

Menangle Virus Infection

*Pig Paramyxovirus Infection,
Porcine Paramyxovirus Infection*

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Importance

Menangle virus is a paramyxovirus that circulates among flying foxes (*Pteropus* sp.) in Australia, and causes reproductive losses if it is transmitted to swine. Reports of clinical cases are currently limited to a single outbreak that occurred in New South Wales, Australia in 1997. During this outbreak, infected sows gave birth to litters with mummified or stillborn piglets, some with congenital defects of the skeleton and central nervous system (CNS). Neither affected sows nor other pigs, including piglets born alive, seem to have any other signs of illness. There is no evidence that Menangle virus currently circulates in Australian pigs, but sporadic infections are possible: two seropositive pigs were detected in another herd during the initial investigations. Once this virus becomes endemic in a herd of swine, it can continue to circulate silently, without further reproductive losses. Menangle virus is also thought to be zoonotic. Two people who were in close contact with infected pigs developed a severe but self-limited influenza-like disease.

Etiology

Menangle virus is a member of the genus *Rubulavirus* and family Paramyxoviridae. It is closely related to Tioman virus, a rubulavirus found in fruit bats in Malaysia, and to some other recently discovered paramyxoviruses in Asia and Africa. None of these viruses is currently known to cause any illness in people or animals, although seropositive individuals have been identified.

Species Affected

Fruit bats of the genus *Pteropus* appear to be the reservoir hosts for Menangle virus. This virus has been isolated from the black flying fox, *Pteropus alecto*, and antibodies have been detected in *P. alecto*, *P. poliocephalus* (gray-headed flying fox), *P. conspicillatus* (spectacled fruit bat) and, very rarely, in *P. scapulatus* (little red flying fox). As of 2017, clinical signs have only been seen in pigs. Cattle, sheep, cats, birds, rodents and a dog tested near affected pig farms were seronegative.

Zoonotic potential

During the 1997 Menangle outbreak, two of 38 people in close contact with infected pigs became ill, and antibodies to Menangle virus were later detected in these two individuals. No one else who had been exposed to the pigs seroconverted.

Geographic Distribution

Infected pigs have been reported only from New South Wales, Australia. Infected fruit bats have been found in New South Wales and Queensland, and may exist in other parts of Australia.

Transmission

Menangle virus circulates in fruit bats, although the exact method of transmission between bats is still unclear. It has been isolated from bat urine, and also seems to be present in feces. This is consistent with an epidemiological study from the 1997 outbreak, which suggested that pigs had probably been infected from bat urine and/or feces.

Experimentally infected, asymptomatic 6-week-old pigs shed Menangle virus in nasal and oral secretions, urine and feces, and sometimes transmitted it to pigs in contact. Most pigs shed this virus for less than a week. However, prolonged urinary shedding might be possible in some individuals: one animal excreted it intermittently in urine for at least 20 days. This study also raised the possibility that coinfection with other pathogens might enhance transmission. During the 1997 outbreak, virus transmission was relatively slow and seemed to require close contact. In one building where sows were kept in pens, it took several weeks for all sows to be affected. There is no evidence that pigs become persistently infected with Menangle virus.

Menangle virus infections have been reported in humans who had close direct contact with infected animals. One person reported being splashed with amniotic fluid or blood during births, while the other reported performing necropsies without gloves

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or protective eyewear. They might have been infected when abraded skin or mucous membranes became contaminated.

Transmission on fomites is possible, but epidemiological evidence suggests that virus survival in the environment is short. When sentinel pigs were placed in an uncleaned area 3 days after removing infected pigs, they did not seroconvert.

Disinfection

The disinfectant susceptibility of Menangle virus has not been published. However, other paramyxoviruses can usually be destroyed by many different agents including sodium hypochlorite, sodium hydroxide, aldehydes (e.g., glutaraldehyde, formalin), iodine, chlorhexidine, detergents, oxidizing agents and low pH.

Infections in Animals

Incubation Period

Some experimentally infected 6-week-old pigs, inoculated intranasally, developed a fever without overt signs of disease 2-3 days later. In pregnant sows, Menangle virus appears to cross the placenta early in gestation, then spreads gradually from fetus to fetus. Although some animals abort, other infections do not become apparent until the sow gives birth.

Clinical Signs

Clinical signs in pigs seem to be limited to reproductive losses. Sows have reduced farrowing rates and give birth to smaller litters with fewer live piglets. Affected litters can contain a mixture of mummified, autolyzed, stillborn and normal live piglets. Degeneration of the CNS may be evident in some dead piglets, and parts of the brain (e.g., cerebrum, cerebellum, brainstem) or spinal cord may be markedly smaller than normal. There may also be skeletal deformities, including arthrogryposis, scoliosis, kyphosis and craniofacial abnormalities such as brachygnathia (shortened jaw) and doming of the skull. CNS lesions are more common and severe during the earlier stages of an outbreak, but skeletal lesions do not seem to change in frequency as the outbreak progresses. Some sows may abort. Many return to estrus approximately 28 days after mating, suggestive of early death of the entire litter. Others may remain in a state of pseudopregnancy for more than 60 days.

Menangle virus infections seem to be subclinical in postnatal animals. Sows that aborted or gave birth to affected litters were not ill, and piglets born alive were also unaffected. Experimentally infected 6-week-old piglets had no overt clinical signs, although some had a fever on one or more days.

Post Mortem Lesions [Click to view images](#)

Fetuses from affected litters may be stillborn, aborted, mummified, semi-mummified or autolyzed. Mummified fetuses vary in size, and are at a gestational age of 30 days

or older. Some stillborn and aborted fetuses may have skeletal and/or neurological deformities. Reported skeletal defects include arthrogryposis, craniofacial abnormalities such as brachygnathia and doming of the skull, and scoliosis or kyphosis. In the CNS, there may be slight to severe degeneration of the brain and/or spinal cord, as well as hydranencephaly. The cerebral hemispheres, brainstem, spinal cord and particularly the cerebellum may be noticeably smaller than normal. In some cases, the brain and spinal cord were nearly absent. Some fetuses may also have straw-colored effusions (sometimes fibrinous) in body cavities, pulmonary hypoplasia, epicardial hemorrhages and/or subcutaneous edema. No gross lesions have been attributed to Menangle virus in postnatal pigs, including live newborn piglets and experimentally infected animals.

Histologically, CNS lesions are characterized by degeneration and necrosis of gray and white matter with infiltrations of inflammatory cells. Eosinophilic to amphiphilic intranuclear and intracytoplasmic inclusion bodies may be found in these neurons. Nonsuppurative myocarditis, multifocal meningitis or hepatitis were noted in some piglets.

Diagnostic Tests

In stillborn piglets and fetuses, Menangle virus is most likely to be found in the brain, lung and myocardium, although it may also occur in other tissues such as the kidney and spleen. Virus isolation is more likely to be successful when the fetus has gross or histological abnormalities of the brain, as these animals were probably infected early, before an immune response could develop. In experimentally infected, older pigs (6 weeks of age), the highest viral titers were found in the intestinal tract, tonsils, and mandibular and mesenteric lymph nodes, with lower levels in tissues such as the lungs, spleen and nasal mucosa. Viremia was low and transient, and more readily detected by RT-PCR than virus isolation.

A wide variety of cell lines can be used to isolate Menangle virus. BHK21 cells were used in past investigations, but many other lines (e.g., HmLu-1, Vero, PK15, MDCK, HeLa, Hep-2) are also expected to be suitable. Menangle virus is non-hemagglutinating and nonhemadsorbing, unlike some other paramyxoviruses that can cause reproductive failure in swine. It can be provisionally identified in cultures by electron microscopy, and confirmed by virus neutralization and immunostaining. An RT-PCR assay was recently developed for use in pigs. Histopathology is also helpful.

Virus neutralization is the only routinely used serological test, at present, although ELISAs were also employed in some studies. Antibodies can be detected in serum samples from sows, and sometimes in fluids from the body cavities of stillborn and aborted fetuses. Because Menangle virus is not known to circulate in Australian pigs, the most rapid method of excluding this disease is to test 10-15 sows for specific antibody.

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Treatment

No treatment seems to be necessary in postnatal pigs, which remain asymptomatic.

Control

Disease reporting

Veterinarians who encounter or suspect Menangle virus infection should follow their national and/or local guidelines for disease reporting. In the U.S., state or federal veterinary authorities should be informed immediately.

Prevention

In endemic regions, pigs should be protected from contact with bats and their excretions or secretions. Food trees favored by flying foxes, and trees planted in configurations that encourage roosting, should be avoided on pig farms. Wire screens can help prevent contact when pigs are raised in open-sided pig sheds. Run-off from the roof should be kept from entering pig pens. Fruits that may have been contaminated by bats should not be fed to pigs. Good biosecurity measures may keep Menangle virus and other infections from entering a farm. Quarantines are expected to be helpful in an outbreak; in 1997, this virus appears to have traveled between farms in infected pigs.

In herds where it has become established, Menangle virus seems to be maintained by infecting 14-16 week old pigs as their maternal immunity wanes. For this reason, the virus can be eradicated by removing 10–16 week-old pigs, or isolating them for a prolonged period. Alternatively, an infected farm can be depopulated and restocked. In one case, the virus was eradicated by disinfecting and briefly depopulating individual units, then restocking only with pregnant sows expected to be immune. The offspring of these sows were protected by maternal antibodies for at least 6 weeks, by which time the virus no longer appeared to be present.

Morbidity and Mortality

Menangle virus appears to circulate subclinically in fruit bat populations. Surveys have detected antibodies to this virus in 25-55% of *P. poliocephalus*, *P. alecto* and *P. conspicillatus* in parts of Australia. Antibodies were rare (1%) or absent in *P. scapulatus*.

The risk of virus transmission to pigs may be low. As of 2017, only one outbreak has been reported. In 1997, Menangle virus affected three Australian (New South Wales) farms including a 3000-sow farrow-to-finish pig farm located near a fruit bat colony, and two associated growing farms. Antibodies to the virus were found in 96% of sows on the breeding farm and 88% of the 25-week-old pigs on the grower farms. Clinical signs occurred only on the farrow-to-finish farm, and were limited to reproductive losses. The weekly farrowing rate declined significantly, with up to 45% abnormal litters during some weeks, and reduced numbers of live piglets in 27% of the litters overall. The sows and their live newborns showed no signs of

illness. Active infections were not found on other Australian farms or in feral pigs in the affected region; however, two archived serum samples from another farm in New South Wales were seropositive. Although this farm is also close to a fruit bat colony, other serum samples from this herd were seronegative.

Clinical signs may occur only in naïve herds. Once the infection became endemic in the farrow-to-finish herd, there were no further reproductive losses. In larger herds, Menangle virus is thought to circulate by infecting each crop of young pigs when they lose their maternal immunity at approximately 14-16 weeks of age. These pigs have usually developed good immunity to the virus by the time they enter the breeding herd, and are no longer susceptible to disease. Menangle virus is less likely to persist in small herds where there are insufficient numbers of susceptible young hosts.

Infections in Humans

Incubation Period

The incubation period in humans is not known.

Clinical Signs

During the 1997 Menangle outbreak, two people developed severe influenza-like illnesses with fever, drenching sweats, severe headaches, myalgia, lymphadenopathy, weight loss and a nonpruritic macular rash. Both recovered after 10 to 14 days.

Diagnostic Tests

The only two known clinical cases were diagnosed retrospectively by serology (virus neutralization). Virus isolation and RT-PCR tests are likely to be useful in people with clinical signs.

Treatment

Both patients recovered spontaneously, without specific antiviral treatment. One consulted a physician and had been prescribed antibiotics for a presumed bacterial infection.

Prevention

The route of transmission from pigs to humans is not known at this time. As a routine precaution, gloves and other protective clothing should always be used when conducting necropsies and assisting at births, or in any other situation where body fluids and tissues could contact skin. Good hygiene (e.g., hand washing) should also be practiced. People exposed to animals known to be infected should wear protective clothing, impermeable gloves, masks, goggles and boots. Contaminated skin should be washed promptly and thoroughly.

It is unclear whether Menangle virus infections can be acquired by contact with bats or their body fluids; however, human infections have not been reported except during the

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outbreak in pigs. Nevertheless, contact with bats should be avoided whenever possible; protective clothing should be used when working with bats, to prevent contamination of mucous membranes and broken skin; and any wounds that might have been contaminated should be promptly washed.

Morbidity and Mortality

During the 1997 Menangle outbreak, 2 of 38 people in close contact with infected pigs became ill and seroconverted. Seroconversion was not seen in any other individual. This resulted in an overall seroprevalence of 5% (2/38) in workers at the affected farms, and less than 1% (2/256) in all exposed individuals including veterinarians, abattoir workers and laboratory workers.

Internet Resources

Australian Scientific & Industrial Research Organisation (CSIRO)

<https://www.csiro.au/>

Commonwealth of Australia. Animal pests and diseases.

<http://www.agriculture.gov.au/pests-diseases-weeds/animal>

Department of Agriculture and Water Resources. Australian and New Zealand standard diagnostic procedure (ANZSDP) for Menangle virus

<http://www.agriculture.gov.au/animal/health/laboratories/procedures/anzsdp/menangle-virus>

New South Wales Department of Primary Industries. Menangle Virus Infection (includes information about diagnostic test submission)

<http://www.dpi.nsw.gov.au/about-us/services/laboratory-services/veterinary/menangle-virus-infection>

References

- Baker KS, Todd S, Marsh GA, Crameri G, Barr J, et al. Novel, potentially zoonotic paramyxoviruses from the African straw-colored fruit bat *Eidolon helvum*. *J Virol*. 2013;87(3):1348-58.
- Barr JA, Smith C, Marsh GA, Field H, Wang LF. Evidence of bat origin for Menangle virus, a zoonotic paramyxovirus first isolated from diseased pigs. *J Gen Virol*. 2012;93(Pt 12):2590-4.
- Barr J, Smith C, Smith I, de Jong C, Todd S, Melville D, Broos A, Crameri S, Haining J, Marsh G, Crameri G, Field H, Wang LF. Isolation of multiple novel paramyxoviruses from pteropid bat urine. *J Gen Virol*. 2015;96(Pt 1):24-9.
- Bowden TR, Bingham J, Harper JA, Boyle DB. Menangle virus, a pteropid bat paramyxovirus infectious for pigs and humans, exhibits tropism for secondary lymphoid organs and intestinal epithelium in weaned pigs. *J Gen Virol*. 2012;93(Pt 5):1007-16.
- Bowden TR, Westenberg M, Wang LF, Eaton BT, Boyle DB. Molecular characterization of Menangle virus, a novel paramyxovirus which infects pigs, fruit bats, and humans. *Virology*. 2001;283:358-73.
- Chant K, Chan R, Smith M, Dwyer DE, Kirkland P; NSW Expert Group. Probable human infection with a newly described virus in the family Paramyxoviridae. *Emerg Infect Dis*. 1998;4:273-5.
- Davis-Fields MK1, Allison AB, Brown JR, Poulson RL, Stallknecht DE. Effects of temperature and pH on the persistence of avian paramyxovirus-1 in water. *J Wildl Dis*. 2014;50(4):998-1000.
- Geering WA, Penrith M-L, Nyakahuma D. Manual on procedures for disease eradication by stamping out. Part 3: Decontamination procedures. Food and Agriculture Organization of the United Nations; 2001. Available at: <http://www.fao.org/docrep/004/Y0660E/Y0660E03.htm>. Accessed 13 Mar 2017.
- International Committee on Taxonomy of Viruses [ICTV]. Virus Taxonomy: 2016 Release EC 48, Budapest, Hungary, August 2016; Email ratification 2017 (MSL #31). Available at: <https://talk.ictvonline.org/taxonomy/>. Accessed 10 Jul 2017.
- Kawana R1, Kitamura T, Nakagomi O, Matsumoto I, Arita M, Yoshihara N, Yanagi K, Yamada A, Morita O, Yoshida Y, Furuya Y, Chiba S. Inactivation of human viruses by povidone-iodine in comparison with other antiseptics. *Dermatology*. 1997;195 Suppl 2:29-35.
- Kirkland PD, Daniels PW, Mohd Nor MN, Love RJ, Philbey AW, Ross AD. Menangle and Nipah virus infections of pigs. *Vet Clin North Am Food Anim Pract*. 2002;18:557-571.
- Kirkland PD, Davis RJ. Australian and New Zealand standard diagnostic procedure (ANZSDP) for Menangle virus. Department of Agriculture and Water Resources; 2006. Available at: <http://www.agriculture.gov.au/animal/health/laboratories/procedures/anzsdp/menangle-virus>. Accessed 10 Jul 2017.
- Kirkland PD, Love RJ, Philbey AW, Davis RJ, Hart KG. Epidemiology and control of Menangle virus in pigs. *Aust Vet J*. 2001;79:199-206.
- Lau SK, Woo PC, Wong BH, Wong AY, Tsoi HW, Wang M, Lee P, Xu H, Poon RW, Guo R, Li KS, Chan KH, Zheng BJ, Yuen KY. Identification and complete genome analysis of three novel paramyxoviruses, Tuhoko virus 1, 2 and 3, in fruit bats from China. *Virology*. 2010;404(1):106-16.
- Love RJ, Philbey AW, Kirkland PD, Ross AD, Davis RJ, Morrissey C, Daniels PW. Reproductive disease and congenital malformations caused by Menangle virus in pigs. *Aust Vet J*. 2001;79:192-8.
- Mackenzie JS, Field HE, Guyatt KJ. Managing emerging diseases borne by fruit bats (flying foxes), with particular reference to henipaviruses and Australian bat lyssavirus. *J Appl Microbiol*. 2003;94 Suppl:59S-69S
- Philbey AW, Kirkland PD, Ross AD, Davis RJ, Gleeson AB, Love RJ, Daniels PW, Gould AR, Hyatt AD. An apparently new virus (Family Paramyxoviridae) infectious for pigs, humans and fruit bats. *Emerg Infect Dis*. 1998;4:269-71.
- Philbey AW, Kirkland PD, Ross AD, Field HE, Srivastava M, Davis RJ, Love RJ. Infection with Menangle virus in flying foxes (*Pteropus* spp.) in Australia. *Aust Vet J*. 2008;86(11):449-54.
- Philbey AW, Ross AD, Kirkland PD, Love RJ. Skeletal and neurological malformations in pigs congenitally infected with Menangle virus. *Aust Vet J*. 2007;85:134-40.
- Public Health Agency of Canada. Pathogen safety data sheet. Rubella virus. Centre for Biosecurity, Public Health Agency of Canada; 2017 Mar. Available at: <http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/rub-eng.php>. Accessed 11 Jul 2017.

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- Queensland Horse Council. Bats and trees. Queensland Horse Council; 2012 Jan. Available at: <http://www.qldhorsecouncil.com/OldHorseCouncil/media/QHC-Portal/Hendra%20Virus/Bats-and-Trees.pdf>. Accessed 28 Dec 2015.
- Queensland Horse Council. Hendra- Property design. Queensland Horse Council; 2010 May. Available at: <http://www.qldhorsecouncil.com/OldHorseCouncil/media/QHC-Portal/Hendra%20Virus/Hendra-Property-Design.pdf>. Accessed 28 Dec 2015.
- U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Center for Emerging Issues [USDA APHIS CEI]. Menangle virus, Australia, Emerging Disease Notice. USDA APHIS CEI; 1998. Available at: www.aphis.usda.gov/vs/ceah/cei/menangle.htm. * Accessed 11 Nov 2007

Link defunct as of 2017