PRRS: the disease, its diagnosis, prevention and control

Porcine reproductive and respiratory syndrome (PRRS) can manifest as lowered farrowing rates, a marked increase in abortions, stillborn, mummified and weak live born piglets and deaths. There is also respiratory disease, which can be severe, particularly when other agents are present and can result in high death rates in suckling and weaned pigs. However, in some herds, infection is asymptomatic.

A. Aetiology

The aetiological agent of PRRS is an RNA virus of the order *Nidovirales,* family *Arteriviridae,* genus Arterivirus. There are two related but antigenically and genetically distinguishable strains: genotype 1, with the prototype Lelystad virus representing the viruses predominating in Europe and genotype 2, represented by VR 2332, the prototype of strains originally mostly found in North America. A variant of genotype 2 is the cause of severe disease in Asia.

B. Susceptible species

The pig (*Sus scrofa*), whether domestic or feral, is the only species known to be naturally susceptible to this disease. Other species of wild pig and members of family *Suidae* may be susceptible.

C. Geographical distribution

PRRS was first recognised in North America in the mid to late 1980s and spread rapidly throughout the world. In Europe, a similar disease caused by a distinct genotype of the virus also spread rapidly in that region during 1990–92. The disease is now present throughout the world, with the exception of Australia, New Zealand, Finland, Norway, Sweden, and Switzerland. Certain other countries are actively engaged in eradication campaigns.

D. Diagnostic criteria

- **Clinical signs**

The clinical signs of PRRS vary with the strain of virus, the immune status of the herd and management factors. Infection may also be asymptomatic. Clinical disease in a herd is a consequence of acute viraemia in individuals and transplacental transmission of virus from viraemic dams to their foetuses, which can occur at any time, though infections in the last third of pregnancy can result in severe disease. Concurrent infections with other pathogens are also common.

In adults:	In affected litters:	In weaned pigs:
• reduced appetite	• stillborn pigs	• loss of appetite & lethargy
• fever	• high pre-weaning mortality	• obvious failure to thrive
• premature farrowing and abortion	• mummified pigs	• laboured or rapid breathing and/or respiratory distress
• death in up to 10% or more of sows	• variably sized weak-born pigs	• blotchy reddening of the skin
• loss of balance, circling and falling to one side	• oedema around the eyes	• rough hair coats.

In sows, a period of acute illness is seen, characterised by lethargy and reduced appetite. With highly pathogenic strains, respiratory disease may also be evident. The disease spreads quickly through a herd over 7–10 days.

As sows become infected and farrow infected litters, the second, or reproductive, phase of the disease occurs as a result of the transplacental transmission. This phase is characterised by late-term reproductive failure and can last from one to four months. Pigs that survive the pregnancy and neonatal phase usually succumb to infection after weaning, although this stage may be masked or exacerbated by concurrent infection with other disease agents, such as *Mycoplasma hyopneumoniae* and *Haemophilus parasuis.*

- **Pathogenesis**

PRRS virus has a tropism for macrophages, also compromising the cellular immune response and damaging mucosal surfaces. The virus replicates mainly in macrophages of the lymphoid tissues and lungs in the acute phase of infection and persists in tonsil and lung macrophages. PRRS virus antigen has been found in the resident macrophages of a variety of tissues, as well as in other cells, including muscle tissues.

- **Gross lesions**

PRRS virus produces a multisystemic infection in pigs, but gross lesions are usually only observed in respiratory and lymphoid tissues. Both gross and microscopic lesions are most marked in neonatal and young weaned pigs. The gross pathology observed after uncomplicated infection of PRRS virus in finishing pigs may be anything from severe to unremarkable.

In severe disease, lungs are mottled, tan and red, and fail to collapse; the cranioventral lobes are most affected. Lymph nodes are moderately to severely enlarged and tan in colour and, for some strains of virus, may be haemorrhagic. Under field conditions, most PRRS virus infected pigs are co-infected with one or more pathogens, which complicates the diagnosis of PRRS based on pathology.

E. Laboratory tests

Laboratories handling live virus should ensure that facilities and protocols are in place to ensure biocontainment. This is especially important where a genotype of the virus is used which is not present in the pig population of the country concerned. We would recommend a minimum of animal biosafety level 3 in such cases.

- **Specimens required**

The following specimens should be collected.

– *For virus isolation and RT-PCR* — whole blood (EDTA) and also serum, lung, respiratory tract, spleen and tonsils of affected animals. Samples from mummified or aborted litters are unlikely to yield virus, but can still be useful for RT-PCR.

– *For antibody testing (serology)* — serum from up to 20 exposed animals in the herd.

Specimens should be chilled and forwarded unfrozen on water ice or with frozen gel packs.

- ***Virus isolation***

  Buffy coat, serum, lung, lymph nodes, spleen and tonsils are the specimens of choice. The virus replicates well on swine pulmonary alveolar macrophages and some strains, particularly those of genotype 2, on Marc 145 cells. Cytopathic effects are evident in 1–4 days. Perform two 7-day passages for maximum sensitivity.

- ***RT-PCR***

  Whole blood (EDTA), buffy coat and clarified homogenates of the above tissues are best. At this time, there is no fully validated PCR that has international acceptability. Please consult the OIE Manual for suggested methods.

- ***Serological tests***

  IgM can be detected within 7 days of infection and IgG can be detected within 14 days. Humoral antibody titres reach a maximum about 5–6 weeks after infection. Antibody can be detected by ELISA and by the indirect staining of pre-prepared monolayers of infected cells (IPMA and IFA). Antibody levels can drop quite quickly in the absence of circulating virus.

F. Differential diagnosis

In the field, suspicion of PRRS is based on clinical signs of reproductive failure and high levels of neonatal mortality. Analysis of farm records will provide helpful information.

The following diseases should be considered within the differential diagnosis of PRRS:

Reproductive disease	Respiratory and postweaning disease
– classical swine fever	– swine influenza
– African swine fever	– enzootic pneumonia
– leptospirosis	– proliferative and necrotising pneumonia
– porcine parvovirus	– *Haemophilus parasuis* infection
– porcine enterovirus	– haemagglutinating encephalomyelitis virus
– haemagglutinating encephalomyelitis virus	– porcine respiratory coronavirus
– Aujeszky's disease	– syncitial pneumonia and myocarditis
	– porcine circovirus-associated disease
	– Nipah virus infection

G. Immunity

- **Passive immunity**

Seropositive sows can transmit maternal antibodies to their offspring via colostrum. Passive immunity appears to decline and gives way to infection soon after weaning.

- **Active immunity**

Pigs infected with PRRSV can generate a specific immune response that is easily detected by the presence of serum antibodies within 7–14 days after infection, reach maximal levels after 30–50 days, and decline to low or non-detectable levels after 4–6 months. Recovered animals are well protected following homologous challenge; however, cross-protection is variable following heterologous challenge.

- **Vaccination**

Modified-live virus vaccines and killed virus vaccines for PRRS are commercially available in many countries; however, each type of vaccine possesses strengths and limitations. It is important to match the genotype of the vaccine with that circulating in the pig population. In general, while vaccination of pigs does not prevent PRRSV infection, it may reduce transmission of wild-type virus and clinical disease. In addition, modified-live vaccine virus can persist in pigs and be disseminated to naïve animals through semen and oral fluids. At this time, it is not possible to differentiate vaccinal antibody from that induced by field virus.

H. PRRS virus transmission

- **Direct routes of transmission**

PRRS virus (PRRSV) is easily spread following direct contact and virus can be detected in saliva, urine, milk, colostrum, and faeces of infected animals. Transmission by semen can also occur, both via natural service and artificial insemination. PRRSV produces chronic infections and viral RNA been recovered from the oropharyngeal region of growing pigs up to 251 days post-infection (PI) and from the sera of piglets infected *in utero* up to 210 days PI.

- **Indirect routes of transmission**

Transmission of PRRSV to pigs fed infected pig meat has been experimentally reproduced. Mechanical transport and transmission has been reported via contaminated needles, fomites (boots and coveralls), farm personnel (hands), transport vehicles (contaminated trailers), and insects (houseflies and mosquitoes). Airborne spread of the virus has been experimentally documented out to 120m under specific meteorological conditions, i.e. prevailing winds.

- **Local spread**

PRRSV can spread rapidly through intensive pig-rearing regions. Significant risk factors for spread between farms include proximity to infected neighbouring herds, purchase of animals from herds incubating infection, and the purchase of semen from boars at PRRS-infected AI centres.

I. Control and eradication

In order to control and eventually eliminate PRRSV, critical issues that allow for maintained circulation of PRRSV within herds must be addressed including the co-existence of genetically diverse isolates, the existence of naïve breeding herd sub-populations, and improper management of gilt replacement pools. Current control measures include the use of vaccines, the management of incoming replacement gilts and implementation of biosecurity protocols validated to reduce the risk of PRRSV spread within and between herds. Methods of eliminating virus from endemically infected herds include whole herd depopulation/repopulation, test and removal and herd closure.

J. Prevention of introduction into a herd

Biosecurity protocols to reduce the risk of PRRSV entry into farms and between herds include the quarantine and testing of incoming breeding stock, use of semen from PRRSV-naïve AI centres, proper sanitation of transport vehicles using validated disinfectants and drying periods, implementation of strategies for personnel/fomite entry into and between farms, proper management of needles, and methods of insect control. In addition, recent evidence suggests that the application of filtration systems to the air inlets may significantly reduce the risk of PRRSV entry via bio-aerosols into farms located in swine dense regions.

K. Prevention of introduction into a country

The main way in which PRRSV has been introduced into previously free countries is undoubtedly via pig movements. The importation of semen has also played a part, in some cases. Whilst there is a theoretical risk posed by fresh meat, there has been no documented case of such. Since the movement of such products is a regular occurrence, even to those countries which remain free, this risk is considered small, provided the hazard of exposure to the pig population of the importing country is ameliorated. This can be achieved by banning swill feeding and/or ensuring that pig-meat is not included therein. The risk posed by vaccinal virus should not be forgotten, since there is documented evidence of circulation and reversion to more virulent form among such.

Protocols are in place, to reduce the risk posed by live pigs and semen. For live pigs, these include sourcing from farms certified free of infection, use of quarantine periods and serological and virological monitoring, both pre- and post-import. For semen, RT-PCR has proved a useful tool in demonstrating absence of virus in semen batches, but care should be taken to ensure that any extender is compatible with such tests.

The borders of a country obviously form the first line of any defence. Illegal pig movements should always be prevented. Where wild pigs may be present, steps should be taken to ensure domestic populations are protected from contact. Ports and airports may also provide a potential avenue for introduction, via galley waste and, in the case of ports, the illegal sale of pigs or pigmeat transported on board.

Further online reading:

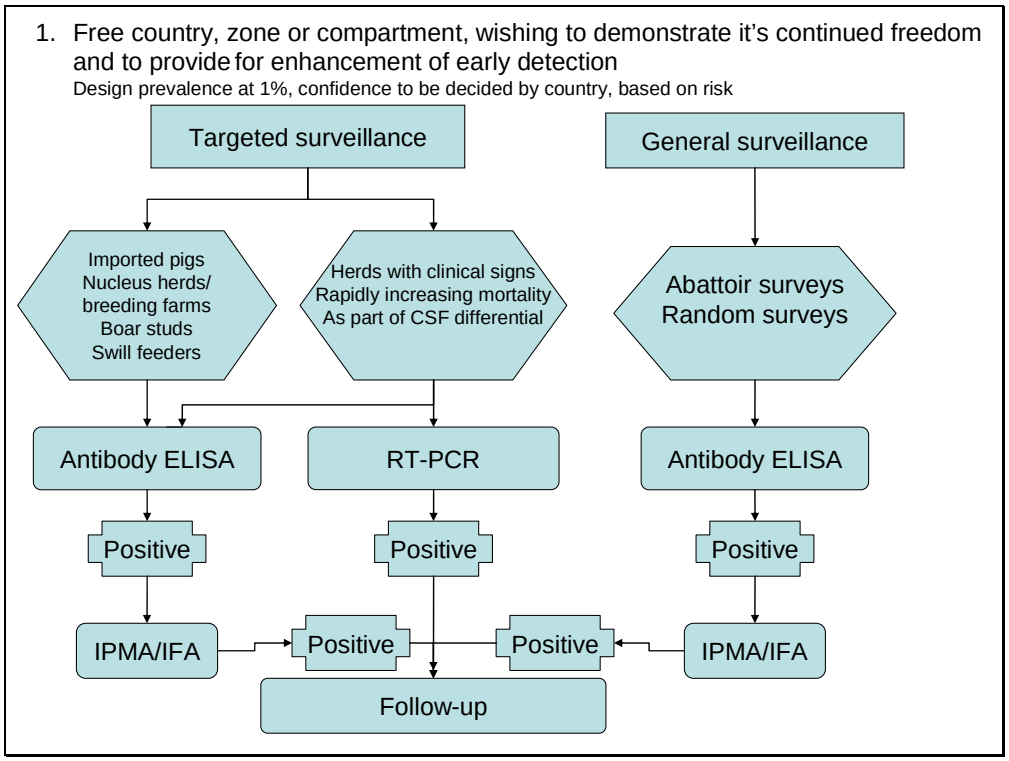
AusVetPlan
http://www.animalhealthaustralia.com.au/fms/Animal%20Health%20Australia/AUSVETPLAN/prrs3final.pdf

New Zealand risk analysis
http://www.biosecurity.govt.nz/files/regs/imports/risk/prrs-risk-analysis.pdf

EFSA Report on risk posed by fresh meat
http://www.efsa.eu.int/EFSA/Scientific_Opinion/ahaw_op_ej239_porcinereprespirasyndrprrs_en2,0.pdf

OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals
http://www.oie.int/eng/normes/mmanual/2008/pdf/2.08.07_PRRS.pdf

PRRS Compendium
http://www.pork.org/NewsAndInformation/News/Publications/pubIssues.aspx?id=113



1. Free country, wanting to demonstrate its continued freedom and for early detection of infection.
(≤1% design prevalence, confidence to be decided by country, based on risk)

*An early detection system would be on-going while demonstration of freedom would sample at regular intervals.

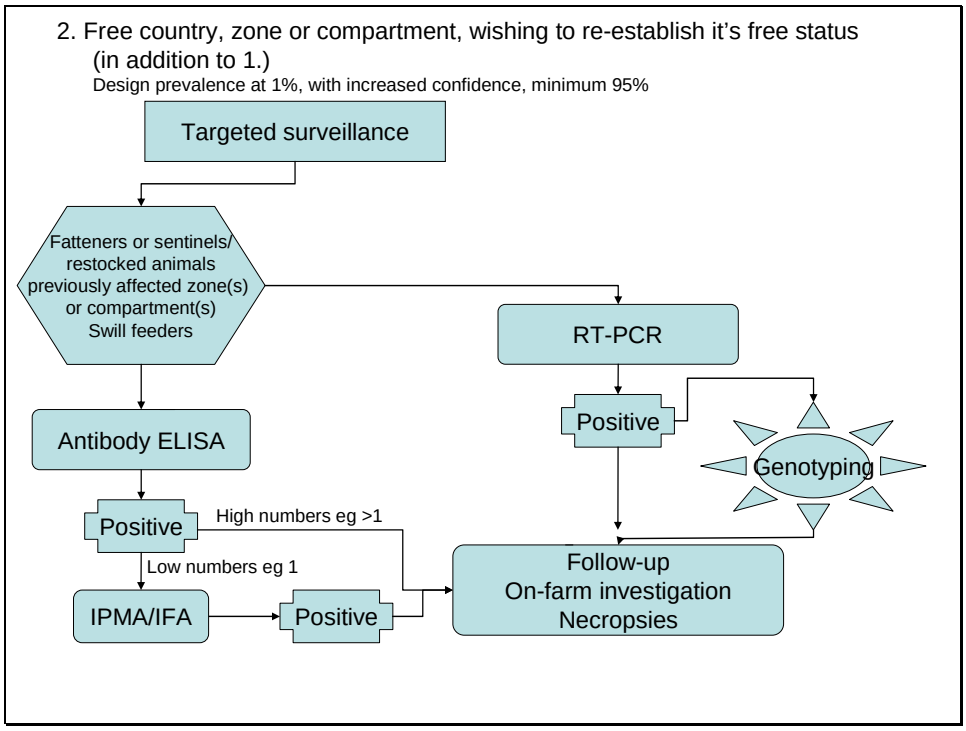
a. Tests = ELISA and PCR

b. Targeted surveillance

i. Imported pigs: ELISA
ii. Nucleus/breeding herds: ELISA
iii. AI centers: ELISA
iv. Swill feeders: ELISA
v. Clinical herds: Both
    1. necropsies included
vi. Herds with reports of rapidly increased mortality w/o known cause: Both
    1. CSF differential

c. General surveillance

i. Abattoirs: ELISA

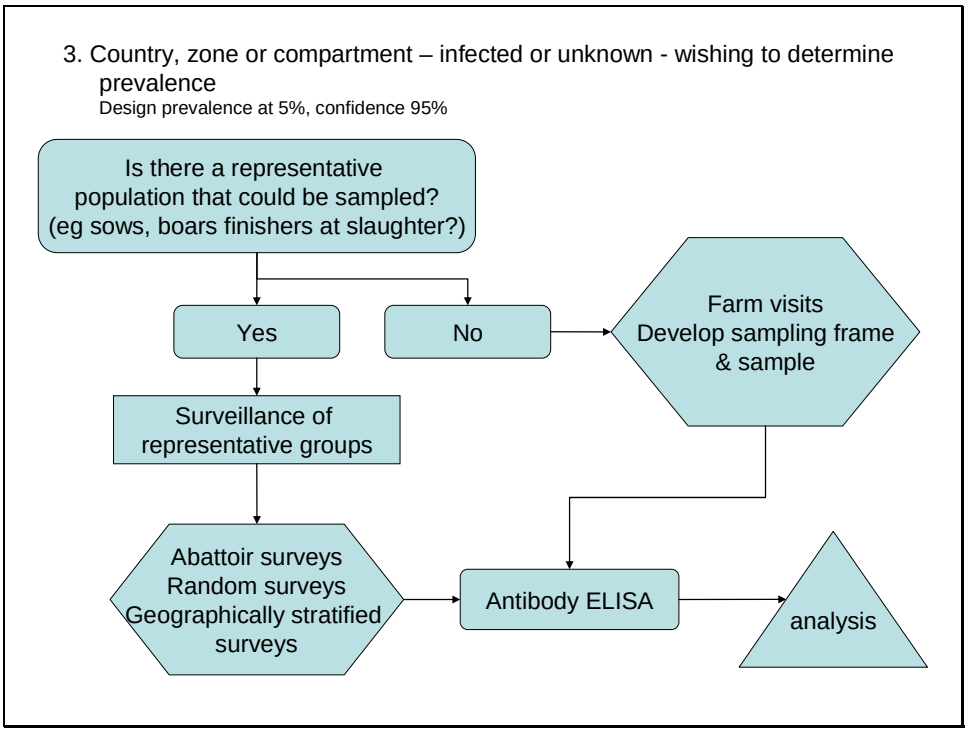


2. Free country, wishing to re-establish its free status

(Design prevalence of at least 1%, confidence at a minimum of 95%)

Same as #1 as well as sampling of previously infected herds/ zones, swill feeders, fatteners, sentinels and re-stocked animals and including:

1. Managing of singleton positive samples
    a. Re-test using both tests and an additional antibody test.
    b. IPMA or IFA
2. Follow up visit to herd with subsequent monitoring.
    a. Necropsies of suspect animals
    b. Additional testing at herd level
        i. genotyping
    c. Assessment of clinical signs



3. An infected country, zone or compartment of known or unknown status wishing to determine its prevalence
(Design prevalence at 5%, confidence 95%)

1. Select a representative population for sampling, such as:
    a. Slaughter surveillance of breeding animals and finishers
        i. Type of production systems will determine which group to select
            1. Multiple site vs F-F one site
    b. If no such population exists, a standardized sampling procedure, i.e. cross-sectional could be developed according to production system
    c. Samples: Blood, meat juice at slaughter
    d. Tests: ELISA
    e. Random surveys could be conducted across farms
        i. Geographically stratified
        ii. GIS tools could be used to summarize findings in a pictorial format.