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Control of Peste des Petits Ruminants and Poverty Alleviation?

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Summary

Peste des petits ruminants (PPR) is a contagious and often fatal viral disease of sheep and goats and also wild small ruminants. The PPR virus is distinct from but closely related to rinderpest virus and both belong to the morbivillivirus genus within the family *Paramyxoviridae*. PPR is a contagious transboundary disease with a significant impact on rural poor farmers. Its control should therefore be considered in programs that aim at alleviating poverty in developing countries.

Introduction

Peste des petits ruminants (PPR) is a contagious and often fatal viral disease of sheep and goats and also wild small ruminants (Furley et al., 1987). It is suspected to occur also in camels (Roger et al., 2001). Although PPR has always been described as a rinderpest-like disease (Gargadennec and Lalanne, 1942), it is in most cases a 'stomatitis–pneumoenteritis complex' syndrome.

Because of the strong clinical resemblance between rinderpest and PPR, the viral nature of the PPR causal agent was suspected early. Moreover, it was suggested that this disease was caused by a variant of rinderpest virus (RPV) better adapted to small ruminants that has become less pathogenic to cattle (Mornet et al., 1956). In 1979, after different serological tests and cross protection studies, PPR virus was recognized definitively as different from RPV and was classified as the fourth member of the Morbillivirus genus within the family Paramyxoviridae, along with rinderpest, measles and canine distemper viruses (Gibbs et al., 1979). Later on, thorough epidemiological and biochemical studies brought out other features which clearly showed the differences between the two ruminant morbilliviruses, which in fact evolved independently in nature (Taylor, 1984; Diallo et al., 1987, 1989a, 1994). Moreover, gene sequence data analysis showed that contrary to the general idea supposing the closest relationship between RPV and PPRV, measles virus and RPV are in fact the most closely related viruses within the Morbillivirus genus (Diallo et al., 1994; Meyer and Diallo, 1995; Haffar et al., 1999).

Symptoms

Peste des petits ruminants is known mainly as an acute disease. However, infection of animal by PPRV can be expressed in different forms: super-acute, acute and subacute disease.

The super-acute form in many cases is observed in kids of more than 4 months of age, thus in animals no longer protected against PPR by maternal immunity provided through the colostrum. After an incubation period of about 3 days following the infection, the disease starts suddenly with a high fever, the rectal temperature of the animal being between 40 and 42°C. The animal is depressed and ceases eating. Different mucous membranes, in particular those of the mouth and eyes, are strongly congested. In 100% of cases, the affected animal dies within 5–6 days after the onset of the disease and without necessarily showing erosive lesion or diarrhoea.

The acute form is the classic form of PPR. In this case, all PPR clinical signs are found although not necessarily observed on one animal. The incubation period, which lasts for 5–6 days, is broken by a sudden dullness of the animal. It is reluctant to feed and its rectal temperature is at around 40–41°C. Ocular and oral membranes are congested. In fact, all symptoms of the super-acute form are present but less severe and evolving over a longer period. The ocular and nasal discharges which were serous at the beginning of the disease gradually become purulent and may stick together parts of the eyelids (ocular discharges) or partially block the nose (nasal discharges). At this stage, breathing becomes difficult and bronchopneumonia is obvious with a moist and productive cough. When the fever which has lasted for 4–5 days starts to drop, numerous necrotic lesions invade the oral cavity. Their removal leaves shallow irregular non-haemorrhagic erosive lesions and give the animal an unpleasant and foetid odour when it breathes. At this stage, the animal is very depressed and is increasingly disinterested in feeding. It has diarrhoea which is sometimes dysenteric. Pregnant females abort. The rate of mortality is about 70–80%, animals dying within 10–12 days following the onset of the disease. Those which survive will fully recover in a week.

The sub-acute form of the disease is the least severe: moderate hyperthermia, 39–40°C, is noted for only 1–2 days; diarrhoea is slight and will last for 2–3 days. Mucosal discharges are less abundant and will make crusts around the mouth and nostril orifices, symptoms similar to those of contagious ecthyma. There is no mortality in the sub-acute form of PPR.

Importance of the Disease and Control

Peste des petits ruminants is a highly contagious disease of small ruminants and is one of a group of animal diseases for which outbreaks must be reported to the World Organization

for Animal Health (Office International des Epizooties, OIE). Although its morbidity and mortality rates may vary considerably from 0 to 80–90% according to animal husbandry, breed and age among other factors, PPR is considered as a disease which constitutes the main constraint to increase sheep and goat production in countries where it is endemic (Ezeokoli et al., 1986; Rossiter and Taylor, 1994; Nanda et al., 1996). However, there are very few economic studies related to the cost of the disease. Hamdy et al. (1976) evaluated at US$1.5 million the annual loss induced by PPR in Nigeria. Stem (1993) published results of his study on PPR consequence in Niger. He concluded that an investment of US$2 million in PPR vaccination would generate US$24 million in return for a 5-year vaccination program. Perry et al. (2002) published the conclusion of an international study which aims at identifying priority in animal health research opportunities in terms of their potential benefits for the poor in developing countries. This report highlighted the importance of sheep and goats for the poor in different regions of Africa and Asia because they were ranked at first or second position in most cases. PPR was ranked in the top ten diseases affecting these animals and therefore having a negative impact on the livelihood of the poor in countries in the African and Asian continents where the study was conducted. The number of sheep and goats in countries which declared PPR to the OIE at least once was more than 750 million in 2002 (Diallo, 2004). Since then, this disease has been identified in many countries of the former Soviet Union Republics. Thus it can be estimated that some 1 billion of sheep and goats are at risk of PPR infection although small ruminant populations are usually subjected to significant fluctuations. Most of the affected countries cannot afford drastic sanitary control measures, including the stamping out policy. Therefore, for them the only effective means to control PPR is vaccination. This approach takes advantage of the fact that hosts that recover from morbillivirus infection develop lifelong immunity. In the case of rinderpest and PPR and contrary to measles and canine distemper, there is no report indicating pathology linked to persistent state of the virus in the host. Following the success obtained early in the control of rinderpest by the attenuated rinderpest tissue culture vaccine, this vaccine was later tested in 1969 in small ruminants and was proven to be effective in protecting those animals against PPR. It was demonstrated that this vaccination can elicit protection against PPR for up to 1 year post-vaccination and probably for the economic life of vaccinates (Bourdin et al., 1970; Taylor, 1979) and was thus used until the mid 1990s when a homologous PPR vaccine became available (Diallo et al., 1989b; Diallo, 2004). With the success of the Global Rinderpest Eradication Programme (GREP), countries which like to be declared free of rinderpest by the OIE should demonstrate the absence of rinderpest antibodies in their animals. Therefore, to fulfil this requirement of the OIE, they stopped using the rinderpest vaccine in animals for any purpose. Thus, the homologous vaccine has now replaced the rinderpest vaccine to control PPR. The thermostability of this vaccine has been dramatically improved by a dehydration process (Worrwall et al., 2001), an important feature for its use in countries with hot climates. This homologous PPR-attenuated PPR vaccine developed by Diallo et al. (1989b) was derived from a PPRV isolated in Nigeria in 1975 and attenuated by successive passages in Vero cells. In the meantime, it was established that PPRV strains exist in four lineages according to partial gene sequencing data (Shaila et al., 1996). Experience has proven that the attenuated PPR 75/1 is effective against representative strains of all lineages. It also protects goats against infection with virulent RPV (Couacy-Hymann et al., 1995). This was not surprising as the heterologous rinderpest vaccine is effective against PPRV, cross-immunity being due to the fact that the proteins which provide protective immunity, the fusion and the haemagglutinin proteins, share high or moderate percentages of amino acid identities: 82% and 59% respectively (Barrett et al., 2006). These percentages of identity are highly important if the comparison of the protein sequences is made between the different strains of PPRV. For haemagglutinin, which is more variable than the fusion protein, the minimum percentage of amino acid homology is 89% (Gajavilli, 1998).

Although PPR vaccine is available from many manufacturers, a recent investigation indicated that the vaccination coverage of small ruminants is so low, about 5%, that it cannot allow an effective control of the disease (Diallo, 2004). In the case of rinderpest, it has been estimated that a minimum herd immunity of 75–80% is needed for its control (Rossiter and James, 1989). This should probably be the case for PPR too. Considering the high turnover of small ruminants which is about 33%, it can be estimated that every 3 years all animals of a flock are susceptible to PPR in absence of pre-immunization. Unfortunately, it seems that in most cases, there is no actual program for effective control of PPR, vaccination being implemented mainly as a precaution in face of PPR outbreaks to avoid possible spread.

Conclusions

Although PPR is a contagious transboundary disease it has little impact on international animal trade. Indeed, South Asia and East Africa, where PPR is endemic, export sheep and goats mainly to the Middle East, a region which is also affected by this disease. Thus the economic importance of PPR is only at farm and national levels because of the high mortality it may cause in contaminated flocks. As PPR is a disease of animals, sheep and goats, which contribute significantly to the livelihoods of rural poor farmers, its control should therefore be considered in programs that aim at alleviating poverty in developing countries. It is a disease of public concern and thus its control should benefit from public funds. If effective, primary beneficiaries for this control are poor farmers who are owners of the majority of small ruminants in developing countries. However, the costs for vaccinating only against PPR may be prohibitive, a source of discouraging the implementation of such action. To cut down this cost, a single operation should address at least one other important sheep and goat disease, along with the immunization against PPR.

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