela. She has always been extremely supportive of me; it is because of her support that I have been able to become more involved with the AASV.

After graduation from veterinary school, I worked for a swine production company in Iowa. Later, we became aware of opportunities to work for a growing integrated pork producer in the Oklahoma panhandle, and we packed up and moved 700 miles in one fell swoop. There was some irony in this, because Angela and I had visited the area for a week when we were in veterinary school. On the way home, we were glad that we had taken the time to visit the area, but we didn't think we would ever live there. We have been in this area for 9 years now, and we have never been more professionally and personally satisfied with the choices we have made that led us to this point. We now have three children, twin boys Eric and Luke who are 7 years old, and 2-year-old Judd.

As vice president, I think it is important to be able to look at issues through the eyes of our membership. My experiences growing up on a family farm engaged in hog, cattle, and crop production gave me the perspective of a farmer. As a veterinarian, working for both a live-hog producer and an integrated food company gave me an appreciation for the inter-relatedness and complexity of hog production, food safety, and disease concerns.

Most recently, Angela and I are the co-owners of a dairy, beef, and swine veterinary practice. As we have grown from having one employee to where we are today, we have been fortunate to be able to diversify and develop food testing, diagnostic, and research capabilities. I think this diversity of experience will allow me to serve our diverse membership in an efficient and thoughtful manner.

For the last 3 years, I have served as director for District 7. It has been an honor and a privilege to serve our membership in this capacity. Through involvement with several AASV committees, I have developed a deep appreciation for the passion and enthusiasm for our members to contribute in a variety of ways. Pork safety, swine well-being, and better control of disease have never been more important. The diversity of interests of our membership is a huge asset to maintain and expand our professional influence.

It has been very rewarding to see how student involvement in our association has grown over the last few years. The best and brightest have many opportunities, and there are several in our membership who deserve a lot of credit for making this happen. Our association has grown in scope of member services; the inception of the summer conference and Production Animal Disease Risk Assessment Program are great examples. The recently created award for young swine veterinarians allows us to recognize those who have made special contributions early in their careers.

The future of our organization will continue to depend on the contributions of our members. For all of you who have helped shape my experiences – thank you! I encourage you to vote and if elected, I pledge to represent your interests in our association.

Randy Jones

It is an extreme honor to be asked to be a candidate for vice president of the AASV. I have been a member of the AASV since graduating from North Carolina State University College of Veterinary Medicine in 1985. The AASV has been and continues to be an integral part of my life and practice of veterinary medicine. I am excited about the opportunity to give back to an organization that has given so much to me.

Swine medicine was not my original career choice in veterinary medicine. I was raised on a cow-calf farm in western North Carolina. During veterinary school, I was heavily influenced toward bovine herd health by Dr Ben Harrington and had a strong desire to practice bovine medicine. But a couple of young clinicians named Dr Harvey Hilley and Dr Gary Dial planted a seed of interest in swine medicine. Their enthusiasm and passion for swine medicine had an impact on me.

This seed was further cultivated by my employer and mentor, Dr Charles Randall. He took me to my first AASV meeting in 1986. That meeting inspired me with the closeness of this organization and the friendliness of the people. I spent the next 9 years in mixed practice. My time and focus was increasingly on swine medicine. I began a swine-only practice in 1995 and have enjoyed every day.

During this time, my wife Beth and I have raised two children: Garrett, a freshman at North Carolina State, and Colleen, a sophomore in high school. We have tried to become an integral part of the Kinston community. I was a Lions Club member for 15 years and Beth and I are now advisors to the North Carolina Junior Angus Association. We attend St Mary's Episcopal Church.

I believe in the need for organized veterinary medicine. I served on the North Carolina Veterinary Medical Association (NCVMA) Board of Directors for 6 years and as an officer for 4 years, completing my service as president in 1999. I am currently fulfilling my second term on the AASV Board of Directors. Veterinary organizations such as the NCVMA, AASV, and the AVMA give veterinarians a unified voice to the public and to the politicians. We as swine veterinarians need to be involved in our state and national veterinary associations. The voice of the food-animal veterinarian needs to be heard from within these organizations as well as from the AASV.

The AASV has been interwoven in my professional career. The annual meeting has been and continues to be my main source of continuing education. It is here that I have met and interacted with many people who have become friends, role models, and mentors. I have also had the opportunity to meet and mentor younger veterinarians and learn from them as well.

My goals as an officer include the following:

To be sure that the AASV continues as the primary source of information and training for our members. The annual meeting, *JSHAP*, the e-Letter, and the summer conference are all excellent ways to stay in touch with the current events of our industry. We must provide our members with the information and training to be the leaders on issues and diseases that face the swine industry.

Work to recruit new members and also to retain current members by making them aware of the tremendous benefits of the AASV. We have to market our association to new veterinarians and other food-animal veterinarians to show them the value of AASV membership. The AASV staff is unequaled in their abilities and the service they provide the members. We are in a global economy, and many of our disease issues are global. I would like to encourage international members in our organization. They are vital to our future and our success.

Encourage current veterinary students to consider food-animal medicine. This is the future of our profession: they need to be made welcome. The AASV has been a leader in these efforts, and we must continue to recruit students to food-animal medicine to avoid having a shortage of practictitioners doing research in the food-animal area.

Work with the AASV Foundation to raise money for research projects important to our industry and outreach to students. The AASV Foundation is starting to hit its stride and become a very important resource to our members and association.

Promote an awareness of animal welfare and work with the allied groups to be proactive in this area. This is a current topic and one that will continue to be a hot topic. We have to work with the swine industry, research institutions, and politicians to be sure we do what is right for all parties concerned.

My vision for the AASV is that this organization would evolve along with the food-animal industry to provide the United States and the world with a safe and plentiful food supply. This will require us to utilize technology to produce more with less. It will also require us to address concerns that the consumer has about animal welfare, antibiotic resistance, and environmental issues.

Veterinarians must be leaders in these efforts. We must promote science-based solutions to emotional people. This will require research, education, and training to bring about the changes needed. I have no doubt that the AASV and its members are up to this challenge. It is my desire to help provide leadership to make this vision a reality.

Thank you for taking time to read this letter and for caring enough to vote and support your organization.

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- For all authors, names (first, middle initial, last), affiliations, and academic degrees beyond bachelor's level; and
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Animal care

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

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

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- Submit each table or figure on a separate page.
- Make reference in the text to all figures and tables, citing them in consecutive order.
- Provide us with numerical data for all figures, including SD or SE for means reported.
- Supply brief but complete titles for tables and legends for figures. Explain the abbreviations used in a table in footnotes, using symbols to identify the footnotes.
- For *P* values reported in a table or figure, provide the name of the statistical method used (eg, Student's *t* test, ANOVA), not the name of the software.
- Submit photographs individually as high-resolution *.jpeg* images or in *.tif* files.
- Do not paste figures into the word processing document containing the text of the manuscript. Submit them separately, eg, submit figures created in Excel® as Excel® files.

Measurements

The *Journal of Swine Health and Production* adheres, with a few exceptions, to the style of the American Medical Association. This includes use of the Système International (SI) for all measurements. A conversion chart is included in each issue of the journal and at the end of the Author guidelines document on the AASV Web site at www.aasv.org/shap/guidelines.pdf.

Please see the Web version of Author guidelines for full details on journal requirements for submitted manuscripts.

Upcoming meetings

North American Veterinary Conference (NAVC)
January 17-21, 2009 (Sat-Wed)
Orlando, Florida

Swine program January 18-19 (Sun-Mon).

Registration headquarters and lodging:
Tel: 352-375-5672; Fax: 352-375-4145
E-mail: info@tnavc.org
Web: http://www.tnavc.org

Centralia Swine Research Update
January 28, 2009 (Wed)
Kirkton-Woodham Community Center
Kirkton, Ontario, Canada

For more information:
Centralia Swine Research Update, Box 37
Exeter, Ontario, Canada N0M 1S6
E-mail: csru@centraliaswineresearch.ca
Web: http://www.CentraliaSwineResearch.ca

2009 Pig Group Ski Seminar
February 18-21, 2009 (Wed-Sat)
Copper Mountain, Colorado

For more information:
Dr Angela Baysinger
Tel: 402-353-4855
E-mail: angela.baysinger@boehringer-ingelheim.com
Web: http://www.keepandshare.com/visit/visit_page.php?i=23169

American Association of Swine Veterinarians 40th Annual Meeting
March 7-10, 2009 (Sat-Tue)
Dallas, Texas

For more information:
AASV
902 1st Avenue, Perry, IA 50220-1703
Tel: 515-465-5255; Fax: 515-465-3832
E-mail: aasv@aasv.org
Web: http://www.aasv.org/annmtg

2009 Annual Meeting of the National Institute for Animal Agriculture
March 31-April 2, 2009 (Tue-Thu)
Galt House Hotel and Suites, Louisville, Kentucky

For more information:
National Institute for Animal Agriculture
1910 Lyda Ave, Bowling Green, KY 42104-5809
Tel: 270-782-9798; Fax: 270-782-0188
E-mail: niaa@animalagriculture.org
Web: http://www.animalagriculture.org

London Swine Conference
April 1-2, 2009 (Wed-Thu)
London Convention Centre
London, Ontario, Canada

For more information:
Tel: 519-482-3333
E-mail: info@londonswineconference.ca
Web: http://www.londonswineconference.ca/

VIIIth International Conference on Pig Reproduction
May 31-June 4, 2009 (Sun-Thu)
Banff, Alberta, Canada

For more information:
George Foxcroft, Local Organizing Committee Chair
Department of Agricultural, Food and Nutritional Science
410 Ag/For Building
University of Alberta, Edmonton, Alberta, Canada T6G 2P5
Tel: 780-492-7661; Fax: 780-492-4265
E-mail: george.foxcroft@ualberta.ca
Web: http://www.icpr2009.com

2009 World Pork Expo
June 3-5, 2009 (Wed-Fri)
Iowa State Fairgrounds
Des Moines, Iowa

For more information:
John Wrigley, World Pork Expo General Manager
National Pork Producers Council
320 Linwood Drive, Neosho, MO 64850
Tel: 417-451-6004; Fax: 417-451-5020
E-mail: wrigleyj@nppc.org
Web: http://www.worldpork.org

21st International Pig Veterinary Society Congress
July 18-21, 2010 (Sun-Wed)
Vancouver Convention and Exhibition Centre
Vancouver, British Columbia, Canada

For more information:
IPVS 2010 Congress Secretariat
c/o Advance Group Conference Management Inc
Suite 101 – 1444 Alberni Street
Vancouver, British Columbia, Canada V6G 2Z4
Tel: 604-688-9655 ext 2; Fax: 604-685-3521
E-mail: ipvs2010@advance-group.com
Web: http://www.ipvs2010.com/

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

Photo Corner

Piggy back

Photo courtesy of Brian Payne
DeKalb, Illinois

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http://www.aasv.org/

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http://www.aasv.org/shap/guidelines.pdf

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