Swine Vesicular Disease in Great Britain

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SUMMARY

The State Veterinary Service in Great Britain has encountered considerable difficulty in eradicating SVD. For the last four years confirmed outbreaks have been mainly confined to one region, linked directly to outbreaks in that region, or have occurred as isolated cases related to the feeding of swill. The surveillance effort to locate subclinical disease has far surpassed that of any other country.

There is no doubt that the introduction of SVD into any country which adopts a stamping-out policy for FMD and does not vaccinate, could present similar problems to those experienced by Great Britain.

INTRODUCTION

The history of this disease is now familiar to most veterinarians. It was first observed amongst pigs in the Lombardy region of Italy in 1966, and a similar disease condition was seen in pigs in the New Territories of Hong Kong during a foot-and-mouth disease vaccine trial in 1971. Swine vesicular disease (SVD) has now been reported from many other countries (Table I).

During 1980 the series of outbreaks which commenced in Great Britain in 1979 continued with a further 37 confirmed outbreaks. The disease has also been recorded from Italy in 1980. Investigations in Italy and in Great Britain (AVRI) have demonstrated that although clinically indistinguishable from foot-and-mouth disease (FMD) the cause was a different virus which was also distinct from the viruses of vesicular stomatitis and vesicular exanthema (9). The virus involved in the Hong Kong outbreak was also shown to be very similar to that isolated in Italy (7). The causal agent was classified as a porcine enterovirus of the picorna virus group which also includes Teschen, poliomyelitis and Coxsackie viruses.

The first outbreak of SVD in Great Britain occurred in Staffordshire in December 1972, and to date there have been 483 outbreaks. The annual incidence of these is illustrated in Figure 1 and the distribution of the outbreaks in the years 1972 to 1975 and 1979 is shown in Figures 2 and 3. No outbreaks of SVD were confirmed between 4 June 1977 and 3 February 1979—a period of 20 months.

The Agent

It is most important to appreciate the characteristics of this virus, especially its durability, as this plays an important part in the epidemiology of the disease and the possibilities of control and eradication.

Initial investigations have established that the virus of SVD is stable at pH 5, is stabilised by MgCl₂ at 50°C and is resistant to ether (9). Its sedimentation coefficient 150S and its buoyant density is 1.32 g/cm². Electron microscope studies have revealed spherical virus particles somewhat larger than those of FMD.

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>SWINE VESICULAR DISEASE—WORLD DISTRIBUTION</th>
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<tbody>
<tr>
<td>UK</td>
<td>13</td>
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<tr>
<td>Austria</td>
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<tr>
<td>Belgium</td>
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<td>France</td>
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<td>West Germany</td>
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<td>Greece</td>
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* Virus not identified

Presented at the 32nd Canadian Veterinary Medical Association Annual Convention, Moncton, N.B. July 1980.
The virus resists desiccation and a suspension with 20% swine feces kept for 30 minutes at 4°C is unaffected by 2% hydrochloric, sulphuric or phosphoric acid, or 10% acetic or citric acid (pH 1.4 to 2.9). Oxidising agents, phenol compounds and 4% soda are equally ineffective but the virus is deactivated by 2% sodium hydroxide (pH 12.4), 10% formalin or 70% alcohol. It will persist in pig-meat in deep freeze for very long periods. Viable virus can be recovered from pig feces stored for 138 days and carcass material stored between 12°C and 17°C shows no drop in infectivity for 12 months. It resists fermentation and smoking processes and is present in salami for 100 days. It is destroyed by heat at 69°C.

These properties are of critical importance in the reintroduction of infection to the pig population from imported or stored infected meat which enters the waste food chain. They are also associated with the important role of contaminated vehicles in transmission and the recrudescence of disease which occurred on a few premises after the slaughter of pigs and cleansing and disinfection in the earlier years before more stringent measures were adopted.

**Relationship Between Strains**

Detailed comparative studies of SVD virus isolates from outbreaks in different countries and in the UK have used antigenic analysis, polyacrylamide gel electrophoresis (PAGE) and RNA hybridization techniques (Table II). The correlation of variation in the virus structural polypeptides with serological properties has demonstrated that isolates from several premises in 1979, including a number of primary swill-feeding outbreaks were all identical. They were distinguishable from strains which had been isolated in previous years. The 1979 UK and 1979 Belgian isolates were also distinguishable by their PAGE patterns. This technique, with supporting serological data, can therefore be used to a limited extent in epidemiological studies.

**Relation to Coxsackie Viruses**

Investigation into the relationship of SVD and Coxsackie viruses was stimulated by the development of symptoms in workers at the AVRI in 1972/73 similar to those seen with Coxsackie B5 infections (CBS). It was shown that these were probably caused by the SVD virus but there has been no clinical or serological evidence of SVD infection in field veterinarians closely involved in dealing with disease outbreaks.

Signs of disease were not produced in pigs inoculated with CB5 (2.3) although neutralising antibody to both CB5 and SVD was detectable. When pigs inoculated with CB5 were challenged by exposure to SVD virus after 28 days they succumbed with typical vesicular lesions. On the basis of the type and distribution of lesions in the central nervous system (CNS) after inoculation of pigs with either SVD or CB5, it was concluded that the viruses might be related (6).

It has been shown that the Faulkner prototype isolated in 1952, and recent isolates of CB5 are as different from each other as they are from SVD. Further detailed analyses of these viruses should give some insight into the changes which occur during antigenic drift, but at the present time it is suggested that both types of virus have a common ancestor.

**Clinical Signs**

Clinically the disease is indistinguishable from FMD. In the field the incubation period is generally three to five days. When investigating outbreaks of the disease, the pigs with older lesions are often detected only when they are examined individually. The epidemiological pattern may be clarified only after all the pigs have been slaughtered and lesions aged.

- Detection under modern husbandry conditions and on premises where waste food is fed, when signs and lesions may be minimal, is often extremely difficult. This is exemplified by the fact that only about 50% of outbreaks confirmed are reported by

**TABLE II**  
**Swine Vesicular Disease Comparison of Isolates**

<table>
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<tr>
<th>Antigenic analysis</th>
<th>Polyacrylamide gel electrophoresis</th>
<th>RNA Hybridization</th>
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<td>(incl. all other</td>
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<td>strains isolated</td>
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<td></td>
<td></td>
<td>in Europe 1972)</td>
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<td>'UKG 233 73'</td>
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<td>'UKG 300 74'</td>
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<td>'UKG 1 79'</td>
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<td></td>
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<td>(incl. other strains isolated in UK 1979)</td>
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<td>'Belgium 79'</td>
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the owner. Many others are detected during tracing as symptoms are developing, because of the speed with which tracing is carried out. The incubation period varies with the weight of infection to which the animals have been exposed and the route of inoculation.

Experimentally infected pigs develop lesions within 48 hours of intradermal inoculation into the foot and there is generalization of the disease within 72 hours.

Relatively large amounts of virus are required to produce a primary vesicle at the inoculation site. Following intravenous inoculation vesicles develop within three days and within two days after subcutaneous inoculation. There may be no obvious clinical response following oral or nasal exposure to the virus, but this does result in subclinical infection, as demonstrable by an antibody response. Such pigs have not been shown to excrete virus, other than in one instance where a single pig did excrete after it had been stressed. There is no evidence from the field to suggest that infected pigs excrete virus in the absence of clinical disease.

The temperature may rise to $41^\circ C$ but reverts to normal within one to two days. Vesicles form on the coronary band, on the ball of the foot, snout and less frequently on the tongue and teats. They are not restricted to the skin horn junction but may extend up the limb. Distribution and development of lesions is apparently related to trauma.

Once the vesicles have ruptured in 24 hours, a shallow ulcer forms and the horny wall becomes loosened and discolored along the coronary band. Total loss of the hoof, such as occurs with FMD, is rarely seen. Older disease may be suspected and aged by the position of horizontal demarcation lines indicating the extent of regrowth of new horn.

Field evidence has suggested that lesions of various age may occur in the same pig after repeated attacks of virus, but this has not been confirmed experimentally.

The severity of the disease varies, recovery can be fairly rapid and clini-
cal effects in older pigs may be transient. Morbidity may be as high as 100% in affected pens but mortality is negligible.

Apart from one isolation from an aborted fetus and the suggestion from Austria and Italy that abortion may occur, there is no evidence that the pregnant sow is a factor in the perpetuation of the disease and the dissemination of infection. Experimentally the virus has not been shown to cause abortion and it is unlikely to infect or cross the placenta.

Histopathological examinations cannot differentiate SVD from FMD. Although clinical disease has only been observed in pigs, small amounts of virus may be recovered intermittently from the pharynx and rectal swabs of cattle housed with experimentally infected pigs. There is some indication of virus growth in in-contact sheep as large amounts can be recovered from the pharyngeal region for up to six days after exposure. Such sheep may develop significant levels of SVD neutralizing antibody. In the field these species do not appear to play any part in disease transmission.

Nervous signs may be produced by the inoculation of day old mice or the intraperitoneal injection of six day old mice and lesions occur in the CNS.

**Diagnosis**

When a vesicular disease is being investigated in Great Britain, SVD Form A is only served on the premises in clearly defined circumstances where there is a highly probable link with a known outbreak. Otherwise, FMD Form A is used. If FMD cannot be eliminated Form C is signed and FMD infected area restrictions are imposed.

The diagnosis of SVD and its differentiation from other vesicular diseases depends on:

1) Isolation of the virus in tissue culture. Positive complement fixation test (CFT) results may be obtained in a few hours, or passage and isolation may take up to four days (after receipt by the laboratory). Confirmation of the absence of FMD virus in epithelial tissue may take up to 48 hours.

2) Serological examination of blood samples. A double immunodiffusion test (DID) which is rather less sensitive than the serum neutralization test (SNT) is highly specific, gives rapid results within eight hours and is economic in reagents and simple to perform. Confirmation by the more sensitive SNT may take up to two days. In a number of instances DID results have been negative and the SNT positive. Single and low titre SNT positives which have been revealed during slaughter-house surveys are difficult to interpret in the absence of clinical disease and without supporting serological evidence of infection in pigs on the premises of origin. Care must therefore be taken in interpreting the results of past serological surveys.

In Denmark, seven of 600 boars showed titres of 1:45 or above, but SVD has never been confirmed in that country; the low titres were shown to be nonspecific on further testing.

The experience elsewhere, that disease left to run its course will disappear from a herd, has been confirmed in Great Britain. In one small herd identified by the monitoring of sera from slaughtered pigs, several animals had high SNT titres in the absence of lesions, and despite exhaustive investigations, virus could not be isolated from the premises.

**Epidemiology**

The sequence of events in the epidemiology of swine vesicular disease is determined by the resistance of the virus, the feeding of waste food in circumstances in which virus may pass from unprocessed material to pigs, and the contamination of vehicles by infective pigs.

The virus may enter the waste food chain in imported pig-meat from abroad, or even in a country such as Great Britain which adopts a slaughter policy, from viraemic pigs sent for slaughter before the disease is confirmed in the herd (Figure 4).

The importance of these various factors is illustrated by the origins of the outbreaks between 1972 and 1977 and those of subsequent outbreaks (Tables III and IV).

Unlike FMD, where the virus is derived chiefly from the bronchi, SVD virus originates primarily from ruptured vesicles and infection spreads slowly from pen to pen unless there is common drainage or movement of pigs. The spread of disease locally

**Figure 4. Epidemiology of swine vesicular disease.**
from one premises to another is exceptional. To comply with EEC requirements, however, Article 19 notices are placed on all premises with pigs within 2 km of an infected premises, restricting the movement of pigs for 15 days from the date of completion of slaughter on the infected premises.

There is differing experimental evidence on the duration of excretion of SVD virus. Burrows et al (1) showed that the peak virus concentrations in secretions, excretions and tissues of infected pigs occurs at two to five days postinoculation. The fecal samples taken at 16 days after inoculation contained significant amounts of virus, and in one animal there was evidence of fecal contamination 23 days later. Gourreau et al (4) were able to detect virus in the feces and urine of experimentally infected pigs for up to 90 days and in the nasal and pharyngeal secretions for more than 60 days. Their failure to isolate virus beyond seven days from muscle, skin, kidney, lymph glands and spleen was attributed to the techniques used and possibly the relatively small amounts of virus in the samples.

Serological Surveys

The State Veterinary Service in Great Britain has never devoted so much effort to surveillance in an attempt to locate persisting subclinical disease and the results of six serological surveys have been published. Sera were screened initially by the DIF and those giving positive results were subjected to the SNT. For the purposes of the survey, titres of 1:45 or greater were regarded as positive and titres between 1:16 and 1:32 as doubtful. All premises from which positive or doubtful results were obtained were visited and the pigs examined clinically; further blood samples were taken at these visits. Clinical disease with serologically positive pigs was only found on the third premises which was located in the Yorkshire/Lancashire region (Yorks/Lancs).

Since January 1976, confirmed outbreaks of SVD have been mainly confined to the Yorks/Lancs region, other than for a few linked directly by movement and a few others related to primary infection through swill. Following the recurrence of SVD in February 1979 in Yorkshire, sera from pigs slaughtered locally were tested. A total of 4997 sera were examined from 669 premises and the samples from two farms were positive. On both of these farms disease was subsequently confirmed.

Because of the localization of confirmed outbreaks to the Yorks/Lancs region and the importance of swill-fed herds in the persistence of the disease, it was decided to sample selectively swill-fed pigs sent for slaughter from premises in the Yorks/Lancs region during 1979. As a result of this exercise two further swill-fed herds with disease were located in October and December respectively, the first leading to the disclosure of one more outbreak attributed to vehicle contamination, and the second being associated with a series of outbreaks in late 1979 and early 1980.

Statutory Measures—Swine Vesicular Disease Legislation

The swine vesicular disease legislation is based on that for FMD and powers are taken to slaughter all pigs when infection is confirmed on a premises with compensation at full market value. Movement restrictions for 28 days are imposed on all pig premises which may have had contact with infection as a result of the movement of pigs, vehicle contamination or personnel contact.

After slaughter of the stock, stringent measures are taken to eliminate the virus before limited restocking is permitted.

Following a preliminary spraying with an approved SVD disinfectant and the disposal of carcasses, all surfaces are cleaned with a detergent solution based on sodium metasilicate. The premises are then sprayed with 1% NAOH and flame-gunned 48 hours later. This treatment is again carried out in 14 days.

Limited restocking does not take place until eight weeks after cleansing and disinfection and up to 50% of the original stock are allowed on to the premises, subject to a maximum of 200 pigs. These are inspected weekly and moved around the pens to facilitate the detection of any residual infection. Total restocking is permitted three weeks later.

Due to the problems which have arisen in the disposal of carcasses from intensive units, arrangements are now made for the movement of these under careful control to a single approved processing plant.

Waste Food Legislation

With the occurrence of SVD in 1972/73 it became apparent that it was necessary to strengthen the controls relating to the feeding of waste food. The Diseases of Animals (Waste Food) Order 1973, with more stringent requirements, replaced previous legislation and resulted in a reduction of the number of swill feeders in Great Britain from 4,000 to the present 1,077.

Movement and Sale of Pigs Legislation

As SVD outbreaks continued, associated with the movement of pigs and contamination of transport, the Movement and Sale of Pigs Order (1975) was introduced to replace previous legislation.

The principal provisions of the Order:

1) Prohibit the movement of pigs off premises within 21 days of the movement of any pigs on to those premises. A number of exempted
movements are specified in the Order.

2) Require the licensing of movement of pigs from all premises, with certain exceptions. In respect of movement from premises where waste food is fed and movements from a slaughter market, the licence can only be issued for movement to a slaughter house.

3) Require the marking of pigs before movement to a slaughterhouse or slaughter market.

4) Impose requirements for the cleansing and disinfection of road vehicles used for moving pigs and restrict the categories of pigs which may be carried.

5) Make the sales of pigs subject to licensing requirements, except in the case of sales after a show or exhibition.

**Vaccination**

European investigators, have reported the development of a vaccine against SVD (5,8). In both cases this is an inactivated experimental vaccine on an aluminium hydroxide or oil base. Vaccinated pigs were afforded a high degree of protection against contact challenge and peak antibody titres were recorded at seven days post-vaccination. More recently, the use of temperature-sensitive mutants of SVD virus has been described (10). These varied considerably in their virulence when administered to pigs. Levels of protection with one of the mutants were similar to those achieved by Mowat (8) using conventional inactivated vaccines.

**Policy Considerations**

The policy adopted to deal with SVD depends on the national FMD control policy. Great Britain is not the only country to practise a slaughter policy as this is also pursued by West Germany, Austria, Switzerland, Belgium, The Netherlands and Japan. Other countries which routinely vaccinate against FMD do not slaughter for SVD.

If Great Britain abandoned the slaughter policy and SVD became widespread, this would lead to a great deal of complacency in the reporting of suspected vesicular disease, and in every instance until FMD was eliminated, the movement of livestock restrictions within a radius of five miles (8 km) would have to be imposed. Very great difficulties would be experienced by the industry in market and slaughterhouse situations when disease occurred.

In the eight years during which the SVD slaughter policy has been operated the cost of compensation has amounted to some £9 million. At the present time a foot-and-mouth disease vaccination policy, vaccinating only cattle and sheep, would cost £45 million in the first year and over £20 million annually thereafter. No protection would be afforded against exotic types of FMD or subtype and pigs would not be protected.

The viability of the national slaughter and compensation policy for FMD depends on the eradication of swine vesicular disease.

Discussions are now in progress to assess the measures necessary for the control of SVD in the European Community in the context of the greater freedom of movement for live pigs and pig-meat.

**REFERENCES**


