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Popular Article

Porcine epidemic diarrhoea: an emerging swine enteric coronavirus disease

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1.1 Introduction

Porcine epidemic diarrhoea (PED) is a highly contagious non-zoonotic enteric viral disease of pigs caused by the PED virus (PEDV), an *Alphacoronavirus* of the family *Coronaviridae*. PED is characterised by watery diarrhoea, vomiting, dehydration and weight loss leading to a very high morbidity and mortality that can reach upto 100% in neonatal piglets (Saif *et al.*, 2012).

Pigs are known to be the natural host for PED. PEDV can infect pigs of all ages. However, the disease progresses with more severity, high case fatalities in the neonatal and suckling piglets. PEDV transmission among pigs usually occurs by a direct or indirect faecal-oral route. PEDV transmits through faeces or vomitus of infected pigs and by contaminated materials, transporting pigs, people (pig owners, clinicians, *etc.*) involved in swine practices, fomites (manures, feed/ food items, contaminated cloths and footwears, biologicals, *etc.*) (Lee *et al.*, 2015).

PED has resulted in death of millions of pigs throughout Asia and United States. It has now emerged or re-emerged as one of the most devastating viral diseases of pig in the world, leading to significant financial concerns in the global pork industry. Emergence and re-emergence of PED leads to more severe epidemics globally that require urgent attention with suitable control strategies.

1.2 Disease prevalence

PED was observed for the first in Europe in 1971 (Oldham, 1972). Subsequently, it has spread to several swine-producing countries in Europe. During 1980s and 1990s, PEDV outbreaks became infrequent in Europe, while the virus persisted in an endemic form at a low rate in the pig population. Since the 1990s, PED occurrence has become rare in Europe, with periodic outbreaks, until its reemergence in Italy in 2005–2006 (Saif *et al.*, 2012). Later on, PEDV outbreaks were noticed in

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fattening pigs in Germany and Belgium, and in a farrow-finish herd in France (Hanke *et al.*, 2015; Grasland *et al.*, 2015; Theuns *et al.*, 2015). These German, French, and Belgian PEDV strains were found to be genetically identical (99.9%) to each other and related most closely to G1b variants identified in China, the United States, and South Korea.

In Asia, PED was first reported in 1982 in Japan (Takahashi *et al.*, 1983). After its emergence in Asian countries, it has continuously seen as a big threat to the Asian pig industry (Li *et al.*, 2012). PED in Asia occurs with more severity than in Europe causing high mortality in neonatal piglets. The first PED outbreak in South Korea was confirmed in 1992 (Kweon *et al.*, 1993). Thereafter, in the late 2000s, it has emerged in the Philippines, Thailand, Taiwan, and Vietnam (Puranaveja *et al.*, 2009; Duy *et al.*, 2011; Lin *et al.*, 2014).

PED still remains a devastating enteric disease leading to serious losses in China since its first identification in 1984 (Xuan *et al.*, 1984). However, PED epidemics increased remarkably in pigs in China during late 2010 (Li *et al.*, 2012). At that time, new PEDV variants belonging to the G1b genogroup were identified in China. PED outbreaks caused death of over 1 million piglets in China, with a death rate of 80%-100%, leading to high economic losses (Sun *et al.*, 2012). Currently, the PED has become endemic in many Asian countries such as China, South Korea, Japan, Philippines, Thailand, Taiwan, and Vietnam (Song *et al.*, 2015).

Despite the high impact of PED on pig industry, it was not recognized a well-known disease worldwide until its first occurrence in the United States in April 2013. PED outbreaks caused deaths of more than 8 million newborn piglets in the United States alone during its one year-epidemic period (Mole, 2013; Vlasova *et al.*, 2014), resulting in 10% decline in pig population (Song *et al.*, 2015). After its introduction in pig population in the United States, it had spread to the neighbouring border-sharing countries like Canada and Mexico (Vlasova *et al.*, 2014).

1.3 Disease status in India

There is no report on clinical existence of PED in India. However, a small surveillance study showed the serological evidence of PEDV in Assam state (Barman *et al.*, 2003). During a limited surveillance study to monitor swine enteric viruses, we have also observed, though at a very low rate, the antibodies against PEDV (unpublished data). It indicates the possibilities of exposure of Indian pig population with PEDV at certain point of time. Moreover, due to high prevalence of PED in the swine population of neighbouring China and other Asian countries, there is a high risk of its emergence into India.

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1.4 Impact on animal production and trade

Emergence of virulent PEDV strains has resulted in death of millions of pigs throughout Asia and United States. During a 1 year-epidemic period, PED outbreaks caused deaths of more than 8 million newborn piglets resulting in 10% decline in pig population in the United States alone (Mole, 2013; Song *et al.,* 2015). Moreover, there has been death of over 1 million piglets due to PEDV infection in China, with a death rate of 80%-100%, leading to high economic losses (Sun *et al.,* 2012). In PED, economic losses occur directly due to mortality and production losses in swine. Further economic losses occur because of the cost of vaccination and biosecurity.

PED is a transboundary animal disease that can spread readily to neighbouring or distant countries even across continents. Since PED is a non-reportable disease to World Organisation for Animal Health (WOAH) (previously named OIE), it does not require implementation of selective testing, quarantine and other bio-security measures on potential sources or routes that mediate PEDV transmission between countries.

1.5 Disease diagnosis

PED cannot be diagnosed solely on the basis of clinical signs and histopathological lesions, because there are several enteric diseases that resemble clinically and pathologically with PED. Therefore, PED must be differentiated with similar clinical diseases in the laboratory. Several diagnostic methods have been used for the detection of PEDV in laboratory. These methods include immunofluorescence (IF) or immunohistochemistry (IHC) tests, *in situ* hybridisation, electron microscopy, virus isolation, enzyme-linked immunosorbent assays (ELISA), and various reverse transcription polymerase chain reaction (RT-PCR) techniques. Conventional and realtime RT-PCR systems available as commercial kits are most widely used to detect PEDV during epidemic or endemic outbreaks, as well as for quarantine or slaughter policies (Lee *et al.,* 2015).

1.5.1 PED diagnostic development at ICAR-NIHSAD, Bhopal

A preparedness to diagnose the PED in situation of its emergence into India, we have developed a reverse transcription (RT) PCR for genomic detection of PEDV. Primers and gene construct targeting the nucleoprotein gene of PEDV were designed and synthesised by analysing the sequences of multiple PEDV strains prevalent in Asia. The developed RT-PCR was found to be sensitive and specific for the detection of PEDV genome in pigs. This RT-PCR is being used for testing of imported and field samples of swine.

1.6 Prevention and control

There is no specific therapy other than a symptomatic treatment of diarrhoea, dehydration and control of secondary infections. Implementation and maintenance of high biosecurity measures is efficient to control PED in endemic countries and to prevent the introduction and spread of the

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causative viruses from diseases prevailing countries to disease free countries. Being an important disease in swine rearing countries, it is essential to prevent the entry of PED across the border. Strategically, vaccination of sows during epidemic or endemic PED is required to control and eradicate the disease. Maternal antibodies in colostrum and milk from immune sows protect the piglets from the lethal episodes of the PED. Several attenuated and inactivated vaccines have been used against PED in China, South Korea and Japan (Lee *et al.*, 2015).

1.7 Challenges

Despite the advancement in diagnostics and vaccine technologies, the PED is still prevalent throughout Asia, Europe and the United States. Due to rapid genetic changes in viral genome (virus evolution), a single detection technique may not be widely useful. Hence, the diagnostic technologies need to be refined and updated in order to cover the recently evolved viral strains.

Globalization puts the entire pig industry at risk of pathogens and diseases arising from the same or different countries. Moreover, high population density, close human-animal interactions, different animal husbandry practices, breach in the biosecurity and non-rigid animal and human movements facilitate the transmission and spread of various viruses. Such demographic features are known to be the risk factors for the emerging viruses like PEDV. Since the PED is widely prevalent in China and other Asian countries, international border areas in North-Eastern states are always at risk of the introduction of the PEDV into India.

1.8 Conclusion

PED is a contagious, fatal enteric viral disease in newborn piglets. It is caused by PEDV, an *Alphacoronavirus*. PED is worldwide in occurrence. Although, PED is not prevalent in India, however, due to its endemic occurrence in China and in south-east Asian countries, there is always a risk of its emergence into India. Preliminary diagnosis of PED can be made on the basis of clinical characteristics of the disease in newborn piglets. However, it requires laboratory testing for confirmatory diagnosis. Development of effective and useful vaccine producing protective mucosal immunity against PED is still challenging. Biosecurity measures are effective to check the spread of PED from one geographical area to another.

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