The important viral infections of pigs

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Introduction

The importance of the many known viral diseases of pigs varies from continent to continent and from country to country. African swine fever, a most devastating disease against which no vaccine is available, fortunately plays a minor role in Italy because there are only a few infectious wild pigs still at large on the island of Sardinia. However, a few outbreaks occurred on mainland Italy.

The same is true for foot-and-mouth disease. Fortunately, this virus has been eradicated in the European Communicyt (EC) countries.

In this paper, these two diseases will be dealt with briefly. Other viral diseases in pigs which deserve major attention will be described and prophylactic measures where applicable will be mentioned. Information will also be given on the collection and dispatch of samples and the diagnostic procedures to be employed.

Agents not discussed are the following: rotavirus infections — under natural conditions they usually do not cause diarrhea and piglets become disease resistant early in life; vesicular exanthema — not present in Europe; adenovirus infections — they are mostly isolated from piglets without clinical symptoms; inclusion body rhinitis (cytomegalovirus) — usually only described outside Europe without relevance; Torovirus infections — identified in feces, but significance unknown; hemagglutinating encephalomyelitis virus — naturally occurring disease is unknown; swine pox — not important at present; encephalomyocarditis virus — antibodies against this virus are frequently found in pigs bled in the slaughter houses without any history of disease (this virus was for a time thought to be associated with the porcine reproductive and respiratory syndrome [PRRS]); and the unclassified congenital tremors virus.

Diseases of economic importance

A disease is termed 'economic' when mortality rates are high or when high morbidity rates lead to a distinct loss of weight or a general ill thrift. Table 1 summarizes the agents responsible for these diseases.

African swine fever

Cases of this important disease have been reported from Spain, Portugal, and Sardinia. Whereas its first appearance was characterized by massive hemorrhages and a 100% mortality, the clinical picture has been changing with sometimes even a mild disease. Although limited to small pig breeders in Spain and Portugal and to wild pigs in Sardinia, there is a constant danger that this virus may spread to other countries of the EC and mainland Italy, especially since infected pigs may carry the virus for long periods without demonstrating typical clinical symptoms.

Foot-and-mouth disease (FMD) and swine vesicular disease (SVD)

Clinically, it is almost impossible to differentiate these two diseases. A few days after infection, vesicles appear on the snout and claws, accompanied by high fever. Losses occur usually due to the inability to walk and eat or drink, but cases are known where infection with the vesicular virus remains unnoticed. In the laboratory, it is easy to obtain a correct diagnosis. Difficulties may arise because the swine vesicular virus is closely related to one of the human Coxsackie viruses.

In Italy, swine vesicular disease occurs more often than in the northern European countries. The last big FMD outbreak also occurred in Italy. Swine vesicular disease was first detected in Italy and described by Nardelli, et al. (1968). There are no vaccines available for SVD, and FMD vaccines have routinely been used only in cattle. Vaccination in cattle is now prohibited in the EC countries.

Teschen disease

This is the third disease caused by a picornavirus, but it has no relationship with the other two already described. The Teschen virus belongs to the group of porcine enteroviruses, which consists of at least 11 serotypes. The Teschen agent is a representative of the virulent serotype 1. There are also mild serotype 1 viruses which are responsible for Talfan disease.

The Teschen virus causes an ascending paralyzing process in the spinal cord accompanied by fever. Diagnosis is fairly easy, if the animals show a dog-sitting posture, but this symptom is usually seen only in older animals. Piglets show weakness, nervous symptoms, listlessness and/or diarrhea very soon after infection. Mortality rates are high after infection with virulent strains, but are lower in older animals.

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Table 1

Viral agents responsible for economic diseases

Name of disease	Name of virus	Family	Genus
Foot-and-mouth	FMDV	Picornaviridae	*Aphtho*
Swine vesicular	SVDV	Picornaviridae	*Cardio*
Teschen	Polioencephalomyelitis virus	Picornaviridae	*Entero*
Hog cholera	swine fever virus	Togaviridae	*Pesti*
Porcine Reproductive & Respiratory Syndrome	PRRSV	Togaviridae	*Arteri*
Transmissible gastroenteritis	TGEV	Coronaviridae	*Corona*
Epizootic diarrhea	PEDV	Coronaviridae	*Corona*
Aujeszky (Pseudorabies)	PRV	Herpesviridae	*Alphavirinae*
SMEDI	Parvovirus	Parvoviridae	*Parvo*
Influenza	Influenza virus	Orthomyxoviridae	*Influenza*

The Talfan strains cause disease only in piglets and weaners. Morbidity may be high, and the course of the disease (pyrexia, nervous disorders, diarrhea) is fairly short; most animals survive.

The virulent strains appear to have almost disappeared, because reports of the virulent disease have been very scarce in central Europe. However, in Madagascar losses due to Teschen disease are of economic importance. Prophylactic vaccination is possible.

Hog cholera (swine fever)

This disease has been eradicated from the EC countries.* During the last epidemic in Belgium, almost 700,000 pigs were slaughtered and indemnities were paid. Vaccination against the disease is prohibited. During the last few decades, the clinical picture of the disease, originally characterized by a peracute or acute course with high body temperatures and massive hemorrhages and stillbirths, has changed to milder forms which are difficult to recognize. A constant danger of reappearance remains, however, because as in African swine fever there is a reservoir in the wild pig populations of Germany, Luxembourg, and Belgium. Another problem is the close relationship between hog cholera and bovine virus diarrhea virus (BVDV).

It has been demonstrated that BVDV can cause stillbirths, neonatal deaths, and clinical signs of disease and gross pathological lesions in piglets resembling those of chronic hog cholera after congenital infection (Terpstra and Wensvoort, 1988 and 1991). Almost the same clinical picture occurs when piglets are born to sows vaccinated with a hog cholera vaccine contaminated with BVDV (Wensvoort and Terpstra, 1988). The clinical picture in pregnant sows injected with the virus may include some or all of the following symptoms:

- abortions;
- mummified fetuses;
- weak newborn piglets;
- neonatal deaths with or without hemorrhage;
- trembling disease;
- healthy virus carriers, but not forming antibodies; and
- healthy seropositive carriers.

Porcine reproductive and respiratory syndrome (PRRS)

The virus (PRRSV) responsible for this syndrome is also a member of the Togaviridae family but it belongs to the genus *Arterivirus* to which the equine arteritis virus also belongs.

This is a fairly new disease and was reported in Germany, the Netherlands, and Belgium during the winter of 1990/1991. It has spread to the United Kingdom and during 1992 was spreading in France at the rate of 15 new cases per week (Bradler, 1992). In the USA and the UK, the disease is called 'blue ear disease,' although only about 10% of the infected animals show this symptom.

In sows, the main symptom is abortion between days 105 and 115. Piglets may be born dead, weak, or without any symptoms; and the severity can vary from litter to litter. The sow may run a high fever prior to parturition and go off feed, but not always. It is even possible to have a very high seroconversion rate with no abortion. It is therefore likely that different strains of varying potency exist which can affect the severity of the disease. In some, but again not in all cases, a sterility problem follows. Differences exist also as far as antibody titers are concerned: some remain high after infection while others decrease very rapidly. In the latter case, the virus is perhaps eliminated earlier than in the others. The severity of symptoms may also be associated with differences in immunological reaction. Some sows, for example, suffer from an erythema of the vagina, and inflammation of the skin along the mammary region, or a conjunctivitis, while others abort mummified fetuses, probably a sign of an early infection during gestation. The disease in young pigs is characterized by an interstitial pneumonia associated with anorexia, pyrexia, cough and/or rough hair coat, and general ill thrift.

Restrictions on animal movements have been imposed by the EC authorities, but not on semen. Although no virus has been isolated from semen, it is advisable not to use seropositive boars, since it is known from the equine arteritis virus that stallions might shed the virus for long periods of time (Bürki, 1991).

It is also known that pigs might harbor the virus in the blood in the presence of antibodies. If breeding pigs are brought in,

*After the preparation of this manuscript, outbreaks were reported from the Netherlands and Germany.

they should be kept in isolation (quarantine) until a serum test shows them to be negative. No vaccine is at present available.

Transmissible gastroenteritis (TGE)

There are two coronaviruses which can only be distinguished from each other by monoclonal antibodies or thyroid tissue cell cultures. One causes the typical gastroenteritis; the other replicates in the respiratory tract without inducing any clinical symptoms and when given orally to susceptible pigs, it does not produce the typical disease (severe diarrhea and dehydration). The younger the piglets, the more severe the disease and mortality rate (up to 100% in newborn piglets). With increasing age, the disease becomes less pronounced, but the virus is always shed, irrespective of the age of the animals. A number of vaccines are available but none of them provides 100% protection.

Epizootic diarrhea

This disease is also caused by a coronavirus, but it can easily be distinguished from the other coronaviruses. Differential diagnosis of this disease from the diarrhea caused by the TGE agent is difficult, unless the piglets are younger than 4 to 5 weeks. In this age group, the epizootic diarrhea virus was originally thought not to cause diarrhea (Oldham, 1972), but it has since been found that piglets can become sick. Older feeder pigs also become affected with this disease, although they are fairly resistant to the TGE virus.

The main symptom is a watery diarrhea. The disease pattern varies among farms; morbidity of all age groups may be 100% in some and much less in others, especially in the younger age group. The spread of the disease within a farm is slow and the course is not dramatic. Vaccines are at present not available.

Aujeszky's disease (pseudorabies)

This disease is at present the most important disease of pigs in the EC countries, and efforts are being taken to eradicate it. Since the etiological agent is a herpes virus, it may take years to achieve this goal.

In common with the diseases already discussed, there are age- and strain-dependent differences in the severity of symptoms. There are, for example, strains that cause severe clinical symptoms or a high mortality in piglets but no symptoms in feeder pigs while there are other strains that kill even fattening pigs.

The most unfavorable characteristic of this virus is that it becomes latent after an infection. This means that the genome of the virus remains in the ganglia of the infected tract and can be reassembled after a stress situation.

The symptoms in young pigs include pyrexia, reddened ears and mouth, nasal discharge, and anorexia. The animals like to move into the darkest corner, shiver, and die. Older animals have a longer period of clinical sickness and a high percentage of recovery. Adult animals may not show any symptoms. Many vaccines— attenuated, inactivated, marker— are presently available. The marker vaccines which are in use in the EC countries are predominantly gI-deleted live vaccines and enable laboratories to differentiate between antibodies induced by the vaccine and those induced by field strains.

Due to the characteristics of the virus, it is generally accepted that breeding sows should be vaccinated with only inactivated vaccines, and that feeder or fattening pigs should be vaccinated with live attenuated or inactivated vaccine at 2 to 4 months of age because maternal antibodies will prevent an active immunization in situations where sows have been vaccinated routinely. A second vaccination can be omitted in fattening pigs. Cattle, when housed together with pigs, are frequently infected by the virus. Until recently, these infections invariably led to the death of cattle. Cattle used to be dead-end hosts, i.e., the virus was not spread to other cattle. Lately, however, a strain has been recovered which has been shown to infect neighboring animals and to cause mortality unless they have been vaccinated a few times against BHV1 (Rademacher, et al., 1991; Straub, 1991)

SMEDI syndrome— parvovirosis

SMEDI stands for stillbirth mummification embryonic death infertility. Some authors now use the term to describe enterovirus infections to which Teschen disease belongs, but more often it is used to describe the parvovirus infection. Infections with this agent cause large losses, mainly in pregnant sows. Depending on the stage of gestation, the virus has different effects as shown in Table 2. The virus is otherwise almost harmless. Since it is present world-wide in probably serologically identical strains and is of remarkable stability, all gilts should be vaccinated. Maternal antibodies can persist for 3 to 6 months and can interfere with the development of an active immunity. The available vaccines are all inactivated. The only difference is that some are of a watery nature and the others of an oily type. It is recommended that gilts and boars be vaccinated twice at an interval of 4 to 6 weeks in the sixth month of life with a repeat vaccination 6 months later. In cases of unknown history, gilts or sows should be vaccinated shortly before or after mating and revaccinated 4 to 6 weeks later (if the first vaccination was done after mating, then the second should be given not later than 4 weeks thereafter).

Table 2

Consequences of parvovirus infection in sows

Infection of sow (days of gestation)	Days of gestation	Consequences of infection in embryos and fetuses
<56	10-30*	embryonic death and resorption
	30-70	mummification
>56	70-116	antibody formation, mostly without disturbances

* assuming that transplacental infection occurs 10 to 14 days after the primary infection of the sow

Swine influenza

The course of the disease is similar to that of human influenza: rapid onset with fever, anorexia, and dyspnea. Morbidity rates may reach 100%; mortality rates are usually low and recovery is fast. Complications can arise when environmental conditions are poor. The virus may be transmitted to humans and vice-versa. Other species playing a role in transmission are equine, chickens, parrots, mink, and water fowl.

For prophylactic measures, a number of inactivated vaccines are available. They contain, in most cases, a mixture of human and porcine strains *[Editor's note: in Europe].*

Table 3

Transmission of virus by boar semen

Virus	Detection in semen	Transmission confirmed	Cause of infertility and/or other disturbances during gestation
FMDV	+		+
SVDV	+		
Teschen virus	+		?
ASPV	+	+	+
HCV	+		
Parvovirus	+	+	+
PRV	+		+
Influenza virus	?		-
PRRSV	?		+
TGEV	?		-

(+) positive
(-) negative
(?) questionable

Table 4

Collection and transport of samples, and the tests used in diagnosis

Disease	Samples required	Tests available
FMD	material from vesicles	CF; ELISA; TC
SVD	material from vesicles paired serum samples	CF; TC VNT; ELISA
Teschen	brain stem; cerebellum; spinal cord paired serum samples	TC→ IF; IP ELISA; VNT
Hog Cholera	tonsils; kidney; ileum serum	IF; TC→ IF IDT; IF; VNT
PRRS	serum	IP
TGE	pieces of small intestine	IF; TC→ IF; VNT
TGE (variant from respir. tract)	nasal swab; tonsils; lung	TC→ IF
Epizootic Diarrhea	small intestine; feces paired serum sample brain nasal swabs; tonsils	IF; ELISA ELISA; IF TC IF
Aujeszky's Disease	lung (also fetal); liver (also fetal) paired serum samples	VNT; ELISA; IF; IP
Parvoinfection	fetuses (up to the 70th day) exceptionally, paired serum samples	IF Immunoglobulin determination
Influenza	nasal swab paired serum samples	HE→ HE; HAH HA; HAH

abbreviations: CF– complement fixation; ELISA– enzyme-linked immunosorbent assay; TC– tissue culture; VNT– virus neutralization test; IF– immunofluorescence; IP– immunoperoxidase; HA– hemagglutination; HAH– hemagglutination inhibition

Transmission of virus by semen

The role that semen from infected boars plays in the transmission of the viruses is summarized in Table 3.

Collection of samples

It is very important to take the right samples for proper diagnosis. It is also necessary that the samples are kept cool, not frozen, during transport and are properly packed. Proper handling methods, including the tests available for the diseases, are summarized in Table 4. There is one exception: the material for Teschen diagnosis should be sent in a frozen state.

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