Leptospira 1

Introduction and pathogenesis

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Leptospira infection in pigs is generally subclinical, particularly in endemic regions, but it can cause severe disease depending mainly on the infecting serovar and the age of the animals. Thus, clinical pictures characterised by meningitis, jaundice and haemoglobinuria have been described in young pigs caused by infection with incidentals or non-adapted serovars, mainly canicola, icterohaemorrhagiae and grippotyphosa. In adult pigs, clinical symptoms are characterised mainly by reproductive disorders such as late abortions and increasing of mummified, stillbirths and weak piglets. Furthermore, infertility with return to regular or irregular service, sometimes accompanied by vulvar discharges, can be observed in the particular case of the adapted serovars of australis serogroup, particularly serovar bratislava.

Leptospires are spirochetes, about 0.1 m in diameter by 6-20 m in length and include both saprophytic and pathogenic species comprising the genus Leptospira, which belongs to the family Leptospiraceae, order Spirochaetales. Leptospires have a typical double membrane structure in which the cytoplasmic membrane and peptidoglycan cell wall are closely associated and are overlaid by an outer membrane. Within the outer membrane, the LPS constitutes the main antigen for Leptospira.

The genus Leptospira is currently formed by 23 species distributed in three groups according to their pathogenicity: pathogens, saprophytes and an intermediate group. The species of Leptospira are categorised in 250 basic taxon o serovars by agglutination-absorption patterns according to expression of surface antigens. Finally, serovars antigenically related are grouped in 24 artificial taxon referred to as serogroups (Table 1).

Pigs act as maintenance host for serovars bratislava, pomona and tarassovi. Among these adapted serovars, only serovar bratislava has a worldwide distribution. Pomona serovar, which is classically associated with pigs, has been the cause of clinical outbreaks in North and South America, some Asian countries, Australia and Eastern Europe, but it has not been reported west of Italy. Finally, serovar tarassovi is described primarily in Australia, New Zealand and Eastern Europe, but is rare in Western European countries. Among the incidental serovars (pig is not a maintenance host), the most important described in pigs are those belonging to icterohaemorrhagiae, canicola, and grippotyphosa serogroups.

Table 1. Most important leptospiras reported in pigs.

Species	Serogroup	Serovar
L. borgpetersenii	Tarassovi	Tarassovi
L. interrogans	Australis	Bratislava
		Muenchen
	Canicola	Canicola
	Icterohaemorrhagiae	Icterohaemorrhagiae
	Pomona	Pomona
L. kirschneri	Grippotyphosa	Grippotyphosa
	Pomona	Mozdok

Leptospires enter the body through small cuts or abrasions, via mucous membranes such as the conjunctiva or through wet skin. One or two days after the infection there is a phase of leptospiremia which lasts about 4-7 days. During this period, leptospires enter and multiply in many tissues, including the liver, kidneys, reproductive tract, eyes, and central nervous system.

After the number of leptospires in the blood and tissues reaches a critical level, lesions due to the action of undefined leptospiral toxin(s) or toxic cellular components appear and consequent symptoms may be observed. This phase of infection usually goes unrecognised in adult animals. In experimental infections or during infection in a previously unexposed herd, many pigs can present mild anorexia, fever and slight conjunctivitis; but in many cases, and especially in endemically infected farms, frequently is undetected. The primary lesion is damage to the endothelium of small blood vessels leading to localised ischemia in organs, resulting in renal tubular necrosis, hepatocellular and pulmonary damage, meningitis, myositis and placentitis. There is usually a mild granulocytosis and splenomegaly.

Approximately 5-10 days after infection, agglutinating antibodies can be detected in serum and reach maximum levels around 21 days post-infection. This immune response results in the clearance of leptospires from blood and the majority of the organs; however, depending on infecting serovar, the leptospires can remain in the proximal tubules of the kidneys and also in the utero of pregnant sows.

Tissue damage, even though it is severe, may be reversible and followed by complete repair (for example kidney, liver) although long-lasting damage may be a complication and may lead to scarring, well recognised in the kidneys. The consequence of the persistence and replication in kidney is the shedding of leptospires in the urine. The duration of leptospiruria is short in infections by incidental serovars (2-3 months) and longer in adapted serovars, may last for up two years in pomona infection. In some of these chronic carriers, gross lesions consist of multifocal intersticial nephritis, usually called 'white spotted' (irregular whitish areas, of up to 1cm in diameter in the kidney) that may be observed at slaughter.

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Leptospira 2

Clinical signs and lesions

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Leptospirosis is a systemic disease of humans and domestic animals, mainly dogs, cattle and swine, characterised by fever, renal and hepatic insufficiency, pulmonary manifestations and reproductive failure. Clinical signs are quite variable; most cases are probably unapparent and associated with host-adapted serovars such as canicola in dogs, bratislava in horses and pigs, hardjo in cattle and tarassovi and pomona in pigs. In case of infection by non-adapted serovars (incidental ones), piglets under three months of age can present a severe acute disease with high fever, jaundice, haemoglobinuria and convulsions. A large proportion of these piglets recover without treatment in less than one week, but some animals may die. In case of infection by adapted serovars, the acute phase is generally unapparent and usually abortion and infertility are the only clinical symptoms observed.

In the utero of pregnant sows, the infection of the foetuses occurs when leptospires cross the placental barrier, which only take place during the limited period of maternal leptospiraemia. So, the majority of foetuses in a litter become infected from half pregnancy onwards, and then abortions, stillbirths, and birth of weak piglets occur. The possibility of transplacental infection is much reduced in the first half of gestation and the consequences in this case could be the embryonic death with reabsorption and regular or irregular return to heat or the reduction in the litter size with or without the presence of mummies. In any case, the embryonic death, abortion, stillbirths and birth of weak piglets usually happen 7-60 days after infection.

In general, sows abort when they are infected by incidental serovars, whereas in adapted serovars infections, abortions or other reproductive consequences may be delayed by several weeks or months. Abortion, stillbirths, or birth of weak piglets of reduced viability which die shortly after birth, are usually the first and only signs of leptospiral infection in pregnant pigs. The aborted foetuses may show non-specific gross lesions, consisting of oedema of various tissues, serous or bloody stained fluid in body cavities, and sometimes petechial haemorrhages in skin, renal cortex and lungs. Small greyish-white spots on the liver due to focal necrosis are present in less than 10% of the cases, but are pathognomonic. Placentas from aborted foetuses are usually normal, but in some cases can be thickened and oedematous or brown and with necrotic appearance.

The clinical severity of leptospira infection is very variable depending on the serovar involved. Thus, infection by incidental serovars such as canicola, grippotyphosa or icterohaemorrhagiae may cause abortion storm, but these outbreaks are time-limited due to the excellent immune response generated (high antibody titers) and the short duration of the renal carrier state. Also, the seropositivity to serovar icterohaemorrhagiae was associated with an increased incidence of premature birth, stillbirth, weak newborn piglets, endometritis and high rate of abortions (23.5%). Likewise, seropositivity to serovar grippotyphosa has been associated with a one day longer weaning to service interval. In the case of adapted serovars, the clinical severity is different. Thus, for serovar pomona, once infection has been introduced in the swine farm, a high prevalence of infection is established and may cause severe losses. So, around 20% of pregnant sows can abort and the number of dead piglets/sow can reach 28%. Also, seropositive herds to serovar pomona had a bigger incidence of mummified foetuses, stillborn piglets and repeat breeding sows than seronegative herds. On the other hand, infection by serovar tarassovi is similar and endemic infection is also readily maintained. However, it does not spread as rapidly in a pig population and tends to be milder than pomona although outbreaks with 30% of abortions have been reported. Also, serovar tarassovi has been associated with overall impaired reproductive performance and with an increase of dead piglets per litter. Curiously, after the initial herd infection by adapted serovars, the infected pigs have usually generated an immune response, but many of them continue shedding leptospires in the urine for a long period of time.

There are important differences between serovars adapted of australis serogroup (bratislava and muenchen) and the other adapted serovars. Thus, bratislava infection persists in the genital tract of non-pregnant sows and boars. So, leptospiras were isolated from oviduct, uterus, vagina and supramammary lymph node of aborted sows killed five months after abortion. Infected animals by this serovar often have a poor and short agglutinating antibody response to infection. In previously uninfected herds or in herds with animals with declining immunity, the first effects may be similar to those observed in other infections by adapted serovars: abortions particularly in late gestation, premature births, litter size reduction, and the increase in stillbirths, mummification and birth of piglets of varying quality, including a high incidence of unviable piglets. However, the most important effect of bratislava infection would be the impact on the subsequent reproductive performance, with an increase in returns to service as much to regular as to irregular times (23-38 days) accompanied in many cases by mucopurulent discharges, which may occur 2-3 days before the return to oestrus and this is customarily referred as a low conception rate. Also, serovar bratislava may occasionally be implicated in major infertility outbreaks that last no more than five months.

Following the initial establishment of infection, an endemic cycle, where the sows have some immunity and the repeat breeders are only restricted to gilts or in some cases second pregnancy sows, can be observed. However, often there is a two-year cycle of disease in sows.

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Leptospira 3

Clinical and laboratory diagnosis – I

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Reproduction can be influenced by a number of infectious and non-infectious factors. For this reason, the diagnosis of reproductive disorders is a complex process that requires not only a clinical but also a laboratory approach. In fact, it must check data records, clinical observation, pathological examination and laboratory testing. The laboratory tests used in the diagnosis of leptospirosis can be classified into two groups: direct and indirect methods. Direct methods are based on the demonstration of leptospires or their components in pig tissues and primarily include culture, polymerase chain reaction (PCR), immunostaining techniques [fluorescent antibody test (FAT) or immunoperoxidase assay (IPA)], histopathology (Warthin-Starry stain) or dark field microscopy. Indirect methods are serological tests that are based on the detection of specific antibodies. The most internationally used is the microscopic agglutination test (MAT). Other serological tests include immuno-enzymatic assays (ELISA) or complement fixation test (CFT) but they are less used.

The diagnostic value of the different tests will depend mainly on stage of infection and the infecting serovar. Thus, it will also be necessary to take into account several parameters in the choice and interpretation of the results. The most important parameters would be sensitivity, specificity, and ability to determine the infecting serovar or at least infecting serogroup, and possibility to differentiate between infected and vaccinated animals. In general, it would be advisable to use a combination of direct and indirect diagnostic techniques in order to ensure a diagnosis of leptospirosis and identify the infecting serogroup or serovar.

CLINICAL AND DIFFERENTIAL DIAGNOSIS

There are many infectious diseases responsible for reproductive disorders in swine (Table 1). Thus, swine viral infections usually appear as reproductive outbreaks in sows and cause similar reproductive symptoms such as late-term abortion, stillbirths and weak-born pigs and these manifestations are very similar after bacterial infections. Curiously, in most cases, there is usually an absence and presence of gross lesions in foetus and placenta after viral and bacterial infections, respectively. Thus, the presence of fibrinous exudates, necrosis or haemorrhages on the surface of placenta and/or other viscera in the foetus is suggestive of bacterial infection. On the other hand, the presence of microscopic lesions such as non-suppurative encephalitis, myocarditis, and interstitial pneumonia are rather suggestive of viral infection. On the contrary, the observation of purulent lesions in the placenta or foetal organs is suggestive of bacterial infection. Finally, the icterus and/or small grayish-white spots on the liver due to focal necrosis are characteristic of leptospirosis but it is an uncommon finding.

Table 1. The most common infectious causes of infertility, embryonic death, abortion and stillbirths in pigs.

Viral diseases	Infertility	Embryonic death	Abortion	Stillbirth
PRRSV*			+	+
PCV2**		+	+	+
Porcine Parvovirus (PPV)		+		+
Aujeszky virus		+	+	+
Swine influenza virus	+		+	+
Classical swine fever		+	+	+
Bacterial diseases				
Leptospira spp	+	+	+	+
Brucella spp	+		+	+
Parasite diseases				
Toxoplasma gondii			+	+

*Porcine Respiratory and Reproductive syndrome virus
**Circovirus porcine type 2

SAMPLES SUBMISSION

The clinician must decide to take samples for laboratory testing after studying the production records and carrying out a clinical and pathological examination. If an infectious disease is suspected, maternal, placental and foetal factors must be considered. In case of abortion, the sampling of foetus and placenta could be essential but maternal samples must also be collected to rule out any infectious agent that may not be found in the foetus. When possible, the submission of weak and live neonates could be also useful. On the contrary, mummified foetuses are usually not suitable for testing, except for PPV and Toxoplasma gondii. In general, it is advisable to contact the laboratory before submitting samples. Laboratories do not always have all available techniques. They should indicate the appropriate samples to collect and advise on the suitable adequate transport media and indicate the transport conditions (mainly temperature and time) with the final goal that the samples arrive at the laboratory in correct conditions.

The laboratory diagnosis of acute leptospirosis is relatively uncomplicated, both by direct and serological methods. The culture is not too difficult, except for serovar bratislava, and other direct tests such FAT or immunoperoxidase produce reliable results because the leptospires are abundant in tissues. Likewise, demonstration of a four-fold change in antibody titers in paired acute and convalescent serum samples (14-21 days after acute phase) are diagnostic. On the other hand, the diagnosis of chronic leptospirosis (reproductive disorders and renal carrier) is more challenging mainly in the case of bratislava infection due to the low bacterial load in tissues. Also, antibodies titers are declining or may be not detectable at the moment of abortion.

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Leptospira 4

Clinical and laboratory diagnosis – II

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Diagnosis of leptospirosis in swine is a challenge. The most common diagnostic methods can be classified as direct and indirect ones. Direct methods are focused on the detection and/or identification of the bacteria and the indirect ones are based on the detection of antibodies against the bacteria through serological methods.

DIRECT METHODS

The isolation and identification of leptospires, the visualisation of leptospires using silver staining or dark field microscopy, the detection of leptospiral antigens by fluorescent-antibody-test (FAT) or immunohistochemistry assays or the detection of leptospiral DNA in pig tissues or body fluids are diagnostic in animals with clinical signs of acute leptospirosis. The same findings from foetal tissues are also diagnostic of leptospiral abortion.

1-Isolation and identification of the agent

The isolation and identification of leptospires from tissues gives a definitive diagnosis of leptospirosis and allows identifying the infecting serovar. The method has high sensitivity and specificity for the diagnosis of leptospirosis. Culture is usually only available at reference laboratories but remains important for epidemiological purposes. Finally, bacterial culture is absolutely necessary to determine its antimicrobial susceptibility.

2-Polymerase chain reaction (PCR)

They are based on the detection of either different specific genes universally present in bacteria or genes restricted to pathogenic leptospira. The main advantages of PCR tests are the possibility to give an early diagnosis and it is not necessary to have viable leptospires to provide a positive PCR result. Finally, validation is the most important pending matter for the use of PCR in the diagnosis of animal leptospirosis.

3-Immunostaining techniques

Immunofluorescence (FAT) and immunochemistry tests are the methods of choice in foetal samples or death animals with advanced autolysis, since isolation can be difficult. Also, they are useful when a rapid diagnosis is required. The main disadvantage of these tests is that they are dependent of the number of leptospires present in the sample. Thus, they are not useful for the diagnosis of the chronic carrier state, where the number of bacteria may be very low.

4-Histopathology and dark-field microscopy

The advantages of silver-staining techniques are that they can be applied to formalin-fixed tissues and they may be a useful adjunct for histopathological diagnosis. However, histological techniques lack sensitivity and specificity and the infecting serovar cannot be determined. Dark-field microscopy from urine or internal fluids of animals and foetus has been used in the diagnosis of leptospirosis. However, it is a technique with low sensitivity and specificity because many tissue artefacts can be mistakenly identified as leptospires.

INDIRECT METHODS

Serological tests are the method most frequently used to confirm the clinical diagnosis. Although a wide variety of serological tests have been described, only the microscopic agglutination test (MAT) and the enzyme-linked immunosorbent assay (ELISA) are usually used in veterinary laboratories. Serology has diagnostic value in individual animals only in two situations. Firstly, when the acute phase is detected and seroconversion is demonstrated in paired serum samples spaced about 14-21 days. Secondly, when antibodies are detected in the blood and/or thoracic fluid of immunocompetent foetuses or in serum of colostrum-deprived piglets. In the diagnosis of abortion at animal level, serological tests could have diagnostic value in infections by incidental serovars or by serovar pomona. However, in the case of infections by serovar tarassovi and mainly by adapted serovars of australis serogroup, the value of serological tests is very limited.

1-Microscopic agglutination test (MAT)

The MAT is the most widely used test for diagnosing leptospirosis and is the standard serological test. The specificity is good considering that there are not usually cross-reactions with antibodies against other bacteria. However, vaccination and cross-reactivity between serovars and serogroups of leptospira can interfere in the MAT results interpretation. The MAT cannot be used to identify definitively the infecting serovar in an individual infection or herd outbreak. Also, antibody titres may persist at significant level against the different serovars included in the vaccine for until two months after vaccination.

2-Enzyme-linked immunosorbent assay (ELISA)

The OMP-based ELISAs have low specificity and detect antibodies against all pathogenic leptospires. Also, their sensitivity is poor in the case of infections by adapted serovars. They may be more useful in the diagnosis of infections by non-adapted serovars. The LPS-based ELISAs are serogroup specific and they are very useful for epidemiological studies. The main disadvantage is that their sensitivity can be less than 50% mainly in infections with serovar bratislava. Like the MAT, ELISA tests do not discriminate between infected and vaccinated animals.

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Leptospira 5

Prevalence of leptospiral infection in pigs

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Infection with leptospira has been demonstrated in all regions of the world where pigs are kept, but information about their prevalence depends upon the nature of the data available and may only apply to some, rather than to all of the serogroups and serovars recorded from pigs. The data have been generated in a number of ways, but the methods used fall into two main groups – those that demonstrate the organisms, their constituents and their products and those which demonstrate immunity to them, principally serum antibody to the organisms.

It is important to specify the husbandry system, as the leptospiral infections in free range pigs differ from those in intensively-housed animals and from those in wild boar or feral pigs. The type of sample used to demonstrate leptospira (blood, aqueous humour, kidneys, or aborted foetuses) may also affect the quality of the data.

PREVALENCE BY REGION

Country reports using serology list the antigens used, the sample size, some information about the source population and give the serogroups and serovars demonstrated. From these data, it is possible to say that leptospirosis has been demonstrated on all continents, although information from Africa is scant. There are reports from Nigeria, Zimbabwe (34%, 1999), Zambia and South Africa (22% slaughter pigs positive, 1995). There are numerous reports from Asia, from Japan, Korea, China (where data frequently refer to pigs from a single province and in a public health context), Vietnam, Laos, Thailand, India (60% positive, 2005) and Iran. In the Americas, there are reports from Argentina where one survey of 20,000 pigs found that 30% were positive in the MAT, mostly to Icterohaemorrhagiae and Castellana. A report from Venezuela found 53% of herds to be infected and 26.25% of pigs. Similar reports come from Brazil, Peru, Colombia, Mexico and Trinidad. There is little recent published data from the United States (57% pigs positive, 2000) and Canada, although case material and isolation studies confirm the presence of the agent. Leptospirosis has been reported from most European countries, but extensive surveys are relatively rare. There are recent data from Spain (86% herds have antibody and 34% individual pigs, 2014), Lithuania (42% pigs) Croatia 38% pigs, 2013) Greece (28% pigs, 2003), Serbia (2.7% pigs 2014), Poland (1.2% pigs positive, 2011). Case reports and analysis of past cases confirm the presence of infection in other countries. Records from Australasia report leptospiral infections in New Zealand at levels of up to 90% in slaughter pigs and there are reports of cases and wild boar infections from Australia. Wild boar and feral pigs have been studied worldwide because of their relevance to the domestic pig populations, particularly where there is extensive husbandry as in southwest Spain. The prevalence of infection varies from 3.1% in Sweden, through 10.7%, Poland,13%, the United States, 20.5%, Brazil, 45.8%, Slovenia, 48-53%, Australia to Portugal, 65.4%. The occurrence and prevalence of serogroups depend upon the strains circulating in local wildlife but includes serogroups for which the pig is a maintenance host.

PREVALENCE BY SEROGROUP/SEROVAR

Pomona serogroup contains pig adapted strains of pomona and kennewicki transmissible from pig to pig. These pig adapted strains are found throughout the world, but are less common in Western Europe. Data are often presented as a percentage of total leptospiral infection: thus Pomona antibody was present in 16% of infected pigs in Germany and 33% in Poland (2011). Tarassovi serogroup may be pig maintained in Eastern Europe (Poland 3% of positives, 2014), but has been reported from pigs in Vietnam and was considered common in India. Australis serogroup contains serovar bratislava, an important serovar which can be maintained in pigs. It occurs worldwide and was reported to be present in 66% of herds in Mexico (2011), 64% of herds in the UK (2006), 52% of sows in Lithuania, 8.8% of pigs in Quebec, Canada (1999) and 6.2% of herds in Spain (2014). It formed 41% seropositives in Germany (2011) and has been isolated in the United States and in The Netherlands. Its presence has been recorded in Zimbabwe, Sweden, Thailand and Serbia amongst others. Icterohaemorrhagiae is associated with the brown rat, its maintenance host, and infections reflect contact between the species. Prevalences of 19% (Mexico 2011), 16% positive herds, 7% positive pigs (Spain, 2014), 12% (Peru, 2012) are high, but lower prevalences, such as 6% (Poland, 2011) are not uncommon. Grippotyphosa is not reported from some countries (such as the UK), but was recorded in 4% positive herds and 0.3% positive pigs (Spain, 2014). Canicola has been recorded at low prevalence in many countries, but was reported in 3.5% of slaughter pigs in Brazil (2013).

CONCLUSIONS

Leptospiral infections are present in pigs all over the world, in intensively managed indoor herds, outdoor herds, backyard pigs and in wild boar and feral pigs. Information about their prevalence comes from serological examination of blood samples or foetal fluids using the classic MAT or, increasingly, ELISA testing, using antigens which are becoming more serovar specific. PCR is increasingly being used on tissue, urine and foetal material and is also becoming more precise. There are marked differences in prevalence in pig populations between the high levels of 90% slaughter pigs infected in New Zealand through 20% found in Brazil to 1.2% reported from Poland in individual surveys. Where data are presented on a herd basis, it is important to note that a varying proportion of herds in a country can be free from infection. The prevalence of infection with different serogroups also varies from one country to another, depending on the presence of maintenance hosts of the organisms and the contact between these hosts and the pig population. Where the maintenance host is the pig (bratislava, Pomona and, probably, Tarassovi) infections may be transmitted from pig to pig and from herd to herd, with consequent continuing effects on production.

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Leptospira 6

Treatment and control

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Treatment and control of swine leptospirosis is based on a set of measures which involve treatment, vaccination and the detailed application of biosecurity procedures, undoubtedly the major factor in preventing the disease.

ANTIBIOTICS

There are lots of products on the market to achieve success in the treatment of swine leptospirosis. The antibiotics indicated for the control of the disease are penicillin, semisynthetic penicillins, streptomycin, doxycycline and tiamulin. Although satisfactory results with different antibiotics, streptomycin still persists as the antibiotic of choice for injectable treatment of leptospirosis. Firstly the sick animals should be medicated parenterally with streptomycin at the dose of 25mg/kg of body weight, in a single dose or in periods of 3-5 days. To reduce the presence of abortion and reproductive failures the adoption of injectable treatment in the females is also recommended, one week before mating and two weeks before farrowing. When there is confirmation of leptospirosis infection in a herd, all animals are considered carriers. So, in addition to introducing the system of strategic injectable medication in females, it is also recommended to medicate the boars massively during the same period with injectable streptomycin (25mg/kg of body weight) for 3-5 days. As previously mentioned, leptospirosis can be eliminated from carrier animals. Thus, the medication of the entire herd through feed and/or drinking water is also recommended. Medication through feed with tetracyclines (800g/ton for four weeks) or parenterally (40mg/kg of body weight for 3-5 days). Doxycycline is recommended orally in doses of 10mg/kg of body weight, for 14 days. As for tylosin, the dose is 44mg/kg of body weight for five days and the erythromycin recommendation is 25mg/kg of body weight for five days. An experimental study had good results for the treatment of leptospirosis when using dihydrostreptomycin/penicillin G (25mg/kg of body weight) for 3-5 days. But the treatment with ceftiofur and ampicillin was not effective in elimination of L. interrogans serovar pomona in swine. When reinfection occurs treatment can be repeated. However, implement strict biosecurity measures such as hygiene of employees and animals, sanitisation programs with proper cleaning and disinfection of facilities, treating and filtration of the drinking water.

CONTROL

Based on the concept that the micro-organism Leptospira sp is sensitive to various detergents and disinfectants, the implementation of consistent cleaning and disinfection programs associated to depopulation based on 'all in, all out' management procedures, are very important measures to remove such bacteria from the premises. The eradication of leptospira from a pig herd will not be easy to adopt when the infection is present. However, one can adopt female over parity six disposal programs and also discard females that prove reactive for swine leptospirosis. It is also very important to be strict with the purchase of replacement animals. In swine intensive production systems the microflora of animals varies greatly, and therefore the resistance of individuals against the disease also varies. Following the application of a vaccine, it is expected that the animals develop sufficient immunity to not get sick when in contact with the infectious agent. Vaccination does not always prevent the development of the disease, but allows it to present itself in a less severe evolution without causing economic losses.

VACCINATION PROGRAM

Vaccinate uninfected females before mating, by using inactivated vaccines containing the appropriate serotypes. The use of these vaccines can prevent abortions, which often appear in the final third of gestation when infection occurs. In piglets, when necessary, the recommendation is to vaccinate before the risk period (6-10 weeks of age). If the protection does not produce good results, it is recommended to confirm the period in which infection occurs through a serology test, establishing the antibody profile of the herd at strategic periods, in order to adopt vaccination before exposure to the infection. In gilts (future breeding females) the vaccination relies on the application of two doses, the first at 180 days of age and the second at 200 days of age, which corresponds to 3-4 weeks before mating. The recommendation for sows is to vaccinate in the first week before farrowing. As for the boars, including the semen donors, the ones that perform natural service and those used in the management of stimulation and diagnosis of heat, vaccination should be semi-annual. However, when starting the vaccination program in a herd, the males should also receive two doses with an interval of 3-4 weeks. Once established the program follows the management of semi-annual vaccination. Young males entering the herd should be vaccinated with two doses, keeping the interval of 3-4 weeks between each application, with the last dose applied four weeks before the start of their reproductive life (semen collection, natural mating or before contact with the females).

IMPORTANT

Vaccination cannot prevent kidney colonisation, which makes it unlikely to eliminate infection when it has already become established. The use of vaccines containing serotype bratislava showed significant improvements in the number of births, in cases of infection with this serotype. It is advisable to maintain the vaccination program against leptospirosis in a herd on a regular basis, after its introduction. The transmission of infection can be eliminated by implementing good management practices and biosecurity, hygiene, cleaning and disinfection, handling all in/all out, vaccination, treatment of clinically sick animals, seropositive slaughter, purchase of seronegative animals for replacement and the strict control of rodents.

References are available from the author on request

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Leptospira 7

Production and economic effects

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Leptospirosis is one of the infectious disease causes of reduced sow productivity ('infertility' or 'reproductive failure').

After a herd becomes infected, leptospirosis continues to spread within the herd. Infected sows never eliminate the infection – they become carriers – but they develop antibodies to the leptospires and thus provide maternal immunity to newborn piglets through colostrum. The piglets' passive immunity lasts for a few weeks after weaning but by 12 weeks of age, finishing pigs start to become infected with leptospires from the environment and by the time they reach market weight almost all finishing pigs have become infected and are positive for leptospirosis. This means that replacement gilts coming from these infected finishing groups will be seropositive, infected with leptospirosis, and experience reproductive failure unless they are vaccinated prior to breeding. If replacement gilts have not been vaccinated, they are likely to experience reproductive failure after breeding.

Production and economic effects of chronic leptospirosis

When it first enters a susceptible (naïve) sow herd, it causes an abortion storm along with an increase in stillbirths and weak pigs at birth with subsequent increase in pre-weaning mortality. But it is the uncontrolled, endemic (chronic, sub-clinical) leptospirosis infection in sow herds that causes the highest economic losses because of its on-going, hidden effects on sow productivity. Chronic leptospirosis causes losses in total pigs born, pigs born alive, and pigs weaned. It increases stillbirths and increases pre-weaning mortality because it increases the number of live but weak, low viability pigs. It reduces the farrowing rate, reduces the average birth weight, and may increase the wean-to-first service interval. Based on clinical disease investigations, research reports and vaccine trials, Table 1 shows the expected reduction in modern sow herd productivity associated with uncontrolled chronic leptospirosis. Table 2 presents an economic analysis that shows the difference in sow herd productivity and resulting cost of production per weaned pig between sows farms with controlled vs. uncontrolled chronic leptospirosis infection. The analysis is based on current economic and market conditions in the United States. Assumptions: 5,000-sow system; feed cost is the same for both systems; other non-feed variable costs are similar between systems: for example, both systems spend $1.00 per weaned pig for vaccinating each weaned pig, both spend the same amount for each replacement gilt, and each spends the same for semen cost per dose; fixed costs such as depreciation, interest on loans for the buildings, the animals, and the land are the same between systems. Because of the negative reproductive impact associated with chronic uncontrolled leptospirosis, a 5,000-sow system will produce 30,000 fewer weaned pigs each year. The entire point of the economic analysis is based on the fact that the total annual costs of running the same 5,000-sow system are approximately the same. The chronic leptospirosis system will have some lower costs; for example, they will spend less for vaccines because they have fewer weaned pigs. But they will spend more on total semen costs and total replacement gilt costs because they have to breed more sows (lower farrowing rate) and bring in more replacement gilts (higher culling rate). In the end, any savings are mostly offset by higher costs so the two systems spend about the same amount each year even though the controlled system is producing 30,000 more weaned pigs each year. The bottom line is that the system in control of leptospirosis produces weaned pigs at a cost of $29.07 per pig, while in the uncontrolled system it costs $37.35 per pig. In this analysis, uncontrolled chronic leptospirosis increased the cost to produce a weaned pig by over $8.00 per pig.

Table 1. Sow herd productivity effects of uncontrolled chronic leptospirosis.

	Direction of effect	Controlled leptospirosis	Uncontrolled chronic leptospirosis	Difference (%)
Total pigs born	↓	14.0	13.0	-6.8
Stillborn	↑	0.7	1.0	30.0
Pigs born live	↓	13.0	10.9	-16.0
Pigs weaned	↓	12.0	9.8	-18.0
Abortion (%)	↑	1.0	2.0	100.0
Farrowing rate (%)	↓	89.0	75.0	12.0

Sow herd productivity	Controlled leptospirosis	Uncontrolled chronic leptospirosis
Number of sows	5,000	5,000
Pigs weaned/sow/year	28.4	21.9
Pigs weaned/space/year	212	163
Litters/sow/year	2.40	2.25
Non-productive days/sow/year	44	64
Pigs born live	13.0	10.9
Pre-wean mortality (%)	8.0	10.0
Wean age (days)	21	21
Pigs weaned/sow	12.0	9.8
Total pigs weaned/year	142,000	112,000
Cost analysis ($)		
Corn cost/bushel	3.55	3.55
SBM cost/ton	280	280
Gestation diet cost/ton	180	180
Lactation diet cost/ton	206	206
Total annual cost	4,133,260	4,089,400
Cost/weaned pig	29.07	37.35

Table 2. Economic analysis of uncontrolled chronic leptospirosis.

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Leptospira 8

Overall view of leptospira from the UK

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Leptospira are subdivided into species such as interogans and serogroups such as pomona, canicola, icterohaemorrhagica, australis and hardjo. They are further subdivided into serovars such as bratislava.

Diseases caused by leptospira are described in all continents and many mammalian species. Disease in domestic species is generally caused by infection from wildlife reservoirs. There are several species of leptospira that can cause disease in pigs and they occur in most pig-keeping areas. Pigs can be the maintenance host for bratislava and pomona. For other serovars rats, field mice, deer and dogs can be the maintenance host and the organism is excreted through the urine and then pigs can become infected by contact with the infected urine. Sources of water can become infected by host species urinating in water up-stream of the take-off point for a pig farm and this can be a cause of infection in pigs. Water can remain infectious for 30 days.

Leptospira can gain access into the target species by any mucous membrane e.g. eyes, nose, mouth, prepuce and vagina either by contact with infected urine or direct contact with an infected pig e.g. by the venereal route.

1-2 days after infection there may be bacteraemia and illness for 7-10 days. The most obvious outcome of infection is acute disease such as icterus, fever and death in growing pigs. However, a more insidious form is described in breeding pigs where infection causes almost no detectable illness in the adult. After the acute phase the organism usually localise in the renal tubules leading to persistent urinary excretion or in the case of bratislava in the uterine tubules, where it can cause blockage, and the uterus. This results in lowered fertility due to conception failure, early embryonic death, abortions, stillbirths and neo-natal disease. Persistent infections in boars can be found in the male genital tract which can be a source of infection at mating or in semen used for artificial insemination if no antibiotics are used to control infection. Antibodies increase after 10 days post-infection to peak after 21 days, but in the case of bratislava they may fall rapidly so are often difficult to detect after three months.

In the UK Leptospira interogans serogroup australis serovar australis has been implicated in such infertility. FAT foetal diagnoses recorded by the VLA in foetal liver and kidney are rare in the UK. Bloods taken from 10% of sows on a farm can show antibodies at low levels of 1/100-1/200 on MAT tests and usually with an incidence of below 30% of animals tested but this can still indicate that a herd has been exposed to bratislava and that some infertility can be attributed to the organism. Diagnosis is hampered by the fact that leptospiras are very hard to culture requiring a specialist medium and even then can take 6-12 weeks. Dark ground microscopy can be used to detect leptospira in urine of carrier sows, semen and aborted foetuses. Disease may be exacerbated by concurrent infections such as PRRS and PCV2.

A typically infected farm would show lowered conception rate, vaginal discharges post-service, 3-5 week returns to service, losses of pregnancy after previously being scanned as pregnant, abortions and lowered litter size. Reducing the risk of venereal infection by using AI, controlling rodents and contact between pigs and other wildlife or livestock is beneficial. Ensuring water supplies are clean by using chlorination will reduce water-borne infections. Controlling concurrent immunosuppressive infections such as PRRS will also reduce the impact of leptospirosis. The traditional treatment for leptospirosis causing such symptoms would be to treat the entire sow herd with tetracyclines in the feed at 800g/t for at least two weeks or use streptomycin 25mg/kg parenterally as a single dose. In both these treatments as carrier pigs may not be eliminated entirely there is the risk of re-infection necessitating re-treatment and often this may be required every 4-6 months. In the case of boars at stud the use of streptomycin 25mg/kg on two occasions two weeks apart during quarantine is usually accepted as sufficient to eliminate leptospira carriers.

These treatments result in high usage of antimicrobials, and we are encouraged wherever possible to use vaccines instead of antimicrobial treatments, so a better approach to controlling such disease due to bratislava is to use vaccination. There are several vaccines, usually killed and multivalent as far as leptospira is concerned and also covering parvovirus and erysipelas. These are generally used six and three weeks before the beginning of service for both boars and gilts. Sows are boosted once every cycle, usually at weaning and boars are boosted every six months. On a herd where vaccine is introduced for the first time all sows also need a two dose course usually given soon after farrowing and then three weeks later at weaning and boars would be vaccinated with two doses with a three week interval. Where such vaccination is practised levels of infertility due to leptospirosis generally fall and numbers born increase without any need for in-feed antimicrobial control.

It is my opinion that where leptospirosis antibodies are detected it is prudent to use vaccination to control the spread of infection sooner rather than later in order to maintain optimal reproductive performance.

It should be noted that carrier pigs can be a source of infection to man and leptospirosis is a zoonotic disease that can infect farm and abattoir workers and butchers.

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