African Swine Fever in Pigs from Feed and Liquid

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hi, everyone, I'm Sarah Gregory, and today I'm talking to Dr. Megan Niederwerder. Dr. Niederwerder is an assistant professor of virology in the Department of Diagnostic Medicine and Pathobiology at Kansas State University. We'll be discussing her article about how pigs can get African swine fever by what they eat or drink. Welcome, Dr. Niederwerder.

[Megan Niederwerder] Hi, Sarah. Good morning. Thank you for having me.

[Sarah Gregory] So, your article defines African swine fever virus as a transboundary animal disease and a major threat to pork production. What does all this mean?

[Megan Niederwerder] African swine fever is caused by African swine fever virus and it's really considered, currently, of the most significant threat to global pork production. And the reason that is, is that, over the last decade or so, this virus has spread to several countries in regions of the world that it had previously never been diagnosed.

[Sarah Gregory] Your article also mentions the Georgia 2007 strain. Tell us about that. And is that the country of Georgia or the state of Georgia?

[Megan Niederwerder] It's the country of Georgia and it was…it's named that—the Georgia 2007 isolate—because the…this particular isolate was first characterized when it was introduced into the country of Georgia in 2007. And the reason this is significant is because there are many different genotypes and isolates of African swine fever virus, but the Georgia 2007 isolate is what, of course, was introduced into the Caucus region and Eastern Europe in 2007. But it's also very, very similar to the isolate that's currently circulating in China and other Asian countries.

[Sarah Gregory] And just real briefly, tell us what an isolate is.

[Megan Niederwerder] Viruses naturally sort of change over time and so the way that we characterize viruses or, specifically, an isolate is by its genome or the sequence of DNA. And so, when we think about how viruses change, then once they have changed, they may be designated a new isolate, based on those changes and, again, that's based on the sequence of DNA.

[Sarah Gregory] Okay, so where…where is this particular virus commonly found?

[Megan Niederwerder] So, historically, this virus, of course, as its name suggests, is…has been found in Africa. But, again, over the last decade, it has really expanded with regards to the countries and regions that it is currently circulating. And so, from 2007 onward, it was introduced into several Eastern European countries, such as Poland and Latvia. In 2017, it was first detected in Romania, and then in 2018, it was detected in China, as well as Belgium. And then, just over the last seven months, in 2019, it's been detected in Vietnam and Cambodia. And so, this virus has really been moving fairly rapidly, as far as the countries that it's been detected in.

[Sarah Gregory] Okay, so is there anything else you want to tell us about this virus? And it's pretty much fatal, right?

[Megan Niederwerder] The virus that's currently circulating is a highly virulent strain, which means that the mortality rates, after pigs are infected, really approach 100 percent. So, it's very…it has a high fatality rate. The disease that it causes is very severe. It often causes high fever in pigs, then they become lethargic, depressed, can have hemorrhage in the skin, as well as hemorrhagic diarrhea. And so, the disease is very, very severe as far as mortality rate, but also with regards to the disease that it actually causes for clinical signs in pigs. The other important thing about African swine fever virus is that it's only a pig disease. It does not affect humans.

[Sarah Gregory] Ah, that is important, because I'm sure a lot of humans were getting quite nervous now.

[Megan Niederwerder] Yeah.

[Sarah Gregory] Any more details about why it's considered an emerging threat? Obviously, it's moving around and getting worse, I guess, but you want to tell us a little more about that?

[Megan Niederwerder] Sure. The reason it's really threatening pork production is not only because of the high mortality rate and severe disease, but China has the world's largest susceptible pig population. China houses approximately half of the pigs that live in the entire world, and so, once the virus was introduced into China, this significantly impacted the overall global pork production, the global pork trade, because China not only produces a lot of pork, but also consumes a lot of pork. And, because the virus is now there, that pork production has significantly changed, as you may imagine, and that is why it's really an emerging threat. The other characteristic of the virus being in China, where this large population of pigs live, is that, of course, a lot of products are shipped from China around the world. And so, that sort of plays into the rationale behind my research, looking at, potentially, feed ingredients serving as a vector for the disease.

[Sarah Gregory] Okay, so as you just said, your study is about the spread of the virus through feed and liquid. So, you know, particularly tell us about that. And why did you originally think this might be the case?

[Megan Niederwerder] In 2013, porcine epidemic diarrhea virus was introduced into the U.S. and that, was really, historically, the last major transboundary animal disease introduced into U.S. swine population. And several epidemiological investigations after PEDV was introduced revealed the risk of feed and feed ingredients serving as a potential route for, not only new transboundary diseases to be introduced into swine populations, but also as a potential route for these viruses to spread to susceptible populations within the country.

And so, that was, you know, several years of research investigating the introduction of this virus into the U.S. and, as we learned more about that, the question really started to develop, well, if feed or feed ingredients can serve as a route for porcine epidemic diarrhea virus, what is the risk of these ingredients serving as a route for other foreign animal diseases? And African swine fever, as we've mentioned, is a significant threat. And so, that's really what led into my research—understanding the risk of both introduction, as well as transmission, of African swine fever virus through feed.

[Sarah Gregory] So, you particularly found that liquid was more likely the cause of the infection than feed itself. And…why is this?

[Megan Niederwerder] So, we tested both feed, as well as liquid, to understand the dose that was required for ASF to cause infection when naturally consumed. And so, a lot of the infection trials that have historically been done are not through natural consumption. So, one of the goals of the study was to simulate what would truly happen in the field with regards to the pig naturally consuming this contaminated feed or liquid. And we also wanted to understand and sort of compare the dose required for infection in plant-based feed versus liquid. And we think that the virus was able to infect pigs at a lower dose in liquid because the liquid facilitates viral contact with the tonsillar tissues, which is where the virus replication initially occurs. But what was interesting is that the virus could be transmitted through both feed and liquid, with increased probability of infection as the dose increased.

[Sarah Gregory] So, despite this fact, your study hypothesizes that feed might actually end up being more likely than liquid to spread this infection. So, is that dose related? What is this?

[Megan Niederwerder] So, it has a lot to do with how feed is manufactured and shipped. So, when you think about the water source for a pig barn in most places in the U.S., that water, of course, is usually locally sourced. Feed ingredients, on the other hand, can be shipped all over the world. And, in fact, the U.S. imports several million kilograms of feed ingredients from countries such as China. And those feed ingredients are in…are, of course, in the country of origin—China, in this case—and then shipped overseas and delivered to feed mills, where the feed is actually manufactured.

And so, the risk is, is if those feed ingredients become contaminated, and then are shipped to the country, they can serve as a source of virus when introduced into the complete feed and then, of course, after the complete feed is manufactured at the feed mill, it is widely distributed to several barns where pigs then consume the feed. And so, the reason that we think that feed may be a higher risk is because, again, feed ingredients are sourced globally, throughout the world, and, of course, from countries with circulating foreign animal diseases, and then after the feed ingredients arrive to the U.S. and are incorporated into a complete feed diet, they are widely distributed to many farms. And so, that…it's really the global distribution of feed and feed ingredients for pigs that makes this a risk factor.

[Sarah Gregory] And I guess it's somewhat along those same exact lines, why is it important to quantify doses of the virus that cause infection? Why not just try to avoid all contamination?

[Megan Niederwerder] Our previous research that we did, actually just right before the oral dose study, was investigating if feed ingredients were contaminated with African swine fever virus and then subjected to environmental conditions that simulate transboundary shipment, such as transoceanic, over the Atlantic or Pacific Ocean, would the virus actually survive in those feed ingredients. And what we found was that ASF was highly stable across feed ingredients and that it was detectable…infectious virus was detectable at the conclusion of the model.

But we also had quantifiable levels of virus. And so, we wanted to understand, thinking about how this virus degrades over time, it's important to quantify that so that we can estimate the risk, but also, once we start implementing mitigation strategies, understand how each mitigation strategy reduces the risk, at a quantifiable level, because each mitigation strategy that we may implement, of course, probably has an economic cost to it. And so, we need to think about how we can reduce the risk of contamination or infection through feed, by implementing these mitigation strategies, but make sure they're the most cost effective strategies to reduce this risk.

Unfortunately, it would be very difficult to completely eliminate the risk. The way that we could do that is looking at where these feed ingredients are imported, and understanding and looking at different strategies for importing feed ingredients from countries that do not have any circulating foreign animal disease. So, that would be one strategy to significantly reduce the risk.

[Sarah Gregory] Okay. Backing up, what was your initial hypothesis and what were the actual findings?

[Megan Niederwerder] Sure. So, we wanted to understand if ASF could be transmitted through the natural consumption of plant-based feed. Historically, we know that ASF can be transmitted through the consumption of pork…contaminated pork products. So this would be where pigs consume swill that may have uncooked pork products in them. But we didn't know if the plant-based feed ingredients would actually support the virus enough to cause transmission when naturally consumed. And so, our initial hypothesis was really just understanding, can the virus be transmitted through these plant-based feed ingredients?

And then, subsequent to that, what is the dose required for infection and how does that dose required for infection change as the number of exposures changes? So, what was interesting in the study is that we actually…the pigs consumed a small amount of contaminated feed. But, when we look at how much pigs consume, let's say throughout the day, we would see that the actual amount that they were…ingested during this study may be up to 40 times that amount in a day for a large finisher pig.

[Sarah Gregory] I'm sorry, let me interrupt a second. What's a "finisher pig"?

[Megan Niederwerder] A finisher pig is an older pig. So, usually they go to the finisher about nine weeks of age and until they're about six months of age. There's different stages of pig production. There's a stage where they're with their mothers. And then there's a stage after they're weaned from their mothers that's called the nursery, when they're fairly young. And then they go to a finisher, again about nine weeks of age, to essentially grow during that phase, until they go to market. And so, those larger pigs would consume more feed and would be exposed, again, several times throughout the day, if that feed was contaminated. And so, we sort of expanded the hypothesis in that we wanted to understand what's the risk of infection if a pig consumes that contaminated feed, let's say throughout the day or throughout several days.

[Sarah Gregory] Okay, so, and moving forward, how do you hope these findings will be used?

[Megan Niederwerder] Well, the next step to our research is really understanding what mitigation strategies we can put in place to reduce the risk of African swine fever virus being transmitted through these feed ingredients. And we've been looking at applications such as storage time, so understanding how the virus degrades naturally over time. We've also been looking at heat treatments to understand if the virus is susceptible to various temperatures. And then also understanding if there are antiviral chemicals that we can actually add to the feed to eliminate the virus infectivity through consumption. And so, we're really hoping that, now that we've defined the risk, understand that there is this risk, what strategies can we at least put recommendations on with regards to reducing the risk, so that we can really prevent infection to our pigs in the U.S. and, of course, hopefully prevent the spread of this virus throughout the world.

[Sarah Gregory] Let me just stop here for a second. This a really, really terrible disease, certainly for the pigs and for the pork industry as a whole. But backing up, you said that this was not contagious to humans, but I know, you know, working in Emerging Infectious Diseases, that a lot of…a lot of diseases become zoonotic, which—for listeners, if they don't know—means that they transfer from an animal to a human. You said this isn't contagious to humans, but is it possible that it could become so?

[Megan Niederwerder] Well, this virus is not related to any virus that infects humans. It's one of the reasons that it's so difficult to control is that we…it's a very unique virus that only infects pig species. But I think an important component of a virus that only infects pigs, is understanding, with a growing world, we need more food and more efficient food production. And so, although this virus does not infect humans, the impact on pig production and the availability of protein can play a significant role in human health and food security for humans. So, I think that's an important consideration with regards to the impact on the population, particularly in China, where 60 percent of their protein consumption is pork.

[Sarah Gregory] Sixty? Six-zero?

[Megan Niederwerder] Six-zero.

[Sarah Gregory] Oh yikes! That's a large number, yes?

[Megan Niederwerder] Yes.

[Sarah Gregory] Okay. Is there anything else you'd like to tell us about the process of doing this study or about what you found?

[Megan Niederwerder] One of the things that's so challenging about African swine fever virus is that there is no effective vaccine. And for many production diseases there are vaccines available that can at least reduce risk, reduce the severity of clinical signs for the viruses when they're introduced. Because ASF is so unique, it's the only virus in its family. It's a very large virus, very complex, many, many proteins—over 150 proteins. The development of a vaccine has been very challenging for the research industry, and for the ability to commercialize and make available a vaccine. And so, that's one of the reasons that this virus has been so difficult to control and one of the reasons that we want to understand risk factors for introduction, to prevent introduction, and do everything we can to maintain the U.S. swine herd as negative.

[Sarah Gregory] Well, tell us about your profession and your job and how you become interested in swine diseases.

[Megan Niederwerder] Sure. So, I am a veterinarian. I practiced for several years prior to coming back to academia and pursuing a PhD and becoming a faculty member here at Kansas State University. And swine diseases are very interesting, especially in the viral disease field. The viruses change quite frequently, there are new strategies, as far as maintaining production levels and understanding what we can do to maintain efficient food production with regards to pork. And what I enjoy about research and doing some of the work that we've discussed is that it really has the opportunity to, hopefully, improve swine health and, of course, in this case, prevent viral spread for a disease that is really impacting the whole world, with regards to pork. And so, that's what I really enjoy about my job. I also teach veterinary students in their second year of the

veterinary curriculum. I teach them about viral diseases in swine and other animals. And I really enjoy being around students and then having the opportunity to do this research.

[Sarah Gregory] Well, thank you so much for taking the time to talk with me today. We really appreciate it. And thank you, my listeners out there, for joining us today. You can read the May 2019 article, Infectious Dose of African Swine Fever Virus When Consumed Naturally in Liquid or Feed, online at cdc.gov/eid.

I'm Sarah Gregory for *Emerging Infectious Diseases*.

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