

RINDERPEST

Aetiology Epidemiology Diagnosis Prevention and Control References

AETIOLOGY

Classification of the causative agent

Rinderpest is caused by a negative-strand RNA virus of the Morbillivirus genus within the family Paramyxoviridae. Three genetically distinct lineages (1–3) of the rinderpest virus (RPV) have been recognised as causal agents of disease in Africa and Asia.

Resistance to physical and chemical action

Temperature:	Small amounts of virus resist 56°C/60 minutes or 60°C/30 minutes.
pH:	Stable between pH 4.0 and 10.0.
Disinfectants/chemicals:	Susceptible to lipid solvents and most common disinfectants (phenol, cresol, β -propiolactone, sodium hydroxide 2%/24 hours used at a rate of 1 litre/m ²).
Survival:	Quickly inactivated in environment as RPV is sensitive to light, drying and ultraviolet radiation. Can remain viable for long periods in chilled or frozen tissues.

EPIDEMIOLOGY

In immuno-naïve populations, rinderpest presents itself as an epidemic with high morbidity and mortality rates (up to 100%). In these classic instances of disease, highly transmissible, virulent RPV strains dominate. In endemic areas, milder RPV strains have emerged and survivor host populations have adapted; disease is found principally in younger animals with waning maternal immunity. Domestic cattle play an important role in maintenance of RPV while in the wild, African buffalo seem to hold a central role though sylvatic survival of the virus is limited. Present day populations are too small to maintain the virus in the absence of infection in domestic species but are an indicator of infection in neighbouring cattle.

Hosts

- In the field: affects Artiodactyles
 - highly fatal among domestic cattle, water buffalo (*Bubalus bubalis*) and yak (*Bos grunniens*); European cattle (*Bos primigenius taurus*) more susceptible than zebu breeds (*Bos primigenius indicus*)
 - highly susceptible wild animals: African buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), eland (*Taurotragus oryx*), kudu (*Tragelaphus strepsiceros* and *T. imberbis*), wildebeest (*Connochaetes* sp.) and various antelopes
 - Sheep and goats are susceptible but epidemiologically unimportant
- Asian pigs seem more susceptible than African and European pigs
- Wild swine: bush pigs (*Potamochoerus porcus*) and warthog (*Phacochoerus africanus*)
- Dogs can seroconvert upon consuming infected meat and become resistant to infection with canine distemper virus
- Rinderpest is rare among Camelidae; especially in endemic areas. They are dead-end hosts and do not transmit the virus

Transmission

- By direct or close indirect contact between infected and susceptible animals
- Airborne transmission is limited and only possible under specific circumstances
- RPV is sensitive to direct sunlight thus fomites are not a viable means of transmission
- No evidence of vertical transmission
- Introduction of RPV into free areas is most commonly by means of infected animals

Sources of virus

- Shedding of virus begins 1–2 days before pyrexia in tears, nasal secretions, saliva, urine and faeces
 - Blood and all tissues are infectious before the appearance of clinical signs
- During periods of clinical disease, high levels of RPV can be found in expired air, nasal and ocular discharges, saliva, faeces, semen, vaginal discharges, urine and milk
- Infection is via the epithelium of the upper or lower respiratory tract
- No carrier state

Occurrence

The Food and Agriculture Organisation of the United Nations (FAO) launched a Global Rinderpest Eradication Programme (GREP) in 1992, calling for eradication of the virus by the year 2010 and success of this programme may be judged by the fact that two of the three rinderpest lineages have now assuredly been eradicated and the third might well have joined them. Most countries now are self-certified as free, although official OIE designation has not yet been made in all cases.

Historically, the virus was widely distributed throughout Europe, Africa, and Asia; recently however, it has only occurred in Africa and Asia. Gene sequence analysis has shown that all known rinderpest isolates fall into one of three non-overlapping phylogenetic lineages, and in recent years it has been possible to describe the virus' distribution in lineage-specific terms.

Lineage 1 appears to have been distributed from Egypt to southern Sudan and eastwards into Ethiopia and into northern and western Kenya. Lineage 2 has been recorded from both East and West Africa and at one time may have been distributed in a sub-Saharan belt running across the whole of the continent. Until recently both lineages were being reported from eastern Africa, but it is now clear that lineage 1 was eliminated from southern Sudan in 2001 by intensive vaccination.

Lineage 2 has been transmitting within the Somali pastoral ecosystem. Although this virus is now seen as having evolved to the point where it has been possible for it to escape veterinary attention in remote areas, its presence did not go unnoticed by the nomadic pastoralists whose cattle it infected. Nevertheless, it is clear that this virus has not been confirmed within this last reservoir since 2001 and although not yet an accredited achievement, it is more than likely that sporadic vaccination has broken the transmission chain of Lineage 2.

The so-called Asian lineage (lineage 3) was only ever recorded in Afghanistan, India, Iran, Iraq, Kuwait, Oman, Pakistan, Russia, Saudi Arabia, Turkey, Sri Lanka and Yemen. Although evaluations are not yet complete, it is almost certain that this virus has been successfully eradicated. The last country to be infected with the virus, Pakistan, declared freedom from rinderpest in 2003.

For more recent, detailed information on the occurrence of this disease worldwide, see the OIE *World Animal Health Information Database (WAHID) Interface* [<http://www.oie.int/wahis/public.php?page=home>] or refer to the latest issues of the *World Animal Health* and the *OIE Bulletin*.

DIAGNOSIS

Classical rinderpest has an incubation period of between 1 and 2 weeks (3–15 days). In the mild form (e.g. lineage 2-associated form) incubation period is also between 1 and 2 weeks. (For the purposes of the OIE *Terrestrial Animal Health Code*, the incubation period for rinderpest is 21 days.)

Clinical diagnosis

Classical clinical signs of rinderpest have not been seen since 2001. A milder form of the disease, with the potential to regain classical characteristics, used to occur in association with endemic situations, latterly in East Africa; it has not been positively diagnosed since 1997 (Tanzania) and could have died out, in which case wild-type rinderpest virus may no longer exist.

Classical acute or epizootic form

- Clinical disease is characterised by an acute febrile attack within which prodromal and erosive phases can be distinguished

- Prodromal period lasts approximately 3 days
 - affected animals develop a pyrexia of between 40 and 41.5°C together with partial anorexia, depression, reduction of rumination, constipation, lowered milk production, increase of respiratory and cardiac rate, congestion of visible mucosae, serous to mucopurulent ocular and nasal discharges, and drying of the muzzle
- Erosive phase with development of necrotic mouth lesions
 - at height of fever: flecks of necrotic epithelium appear on the lower lip and gum and in rapid succession may appear on the upper gum and dental pad, on the underside of the tongue, on the cheeks and cheek papillae and on the hard palate; erosions or blunting of the cheek papillae
 - necrotic material works loose giving rise to shallow, nonhaemorrhagic mucosal erosions
- Gastrointestinal signs appear when the fever drops or about 1–2 days after the onset of mouth lesions
 - diarrhoea is usually copious and watery at first; later may contain mucus, blood and shreds of epithelium; accompanied, in severe cases, by tenesmus
- Diarrhoea or dysentery leads to dehydration, abdominal pain, abdominal respiration, and weakness
- Terminal stages of the illness, animals may become recumbent for 24–48 hours prior to death and possible death within 8–12 days
- Deaths will occur but mortality rate will be variable; may be expected to rise as the virus gains progressive access to large numbers of susceptible animals
 - initial mortality rates may be in the order of 10–20%
- Some animals die while showing severe necrotic lesions, high fever and diarrhoea, others after a sharp fall in body temperature, often to subnormal values
- In rare cases, clinical signs regress by day 10 and recovery occurs by day 20–25

Peracute form

- No prodromal signs except high fever (>40–42°C), sometimes congested mucous membranes, and death within 2–3 days
- This form occurs in highly susceptible young and newborn animals

Mild subacute or endemic form

- Clinical signs limited to one or more of the classic signs
- Usually no associated diarrhoea
- May show a slight, serous, ocular or nasal secretion
- Fever: variable, short-lived (3–4 days) and not very high (38–40°C)
- No actual depression; animals may continue to graze, water and trek
- Low or no mortality; except in highly susceptible species (buffalo, giraffe, eland, and lesser kudu)
 - in these wild species: fever, nasal discharge, typical erosive stomatitis, gastroenteritis, and death

Atypical form

- Irregular pyrexia and mild or no diarrhoea
 - fever may remit slightly in the middle of the erosive period, and
 - 2–3 days later, return rapidly to normal accompanied by a quick resolution of the mouth lesions, a halt to the diarrhoea and an uncomplicated convalescence
- The lymphotropic nature of RPV leads to immunosuppression and favours recrudescence of latent infections and/or increased susceptibility to other infectious agents

Sheep and goats

- Variable signs; some pyrexia, anorexia and minor ocular discharge
- Sometimes diarrhoea
- Asian RPV strains can be transmitted to cattle by contact with infected small ruminants

Pigs

- Swine in Asia more commonly affected
- Pyrexia, anorexia and prostration
- Erosions of buccal mucosa 1–2 days after fever and diarrhoea at 2–3 days
- Diarrhoea may last a week leading to dehydration and possible death

Lesions

- Either areas of necrosis and erosions, or congestion and haemorrhage in the mouth, intestines and upper respiratory tracts
- Highly engorged or grey discolouration of abomasum (epithelial necrosis of mucous membrane); pyloric region severely affected and shows congestion, petechiation and oedema of the submucosa
- Rumen, reticulum and omasum usually unaffected; necrotic plaques are occasionally encountered on the pillars of the rumen
- Enlarged and oedematous lymph nodes
- White necrotic foci in Peyer's patches; lymphoid necrosis and sloughing leaves the supporting architecture engorged or blackened
- Linear engorgement and blackening of the crests of the folds of the caecum, colon and rectum ('Zebra striping')
- Typically the carcass of the dead animal is dehydrated, emaciated and soiled
- Histologically, evidence of lymphoid and epithelial necrosis accompanied by viral associated syncytia and intracytoplasmic inclusions
- In milder form of rinderpest: most domestic animals escape development of erosions
 - some may develop slight congestion of mucous membranes and small, focal areas of raised, whitish epithelial necrosis may be found on the lower gum (no larger than a pin head); possibly a few eroded cheek papillae
- In milder form of rinderpest in wild animals
 - African buffaloes infected with milder RPV lineage 2 have demonstrated enlarged peripheral lymph nodes, plaque-like keratinised skin lesions and keratoconjunctivitis
 - Lesser kudu were similarly affected with blindness due to severe keratoconjunctivitis but no diarrhoea
 - Eland also showed necrosis and erosions of the buccal mucosa together with dehydration and emaciation

Differential diagnosis

Cattle

- Bovine viral diarrhoea/mucosal disease
- Malignant catarrhal fever
- Infectious bovine rhinotracheitis
- Foot and mouth disease
- Papular stomatitis
- Membrana disease
- Vesicular stomatitis
- Contagious bovine pleuropneumonia
- Theileriosis (East Coast fever)
- Salmonellosis
- Necrobacillosis
- Paratuberculosis
- Arsenic poisoning

Small ruminants

- Peste des petits ruminants
- Nairobi sheep disease
- Contagious caprine pleuropneumonia
- Pasteurellosis

Swine

- *Campylobacter* spp.
- *Brachyspira hyodysenteriae*
- Salmonellosis

Laboratory diagnosis

Samples

- Animals showing a pyrexia are probably viraemic and usually the best source of blood for isolating virus; take blood from several pyrexia animals
 - sterile whole blood preserved in heparin (10 IU/ml) or EDTA (0.5 mg/ml) and transferred to laboratory on ice (but not frozen); do not use glycerol as preservative transport media as it inactivates RPV
 - blood for serum
- Spleen, prescapular or mesenteric lymph nodes of dead animals chilled to sub-zero temperatures for virus isolation
- Full set of tissue samples is advised in 10% neutral buffered formalin for histopathology and immunohistochemistry
 - base of the tongue, retropharyngeal lymph node and third eyelid are suitable tissues
- Ocular and nasal secretions of infected animals during either the prodromal or the erosive phase

Procedures

Identification of the agent

Virus isolation

- RPV virus can be cultured from the leukocyte fraction of whole blood (heparin or EDTA) or uncoagulated blood
- Virus can also be isolated from samples of the spleen, prescapular or mesenteric lymph nodes of dead animals
 - 20% suspensions (w/v) of lymph node or spleen may be used

Antigen detection by agar gel immunodiffusion

- Test is neither highly sensitive nor highly specific however is robust and adaptable to field conditions
- Conducted in Petri dishes or on glass microscope slides covered with agar
- Rinderpest hyperimmune rabbit serum should be placed in the central well; control positive antigen placed in alternate peripheral wells; negative control antigen is placed in well four
- Reaction area should be inspected from 2 hours onwards for the appearance of clean, sharp lines of precipitation between the wells forming a line of identity with the controls
- Tests should be discarded after 24 hours if no result has been obtained
- Positive small ruminant results should be treated as having been derived from a case of rinderpest or peste des petits ruminants (PPR) and requiring further differentiation

Histopathology and immunohistochemistry

- Haematoxylin and eosin should be examined for the presence of syncytial cell formation, and cells with intranuclear viral inclusion bodies
- Presence of rinderpest antigens can be demonstrated in the same formalin-fixed tissues by immunoperoxidase staining following the quenching of endogenous peroxidase activity
 - monoclonal antibodies (MAbs) specific for rinderpest and PPR used in duplicate tests

Lineage identification using the reverse-transcription polymerase chain reaction

- Viral RNA can be purified from
 - spleen (not ideal due to its high blood content)
 - lymph node and tonsil (ideal)
 - peripheral blood lymphocytes (PBLs), or
 - swabs from eyes or mouth lesions (contingent)
- The World Reference Laboratory in the United Kingdom (UK), which is also an OIE Reference Laboratory for rinderpest and other morbillivirus diseases, and the OIE Reference Laboratory in France (see OIE web site: http://www.oie.int/eng/OIE/organisation/en_listeLR.htm), can advise on use of the technique for field sample analysis

Differential immunocapture ELISA

- Used for rapid differentiation between rinderpest and PPR
- Test employs Mabs
 - one MAb, with a reactivity against both viruses, is used as a capture antibody
 - second biotinylated MAb specific against either rinderpest or PPR

Chromatographic strip test

- Not a definitive diagnostic test
- Rapid chromatographic strip test has proved a useful tool for assisting field personnel in investigating suspected outbreaks of rinderpest

Serological tests

The competitive enzyme-linked immunosorbent assay (the prescribed test for international trade)

- Test is based on the ability of positive test sera to compete with a rinderpest anti-H protein MAb (C1) for binding to rinderpest antigen
- Presence of such antibodies in the test sample will block binding of the MAb, producing a reduction in the expected colour reaction following the addition of enzyme-labelled anti-mouse IgG conjugate and a substrate/chromogen solution
- Rinderpest antigen is prepared from Madin–Darby bovine kidney cell cultures infected with the attenuated Kabete 'O' strain of rinderpest virus
- Both C1 and standardised rinderpest antigen are directly available from the OIE Reference Laboratory for Rinderpest in the UK (see OIE web site: http://www.oie.int/eng/OIE/organisation/en_listeLR.htm)
- Kits are available commercially

Virus neutralisation

- The traditional 'gold standard' virus neutralisation (VN) test in roller-tube cultures of primary calf kidney cells has now been replaced by a microneutralisation test format
- test may be used to examine the sera of ELISA reactors during national serosurveillance programmes designed to demonstrate freedom from infection, or
- to qualify susceptible cattle for vaccine testing
- Under these circumstances, the presence of any detectable antibody in the ½ final serum dilution is considered to indicate previous infection with rinderpest virus
- VN is the test of choice for the examination of wildlife serum samples

For more detailed information regarding laboratory diagnostic methodologies, please refer to Chapter 2.1.15 Rinderpest in the latest edition of the OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* under the heading "Diagnostic Techniques".

PREVENTION AND CONTROL

No treatment; supportive care may be employed in aiding recovery of valuable animals.

Sanitary prophylaxis

- Humane slaughter and disposal of sick and in-contact animals
 - destruction of cadavers; burned or buried
- Strict quarantine and control of animal movements
- Effective cleaning and disinfection of contaminated areas of all premises with lipid solvent solutions of high or low pH and disinfectants as described above; includes physical perimeters, equipment and clothing
- Use of vaccine must be carefully considered; all vaccinates should be identifiable in order to regain RPV-free status
 - epidemic situations, usually employed to reduce number of available susceptible animals to virus; applied in ring-vaccination strategy with strict animal control
 - endemic situations, vaccination is applied annually to all calves 2 years of age and less

- Conventionally, restocking is delayed for period no less than 30 days after cleaning and disinfection
- Animal imports from affected zones or countries with unknown status should follow OIE *Terrestrial Animal Health Code* recommendations; susceptible import animals may be vaccinated and tracked
- Fresh meat (which has undergone normal pH change) and hides pose little risk but for purposes of trade, please refer to the appropriate Chapter and corresponding Articles in the OIE *Terrestrial Animal Health Code*.

Medical prophylaxis

- Due to success of GREP, vaccination for rinderpest has been supplanted by surveillance in domestic and wild animals; the latter acting as sentinels due to higher susceptibility
 - vaccination of small ruminants with rinderpest vaccine to protect against peste des petits ruminants (PPR) is now prohibited but an effective homologous PPR vaccine is now available to control this disease in small ruminants.
- Live attenuated cell culture rinderpest vaccine is available
 - use has been discontinued, as induced lifelong immunity may interfere with serological assessments for rinderpest-free accreditation
 - Member Countries should catalogue and secure all remaining stocks of this vaccine in order to safeguard the ability to undertake post-campaign serosurveillance
- In some countries a mixed Rinderpest/contagious bovine pleuropneumonia vaccine was commonly used
- Immunity lasts at least 5 years and is probably life-long with annual revaccination recommended in order to obtain a high percentage of immunised animals in an area
- Genetically engineered thermostable recombinant vaccines are also available but none of these has been used in the vaccination campaigns to eradicate rinderpest

For more detailed information regarding vaccines, please refer to Chapter 2.1.15 Rinderpest in the latest edition of the *OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* under the heading “Requirements for Vaccines”.

For more detailed information regarding safe international trade in terrestrial animals and their products, please refer to the latest edition of the *OIE Terrestrial Animal Health Code*.

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<p>The OIE will periodically update the OIE Technical Disease Cards. Please send relevant new references and proposed modifications to the OIE Scientific and Technical Department (scientific.dept@oie.int). Last updated October 2009.</p>
