Peste des Petits Ruminants

Control Tools

Diagnostics availability

Commercial diagnostic kits available worldwide

Kits are available for use in main laboratories
- Kits available are at high cost for developing countries
- Penside test not yet available
GAP: Kits available are at high cost for developing countries
- Penside test not yet available

Commercial diagnostic kits available in Europe

Commercial diagnostic kits available in Europe but for use in countries where PPR is endemic (Asia, Middle east and Africa)

Diagnostic kits validated by International, European or National Standards

None

Immunocapture kit for PPR antigen detection an PPR competitive ELISA test indicated in OIE Manual
GAP: Immunocapture kit for PPR antigen detection an PPR competitive ELISA test indicated in OIE Manual but not yet recommended as prescribed test for international trade

Diagnostic method(s) described by International, European or National standards

Methods are described in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2009 chapter Identification of the agent Antigen detection

- Agar gel immunodiffusion
  - Counter immuno-electrophoresis
  - Indirect fluorescent antibody test
  - ELISA
  - Immunohistopathology

- Virus isolation and identification
  - In primary lamb kidney cells or VERO cell line
  - Virus neutralisation
  - Electron microscopy

- Virus RNA detection
  - PPR-specific cDNA probes

Amplification by polymerase chain reaction (classical RT-PCR and Quantitative Rt-PCR assays available

Serological tests
- Virus neutralisation
- Competitive ELISA
- Counter immuno-electrophoresis
- Agar gel immunodiffusion

Immunodiffusion inhibition test

GAP: New cell line expressing the PPRV receptor is available for efficient isolation of PPRV not yet described in the OIE Manual yet (but is indicated in inserted in the new edition of the Manual to come out probably in 2012)
Commercial potential for diagnostic kits in Europe

Negligible as there is a very limited market in Europe.

DIVA tests required and/or available

Not available. Urgently required especially if vaccination, surveillance and eradication are proposed. Novel DIVA vaccines are important.

GAP: DIVA test needed

Opportunities for new developments

Recombinant capripox-PPR dual vaccine has been developed but not yet fully tested (duration of immunity, PPR pre-immune or capripox-pre-immune influence).

GAP: PPRV marker vaccine with its companion test (marker vaccine based on the current PPRV attenuated vaccine has to be developed by reverse genetics technology).

Vaccines availability

Commercial vaccines availability (globally)
The production of the commercially available live attenuated PPRV vaccine is available from a number of vaccine production companies and government laboratories in Africa, the Middle East, India and Turkey.

Commercial vaccines authorised in Europe
None

Marker vaccines available worldwide
None - NEEDED

Marker vaccines authorised in Europe
None

Effectiveness of vaccines / Main shortcomings of current vaccines
Animals vaccinated with the current live attenuated vaccine for PPR (PPRV Nigeria 75/1 vaccine strain) have a good immunity which may last for at least 3 years but cannot be distinguished serologically from infected animals. A cold chain is required for transport of PPR vaccine.

Commercial potential for vaccines in Europe
Very low

Regulatory and/or policy challenges to approval
No applications but the use of genetically modified vaccines may be a problem in some countries.
In principle it is possible to use vaccination as a barrier between free and endemic countries or zones although the movement of sheep and goats may render this unsuccessful.

There have been a number of reports on the preliminary results of the development of recombinant capripox-based PPR vaccine able to protect against both capripox and PPR. Animal experiments to determine the duration of immunity in the capripox-PPR recombinant vaccinated animals and also to determine the effect of pre-immunisation against PPR or Capripox on the efficacy of the recombinant are ongoing.

There is no therapy for PPR.

Possible antivirals or immunostimulants to be used in conjunction with antigens.

GAP: RNAi technology under investigation.

Commercial potential for pharmaceuticals in Europe
None

Regulatory and/or policy challenges to approval
None specific

Commercial feasibility (e.g manufacturing)
Not applicable

Opportunities for new developments
Antivirals may offer possible tools for use in PPR control. A couple of reports have been published on RNAi to cure PPRV from infected cells.

GAP: RNAi not yet available

New developments for diagnostic tests

Requirements for diagnostics development
To develop simple, rapid, serological tests which can be carried out in the field to differentiate vaccinated from infected animals. Validation of new tests must be undertaken both in laboratory situation but also under field conditions in countries where the disease exists
Time to develop new or improved diagnostics

Time and costs depend on the type and nature of the test. Proof of concept and the development of a new test will take time as will the validation necessary before the new tests are accepted as a diagnostic tool by the international organisations. Further time will elapse before the tests are commercially available.

Cost of developing new or improved diagnostics and their validation

This is time and labour consuming. Co-operation between all parties involved from discovery to commercial availability will be crucial.

Research requirements for new or improved diagnostics

Pen-side diagnostics for the detection of antibodies against a marked PPR vaccine to allow differentiation of vaccinated from infected animals

GAP: Highly sensitive and specific pen-side test is needed for the virus detection.

Technology to determine virus freedom in animals

Tests are available to determine the virus freedom: immunocapture test and gene amplification assays for Ag and nucleic acid detection; cELISA for antibody detection

New developments for vaccines

Requirements for vaccines development / main characteristics for improved vaccines

With the advent of DNA recombinant technology, efforts are being made to develop effective PPR marker vaccines to enable such differentiation and which would allow countries to implement both vaccination and disease surveillance programmes at the same time.

GAP: Recombinant capripox-PPR dual vaccine might be an effective PPR marker vaccine. Reverse genetic technology to develop a PPR marker vaccine is also being explored

Time to develop new or improved vaccines

10 years for development, clinical trials and licensing is realistic.

Cost of developing new or improved vaccines and their validation

Very expensive

Research requirements for new or improved vaccines

Production of recombinant non-infectious PPR virus antigens based on the use capripox viruses as vectors to express immunogenic proteins of the viruses. Recent work, to produce PPR/capripox recombinants has also shown them to be effective in protecting sheep and goats from PPRV and capripox infections. The capripoxvirus recombinants may be more readily accepted than vaccinia recombinants since they are not hazardous to humans and the vector is already used as a vaccine to protect against capripoxvirus infections in sheep and goats. Technologically reverse genetics to produce multivalent and marker vaccines against PPR may be successful in future.

New developments for pharmaceuticals

Requirements for pharmaceuticals development

Although the potential of antiviral compounds could be investigated there seems little application at present.
RNAi technology is being explored

Time to develop new or improved pharmaceuticals
Not known

Cost of developing new or improved pharmaceuticals and their validation
Not Known

Research requirements for new or improved pharmaceuticals
None at present

Disease details
Description and characteristics.

Pathogen
Virus family Paramyxoviridae, genus Morbillivirus. Antigenically close to rinderpest virus. Other members of the genus include measles virus, canine distemper virus and phocine distemper virus of sea mammals (seals).

Variability of the disease
Molecular studies showed that it was distinct from, but closely related to, rinderpest virus. Four genetic lineages (lineages 1-4) of PPR virus have been identified. Until recently the known natural hosts were restricted to goats and sheep but recently the natural host range has extended to include smaller species of wild ungulates. Cattle do not appear to become clinically infected but PPRV has been identified once in a rinderpest-like disease of buffaloes. PPRV is suspected also to be causal agent of a respiratory disease in camel in Sudan and Ethiopia.

Stability of the agent/pathogen in the environment
The virus is susceptible to most disinfectants, e.g. phenol, sodium hydroxide but can survive for long periods in chilled and frozen tissues. There is little information on the virus survival in the environment

Species involved

Animal infected/carrier/disease
Sheep and especially goats. It has also been diagnosed in a number of species of captive wild ungulates. Experimentally the American white-tailed deer (Odocoileus virginianus) is fully susceptible. Inapparent infections may occur in cattle and pigs. Breed-linked predisposition in goats. No carrier state has been identified.

Human infected/disease
None

Vector cyclical/non-cyclical
None

Reservoir (animal, environmental)
None

Description of infection & disease in natural hosts
Transmissibility

Sick goats and sheep generate aerosols containing infective droplets. Successful transmission requires close contact between sick and healthy animals. Fomites do not play a role in transmission of the virus.

Pathogenic life cycle stages

Not applicable

Signs/Morbidity

The natural disease affects mainly goats and sheep, but in many cases, it seems to be more severe in goats than in sheep. But there are also reports about outbreaks where sheep were the animal species paying heavy losses. Clinical signs may not be apparent in areas where the disease is widespread. It is usually acute and characterised by serous ocular and nasal discharges. PPR is characterised by severe pyrexia, erosive lesions on different mucous membranes and particularly in the mouth, diarrhoea and pneumonia. Animals rapidly become very dull, with sneezing and lip-licking, followed by salivation due to mouth lesions and severe diarrhoea. Many animals will die and any survivors will be in poor condition for a prolonged period and susceptible to other diseases. Can frequently be per acute in young goats. Sub acute and chronic cases may be frequent in some areas because of local breed susceptibility.

Morbidity rate 90% (susceptible population),

GAP: Investigations have to be carried out to understand well the epidemiology of PPR:

- Identification of factors involved in the animal species susceptibility (outbreaks severe only in goats, outbreaks severe only in sheep, outbreaks severe in both small ruminant species)
- Variation in pathogenicity of the same virus strain
- Difficulties to reproduce PPR disease sometimes
- Importance of animal species other than sheep and goats in the epidemiology of PPR
- With new highly sensitive tests, re-assessment of the duration of virus excretion by an infected animal has to be made
- Assessment of conditions for an effective and successful transmission of the disease (minimum time required)
- Modellisation of PPR

Study of the immune suppressive effect of PPRV

Incubation period

The incubation period is 4–6 days, but may range between 2 and 10 days.

Mortality

Mortality rate 50-80% (susceptible population)

Shedding kinetic patterns

Shed in droplets from the infected animals

Mechanism of pathogenicity

Wild-type morbillivirus infections can have a strong immunosuppressive action

Zoonotic potential

Reported incidence in humans

There are no reports of PPRV affecting humans.

Estimated level of under-reporting in humans

None
Acute PPR is a severe welfare problem in terms of the disease syndromes it causes.

Since its first description in the Ivory coast in 1942 PPR has expanded to cover large regions of Africa, the middle East and Asia. Since 2008, PPR has been reported in different African countries from Morocco to Tanzania. It is endemic in the Arabian Peninsula, throughout most of the Near East and Middle East, and in countries located from Central Asia to China. Until June 2008 the disease had not been reported in the northern part of the African continent, aside from Egypt but in that month PPR was confirmed in Morocco. Since then, both Algeria and Tunisia have reported the disease to the World Organization for Animal Health.

In sub Saharan Africa PPR cycles endemically in the nomadic herds and flocks which graze the areal Transhumance annually introduces the virus into immunological naïve herds and flocks south of the Sahel with disastrous results.

Related to many factors but mainly availability of grazing

In 2008, Morocco reported 360 outbreaks of PPR in goats and sheep over a six month period, indicating how rapidly the disease can spread through a naïve population.

The increase of animal movement for commercial and trade purposes (e.g. the massive imports of small ruminants to the Middle East), transhumance and nomadic customs along with extensive farming practices in the Sub-Saharan regions have all contributed to the spread of PPR. The fact that both PPRV lineage IV, lineage of Asian PPRV strains, and lineage III, East African PPRV lineage, are found in the Middle East indicates that many sources of infection in this region are probably
infected sheep and goats imported from both Asia and East Africa.

**Seasonal cycle linked to climate**
Seasonal variations: more frequent outbreaks during the rainy season or the dry cold season in Sub-Saharan Africa.

**Distribution of disease or vector linked to climate**
No

**Outbreaks linked to extreme weather**
Only due to drought and the need to search for food

**Sensitivity of disease or vectors to the effects of climate change (environmental changes/land use)**
None

### Route of Transmission

**Usual mode of transmission (introduction, means of spread)**
Direct contact through aerosol spread

**Occasional mode of transmission**
None

**Conditions that favour spread**
Transhumance and movement of infected animals

### Detection and Immune response to infection

**Mechanism of host response**
Sheep and goats that recover from PPR develop an active immunity against the disease. Antibodies have been demonstrated 4 years after infection suggesting that immunity is probably life-long.

**Immunological basis of diagnosis**
Goats and sheep infected with PPRV develop antibodies that may be demonstrated to support a diagnosis by the antibody detection tests. The OIE recommended test for trade purpose is the virus neutralisation (VN) test. However, the competitive ELISA is currently the serological test the most routinely used.

### Main means of prevention, detection and control

**Sanitary measures**
In Europe affected animals would have to be slaughtered, and a 3km protection zone and 10 kilometers surveillance zone set up around the infected premises. Eradication is recommended when PPR appears in new areas. Methods that have been successfully applied for rinderpest eradication would be appropriate for PPR. These should include quarantine, slaughter, and proper disposal of carcasses and contact fomites, decontamination, and restrictions on importation of sheep and goats from affected areas.

Disease control measures would be put in place including ring vaccination or mass prophylactic vaccination depending on the situation in individual countries.
Mechanical and biological control

In free zones slaughter of affected flocks
Disposal of carcasses.
Detailed epidemiology to identify origin and [potential spread]

Diagnostic tools

Virus isolation is important. But the Immunocapture enzyme-linked immunosorbent assay (ICE-ELISA), and the nucleic acid amplification are the most currently diagnostic tests used for PPRV identification Serological test can also be used and include mainly the competitive ELISA but also the virus neutralisation.

Vaccines

Rinderpest tissue culture vaccine has been used in the past due to the strong antigenic relationship between PPR and rinderpest viruses. It use is now forbidden. There are homologous live attenuated PPR virus vaccines. The attenuated PPR Nigeria 75/1 vaccine strain is most widely produced and commercially available. is. Over 10 countries produce the vaccine. Genetically engineered recombinant vaccines are currently undergoing limited field trials.

Therapeutics

No specific treatment

GAP:RNAi technology is under exploration

Biosecurity measures effective as a preventive measure

Safety measures are required to work with PPR virus

Border/trade/movement control sufficient for control

Import controls on live sheep and goats. In the event of an outbreak in a free country or region movement controls would be imposed on the infected, protection and surveillance zones.

Prevention tools

Rules on imports of live animals

Surveillance

Surveillance in infected zones and surrounding areas. Surveillance in affected countries although the lack of a marker vaccine will hamper this work.

Past experiences on success (and failures) of prevention, control, eradication in regions outside Europe

Occasional incursions have been controlled when PPR enters a free country. Mass vaccination in Morocco after the 2008 outbreak helped to control the disease: no clinical reported since early 2009.

Costs of above measures

Incomplete knowledge on the detail of the costs of vaccination and surveillance

Disease information from the OIE

Disease notifiable to the OIE
Economic losses are due to loss of production, death and abortion.

The huge number of small ruminants, which are reared in the endemic areas, makes PPR a serious disease threatening the livelihood of poor farmers.

The presence of disease can limit trade, export, import of new breeds and the development of intensive livestock production. PPR is a major constraint on the availability of protein for human consumption as well. Important in relation to poverty with loss of animals and production

PPR virus infection has for many years been one of the most important constraints to the increased production of small ruminants in sub-Saharan Africa

Trade implications

Impact on international trade/exports from the EU due to existing regulations

In the case of free countries movement controls imposed on the country or region. In endemic countries prohibition on exports of live sheep and goats. Standards for the control of movements are contained in the OIE Terrestrial Animal Health Code 2009 chapter 14.8

Impact on EU intra-community trade due to existing EU regulations

Movement controls within the EU
Impact on national trade due to existing regulations
Local movement controls imposed on the movements from the protection and surveillance zones.

Main perceived obstacles for effective prevention and control
Difficulties in the control of movements of affected and more importantly incubating animals into free areas. Problems of differentiating infected from vaccinated animals.

Main perceived facilitators for effective prevention and control
Awareness, fast and robust diagnosis, Easy methods for surveillance in areas. Development of marker vaccines.

Risk
The PPR situation in countries bordering the EU emphasises the importance of implementing and maintaining appropriate control measures with regard to illegal imports and animal movements to mitigate risks. Equally the tools necessary to control and eradicate any incursion into the EU must be available. As this is one of the most economically important diseases in developing countries the development of improved vaccines with the appropriate tests to differentiate vaccinated from infected animals is vital.

Main critical gaps

Conclusion

Sources of information
Name of expert group leader

Names of expert group members are included where permission has been given
Dr. Adama Diallo, International Atomic Energy Agency, Austria (leader)

Name of reviewers

Date of submission by expert group

References