



# Control of swine pseudorabies in China: Opportunities and limitations



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## ABSTRACT

Pseudorabies (PR), also known as Aujeszky's disease (AD), is caused by pseudorabies virus (PRV) or called suid herpesvirus 1 (SuHV-1). It is an economically significant viral disease of pigs and other animals. Although the disease has been eradicated in commercial swine populations of some countries using gE-deleted vaccines and differentiating infected from vaccinated animals (DIVA) strategy, PR continues to be one of the most important diseases of pigs in many countries, particularly in regions with dense pig populations, including China. This article reviews the current situation of PR in China, including epidemiology, diagnostic assays, control strategies and challenges of the disease. PR has been endemic in most provinces of China largely due to the lack of appropriate compulsory vaccination campaigns of pigs, sufficient awareness and biosecurity measures, although gE-deleted vaccines based on the Bartha-K61 strain and regional DIVA-based eradication programs have been widely used in the past decades. Notably, since 2011, an emerging variant PRV with enhanced pathogenicity has become prevalent in vaccinated swine herds in many regions of China and the disease situation is worsening. Control and eventual eradication of PR remain a big challenge in China, and strengthened control measures based on updated DIVA strategy are urgently needed toward national eradication of PR.

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## 1. Introduction

Pseudorabies (PR), also known as Aujeszky's disease, is an economically important viral disease of pigs and other animals in many countries. The disease is caused by suid herpesvirus 1 (SuHV-1), or called pseudorabies virus (PRV) or Aujeszky's disease virus (ADV). SuHV-1 is a member of the genus *Varicellovirus* of the subfamily *Alphaherpesvirinae* within the family *Herpesviridae*. Pigs

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are the natural host for PRV and the only animals to become latent carriers, although the virus can infect numerous other species of mammals, including ruminants, carnivores and rodents (Mettenleiter, 2000; Pomeranz et al., 2005).

In pigs infected with PRV, the clinical manifestations vary from subclinical signs to death. In newborn piglets as well as other susceptible species, PRV infections are often fatal, and animals die from central nervous system disorders. In contrast, older pigs develop primarily respiratory symptoms. Like other alphaherpesviruses, PRV usually establishes a life-long latent infection in the host peripheral nervous system. Latently infected pigs can be a source of reinfections when the latent viral genome reactivates spontaneously or is reactivated by stress and triggers virus shedding. In pregnant sows, PRV infections may result in reproductive failure including abortions and/or stillbirths (Rziha et al., 1986; Tong and Chen, 1999; Klupp et al., 2004).

Due to control efforts and strict implementation of national eradication programs, including large-scale compulsory vaccination with gE-deleted vaccines and the DIVA (differentiating infected from vaccinated animals) strategy, PR has been eradicated from domesticated pigs in North America and a number of European countries (Müller et al., 2011; OIE, 2012). However, PR remains one of the most important diseases of swine in many countries, particularly occurring in regions with dense pig populations, including China, the biggest pork producer in the world (Tong and Chen, 1999; Pomeranz et al., 2005; Yang, 2015).

## 2. Epidemiology

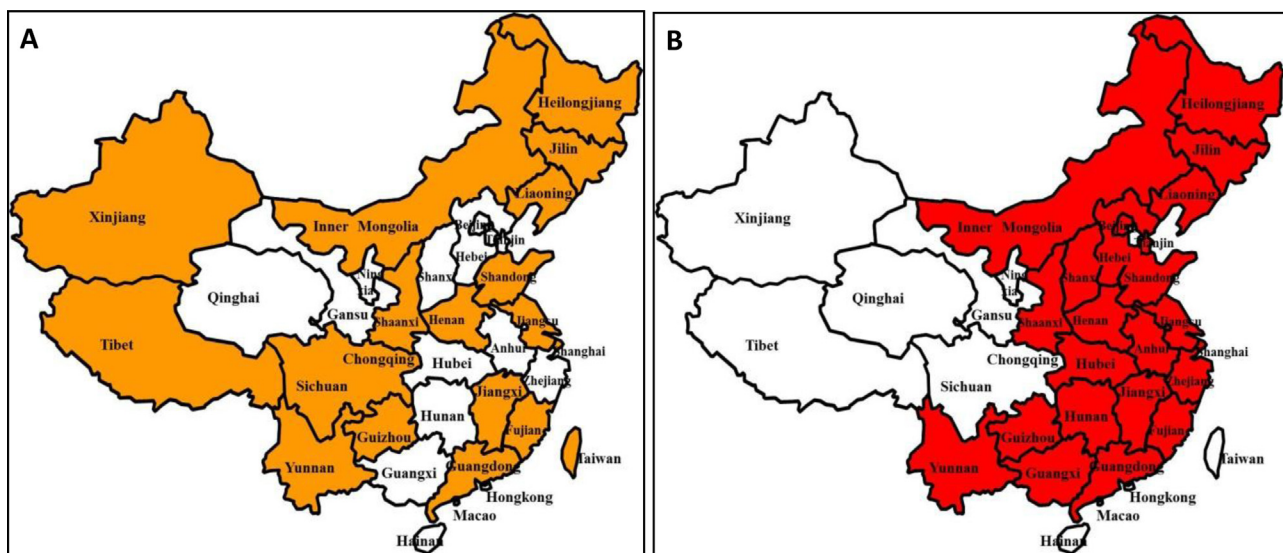
In China, PRV infection was first identified in cats by Liu in 1947, and subsequently documented in cattle and swine (Zhou and Sun, 1957; Guo, 1963). It was reported that PR had been endemic in China before 1960s (Zhou and Sun, 1957; Ou and Huang, 1958; Cao, 1959), but it did not cause significant economic losses (Yuan et al., 1986; Tong and Chen, 1999). By early 1980s, PRV infections had been identified in 18 regions (14 provinces, 1 municipality and 3 autonomous regions of China) in diverse species, mainly in pigs but also in cattle, sheep, goats, cats, dogs and minks (Fig. 1A and Table 1; Yuan and Wu, 1986). These animals are infected with PRV mainly through direct/indirect contact with infected pigs or feeding of infected pork due to poor biosecurity measures. Since 1980s, PR outbreaks have risen and spread widely around the country, which was coincident with the increase in the intensity of

**Table 1**

Geographic distribution and recorded year and species of first pseudorabies occurrence in China.

Region	Year	Species
Heilongjiang	1957, 1981	Pig, dog, cat
Liaoning	1982	Pig, cattle
Jilin	1975, 1985	Pig, cattle
Inner Mongolia	1975	Mink
Guangdong	1958, 1980	Pig, cattle
Fujian	1962, 1974	Pig, cattle
Shanghai	1947, 1978	Cat, pig
Jiangsu	1959	Cattle, pig
Jiangxi	1977	Pig
Sichuan	1959, 1982	Pig
Guizhou	1979	Pig
Yunnan	1984	Cattle
Shaanxi	1978–1979	Pig, cattle
Shandong	1980	Goat, sheep
Henan	1979	Cattle, sheep, cat, dog
Xinjiang	Before 1980	Pig
Tibet	1980	Cattle, sheep
Taiwan	1971	Pig
Hunan	1991	Pig
Beijing	1992	Pig
Hong Kong	1990s	Pig
Hubei	1990	Pig
Tianjin	1997	Pig
Chongqing	1990s	Pig
Guangxi	1990s	Pig
Hainan	Early 2000s	Pig
Gansu	Late 1990s	Pig
Qinghai	Late 1990s	Pig
Ningxia	Late 1990s	Pig
Hebei	1997	Pig
Zhejiang	1994	Pig
Anhui	Early 2000s	Pig
Shanxi	2001	Pig

swine production in China (Yuan and Wu, 1986; Zhang and Chen, 2008). In addition, a high proportion of pigs infected with PRV become latently infected in the field (Sabó, 1985), which was considered to be the most possible source of infection (Yuan and Wu, 1986). During that time, the morbidity and mortality in newborn piglets of infected pig herds were 70–100%. To control PRV infections of pigs in China, the Bartha-K61 vaccine strain was imported from Hungary in 1979 and evaluated for its safety and efficacy (Yuan et al., 1983, 1985, 1986). Since late 1980s, Bartha-K61 vaccines have been widely applied in China, resulting in



**Fig. 1.** Geographic distribution of PRV infections in China. (A) Classical PRV strains infections before 1980; (B) PRV variants infections since 2011.

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