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FULL PAPER

Porcine epidemic diarrhea (PED) in Europe and strategies to control outbreaks

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Summary

Porcine epidemic diarrhea (PED) has been recognized for the first time in 1971 in the United Kingdom during outbreaks of diarrhea in feeder and fattening pigs. Subsequently, the disease spread to other European countries and clinically also appeared in suckling pigs. During the 1970 and 1980 widespread PED epidemics were prevalent throughout Europe. Thereafter, PED epidemics became rare and the virus responsible for PED, PED virus (PEDV) was more often associated with single outbreaks due to widespread natural stabilization of breeding herd immunity. However, a PEDV epidemic was observed in Italy in 2005–2006 emphasizing that PEDV was still present and active in Europe. The emergence of PEDV in the USA in 2013 has raised concerns from European swine producers over introduction of emerging PEDV strains into the European Union (EU). In 2014, PEDV associated with high mortality was recognized in the Ukraine. Subsequently, PEDV outbreaks associated with watery diarrhea in piglets were also seen in Germany, Portugal, France, the Netherlands, Italy and Belgium. Genomic analysis revealed that the Ukraine PEDV resembled a PEDV genogroup 2 prototype strain. In contrast, in essentially all EU PEDV outbreaks a PEDV genogroup 2 S-INDEL strain different from the PEDV prototype genogroup 2 strains was identified. PEDV S-INDEL strains are associated with lower pathogenicity compared to prototype strains in infected pig populations. Tools to control PED in the EU are limited. During the initial European outbreaks of PEDV in the 1970ies, pregnant sows were deliberately exposed to the intestinal content of pigs that had died of PED. However this practice is currently not recommended and control is largely based on improving biosecurity and stop farm-to-farm transmissions. In December 2015 PED became a notifiable disease in England. Efforts to implement a commercial inactivated sow vaccine in several European countries are ongoing. Overall, PEDV has been re-emerging in Europe but appears to have an altered virulence different from what has been observed in North America and Asia in recent years. Control measures such as improving biosecurity are in many cases sufficient to control the disease.

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Disease and virus characteristics

Porcine epidemic diarrhea (PED) is an acute, highly contagious enteric disease of pigs commonly associated with diarrhea, vomiting, dehydration, lethargy and high mortality especially in suckling pigs (Saif *et al.*, 2012). The causative agent of PED, porcine epidemic diarrhea virus (PEDV) is an enveloped, single-stranded RNA virus that belongs to the family *Coronaviridae*, genus *Alphacoronavirus*.

Historical information

The PED virus (PEDV) first appeared in Europe in the early 1970s as the cause of acute diarrhea, first affecting fattening pigs and sows but later also involving neonatal pigs (Oldham, 1972). PEDV was first isolated in 1977 (Chasey and Cartwright 1978; Pensaert and DeBouck, 1978) and experimentally tested at the University in Ghent in the pig model (Pensaert and DeBouck, 1978). The isolated strain CV777 (Pensaert and DeBouck, 1978) became the prototype genogroup 1 PEDV strain (Huang *et al.*, 2013). Subsequently, the disease spread to other European countries and widespread PED epidemics were prevalent throughout Europe including major swine producing countries such as Belgium, England, Germany, France, the Netherlands and Switzerland.

In the 1980s and 1990s, outbreaks of PED became rare with PEDV persisting in the pig population at a low rate. Occasional or limited outbreaks were reported in some countries and serological surveys confirmed a low prevalence of the virus. For example, Belgian surveys indicated 14% of sows positive in 1986, 50% of fattening pigs positive in 1990, 7/7 groups of feeder pigs were positive after experiencing clinical diarrhea during 1996, and no positive fattening pig was identified in 1997 (Van Reeth and Pensaert 1994, Pensaert and Van Reeth 1998).

Between 2005 and 2006, clinical PED appeared on several farms in Italy and the presence of PEDV was confirmed (Martelli *et al.*, 2008). Specifically, there were two initial outbreaks in May 2005, one in June 2005, one in July 2005, two in October 2005, five in November 2005, 10 in December 2005, 14 in January 2006, 10 in February 2006, 10 in March 2006, five in April 2006, two in May 2006 and one in June 2006 (Martelli *et al.*, 2008). During the Italian PEDV epidemic, the mortality in new-born piglets was up to 34% whereas it was very low in growers despite a high morbidity (Martelli *et al.*, 2008).

PED in Europe during 2014 and 2015

The emergence of PEDV USA in 2013 (Stevenson *et al.*, 2013) has raised concerns from European producers over re-emerging of PED or introduction of novel more virulent PEDV strains and most countries initiated PEDV surveillance in their pig populations. In January of 2014, PEDV associated with high mortality was first identified in the Ukraine (Dastjerdi *et al.*, 2015). Subsequently, PEDV outbreaks associated with watery diarrhea in piglets were also seen in Germany (Stadler et al, 2015), Portugal (Mesquita *et al.*, 2015), France (Grasland *et al.*, 2015), Italy (Boniotti *et al.*, 2016), Belgium (Theuns *et al.*, 2015) and Austria (Steinrigl *et al.*, 2015).

Genomic analysis revealed that the Ukraine PEDV resembles a PEDV genogroup 2 prototype strain (Dastjerdi *et al.*, 2015). In contrast, in essentially all EU PEDV outbreaks a PEDV genogroup 2 S-INDEL strain similar to strains circulating in the US but different from the PEDV prototype genogroup 2 strains was identified. When characterized in pigs in the US, genogroup 2 S-INDEL strains have been found to be less pathogenic compared to prototype stains (Lin *et al.*, 2015) and this somewhat milder clinical disease course has also been noted in the European field.

Treatment and control

As the suckling pig is the primary target of PEDV and highest mortality rates are typically seen in this age group, vaccination or exposure of dams is critical to control PED epidemics. During the initial European outbreak of PEDV in the 1970ies, pregnant sows were deliberately exposed to the intestinal contents of dead infected pigs. However this practice commonly known as "feedback" or "controlled exposure" is currently not recommended in Europe.

There are efforts to implement a commercial inactivated sow vaccine in several European countries but there is only limited information available to date. Specifically, Zoetis carried out a vaccine challenge study in Spain using their inactivated product conditionally licensed by the USDA (http://www.thepigsite.com/swinenews/40244/are-you-prepared-for-pedv-zoetis-ready-to-bring-vaccine-to-europe/). The Spanish study showed that the inactivated two dose sow PEDV vaccine was able to deliver partial cross protection to piglets born from sows that had been vaccinated when challenged with a heterologous PEDV Spanish isolate.

At the moment control of PEDV in Europe is currently largely limited to improving biosecurity. As an additional tool to detect possible cases as soon as possible, England made PEDV a notifiable disease on December 18, 2015 (https://www.gov.uk/government/news/porcine-epidemic-diarrhoea-ped-becomes-notifiable-disease-in-england).

Summary

During 2015, PEDV has been re-emerging in Europe but appears to have an altered virulence different from what has been observed in North America and Asia in recent years. Control measures such as improving biosecurity appear in many cases sufficient to control the disease.

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