**Porcine reproductive and respiratory syndrome (PRRS): A Comprehensive Review of recent developments in diagnosis and Control Strategies**

**ABSTRACT:**

Porcine reproductive and respiratory syndrome (PRRS) is an economically important viral disease of pigs. The disease is characterized by respiratory symptoms in pigs of all age groups and reproductive failure in sows. It is caused by PRRS virus belonging to family *Arteriviridae*. The virus is transmitted through oronasal and genital route. The reproductive disease is characterized by abortion, foetal mummification, still birth and birth of week piglets. Whereas the respiratory syndrome is characterized by fever, inappetence, lethargy and dyspnea. In this review we discuss about recent developments in diagnosis and control of PRRS.

*Keywords: Porcine reproductive and respiratory syndrome, PRRS, diagnosis, control, infectious disease, pig*

1. **INTRODUCTION:**

Porcine reproductive and respiratory syndrome (PRRS) is first reported to cause disease outbreak in pigs during late 1980s in United States of America (USA). The disease was characterized by reproductive ailments, respiratory distress, decreased weight gain and increased mortality. Initially the disease was named ‘mystery swine disease (MSD)’ as the exact etiology was unknown (Ruedas-Torres et al., 2021; Mengeling et al., 2000). In the year 1991, studies revealed that the disease is caused by an unknown RNA virus. Virus used in these studies were isolated from Lelystad in the Netherlands (Wensvoort et al., 1991). Present name of the disease ‘porcine reproductive and respiratory syndrome (PRRS)’ was proposed by the European scholars in the same year (Neumann et al., 2005).

PRRS is caused by PRRS virus (PRRSV) of genus *Arterivirus* under family *Arteriviridae* and order *Nidovirales* (Chaudhari and Vu, 2020). Morphologically the virus is spherical and enveloped with a diameter of 50-60 nm. The genome of the virus is positive sense single stranded RNA in nature. There are at least 10 open reading frames (ORFs) in genome size of approximately 15 kb (Zhou et al., 2022). PRRSV was first isolated at the central veterinary institute at Lelystad, Netherlands (Wensvoort et al., 1991). There are two genotypes of the virus- European type (PRRSV-1) and North American type (PRRSV-2). The prototype of European and North American genotype is Lelystad and VR-2332 virus respectively (Kim et al., 2022; Zimmerman et al., 2019).

The disease is prevalent all over the world and causes significant economic losses to the pig industry. (Neumann et al., 2005). PRRSV is transmitted via various body fluids such as faeces, urine and semen in addition transmission can also occur directly from the sick pigs when they come in contact with susceptible population (An, 2011; Cho & Dee, 2006). The virus can also transmit via aerosol (Prieto and Castro, 2005). PRRSV infects pigs belonging to all age groups manifested by respiratory issues and reproductive failure (Raymond et al., 2017; Chand et al., 2012). The disease is also known as Mystery Swine Disease, Blue Ear Disease, Porcine Endemic Abortion and Respiratory Syndrome (PEARS) and Swine Infertility Respiratory Syndrome (SIRS) (Rimayanti et al., 2024).

1. **CLINICAL SIGNS AND SYMPTOMS:**

Pigs of all age groups are affected. The disease is characterized by significant increase in body temperature of pigs up to 41-42°C, anorexia, lethargy, rough hair coat, hyperaemia and bluish discolouration of ear, snout and vulva. The course of the disease is 1-3 weeks; death of pigs usually occurs within 5-7 days then the mortality is gradually reduced. The morbidity is usually 50-100%, whereas mortality ranges between 20-100%. Mortality rate is usually high in younger pigs and decreases with age. Pregnant sows often abort but seldom die from the disease. There is infertility, foetal mummification and still births. The respiratory syndrome is characterized by sneezing coughing, dyspnea, ocular secretion and conjunctivitis etc. In some case constipation or diarrhoea as well as neural signs are seen. In long term the diseased pig becomes pale, emaciated with rough hair coats (Zhou and Yang, 2010).

At necropsy there is severe pulmonary edema and consolidation. Edema of lymph nodes is also observed. In some cases there is pulmonary interstitial hyperplasia and congestion, bleeding in larynx and trachea and mucosal congestion, hydropsia and ulcers in gastrointestinal system (Zhou and Yang, 2010). Microscopic there is moderate to severe multifocal interstitial pneumonia characterized by a mixed population of mononuclear cells infiltrating the alveolar septum, hypertrophy and hyperplasia of pneumocytes and an apparent mixed necrotic and inflammatory alveolar exudate.

**3. DIAGNOSIS:**

**3.1 Virus isolation:**

The samples for isolation of virus are collected from recently infected animal. After collection the samples are quickly sent to the laboratory under refrigeration. During necropsy samples are usually collected from different organs such as lungs, spleens, lymph nodes, serum and plasma. Samples for detection of the virus includes whole blood, serum, buffy coat, lung, lymph nodes, spleen and tonsil of affected animal (Horter et al., 2002). Aborted foetal materials can be used for RT-PCR. PRRS virus grows well on swine pulmonary alveolar macrophages (PAM), Marc-145 cells, passenger cells CL 262, HS2H cells (derived from Marc-145) and ZMAC cell lines (derived from PAM). Different cell lines differ in their susceptibility to different strains of the virus. Most strains grow well on PAM, especially PRRSV-1 genotype. PRRSV-2 viruses grow well on Marc-145 cells.

##### **3.2 Serological tests:**

Four serological tests are commonly used for diagnosis of PRRS, i.e. enzyme linked immunosorbent assay (ELISA), serum neutralization test (SNT), monolayer immunoperoxidase assay (IPMA) and indirect fluorescent antibody (IFA) test (Pan et al., 2023).

##### **3.3 Molecular tests:**

Various molecular tests for detection of viral RNA are available such as polymerase chain reaction (PCR), quantitative real-time PCR (qPCR), digital PCR (dPCR), loop-mediated isothermal amplification (LAMP), recombinase polymerase amplification (RPA), clustered regularly interspaced short palindromic repeats (CRISPR) and metagenomic next-generation sequencing (mNGS) etc.

**3.4 Differential diagnosis:**

The reproductive signs associated with PRRS need to be carefully differentiated from those caused by other infectious diseases with similar clinical presentations. These include leptospirosis, porcine parvovirus infection, porcine enterovirus infection, haemagglutinating encephalomyelitis, *Toxoplasma gondi*, Aujeszky’s disease (pseudorabies), African swine fever (ASF), and classical swine fever (CSF) (Mengeling et al., 2000). Accurate diagnosis is crucial, as these diseases vary significantly in epidemiology, control measures, and public health implications.

For the respiratory and post-weaning form of PRRS, differential diagnosis should consider diseases such as myocarditis, swine influenza, enzootic pneumonia (primarily caused by *Mycoplasma hyopneumoniae*), proliferative and necrotising pneumonia, swine respiratory coronavirus, porcine circovirus associated disease, nipah virus infection and infections caused by *Haemophilus parasuis* (Saade et al., 2020). A combination of clinical evaluation, serology, PCR, and histopathology is often required to establish a definitive diagnosis and distinguish PRRS from these other respiratory pathogens.

1. **PREVENTION AND CONTROL:**

The control and eradication of PRRS (Porcine Reproductive and Respiratory Syndrome) primarily depend on early detection of the disease, rapid laboratory confirmation, swift identification of infected farms, and effective infection control measures, including various stamping-out strategies. The effectiveness of these measures is influenced by factors such as pig population density, the structure of multi-site farming operations, patterns of pig movement, and whether contaminated pork is properly cooked. Although implementing control strategies at slaughterhouses, processing plants, and livestock markets is recommended, it is not mandatory, as PRRS spreads mainly through direct contact between pigs. Additional control efforts may include strict biosecurity protocols, movement restrictions, quarantine of affected herds, and vaccination strategies where applicable. Continuous surveillance, farmer education, and coordination between veterinary authorities and stakeholders are also vital to ensure long-term success in controlling and eventually eradicating PRRS from pig populations.

**4.1 Surveillance:**

Determining the extent of infection is a crucial first step in the management of PRRS (Porcine Reproductive and Respiratory Syndrome). Veterinary officers or inspection teams should conduct thorough clinical examinations of pigs, collect blood samples from a statistically representative number of animals, and review production records for signs of reproductive failure, such as abortions, stillbirths, weak-born piglets, and elevated pre-weaning mortality. Farms with a recent history of introducing new pigs, selling breeding or grower stock, using artificial insemination, or sharing equipment between farms should be prioritized for detailed investigation due to increased risk of disease introduction and spread. In areas with feral pig populations, sero-surveillance becomes especially important for detecting asymptomatic carriers and tracking transmission between wild and domestic pigs.

When an infected herd is identified, tracing the source of infection and mapping potential contact networks is critical for containment. Quarantine measures should be imposed on affected farms, and movement restrictions may be necessary to prevent further spread. In addition, laboratory testing of boar semen, feed, and water sources can help rule out potential transmission routes. Awareness and education campaigns targeting farmers, workers, and local communities play a vital role in encouraging early reporting and participation in passive surveillance. Establishing a centralized reporting system and providing incentives for transparency can further enhance early detection and rapid response efforts.

**4.2 Quarantine and movement controls:**

All farms with confirmed or suspected PRRS infections should be immediately placed under strict quarantine. In village or free-range systems, pigs should be confined within secure enclosures to prevent further spread. The movement of pigs into or out of infected farms or communities must be prohibited, except in cases where animals are being transported directly for immediate slaughter under official supervision. To limit disease transmission, movement controls should be enforced not only within the affected zone but also across neighbouring areas, covering both live pigs and carcasses intended for further processing.

Transport vehicles used for moving infected or exposed pigs must undergo thorough cleaning and disinfection before being reused. These biosecurity measures are essential to break the transmission cycle and contain the outbreak. In addition, proper disposal of carcasses, waste management, and disinfection of farm premises, equipment, and personnel clothing are critical components of the containment strategy. Close monitoring and enforcement of these regulations by veterinary authorities are vital to ensure compliance and reduce the risk of further disease spread.

**4.3 Biosecurity:**

To strengthen biosecurity and prevent the spread of PRRS, farmers should be encouraged to adopt several key practices. These include sourcing pigs only from PRRS-free herds, limiting farm visitors, installing perimeter fencing, properly managing wastewater, and establishing pig-loading facilities at the boundary of the farm to minimize external contact. All pig-transport vehicles should be thoroughly cleaned and disinfected after each use. A secure perimeter fence also plays a critical role in preventing disease transmission between domestic and feral pig populations. Additionally, domestic food waste must be kept out of reach of wild pigs to avoid attracting them near farming areas.

Village settings, where pigs are often allowed to roam freely, pose unique biosecurity challenges. In such cases, pigs should be kept in enclosed areas whenever possible, and the premises, including equipment, should be regularly cleaned and disinfected. Shared use of equipment between farms or villages should be avoided unless proper disinfection protocols are followed. Farmers and workers should wear dedicated work clothing and avoid contact with other pig populations to prevent indirect disease transmission.

Replacement breeding stock should only be obtained from reliable, PRRS-free suppliers. Casual visitors, especially those who may have recently visited other pig farms, should be discouraged from entering pig-rearing areas. Clear signage at the entrance of farms or communities should advise visitors to avoid contact with pigs. Proper disposal of pig offal and waste—by burning, burial, or composting—is essential to reduce environmental contamination. During outbreaks, decontamination stations equipped with disinfectant, brushes, and water or footbaths should be set up at village entry and exit points to help control the spread of the disease.

**4.4 Zoning:**

If PRRS is endemic in only certain regions of a country, it is both practical and effective to establish clearly defined infected and disease-free zones. Strict regulations should then be enforced to control the movement of pigs, pig products, and related goods between these zones. This zoning approach helps contain the disease within affected areas, protects uninfected regions, and facilitates more targeted surveillance, control, and eventual eradication efforts.

**4.5 Stamping out:**

Depending on the epidemiological situation, stamping-out strategies may be considered as part of PRRS control. This approach is most appropriate during the early stages of an outbreak, particularly when the affected area is small and the number of pigs to be culled is limited. However, in low-resource settings, traditional stamping out faces significant challenges due to the lack of adequate funds for compensating pig owners. Without financial compensation, farmers are often reluctant to comply with culling orders, which may lead to the illegal movement of infected pigs and hasten the spread of the disease.

To address these challenges, a more flexible and modified stamping-out strategy is required. This typically begins with the imposition of strict quarantine measures. Marketable pigs are then humanely slaughtered at designated abattoirs. For the remaining pigs, several options may be considered: (1) culling unsellable pigs on the farm with compensation, (2) allowing pigs to grow to market weight before slaughter, and/or (3) allowing sows to wean their piglets before removal. Importantly, pigs showing clinical signs of disease must either be euthanized or quarantined until full recovery; they must not be sent for slaughter under any circumstance.

Following the completion of the stamping-out process, all carcasses must be disposed of safely through approved methods such as burial, incineration, or composting, to avoid environmental contamination and further disease spread. Guidelines outlined in the FAO Manual on Stamping-Out Procedures for Disease Eradication should be referenced and followed to ensure effective implementation.

**4.6 Cleaning and disinfection:**

Due to the low environmental resistance of the PRRS virus (PRRSV), routine cleaning and disinfection using a wide range of commonly available disinfectants is generally sufficient for decontaminating farms, vehicles, and equipment. Studies have shown that lipid solvents such as detergents, quaternary ammonium compounds, chlorine-based disinfectants, as well as phenolic and organic acid formulations, are highly effective in inactivating PRRSV. Thorough cleaning to remove organic matter should always precede disinfection, as the presence of dirt or manure can reduce the efficacy of chemical agents. Equipment that is difficult to clean or disinfect effectively should either be replaced or removed from use to prevent it from becoming a reservoir for the virus. Implementing routine sanitation protocols and using appropriate disinfectants is a key component of effective PRRS biosecurity and control programs.

**4.7 Vaccination:**

While vaccination cannot completely prevent PRRSV infection, it remains one of the most effective tools for managing and mitigating the impact of the disease. For a vaccine to be effective, it must closely match the circulating antigenic strain. Field experience has shown that vaccination with a homologous strain (one closely related to the field virus) provides significantly better protection than vaccination with a heterologous strain. In the United States, modified-live virus (MLV) vaccines are licensed for both the respiratory and reproductive forms of PRRS. These vaccines are typically administered to sows and gilts three to six weeks before breeding, and to piglets as early as three weeks of age.

In addition, an inactivated vaccine targeting the reproductive form of PRRS is available in both the United States and Europe, though its efficacy is generally lower than that of MLV vaccines. A common strategy includes vaccinating seronegative replacement breeding stock 60 to 90 days prior to introduction into the herd, allowing sufficient time for the development of protective immunity.

However, MLV vaccines have certain drawbacks. Vaccinated animals can shed the vaccine-derived virus, which may spread in the field and complicate disease surveillance. This shedding makes it more difficult to distinguish between vaccine strains and wild-type PRRSV through routine virological and serological testing. Therefore, while vaccination plays a critical role in disease management, it must be combined with strict biosecurity, monitoring, and strategic herd management for optimal results.

**4.8 Sentinel and restocking:**

To prevent reinfection with PRRSV, restocking of farms should only be carried out after a minimum of 14 days following thorough cleaning and disinfection. This allows sufficient time for any residual virus to be inactivated. Once the farm is repopulated, serological testing should be conducted on the new animals at approximately six weeks and again at two months post-introduction to monitor for any signs of viral circulation or re-emergence.

However, restocking—especially when aimed at restoring previous population levels—can carry a significant risk of sparking a new outbreak, particularly in regions where biosecurity and husbandry practices may be suboptimal. This concern is especially relevant in parts of Africa, Latin America, and Asia, where smallholder systems, poor infrastructure, and unrestricted animal movement are common. Therefore, restocking efforts must be carefully planned, ideally using PRRS-free or vaccinated animals from reliable sources, and supported by strict biosecurity and monitoring protocols to minimize the risk of reintroducing the virus.

**4.9 Public awareness:**

Outbreaks of PRRS should be widely and transparently reported, with particular emphasis on raising awareness about the dangers of swill feeding—especially in small-scale pig farming operations. Supporting commercial pig farms in upgrading their biosecurity measures is equally important to reduce disease spread and safeguard the wider pig production sector. At the state, regional, and national levels—particularly in parts of Africa, Eastern Europe, and many Asian countries—early warning systems should be established and strengthened to facilitate timely reporting and rapid response to emerging outbreaks.

Community engagement is vital for the success of any control program. Organizing village-level sensitization and informational meetings can help educate pig owners about PRRS, build trust, and encourage cooperation with surveillance and control measures. Civil administrative authorities should also be regularly updated and placed on alert through the use of periodic epidemiological data to ensure coordinated action during outbreaks.

1. **CONCLUSION AND FUTURE RESEARCH:**

PRRS is one of the most important disease of pigs causing significant economic losses to the farmers. The disease is characterized by respiratory syndromes in pigs of all ages and reproductive syndrome in sows. Different diagnostic tests are available for diagnosis of the disease such as virus isolation, serological tests and molecular tests for detection of viral nucleic acids. The control of the disease is focused on continuous surveillance, maintaining proper biosecurity, stumping out and vaccination etc. Both inactivated and modified live virus (MLV) vaccines are available for the disease. The inactivated vaccines are generally less effective than the MLV vaccines but the MLV vaccination may lead to shedding of the vaccine virus by the animal to the environment.

Further study into immune evasion mechanisms of the virus, host genetic resistance and mechanism of persistence of the virus in the host body is required for formulating effective control measures. Molecular epidemiology may be undertaken to track evolution, recombination and emergence of virulent variants. Development of rapid and sensitive diagnostic tools, surveillance system, new generation vaccines, effective against diverse strains of PRRSV, also DIVA vaccines for distinguishing the vaccinated and infected animal is important for combating the disease.

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