# Management of Porcine Epidemic Diarrhea

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First reported in Europe in the 1970's, porcine epidemic diarrhea or PED has emerged in Asia, the United States, and recently Canada, causing explosive outbreaks of diarrhea with neonatal mortalities approaching 100% in some herds. Currently, strategies to manage and control the disease are based on deliberate and controlled exposure of breeders to the PED virus, disinfection and biosecurity, and supportive programs that alleviate the effects of diarrhea.

## 1. Introduction

Porcine epidemic diarrhea (PED) is an emerging disease of pigs caused by the PED virus (PEDV). First reported in Europe in the 1970s, initially as a cause of diarrhea in fattening pigs (Oldham, 1972) and later epidemic diarrhea affecting pigs of all ages (Pensaert and Debouck, 1978), PEDV has since been reported to cause devastating epizootic outbreaks with high mortality in neonatal piglets in several Asian countries including Japan, Korea and China in the 1990's (Hwang et al, 1994; Sueyoshi et al, 1995), Thailand, Vietnam and the Philippines from 2006 (Puranaveja et al, 2009), the US (Chen et al, 2013), and recently, Canada. Currently, enzootic infection with sporadic acute outbreaks occur in many herds in the Philippines, Vietnam and Thailand, while epizootic outbreaks are ongoing in the US and Canada.

PEDV destroys villous enterocytes causing blunting of villi and thinning of intestinal walls (Fig 1a). The events leading to diarrhea are most likely similar to that of a related enteric coronavirus, the transmissible gastroenteritis virus (TGEV), where virus destruction of mature enterocytes leads to a marked reduction in their enzymatic activity, and consequently, disruption of digestion and cellular transport of nutrients and electrolytes resulting in malabsorptive diarrhea (Bohl, 1989). The severity of diarrhea, duration of disease, and mortality decreases with age (Pensaert and Yeo, 2006). Thus, in neonatal piglets, mortality resulting from severe dehydration and starvation can approach 100% (Fig 1b), whilst in weaned and fattening pigs, morbidity characterized by diarrhea of short duration can reach 100%, but pigs generally remain in good condition and mortality is usually low to none (Fig 1c). In gestating and lactating sows, diarrhea may (Fig 1d) or may not be observed. Other possible clinical signs of PED in breeders include inappetence, fever and agalactia. Suckling piglets are more prone to severe disease for several possible reasons: (1) the intestinal villi of neonatal piglets are longer and may have more mature permissive enterocytes than older pigs, (2) the replacement rate of enterocytes is slower in neonates compared to older pigs, (3) digestion of milk is disrupted in suckling piglets causing undigested lactose to exert osmotic pressure from within the intestinal lumen attracting water out of the body and into the intestines and feces, and (4) the colon of neonates has a lower capacity to reabsorb water and compensate for electrolyte and acid-base imbalances compared to older pigs (Bohl, 1989; Herdt, 2007; Schwartz et al, 2013). The immaturity of the digestive tract of neonatal piglets and their less established gut microbial flora possibly contribute to more severe diarrhea in these piglets compared to older ones.


*Fig 1. Gross lesions and clinical manifestation of PED in pigs of different ages. (a) Distended stomach and distended thin-walled intestines containing yellowish to greenish fluid in a 3-day old piglet. (b) Neonatal and (c) weaned piglets, and (d) a gestating sow with PED.*

## 2. Strategies to manage and control PED

Several strategies are used in the field to manage and control PED outbreaks. Intentional exposure of the breeding herd to PEDV is the primary strategy used to establish immunity in breeders, and consequently, reduce and stop mortalities in neonatal piglets. In combination with other programs, total control and prevention of further outbreaks of PED in the herd can be accomplished. Some of these strategies are described below.

### 2.1. Deliberate exposure of the breeding herd to PEDV (feedback)

The first and most important step in managing PED is the rapid intentional exposure of all sows and gilts to PEDV at the same time. The purpose of this simultaneous exposure is twofold: (1) to infect sows with PEDV in order to stimulate active production of PEDV-specific sIgA antibodies for passive transfer via colostrum and milk to suckling piglets, and (2) to assure simultaneous uniform build-up of breeder herd immunity and simultaneous cessation of virus shedding in breeders (Schwartz, 2013). As long as suckling piglets receive sufficient sIgA antibodies in milk, they are protected from disease. Obviously, conditions that impede this passive transfer of antibodies, such as mastitis and agalactia, will render piglets unprotected and vulnerable to PEDV. If breeders are not exposed to PEDV at the same time, susceptible breeders will remain available and over time will be infected and transmit the virus to its litter. This prolongs the occurrence of diarrhea and mortalities in suckling piglets, and potentially the entire herd. Feces and/or chopped intestines from live diseased neonatal piglets are the best materials for exposure as they contain higher amounts of virus compared to material from older pigs. In the Philippines, a common practice is to sacrifice entire batches of affected neonatal piglets. Aside from providing sufficient material for simultaneous aggressive feedback of all sows and gilts for a period of 1–4 days, this strategy decreases the virus load in the farm and more importantly, creates a gap in production which reduces the chance PEDV perpetuation in successive batches of weaned piglets. After feedback, temporary closure of the herd to animal introductions for a period of 4 months helps in building-up whole herd immunity.

### 2.2. Disinfection and biosecurity

Proper disinfection and biosecurity are crucial adjuncts to feedback. These programs become even more important as preliminary reports of ongoing studies in the US reveal that very low amounts of virus are needed to infect piglets, and that PEDV can survive in feces, feed and water for extended periods of time: fresh feces (up to 1 wk at 40$^{o}$C), dry feed (1 wk at 25$^{o}$C), wet feed (4 wks at 25$^{o}$C), drinking and recycled water

(1 wk at 25°C) and slurry (2 wks at 25°C) (Goyal, 2014). Reducing or eliminating the virus from the environment after feedback through rigid disinfection and biosecurity protocols is necessary so that the benefits of immunity from feedback are maximized. When the virus load in the environment is reduced, the likelihood of neonatal piglets that have passively acquired immunity being overwhelmed by PEDV is also reduced. To this end, disinfection protocols that incorporate thorough washing, scrubbing, disinfection, drying and resting of facilities are helpful. All-in, all-out pig flow, restricted movement and transfer of people, vehicles, equipment and feed between buildings and farms, control of flies, rodents and birds must also be performed (Pospischil and Struedli, 2002; Pensaert and Yeo, 2006). Off-site weaning helps to stop virus perpetuation in the nursery by blocking the infection of successive batches of weaned piglets. In the Philippines, the practice of sacrificing entire batches of affected neonatal piglets helps to reduce virus perpetuation in weaned piglets by creating a gap in production, thereby mimicking the effect of off-site weaning.

### 2.3. Vaccination

Several PED vaccines are commercially available in Asia (Song and Park, 2012). Their efficacy, however, varies between herds. In the Philippines, PED vaccination remains unpopular as some vaccinated herds still experience severe acute outbreaks, and tend to respond poorly to feedback compared to non-vaccinated herds.

### 2.4. Supportive programs

Several supportive programs have been used in farms to alleviate the negative effects of diarrhea and promote recovery of pigs. For neonatal piglets, particularly those less than 7 days of age, provisions for a warm, dry and draft-free environment, readily available electrolyte solutions, milk replacers and water are helpful to mitigate the adverse effects of dehydration and starvation. Anti-PED chicken egg-yolk IgY has been shown to reduce disease in challenged piglets (Kweon et al, 2000), but their affectivity in the field is often variable. Dietary supplementation with pre- and probiotics, organic acids and nucleotides may enhance recovery of piglets by promoting regeneration of the gut microflora, reducing proliferation of secondary bacterial enteric pathogens, and improving local immunity. In fattening pigs, withdrawal of feed can be useful in reducing the severity of diarrhea. In lactating and gestating sows, the use of anti-pyretic and anti-inflammatory drugs is helpful in reducing fever and its harmful effects during pregnancy and lactation. This is particularly essential during feedback when pathogens other than PEDV may be present in the feedback material and cause severe fever which can lead to agalactia, abortions, or a decrease in the number of liveborn piglets.

## 3. Conclusion

PED is an ongoing problem in Asia, the US and Canada, and is an imminent threat to other pig producing regions around the world. In countries where outbreaks of the disease have been reported, the focus is on rapid induction of breeder herd immunity, reducing mortalities in neonatal piglets, and ultimately, virus elimination from the herd. Currently, induction of active herd immunity through deliberate exposure to PEDV (feedback) together with strict disinfection and biosecurity protocols are the cornerstones of PED control. Supportive programs that can mitigate the negative effects of diarrhea, including those that promote the recovery of the gut microflora, are among the considerations in PED management.

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