HOW TO STOP PEDv?
HOW TO STOP PEDv?
Porcine Epidemic Diarrhoea (PED) virus took the pig industry by surprise. The understanding of it is progressing, albeit slowly. In this white paper, Pig Progress and Dr Tom Burkgren (AASV) dive into the major questions and try to uncover which are yet to be answered. What do we know – and what needs to be yet unveiled?

Join the discussion!
SYMPTOMS
PEDv attacks the gastrointestinal tract and causes the destruction of villous enterocytes and villous atrophy within the jejunum and ileum. Incubation period is very short and clinical signs start at 15-24 hours after infection and last usually two to three days. Transmission is very fast and once clinical signs are detected, most of the piglets in either house or whole farms are infected within two to three days. Suckling piglets show vomiting and severe diarrhoea and these symptoms in conjunction with reduced milking lead to fatal dehydration and malnourishment. Most piglets less than one week of age will die in a naïve herd. Growing pigs and breeding animals will generally have watery diarrhoea and vomiting, which can cause increased mortality and reduced average daily gain.

PEDv AND FEED
Can PEDv be transmitted through livestock feed? Yes, many have been believing for some while. But how? Earlier this year plasma was thought to be the ingredient to blame, but in August, a study showed that there is a chance that livestock feed can carry the virus. In the study, researchers collected feed residue from three farms in Iowa and Minnesota that had outbreaks of PEDv and had received feed from the same source. They fed it to five piglets in an experiment at South Dakota State University, and all became infected with the virus. Piglets that were not fed the infected feed did not get sick. The study did not determine how the feed became infected with PEDv.

PEDv AND THE MOMENT OF INFECTION
Based on on-farm detection, there appears to be a delay of 24 to 48 hours post-introduction before clinical signs of PED virus are detected by caretakers. This means that infection of PEDv could have happened as much as two to four days prior to the onset of disease. For veterinarians and pork producers, this is important knowledge, as this places the quest for a potential source of infection on a farm in a different perspective.

VIRUS
Typically introduced via a faecal-oral route of transmission, PEDv begins replication in the cells, lining the walls of the small intestines as early as 12-18 hours after introduction to the body. It quickly replicates and causes fusion and blunting/shortening of the small intestinal villi. The maximum prevalence of the virus in small intestinal enterocytes is seen 24-36 hours post-infection.

PEDv is classified as being a coronavirus and as far as it is known, there are currently two subtypes of the virus present. The 'original' version showed very much resemblance to earlier isolates found in China's Anhui province – hence this country is considered to be the origin of the virus. Burkgren says, “The virus destroys the villi of the intestines and it is very similar to Transmissible Gastro-Enteritis (TGE). In a way it is quite shocking to see what damage it can do to baby pigs.”

The virus appears to have mutated as well, as in January 2014, researchers at the Animal Disease Diagnostic Lab of the Ohio Department of Agriculture distinguished a second variety which was later confirmed by Iowa State University and the University of Minnesota. In this variety sows were known to be infected, and although piglets also did show clinical signs and died, it was in some cases not as severe as the original strain.

To make things a little more complicated, another coronavirus also first appeared in the US in February of this year. Clinical signs of this virus, called Swine Delta Coronavirus (SD Cv), has been reported to be similar to PEDv, causing diarrhoea and vomiting and all age groups and mortality in nursing pigs. Mortality rates, however, appear lower than in cases of PEDv. Both diseases (PED and SDCv) are reportable in the US and Canada.
**CORONAVIRUSES**
Coronaviruses can be divided into three serologically distinct subgroups. Alphacoronavirus and Betacoronavirus have been isolated from mammals and Gammacoronavirus from birds.

They infect many animals including humans, in species-specific manner. It has been reported that coronaviruses mainly infect respiratory and gastrointestinal tracts causing acute and chronic respiratory and enteric disorders in respective species. Together with Transmissible Gastro-enteritis virus (TGEV), Canine Corona-virus, Feline Infectious Peritonitis virus (FIPV), Porcine Epidemic Diarrhoea virus (PEDv) belongs to the subgroup of Alphacoronavirus. It is an economically very detrimental pathogen and is currently one of the hottest topics in pig industry, especially in the Asian swine market. PEDv results in approximately 50% mortality among suckling piglets. In addition, it reduces the weight of finishing pigs.

**WHERE?**
This disease has been seen in Europe throughout the 1970s and more recently in Asia since it was confirmed as the cause of acute diarrhoea in 1984. Since the first report in the United Kingdom in 1971, it progressed from only affecting finishing pigs to affecting suckling piglets as well by 1976. European cases described in the 1990s depicted PEDv as more severely affecting sows and fattening pigs, while still causing mild or no clinical signs in suckling and young pigs.

Outbreaks in Southeast Asia, however, have had more severe diarrhoea and high mortality in suckling piglets. These Asian outbreaks show similar clinical presentation and neonatal mortality to current US examples and also are genetically similar to US isolates. Acute infection in Asian herds throughout the 1990s has developed into endemic infection characterised by intermittent periods of clinical signs and elevated preweaning mortality.

Although it was May 2013 when the virus was first found on a farm in Indiana, United States, the strain of Porcine Epidemic Diarrhoea virus (PEDv) that hit the North American pig industry still remains a mystery in many ways. As the virus has also spread to 30 US states and other American countries like e.g. Canada, Mexico, the Dominican Republic, Colombia and Peru and simultaneously has been causing big losses in Asia, predominantly Japan of late, there are still many lessons to be learnt.

Burkgren says, “We don’t really know the route of entrance into the United States, this is a subject of analysis. We need to establish what have been risk factors and what products might have been infected. This does mean, however, that a lot of products need to be investigated – think of feed, but also e.g. vaccines. And don’t forget that people travel a lot – including Chinese nationals.”

He continues, “What has been striking is a certain pattern. The virus showed up in three different places more or less simultaneously – it happened within days of each other. The earliest entrance was backtracked to April 15, 2013 in Ohio. But a retrospective test also showed outbreaks in Indiana, Iowa, Colorado and Minnesota.”
Click on the map to see the spread of recent PEDv outbreaks worldwide!

HOW DOES PEDV TRANSMIT?
There are mixed opinions about this, as theories point into several directions including road transport, feed inclusion or air transmission, Burkgren says. “We definitely have to spend time on the matters we haven’t fully understood. There have been several room studies in which infected pigs shared air space with naïve pigs – and the naïve pigs did not get infected. At the same time, there have been trials trying to establish whether or not PEDv is an airborne virus, at the University of Minnesota. They found traces of PEDv using PCR air samples ten miles away from an infected herd.”

Burkgren also pointed to research in pig dense North Carolina, where the disease spread very rapidly. Research by the University of Minnesota showed that farms within a three-mile radius from PEDv positive farms have a higher risk of infection.

COMMUNICATION
Owners of infected herds are encouraged to communicate their PEDv status with nearby neighbours. Research has shown that regions with high swine site density, i.e. over five sites within a 25 square mile area (65 km2) – have increased odds of sites being positive for PEDv, and that sites in close proximity to a positive site have increased odds of being positive. Collaboration and sharing of knowledge between neighbours is crucial to try to prevent as much site-to-site transmission as possible.

The long-term effects of PED on a herd are still unknown. Since its emergence in the US, early-infected herds have demonstrated for the most part a return to normal production at six weeks post-infection on average. More recent herds have had a prolonged recovery time. It is still unclear whether these trends are related to exposure methods, hygiene at the site, season/ weather, or immunity. However, the immunity conferred by whole-herd exposure methods seems to be brief, reducing to low levels of detected nucleocapsid antibodies after only six to seven weeks.
PREVENTION IS DIFFICULT

Though PEDv, like transmissible gastroenteritis virus (TGEv), is primarily a faecal-oral transmitted pathogen, unlike TGEv it has been difficult to prevent its introduction to even some of the most bio-secure breeding herds in the US. Many common routes of spread have been implicated through pilot studies of feed, air and transportation contamination. An enormous amount of viral RNA can be detected in acutely infected pigs, and the infectious dose has been suggested to be very low. Therefore, once PEDv is introduced to a region it is important to re-double efforts to maintain biosecurity at negative sites. Based on risk factors implicated to date, this should include restricting access that any birds or pests may have to swine, compost piles, and rendering pickup locations and hygiene of any transportation entering the premises and subsequently of any employees interacting with incoming vehicles.

Swine production companies in the US are attempting to prevent transmission and infection of sentinel animals after outbreaks by establishing thorough disinfection protocols involving multiple methods such as conventional chemical disinfectants (Synergize, bleach, etc.), use of flame, and use of whitewash on the floors and walls. It may also be necessary to test incoming feed products to the site for contamination. Airborne site-to-site transmission has been implicated by detection of virus RNA in the air as far as 10 miles away from acutely-infected sites, but it is unclear in what types of situations this is more likely and whether air filtration of a site is effective at preventing its spread.

HOW TO FIGHT IT?

While waiting for various vaccines to become widely available, maternal immunity has been a widely applied strategy for producers and veterinarians. Burkgren explains, “This comes down to stimulating sow immunity by offering her feedback, as what we need to achieve is an increase in immunity combined with a decrease of the viral load. Usually, once PEDv is confirmed, the sows will be aborted or piglets will be euthanised. Part of this will be fed back to sows. They may get a little bit sick or be off feed for a little while, but no mortality is observed. What is more important is that she will also build up immunity. While doing that, a cleaning and disinfection process will start (decreasing viral load in the environment) and pregnant sows are being moved in again. This would mean that the production is hopefully back to normal, about eight to ten weeks after the first onset of clinical signs.”

He continues, “Once the sows are immune, she will have immunoglobulin A (IgA) antibodies in her milk. The piglets thus can develop a balance point with lactogenic immunity – they need a lot of this to resist a viral load. Here again, the real concern is that we don’t actually know how high the immunity is. It is an area where more research is needed.”

It is one of the areas where PEDv surprised science, as this summer, sow immunity proved not to be a 100% safe option. Burkgren says, “Some of the farms applying sow immunity, the first being in Indiana again, have seen a re-occurrence of the virus, eight to nine weeks post-infection. That poses questions about sow immunity.

VACCINATION

How is the progress with regard to PEDv vaccines? In Korea, several vaccines have been developed, but for several reasons of compliance and different subtypes, these cannot be used in the Americas. Several animal health companies are known to work on vaccines; two already have been granted a conditional license. US-based company Harrisvaccines managed to receive a conditional USDA licensure for its sow vaccine in June 2014. Zoetis was granted conditional license for a PEDv vaccine in September 2014, for use in sows and gilts. In addition, Merck and Boehringer Ingelheim have announced to work on a vaccine.
FIRST PEDv VACCINE
Harris vaccines was the first company to develop a vaccine for the treatment and/or prevention of Porcine Epidemic Diarrhoea virus in the United States. The vaccine was developed within 60 days of the outbreak and made available by prescription via veterinarians in August 2013. This rapid response to the introduction of transboundary virus was possible due to the company’s non-traditional vaccine platform. The vaccine is for sows only at this point. Studies to the results of the vaccine are currently being conducted.

STANDARD TREATMENTS
If PEDv is detected in a herd, standard treatment is to expose all animals at the site to the virus. Korean literature has reported that PEDv immunoglobulins in egg yolk or bovine colostrum fed to suckling piglets has a protective effect and alleviates some of the mortality. There are no commercial vaccines available in the US with proven efficacy. Therefore, in US herds exposure is achieved as quickly as possible after confirmation of infection to inoculate animals orally. The impact of different concentrations of PEDv in this feedback material on exposure and immunity in sows is yet unknown.

At the time of exposure, it has also become standard practice to immediately wean older suckling piglets (age cutoff is variable) to a growing site. It appears that many of these piglets do better with free access to water and less environmental challenges than was seen in farrowing with the virus shed by sows.

Whole-herd exposure is done to facilitate the spread of the pathogen so that the acute phase of the disease is shorter, herd immunity is uniform. There will, however, be a period of high preweaning mortality that can last approximately seven weeks post-infection. It is thought that persistent hygiene and disinfection of a recovering herd’s facilities will mitigate further challenge and help return a herd to production faster.

VACCINES IN ASIA
Two types of vaccines against PEDV are available in the market either killed or live. Several Japanese and Chinese companies manufacture a PEDV vaccine and so do all five major animal vaccine manufacturers in South Korea (Komipharm, Koryo B&P, Cavac, Green Cross and Joongang). The recommended programme is to vaccinate sows twice – at four weeks and two weeks before farrowing. Some farms use only live vaccines, some farms only killed vaccines; others use both. Efficacy and protection by PEDV vaccine is considered not that bad, but is still not that promising in swine industry.

There are some issues in PEDV vaccine efficacy. The main reason could be that wild type PEDV is quite different from vaccine strains. Based on the Korean situation, wild type viruses are genetically different from vaccine strains. This does not mean vaccine never works, as the protection efficiency of vaccination is higher than when no vaccination is applied at all.

Based on all the factors, situation and reports in Asian countries, the PEDV problem seems to be continued for quite long period of time and the financial impact on the swine industry in these regions may get higher in the future.

The main reason Korea and Japan have been successful in reducing the effects of PED has been strong regulation, joint efforts, and active support from their governments. In South Korea, PEDV has been recognised as a reportable disease.
PEDV transmission is very fast and hard to control once an outbreak has occurred in a farm. Therefore, only when all regulations are followed, and vaccination programmes are controlled by government, the viral disease could be diminished.

**HOW MUCH IS LOST?**
Another question which is easier to ask than to formulate an answer. At the World Pork Expo, Dr Steve Meyer from Paragon Economics estimated that roughly seven million piglets had died in the US – by mid-August estimates had grown towards eight million. Burkgren comments, “These figures are not for sure, as nobody is tracking mortality. There are also production losses of between two to five days in finishing pigs. But there are also reproductive problems as sows don’t rebreed, causing farrowing rates to get depressed.”

Hence, total costs are difficult to estimate too. Burkgren says, “The amount of piglets that have perished can be multiplied with $75, the average price of a weaned pig. And that is just the pig losses. I’m not sure where we stand if we also add production and reproduction losses or the cost of cleaning, disinfecting and increased biosecurity.”

Ironically, on the US pig market, the effects of PED virus have not been noted to a very large extent well into summer, Burkgren says, as slaughter numbers are down, but average weights have increased. He adds, “Pigs are being sent to market quite a bit heavier; this could be 5-10 pounds up to even 20 pounds heavier (2.25-4.5 kg and 9 kg respectively, ed.).”

It is feared that stronger effects will be felt next winter, as the virus is known to thrive in colder temperatures.

**LESSONS LEARNT**
It’s not all doom and gloom, Burkgren says as in the wake of all losses, several good developments have also been happening. He says, “The attention for biosecurity in the US definitely has gone up. Establishing a good cleaning and disinfection programme is really required in order to achieve an exclusion of the virus. This includes people, equipment, feed, pigs – all supplies that are being carried in.”

In addition, our understanding of viral diseases has gone up as well. You could also add that the cooperation of the three pig organisations, National Pork Producers Council (NPPC), National Pork Board (NPB) and the AASV has definitely been improved as a result of the disease.

Last but not least, Burkgren has wise words for the pig industry in those countries which so far have been spared from PEDv outbreaks: “I would not wish PEDv on any country. The past 15 months of dealing with PEDv have been extremely difficult. I believe that identification of pathways of entry into a country is paramount. Once identified then vigilance, preparation and increased biosecurity are needed.”
Click on the timeline to stay up-to-date on all PEDv news!

**PEDV disinfectant tested for efficacy**

September 4, 2014

With Porcine Epidemic Diarrhea Virus (PEDV) continuing to threaten worldwide pork production, DuPont Disinfectants has announced that the company can now offer pig producers a proven disinfectant for PEDV: Virkon S.