

Pseudorabies

**USDA APHIS VS Career Services Program
Program Diseases Training Module**

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**November 2003
Revised August 2004**

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This course is designed to provide updated information on the major domestic diseases for which Veterinary Services (VS) has program responsibility. It will provide information on surveillance, disease control and eradication for these diseases. It will also give an overview of the duties of a field Veterinary Medical Officer (VMO) as a support worker of VS animal disease programs and how they interact with other units in APHIS.

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1. DISEASE INFORMATION

a. Agent

Pseudorabies, also known as Aujeszky's disease, results from infection by the pseudorabies virus, an alphaherpesvirus in the family *Herpesviridae*. Pigs are the natural host for the virus and the only animal to become latently infected.¹⁻³ Incidental infections can be seen in nearly all domestic and wild mammals, including cattle, sheep, goats, cats and dogs.¹⁻³ The pseudorabies virus does not infect humans, and horses appear to be relatively resistant to infection.^{1,2,4,5}

The pseudorabies virus can be inactivated by sunlight, drying and high temperatures.^{1,6} While the virus will only survive for a day at 37.2 °C (99 °F), it can remain viable for up to 10 days at 23.8 °C (75 °F), 30 days at 18 °C (65 °F), and 6 months at 7-13 °C (45-55 °F).⁵ It may be found for up to 7 hours in unchlorinated water, 2 days in anaerobic lagoon effluents, green grass, soil, feces and shelled corn, three days in pelleted hog feed, four days in straw bedding, up to three weeks on plastic or steel surfaces, and up to five weeks on whole corn.^{1,5} It can survive for a week in clean soil; survival is prolonged if feces or urine are present.⁵ Animal carcasses can contain live virus for a week or more in summer weather and longer if the temperatures are cold.⁵

b. Transmission

The pseudorabies virus is usually transmitted between domestic pigs by the respiratory or oral routes.¹ During acute infections, viruses can be found in the tonsillar epithelium, milk, urine, nasal secretions, and vaginal and preputial secretions for more than two weeks.¹ The virus is usually spread directly between animals by nose-to-nose transmission; however, it can remain infectious for up to seven hours in the air, if the relative humidity is at least 55%, and may travel up to two kilometers as an aerosol.^{1,3,4} It can also be transmitted on fomites and in carcasses.^{1,3,5} Venereal transmission is possible and may be particularly prominent in wild pigs.⁶⁻⁸ Piglets can be infected *in utero*.^{6,7}

Infected pigs can become latent carriers.¹⁻³ The inactive virus is carried in the trigeminal ganglia and can become reactivated after stressors such as transport, crowding, corticosteroid injections, other illnesses, farrowing, or breeding in boars.

Other animals usually become infected through contact with infected pigs. Most animals are considered to be dead-end hosts.^{4,5} Sheep and cattle may occasionally excrete some virus; rare cases of lateral infections have been seen in these species.⁵ Carnivores can become infected if they eat infected animals or their carcasses.^{1,5}

c. Clinical signs

In pigs, the incubation period is approximately 2-4 days.^{5,6} In this species, clinical signs vary with the age of the animal. Neurologic signs predominate in nursing piglets.^{1,6,10} In young piglets, the symptoms may include depression, high fever, anorexia, vomiting, diarrhea, and neurologic signs such as trembling, staggering, paddling, incoordination, and convulsions.^{4,5,9,11} Entire litters may die within a day or two, and very young piglets may die before any symptoms develop.^{1,4,5,9}

As pigs become older, neurologic signs become less prominent, respiratory symptoms begin to predominate, and the severity of the disease decreases.^{1,6,10} In weaned pigs, the symptoms may include fever, anorexia, weight loss, coughing, sneezing, conjunctivitis, dyspnea, excessive

salivation, a clear to yellowish nasal discharge, and vomiting.^{1,4,5,9-11} Neurologic signs may also be seen.^{1,4,5,9,11} Incoordination is particularly noticeable in the hind legs and infected pigs often develop convulsions before death.¹¹

In adult pigs, the infection is similar but milder or inapparent, respiratory symptoms predominate, and deaths are uncommon.^{9,10} The illness may last from 6-10 days.¹⁰ Neurologic signs, including trembling, incoordination, and itching are occasionally seen, and, rarely, animals may become blind.¹¹ An acute, highly fatal secondary pneumonia sometimes develops, particularly in herds with a prolonged history of pseudorabies.¹¹ Pregnant animals may abort, reabsorb their fetuses, or give birth to mummified or stillborn fetuses.^{4,5,9,10} Piglets born alive may die within a day or two or become "shaker" piglets.^{4,9}

In species other than pigs, pseudorabies can resemble rabies and is usually fatal within a few days.^{3-5,7,9} In cattle and sheep, the typical symptoms may include anorexia, convulsions, depression, incoordination, shallow breathing, cardiac irregularities, and intense pruritus of a localized area of the skin, with scratching, rubbing, biting, and self-mutilation.^{5,7} Similar symptoms may be seen in cats and dogs and the pharynx may be paralyzed, resulting in intense salivation.⁷

d. Epidemiology

1) Pseudorabies in domestic pigs. Pigs are the natural hosts and reservoirs for pseudorabies. The virus is usually introduced into a herd in an infected pig.⁷ It can also enter the herd by contact with infected pigs, on fomites, and in the carcasses of infected animals; this last mode of transmission is unusual.⁹ During the acute infection, most pigs excrete the virus for approximately three weeks, although some animals can shed it for months.^{5,9} Pigs can become lifelong carriers, with the virus reactivated and shed periodically when an animal is stressed.^{1-3,5,9}

Although the pseudorabies virus can spread slowly between herds, it usually spreads quickly within a herd.⁷ When the virus is first introduced into a non-immune swine herd, the symptoms are usually severe and the death rate is high in young pigs.¹² The mortality rate can be up to 100% in animals less than a week old, up to 50% in nursery pigs, 5-10% in weaner pigs, and as low as 1-2% in grower and finisher pigs.^{1,7,10} The severity of the disease varies with the virus strain.¹¹ Pigs that recover from pseudorabies are usually resistant to re-infection for at least a year and are often asymptomatic if re-infected.¹¹

Clinical signs are most likely to be seen in very young piglets and breeding sows.⁷ In herds where the breeding sows are immune, the infection may be mild or inapparent in piglets.¹² Maternal antibodies can protect piglets for 5-10 weeks according to some researchers and up to 8-18 weeks according to others.^{5,11} If the breeding and growing-finishing operations are in separate locations, outbreaks may be seen when the maternal antibodies wane and weaned pigs from different sources are combined in the growing-finishing unit.¹²

2) Pseudorabies in feral and wild pigs. Pseudorabies eradication is complicated by the presence of the disease in wild and feral swine. There are thought to be nearly three million wild and feral swine in the U.S. in more than 30 states; the populations are greatest in the Southeast and Texas.^{8,13} Pseudorabies has been confirmed in wild/feral pigs in at least 11 states including California, Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Florida,

Georgia, South Carolina, and Hawaii.¹⁴ The overall seroprevalence is approximately 19% nationwide; however, the number of seropositive pigs can fluctuate rapidly.⁸ Wild pigs appear to be expanding their geographic range and carrying pseudorabies with them.⁸

The information about pseudorabies in wild and feral pigs is limited and the significance of the threat to domestic pigs uncertain.⁸ The risk of infection depends on the properties of the viruses, as well as the opportunities for domestic and feral herds to mingle. Pseudorabies viruses isolated from wild swine are genetically distinguishable from domestic isolates and seem to be adapted to free-living pigs.^{8,13} These viruses are often isolated from the genital tract rather than the respiratory tract.^{8,15} They also seem to be very attenuated for both domestic and feral pigs; infections are often asymptomatic except in very young animals.⁸ Seroconversion is often delayed and some pigs have no detectable titers.⁸ As a result, an infection that spreads to domestic swine may not be recognized quickly. More virulent strains might evolve if the population density of wild swine increases or the virus is transmitted into domestic herds.⁸ There is also some evidence that feral and domestic strains can recombine.¹³

Anecdotal evidence and experimental studies suggest that the viruses from wild and feral pigs can be transmitted to domestic herds if they mingle, but definitive proof is lacking.^{8,16} It is also theoretically possible that the viruses could be spread to domestic herds by aerosols.⁸ However, the actual frequency of transmission is unknown. In East Germany, pseudorabies was eradicated from domestic herds in 1985 and there has been no evidence of transmission from infected wild boars.⁸

Most producers have completely isolated their herds from wild and feral pigs to prevent disease transmission; however, diseases can spread to swine owned by backyard swine producers and other small farmers who may use old-fashioned husbandry techniques.¹⁵ These farms could, in turn, re-introduce pseudorabies into the domestic swine industry. Careless transportation and release of feral or wild swine by hunting interests may also disseminate pseudorabies.¹⁵

3) Pseudorabies in other species. Sporadic cases of pseudorabies are seen in animals in close contact with pigs. Species other than pigs become infected by contact with live or dead pigs, aborted fetuses, and fetal membranes.⁹ In these species, the disease is almost always fatal.³⁻⁵ Infected animals can occasionally transmit pseudorabies if they are eaten; however, their capacity to act as vectors is limited as the infection kills the animal very quickly.^{1,5}

e. Diagnosis

In pigs, pseudorabies should be considered in viral infections characterized by abnormal death losses, unusual weight loss, or neurologic or respiratory signs.¹⁷ Cases in young piglets may look very similar to transmissible gastroenteritis, if there is vomiting and diarrhea.¹¹ In species other than pigs, intense pruritis and neurologic signs may be suggestive. Pseudorabies can be diagnosed by virus isolation, immunofluorescence to detect viral antigens in tissues, polymerase chain reaction (PCR) on tissues or secretions, and serology.^{2,11}

Virus isolation is most useful in symptomatic animals.² In living pigs, the pseudorabies virus can be isolated from the oropharyngeal fluid, nasal swabs, or tonsil biopsies.² At necropsy, the brain and tonsil are the preferred organs, although virus may also be isolated from other organs including the spleen and lung.^{1,2} Virus isolation can be difficult in latently infected pigs; the best

probability of success is with the trigeminal ganglion.² In cattle, the section of the spinal cord that innervated the pruritic area should be collected.²

Serologic tests include virus neutralization, enzyme-linked immunosorbent assay (ELISA), and latex agglutination tests.^{2,11} Some ELISAs can distinguish natural infections from titers due to gene-deleted vaccines.² Antibodies to the pseudorabies virus usually develop after 7-14 days.⁵ Paired serum samples, collected 3-4 weeks apart, may be necessary.¹¹ Latently infected pigs are sometimes seronegative.¹ In species other than pigs, serology is of limited utility, as the animal often dies before developing an antibody response.²

Necropsies are generally not diagnostic, as the post-mortem lesions are often absent or subtle.^{1,7} Many pigs have a serous or fibrinous rhinitis; this may be visible only if the head is split and the nasal cavity opened.^{1,6} Pigs may also have necrotic tonsillitis, necrotic placentitis, endometritis, congested meninges, lesions indicative of pneumonia.^{1,6,7,11} The lymph nodes may be congested and the liver and spleen may contain necrotic foci, particularly in piglets less than one week old. Aborted piglets can also have necrotic lesions in the lungs and tonsils.⁶ In species other than pigs, the only lesions may be areas of edema, congestion, and hemorrhage in a portion of the spinal cord.⁷

f. Prevention and control

There is no specific treatment for animals with pseudorabies.¹ Its introduction into a herd is prevented mainly by management and sometimes vaccination. Infected herds are identified by a variety of surveillance methods, including testing of breeding animals sent to slaughter and to markets, pre-movement testing, area testing, and diagnostic testing of herds with clinical signs.^{17,18} Additional herds may be found during epidemiologic investigations of infected herds. Although most domestic swine herds in the U.S. are now free of pseudorabies, sporadic outbreaks have continued to occur through 2003.¹⁶ Many of these outbreaks occurred in herds that had contact with feral pigs.

The pseudorabies virus is quickly inactivated when exposed to sunlight and drying.¹⁹ It can be destroyed with a variety of disinfectants, including orthophenolphenate compounds, phenolic compounds, 2% sodium hydroxide, trisodium phosphate, sodium or calcium hypochlorite, quaternary ammonium compounds, and chlorhexidine.^{5,19} All disinfectants are less effective in the presence of organic matter; therefore, surfaces should be cleaned before being disinfected.

The pseudorabies vaccines can reduce shedding, clinical signs, and the establishment of latent infections, but cannot completely prevent infection or latency.^{1,6,11} Gene deleted vaccines allow natural infections to be distinguished from vaccination titers.²

g. National Institute for Animal Agriculture (Livestock Conservation Institute) Plans

The National Institute for Animal Agriculture (NIAA), formerly known as the Livestock Conservation Institute (LCI), has three plans to free herds from pseudorabies: test and removal, offspring segregation, and depopulation.¹⁹

1) Test and removal. If less than 20% of the herd is positive for pseudorabies, test-positive animals can be removed without herd vaccination.¹⁹

If many of the breeding animals are infected or grower-finisher pigs are also infected, the entire breeding herd should also be vaccinated three times at six-month intervals.¹⁹ Six months after the last vaccination, all breeding animals and a representative sample of their 16-week old and

older offspring are tested. If the offspring are negative, all positive breeding animals are re-tested and removed if still positive.

A third option, which can minimize the interruption to pig flow, is a phased test and removal plan with vaccination.¹⁹ This plan, which is the cheapest option, is the most likely of the three test-and-removal options to fail. All test-negative breeding animals are vaccinated with a killed vaccine. All positive boars are immediately removed from the herd, but positive sows are not removed until their next weaning. The positive sows are then replaced with unvaccinated gilts. Four months after vaccination, all sows are retested and any remaining positive animals are immediately removed from the herd. The herd is retested in 30 days.

2) Offspring segregation. In the offspring segregation plan, all sows are vaccinated 3-4 weeks before they farrow.¹⁹ Piglets from selected sows are weaned when they are 3-4 weeks old and moved to new facilities to establish the new herd. The gilts are placed in separate pens, ideally with gilts from a single litter in each pen, and tested for pseudorabies when they are 16 weeks old. If any pens contain seropositive animals, these gilts are removed and the entire pen is retested after 30 days. Any pens that still contain reactors are removed from the program. As entire pens test negative, they are combined to establish the new herd. If possible, the gilts are bred to pseudorabies-free boars and segregated through gestation. Alternatively, the piglets can be weaned at the regular age and isolated from the sows in a nursery on the same farm.¹⁹ Starting when they are 12 weeks old, potential replacement gilts are tested at 2-week intervals and negative animals are moved to a segregated growing facility. The negative gilts are retested 30 days after the last addition.

Once the new herd has been established, the original herd is depopulated.¹⁹ The premises should be disinfected and kept empty for at least 30 days before the new gilt herd is added.^{18,19}

3) Depopulation. The third option, depopulation, is the most likely plan to succeed in a confinement operation with a high level of infection.¹⁹ In the past, the herd was usually depopulated over several months as the hogs reached market weight; however, a USDA APHIS indemnity plan now encourages producers to depopulate the entire herd at one time.¹⁹⁻²¹ After depopulation, the premises should be cleaned and disinfected and left empty for 30 days.¹⁹ A longer period may be necessary in some cases. The new herd should be retested 30 days after the farm is repopulated.¹⁹

h. Public health consequences

Although seroconversion has been seen, pseudorabies does not affect humans.^{1,3}

i. Economic impact

Before 1998, U.S. pork producers alone spent over \$30 million annually on pseudorabies.²² Vaccination of herds cost approximately \$17 million while \$11 million was attributed to pig deaths. The remaining \$2 million was spent on testing.

2. HISTORY OF PSEUDORABIES AND ITS CONTROL PROGRAMS

Pseudorabies, also known as “mad itch” and infectious bulbar paralysis, has existed in the United States since at least 1813.^{3,4,10} The first scientific report, published in 1902, was a description of the disease in Hungarian cattle and dogs written by Dr. Aladar Aujeszky.^{3,4,11} In many countries, pseudorabies is still known as Aujeszky’s disease.

Until the middle of the 20th century, pseudorabies in the U.S. was a mild and often asymptomatic infection, except in suckling pigs.^{3,4,10} However, in 1962 a virulent strain appeared in Indiana and began to spread across Midwestern pig farms and then to the rest of the U.S.⁴ The cause of the increased virulence will probably never be determined; hypotheses include increased confinement rearing, eradication of classical swine fever and the discontinuation of its antiserum, and a mutation or change in the virus itself.^{1,3,4} By the 1970s, pseudorabies had become widespread and in 1973 and 1974, concentrated pseudorabies outbreaks occurred in the Midwest.^{3,23} Pork producers began to demand that infected herds be quarantined and the movements of infected pigs be controlled.²³ States without pseudorabies problems asked to be classified as pseudorabies-free to facilitate the movement of pigs. In response, a Livestock Conservation Institute (LCI) task force defined two state stages. The National Pseudorabies Control Board, which contained members from the LCI, the U.S. Animal Health Association (USAHA), and the National Pork Producers Council, was given the authority to oversee the stages and determine the status of each state. This board still exists as an advisory body which reviews state status applications in the current eradication program and makes recommendations to APHIS.²³

In 1976, an USAHA resolution endorsed eradication.²³ In the pork industry, the relative merits of eradication and control continued to be debated into the 1980s.²³ However, pilot projects eventually convinced the industry that eradication would be feasible and an industry group drafted an eradication plan, which was approved in 1986-1987 by pork industry groups, the National Pork Producers Council and USAHA. USAHA drafted the initial program standards, which were approved in 1988 and published by USDA-APHIS in 1989. The eradication program was aided by the development of gene-deleted vaccines, which became available in 1988.²³

The original goal of the pseudorabies program was complete eradication by the year 2000.²¹⁻²³ By 1999, approximately 1,000 infected herds, just under 1% of all swine herds, remained in the U.S.²¹⁻²² In January 1999, a severely depressed market for pork led to decreased vaccination among struggling pork producers, prompting the declaration of a state of emergency by the U.S. Secretary of Agriculture.²¹ This declaration provided funds that allowed APHIS to purchase and depopulate infected herds and conduct increased surveillance. Currently, the program goal is to have the domestic herds in all states, Puerto Rico, and the U.S. Virgin Islands pseudorabies-free by the end of FY 2005.¹³ Plans to control pseudorabies in states with infected feral and wild pigs are also in development.¹³

3. CURRENT CONTROL PROGRAM

The pseudorabies eradication program identifies infected pigs and eliminates infected herds by depopulation or herd management. The program has five stages, beginning with a preparatory phase in stage I and culminating in the pseudorabies-free stage V. Stage II, III, IV and V states must be re-certified at 12-14 month intervals; stage I status applies for 24-28 months.¹⁸ States

must apply each year for re-certification or lose their status. States in stage III and below must also demonstrate progress in herd cleanup consistent with the goal of eradication by FY 2005.¹⁸

a. State Classifications

1) Stage I. In stage I, a state establishes a pseudorabies committee and prepares for pseudorabies surveillance and eradication.¹⁸ Stage I states must establish the authority to impose quarantines, trace infected pigs, regulate shipments of swine within and into the state, control vaccine use, and other activities necessary for the program.

2) Stage II – Control. In stage II, infected herds are identified and voluntary herd cleanup begins.¹⁸ The herd cleanup plan should be based on the National Institute for Animal Agriculture's Swine Pseudorabies Eradication Guidelines.¹⁸ These plans include test and slaughter, offspring segregation, and depopulation plans. Stage II states must have a surveillance program. Sows and boars are tested for pseudorabies at slaughter, on the farm, or at the first point of concentration.¹⁸ Circle-testing is also done for 1.5 miles around all infected herds.¹⁸

Swine movements within the state are controlled as the state finds necessary; however, the state must control the importation of pigs in conformance with federal regulations.¹⁸ Unexposed breeding pigs entering the state must be negative on an official test within the 30 days before they are shipped, unless they come from qualified pseudorabies negative (QN) or qualified pseudorabies negative gene-altered vaccinated (QNV) herds or are shipped directly from the farm of origin in a stage IV or V state.¹⁸ Breeding pigs that come from an all class market must be isolated and retested in 30-60 days at the importer's expense. Unexposed feeder pigs must also test negative unless they come from a QN, QNV or pseudorabies-monitored feeder-pig herd, or directly from the farm in a stage III, IV, or V state. Pigs from an approved feeder pig market can be imported for feeding without restrictions. Unless they have been exposed to pseudorabies, all pigs can be imported directly to slaughter, approved slaughter markets, or feeding at a quarantined feedlot without testing.^{18,24} Infected or exposed pigs also can be sent directly to a slaughterhouse or approved slaughter market, but only by permit and in sealed vehicles.^{13,18} Other livestock cannot be moved interstate if they have symptoms of pseudorabies or have been exposed to pseudorabies during the last 10 days.²⁴

Wild or feral swine can be sent for immediate slaughter without testing; however, pigs moved to hunting preserves and game farms, or for exhibition or feeding, must be negative within the 30 days before they are shipped.¹⁸ Wild and feral pigs sent for breeding must be isolated for 90 days and test negative on two official pseudorabies tests, done at least 60 days apart. Pigs that have been exposed to wild or feral swine must be quarantined until they are known to be uninfected.

3) Stage III—Mandatory. During stage III, eradication efforts are intensified and herd cleanup by test-and-slaughter, offspring segregation, or depopulation becomes mandatory.¹⁸ Vaccination can be permitted by the State animal health official as part of a herd-cleanup plan and in area control programs.¹⁸ States must continue to conform to all stage II regulations. In addition, the prevalence of infection must be 1% or less.¹⁸

Surveillance is intensified during stage III. The surveillance program can test pigs at slaughter and the first point of concentration, or use herd testing.¹⁸ If the testing is at slaughter and the

first point of concentration, the state must maintain a surveillance index of 0.08.¹⁸ The surveillance index is the percentage of the sows and boars sampled, multiplied by the percentage of positive pigs traced back to the farm of origin.¹⁸ If no animals are positive, the surveillance index is simply the percentage of sows and boars sampled. At least 10% of all breeding swine population must be randomly tested each year with an official pseudorabies serologic test, and at least 80% of the seropositive animals must be traced back to the farm of origin.¹⁸ If surveillance is by herd testing, at least 25% of the swine herds in the state, or 10% of the breeding swine, must be tested annually with an official random sample test (95/10) or a monitored herd test.¹⁸ If an official random-sample test (95/20) is used, 33% of the herds must be tested.

If a positive herd is found, all herds that have sold animals to, or received animals from, the infected herd are traced.¹⁸ These herds are tested with either an official random-sample test or a test on all breeding pigs. All establishments within a 1.5-mile radius of the infected premises must also be tested.¹⁸ In stage III states, pigs cannot be moved from a quarantined herd unless part of the herd was at the new location when the herd was quarantined or unless such movement is part of the herd-cleanup plan.¹⁸

4) Stage IV—Surveillance. To enter stage IV, the state can have no infected herds, the stage III surveillance program must have been in place for at least two years, and no new cases of pseudorabies can have been identified during the year before application.¹⁸ An exception may be made if, in an isolated incident, the herd was culled within 15 days, the infection did not spread to other premises, and all exposed herds and herds within two miles of the new case were tested with an official random sample test (95/5).^{13,18} In stage IV states, vaccination is only allowed in certain high-risk herds or as part of an approved herd-cleanup plan by special permit from the State Veterinarian.^{13,18}

Breeding herds must be under surveillance as in stage III states.¹⁸ Feedlots without breeding animals must be included in a down-the-road (area) herd-testing program or monitored by slaughter or first-point surveillance of butcher hogs.¹⁸ These provisions do not apply if, since the last case in the state was cleaned up, the feedlot herd was negative on an official random-sample test (95/10) or has undergone a 30-day depopulation, with appropriate cleaning and disinfection. All other untested feedlots must be operated as an all-in/all-out premises.

There are no restrictions on the intrastate movement of swine in a stage IV state; however, imported animals may still need to be tested for pseudorabies.¹⁸ Unexposed breeding pigs can be imported directly from a QN herd or from a stage IV or V area without testing.¹⁸ Other breeding pigs must be tested within the 30 days before shipment, isolated, and retested at their destination 30–60 days after shipment.¹⁸ Feeder pigs can be imported if they come directly from the farm of origin or a market in a stage IV or V state, the farm of origin in a stage III state, or a QN or QNV herd. Feeder pigs can be imported, by permit, from feeder pig monitored herds or approved feeder pig markets in stage II states if they go directly to a designated feedlot and are quarantined until they are sent to slaughter. Infected or exposed slaughter swine can only be shipped into a stage IV state by permit and prior approval from the State Veterinarian, and must go directly to a slaughterhouse or an approved slaughter market in sealed vehicles.^{13,18} Federal or state officials must supervise their unloading. Unexposed slaughter swine from stage I, II or III states are allowed to go only to a slaughterhouse or approved slaughter market.¹⁸

If a case of pseudorabies is confirmed in a stage IV state, the national program coordinator for Veterinary Services must be notified immediately.^{13,18} The county, as well as all other counties within a two mile radius of the new case, revert to stage III status until 60 days after quarantine release.^{13,18} All exposed herds and herds within two miles of the case must be tested with an official random sample test (95/5) between 30 and 60 days after cleanup.^{13,18} If the infected herd is isolated and depopulated within 15 days and the infection has not spread to other herds, the state can regain its stage IV status.

5) Stage V – Free. In stage V, the state is declared pseudorabies free. A state can enter stage V if it has been free of pseudorabies for one year since it became stage IV.¹⁸ Surveillance continues on breeding herds in stage V states at half the required rate for stage III and IV states.^{13,18} Once all states are in stage IV or V, surveillance will not be required in stage V states that have no feral swine, have been in stage V for at least 5 consecutive years, and have not had any cases of pseudorabies for 5 years.^{13,18}

Slaughter hogs, breeding swine, and feeder pigs can be imported as in stage IV states.¹⁸ Vaccination is only allowed in certain high-risk herds, by special permit from the State Veterinarian.^{13,18}

If a case of pseudorabies is confirmed in a stage V state, the national program coordinator for Veterinary Services must be notified immediately.^{13,18} The county, as well as all other counties within a two mile radius of the case, revert to stage III status.^{13,18} All other counties in the state revert to stage IV status. The affected county can be reinstated to stage IV if it meets all of the requirements for herd cleanup and testing in stage IV states.¹⁸ If these requirements are met, the state can remain in stage V.

If pseudorabies is found in a stage IV or V state, all counties within a two mile radius revert to stage III until 60 days after the quarantine release.^{13,18} In stage V states, all other counties revert to stage IV status. The national program coordinator for Veterinary Services must be notified immediately. In turn, the national program coordinator and state officials notify all 50 states of the outbreak. All exposed herds and herds within two miles of the case must be tested with an official random sample test (95/5) between 30 and 60 days after cleanup. If the infected herd is isolated and depopulated within 15 days and the infection has not spread to other herds, the entire state can regain stage IV or V status.

b. Herd classifications

1) Pseudorabies-monitored feeder pig herds. In a stage III, IV, or V states or areas, a pseudorabies-monitored feeder pig herd includes any breeding herd not known to be infected with pseudorabies.¹⁸ In stage I and II states, a herd can qualify if 10-30 randomly selected animals, depending on the size of the herd, were all negative on an official pseudorabies test during the last 12 months.¹⁸

2) Qualified negative herds (QN). All breeding herds in stage IV and V states are recognized as qualified pseudorabies negative (QN) breeding herds.¹⁸ In stage III or lower status states, a herd can become a QN herd if all pigs over 6-months old, plus a percentage of the 4-6 month old progeny, are negative for pseudorabies.¹⁸ At least 90% of the pigs must either have been part of the herd for the last 90 days, or have come directly from another QN herd.^{17,24}

QN breeding herds must be re-tested monthly or quarterly for pseudorabies.^{17,18} If the herd is tested monthly, 7% of all 6-month old and older breeding swine, and a percentage of their 4-6 month-old offspring, are tested. The State Veterinarian in stage III, IV, or V states can allow QN herds to maintain their status with a monthly official random sample test (95/5) in the breeding swine and 50 offspring.¹⁸ In quarterly testing, 20% of all 6-month old and older breeding swine, and a percentage of their offspring, are tested every 80 to 105 days.^{17,18}

3) Qualified negative gene-altered vaccinated herds (QNV). Qualified-negative gene-altered vaccinated (QNV) herds are qualified under the same guidelines as QN herds, except the herd can be vaccinated with an approved gene-deleted vaccine and the herd is tested with an official differential test.¹⁸ Official vaccinates must be vaccinated by an accredited veterinarian or a state or federal veterinarian.²⁴ These pigs are identified with a numbered pink eartag. QNV status can be maintained with a single annual test or by monthly or quarterly testing.²⁴

Swine can be added directly from a QN to a QN herd or a QNV to a QNV herd, without testing.¹⁸ Other pigs must be isolated until they have had a negative serologic test 30 days or more after shipment. Swine from a herd of unknown status must also be negative on an official serologic test during the 30 days prior to movement.

4) Feral/wild swine program. States with feral swine must ensure that domestic pigs and feral swine do not come into contact.^{13,18} USAHA recommends that feral and wild pigs be handled in a separate national feral/wild swine program.¹³ The program will need to provide for surveillance of wild pigs, an educational program, and a separate marketing system for feral/wild swine with surveillance, identification, and traceback capabilities. States with infected wild pigs will need additional testing of domestic herds to assure other states of their disease "free" status.¹³ USAHA has recommended that such additional testing and/or surveillance be added to the Pseudorabies Eradication Program Standards.

c. Accelerated Pseudorabies Eradication program

The Accelerated Pseudorabies Eradication Program (APEP), which was established in 1999, is intended as a way to quickly reduce the number of infected herds by whole herd depopulation.²⁰ USDA pays the producer the fair market value for a depopulated herd and also pays all associated costs for the depopulation, including transportation, euthanasia, disposal, equipment, and employee salaries.²⁰ Herds are not required to participate in the indemnity program or depopulate the herd, but must still adhere to all program regulations.

Any infected commercial swine herd can participate.^{20,22} The producer initiates the process by contacting the USDA.²⁰ The Area Veterinarian in Charge (AVIC) prioritizes the applications based on feedback from the official pseudorabies epidemiologist, State Veterinarian, the State Pseudorabies Committee, and the National Pseudorabies Coordinator. USDA and state personnel visit the premises and jointly conduct an appraisal of the swine, based on the fair market value.²⁰ If state authorities approve, an APHIS representative can do the appraisal alone.²² If possible, the appraisal and depopulation should take place on the same day.²⁰

The producer is allowed seven working days to accept or reject the plan.²⁰ The AVIC must also approve the appraisal and indemnity claim before the herd is depopulated. Pigs can either be

ethanized on the farm or, if several sites need to be depopulated, transported to a central facility and killed there. The carcasses are rendered whenever possible, but burial may be considered in some circumstances.

After depopulation, all premises and vehicles used to transport infected animals must be cleaned and disinfected, under the supervision of an APHIS representative or state employee.²² Producers are responsible for cleaning and disinfecting their own premises and the associated costs.^{20, 22} The premises can be restocked after a minimum of 30 days.²²

4. CONTROL PROGRAM STATUS

The pseudorabies eradication program is nearing completion. At the end of 2003, a total of 46 states, plus Puerto Rico and the U.S. Virgin Islands were in Stage V. The current goals for the program are for 49 states, Puerto Rico, and the U.S. Virgin Islands to be in stage V by the end of FY 2004, and all states to be in stage V by the end of FY 2005.²⁷

In January 1999, the Secretary of Agriculture declared an emergency due to pseudorabies, citing the severely depressed swine prices in the U.S. and the resulting failure to vaccinate many swine herds due to economic hardship.²¹ The decrease in vaccination had increased the risk of spreading pseudorabies to additional herds and slowing eradication. The declaration of emergency established the voluntary accelerated pseudorabies eradication program. This program allows APHIS to purchase and depopulate infected herds.^{13,21} It also provides funds to conduct surveillance of adjacent herds, vaccinate pigs in high risk areas, and continue enhanced surveillance in high-risk areas and at slaughter for both breeding and "finisher" swine.

As of November 1, 2003, four states - Florida, Iowa, Pennsylvania and Texas - were in stage IV.¹⁶ All other states were in stage V - Free.²⁷

In FY 2003 (October 1, 2002 through September 30, 2003), twenty-three pseudorabies-infected herds were found across the U.S.¹⁶ Nine herds were located in Texas, eight in South Carolina, two in Arkansas, and one each in Pennsylvania, Hawaii, Tennessee and Alabama. All of these herds, except the one in Pennsylvania, either contained or were exposed to feral/wild pigs.²⁷

5. ROLE OF THE VMO IN THE PSEUDORABIES ERADICATION PROGRAM

Full time state or federal animal health veterinarians must supervise the Cooperative State-Federal-Industry Pseudorabies Eradication Program.¹⁸

a. Accelerated Pseudorabies Eradication Program

In the Accelerated Pseudorabies Eradication program (APEP), APHIS Veterinary Services field services:²⁰

- 1) Monitors and advises on depopulation, indemnity, and program enrollment.
- 2) Coordinates plans with local investigative officers to ensure proper security and control.
- 3) Coordinates depopulation plans with renderers, slaughterhouses, and the USDA - Food Safety and Inspection Service (FSIS).
- 4) Facilitates and coordinates all general administrative support and service activities, and provides support on appraisals, contracts, leases, finances, state cooperative agreements, personnel, and safety.

The APEP Headquarters team is responsible for communications, including the dissemination of information from the field to the Veterinary Services Deputy Administrator's office and other state and federal agencies.²⁰ The headquarters team generates national monthly reports from state reports, provides information to the national media, and maintains liaisons with national industry groups. It also provides assistance and advice on technical issues such as euthanasia, cleaning and disinfection, transportation, and rendering, as well as training guidelines and aids to field personnel. At the National Center for Animal Health Programs, the team monitors and advises on depopulation, indemnity, and program enrollment, and coordinates all general administrative support and services. It also coordinates the depopulation plans with the FSIS, renderers, slaughterhouses, and local investigative officers.

b. Testing and diagnosis

Official pseudorabies tests include virus isolation and identification, the fluorescent antibody tissue section test, the microtitration serum-virus neutralization test, enzyme-linked immunosorbent assay (ELISA), latex agglutination, and particle concentration fluorescence immunoassay (PCFIA).^{17,22,24} Approved differential tests, including ELISA and PCFIA differential pseudorabies tests, can distinguish vaccinated pigs from unvaccinated animals.²⁴ All blood samples taken as part of an official state pseudorabies program, including samples collected at markets, must be submitted to a designated program laboratory within 24 hours.¹⁷

Official random-sample tests are classified as 95/20, 95/10 and 95/5 tests. A 95/20 test samples enough pigs in the herd that there is a 95% chance of detecting pseudorabies in herds containing at least 20% seropositive swine.¹⁸ Likewise, 95/10 and 95/5 tests have a 95% probability of detecting infected herds containing 10% and 5% infected pigs, respectively. The number of pigs to be tested varies with the size of the herd.

All suspected cases of pseudorabies must be reported by producers, veterinarians, animal health inspectors, and diagnostic laboratories to the state animal health official.^{17,18} On the day of the results, laboratories must report any pseudorabies-positive test results from slaughter animals to officials in the state of origin, the State Veterinarian, and the AVIC.¹³

c. Managing an infected herd

State or federal program officials should notify local swine owners within 30 days of a herd quarantine for pseudorabies, quarantine release, or approval of a quarantined feedlot.¹⁸

In stage II and III states, a herd-cleanup plan must be in place within 30 days of quarantine.¹⁸ All quarantined breeding herds must be tested with a whole-herd test every 30 days.¹⁸ Test positive sows and boars are sent for slaughter or isolated for slaughter within 15 days. All quarantined continuous-flow finishing sites are tested every 45 days with an official random sample test (95/10).¹⁸ If positive pigs are found on two consecutive tests, no pigs can be added to the premises until the quarantine is released. Unless the State Veterinarian and pseudorabies epidemiologist recommend otherwise, all pigs in the quarantined herd and all swine within two miles of the herd should be vaccinated.¹⁸

If pseudorabies is found in a stage IV or V state, all counties within a two mile radius revert to stage III until 60 days after the quarantine release.^{13,18} In stage V states, all other counties revert to stage IV status. The national program coordinator for Veterinary Services must be notified immediately. In turn, the national program coordinator and state officials notify all 50

states of the outbreak. All exposed herds and herds within two miles of the case must be tested with an official random sample test (95/5) between 30 and 60 days after cleanup. If the infected herd is isolated and depopulated within 15 days and the infection has not spread to other herds, the entire state can regain stage IV or V status.

d. Quarantine release

A site can be released from quarantine if the herd is depopulated and the premises cleaned and disinfected under official supervision.^{18,24} The premises cannot be restocked with swine for at least 30 days.

In stage III and below, the quarantine can also be lifted if all positive pigs have been removed and all remaining pigs, other than nursing piglets, are negative on an official test after 30 days.¹⁸ Alternatively, all breeding pigs are tested and an official random sample (95/10) test is done on all 2-month old and older pigs. If the state is in stage III, grower finishing swine are tested again after 30 days. The quarantine can also be released in stage I, II and III states if all pigs present on the first day of quarantine were removed and the herd has been free of clinical signs for at least 6 months.¹⁸ The breeding herd must be negative on two random-sample (95/10) tests, at least 90 days apart, in stage I and II states, and two 95/5 tests in stage III states. The 4-month old and older progeny must be tested with two random-sample (95/10) tests, at least 90 days apart. If the quarantine is released by this method, a final 95/10 test is done a year later.¹⁸

If the quarantined herd has no breeding swine, it can be released if the premises were depopulated and disinfected, left empty for at least a week, and a (95/10) random sample test is negative after 30 days or more.¹⁸ Alternatively, the herd can be released with a (95/10) random sample test, followed by a (95/5) test at least 30 days later, and another (95/10) test 60 to 90 days after the quarantine was released.¹⁸

e. Surveillance

Routine passive surveillance includes change-of-ownership testing, testing before a show or exhibition, diagnostic testing in cases with clinical signs, and sampling of hunter killed feral swine tissue.^{17,18} All suspected cases of pseudorabies must be reported by producers, veterinarians, animal health inspectors, and diagnostic laboratories to the state animal health official.^{17,18}

Sentinel surveillance includes annual herd testing of QN herds.¹⁷ In some states, negative feral swine populations from geographically defined areas may also be continuously monitored.¹⁷ Epidemiologic testing includes circle testing and tracing of movements into and out of infected herds.¹⁷

In area testing, blood samples are collected on-farm from targeted swine herds in high incidence areas or areas with infected feral pig populations.¹⁷ Surveillance is also required on some pigs during interstate movement.

States in stages III and IV must maintain a surveillance index of 0.08.¹⁸ In general, the only tests included in this index are Market Swine Testing and slaughter surveillance. In Market Swine Testing, blood samples are collected from sows and boars at concentration points such as auction markets and buying stations.^{17,18} Blood samples are also collected from cull breeding swine at slaughter establishments.^{13,17,18} Surveillance of finisher swine at slaughter was begun

in 2001.¹³ This surveillance is based on testing the "meat juice" recovered from the diaphragm muscles of carcasses. Positive animals from market or slaughter surveillance are traced back to their farms of origin.

If a state uses herd testing for surveillance, at least 25% of the herds or 10% of all breeding swine must be tested annually with an official random sample test (95/10) or a monitored herd test.¹⁸ If an official random-sample test (95/20) is used, 33% of the herds must be tested.

In stage V states, surveillance of breeding herds continues at half the rate required in stage IV.¹⁸ Once all states are in stage IV or V, surveillance will not be required in stage V states that have no feral swine, have been in stage V for at least 5 consecutive years, and have not have any cases of pseudorabies for 5 years.^{13,18}

6. ROLES OF OTHER AGENCIES , STATES, AND INDUSTRY

The pseudorabies eradication program is a national program, conducted in cooperation with state governments and swine producers.^{21,22}

The federal government is responsible for coordinating the eradication program.²² APHIS' Regional Offices provide Regional Program Coordinators, Regional Epidemiologists, technical support personnel, and administrative support as needed.²⁰ APHIS Veterinary Services personnel periodically review the progress of state pseudorabies programs to ensure compliance with the program standards.¹⁸ The AVIC is responsible for generating monthly reports on the state's depopulation activities.²⁰ Applications for advancement in status must be reviewed by the National Pseudorabies Control Board and approved by the Veterinary Services pseudorabies eradication program staff prior to a final decision by the Deputy Administrator.²⁷

State governments enforce pseudorabies regulations within the state.²² The state pseudorabies committee, which is composed of pork producers, animal scientists, state and federal regulatory officials, and other representatives of the swine industry, is responsible for disseminating information about pseudorabies eradication to producers.¹⁸ This committee also reviews the state pseudorabies program and makes recommendations to state and federal animal health officials.¹⁸ The committee maintains contacts with other states and the national pseudorabies eradication program through the National Pork Board, USAHA, the National Institute for Animal Agriculture, and APHIS.¹⁸

Producers are responsible for having their herds tested and purchasing their own vaccines, practicing good management, and handling their own animals.^{18,22} A committee of pork producers reviews the national pseudorabies eradication program and program expenditures at least once a year.¹⁸

Both state and federal employees are responsible for carrying out the APEP. In each state, the AVIC, official pseudorabies epidemiologist, State Veterinarian, and state pseudorabies committee are responsible for implementing the APEP.²⁰ The official pseudorabies epidemiologist reviews applications from producers, maintains the participating herd records, and determines, for each case, the disease risk of multi-site premises, whether test-negative swine on premises can become replacements and if restocking should include vaccination.²⁰ The AVIC prioritizes the applications based on feedback from the official pseudorabies

epidemiologist, State Veterinarian, and the state pseudorabies committee.²⁰ An APHIS employee and a state representative jointly appraise the fair market value of the herd although, if state authorities approve, an APHIS representative can do the appraisal alone.^{20,22} The AVIC, VS depopulation technical advisors, the official pseudorabies epidemiologist, State Veterinarian, and state pseudorabies committee develop the plans for herd depopulation and disposal of the carcasses.²⁰ The AVIC submits the plans to the Regional Program Coordinators and the National Pseudorabies Program Coordinator for approval.²⁰

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