Case Report/Series

Streptococcus suis meningitis related to processing and consuming raw pork during Balinese tradition, *Mebat*

IGM Ardika Aryasa,[1] Ni Putu Ayu Widiasari,[1] Ni Made Susilawathi,[2] Ni Nengah Dwi Fatmawati,[3] I Made Oka Adnyana,[2] Anak Agung Raka Sudewi,[2] Ni Made Adi Tarini[3]

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Authors' affiliations:
[1]Faculty of Medicine, Universitas Udayana, Bali, Indonesia, [2]Department of Neurology, Faculty of Medicine, Universitas Udayana/Sanglah General Hospital, Bali, Indonesia, [3]Department of Clinical Microbiology, Faculty of Medicine, Universitas Udayana/Sanglah General Hospital, Bali, Indonesia

Corresponding author:
Ni Made Adi Tarini
Sanglah General Hospital, Jalan Diponogoro Dauh Puri Klod, Denpasar, Bali 80113, Indonesia
Tel/Fax: +62-361-222510 Ext. 201/ +62-361-246656
E-mail: nmatarini@unud.ac.id

ABSTRACT

Streptococcus suis is a zoonotic pathogen that can infect humans, especially meningitis. *S. suis* meningitis has been commonly diagnosed in Bali, which is associated with the consumption of raw pork. We reported case of *S. suis* meningitis that could have occurred due to the ingestion of undercooked pork during a traditional ceremony, which also involved two more patients with similar symptoms. A 62-year-old male was brought to the emergency unit because of decreased consciousness (Glasgow coma scale 14/15) in the last 8 hours before admission. He also had a headache, high fever, and stiff neck. Examination of cerebrospinal fluid revealed the presence of *S. suis* infection and was confirmed by polymerase chain reaction. The patient was administered ceftriaxone and showed a clinical improvement on the third day without any hearing problem.

KEYWORDS foodborne disease, meningitis, polymerase chain reaction, *Streptococcus suis*

Streptococcus suis (*S. suis*) is a zoonotic pathogen. Humans can be infected by *S. suis* through the consumption of raw pork products or by direct skin contact with infected pigs.[1] The risk becomes higher when there is a wound in the skin.[2] *S. suis* is found as normal flora in pigs and can be detected in 80% of pig tonsils; however, in some cases, it can cause lethal infections in pigs.[3,4]

In recent years, there has been an increase in the number of cases of *S. suis* infections in Southeast Asian countries and China.[1,2,5–7] The incidence of *S. suis* infection has been estimated at 6.2 per 100,000 in the general population, and the case fatality rate has been reported to be 16.1%.[6] Clinical manifestations of *S. suis* infection include purulent meningitis (48%), endocarditis (14%), and septicemia (38%).[1,2,6,7] Meningitis presents with fever, headache, and neck stiffness. The most common sequela is hearing loss occurring in 53% of the infected patients.[1]

In Indonesia, especially Bali, the cases of *S. suis* infection have been reported corelated to ingestion of fresh blood from sick or subclinically infected pigs.[8] Balinese people also have a unique tradition known as *Mebat*, which is the tradition for food processing and cooking, especially pigs, and several people consume this meat as a part of Hindu ceremonies.

In this tradition, it includes the slaughtering of pigs, cutting the pork, cooking it, and serving the meat as dishes termed as red *lawar* and *komoh* soup. Red *lawar* is prepared from minced pork mixed with raw pork blood and vegetables. Meanwhile, *komoh* soup, is prepared using fresh pork blood and Balinese herbs. The consumption of raw pork products, especially undercooked pig blood, is a strong risk factor for the transmission of *S. suis* infection.[5] This infection have also been reported in Vietnam and Thailand that have a similar habit of processing and consuming typical foods prepared using raw pork products.[1,2,6] Hence, this case report will described a similar case of *S. suis* infection which has a strong risk factor from consumption of raw pork products especially undercooked pig blood in Bali.

CASE REPORT

A 62-year-old man came to the emergency room of Sanglah General Hospital, Bali with a decreased consciousness since 8 hours before admission. The patient was reported to be agitated as well as talking in a rambunctious manner. He also had fever, headache, nausea, vomiting, and stiffness and pain in the neck since 2 days before admission. There was no history of trauma, chronic cough, and weight loss. There was no previous ear, nose, throat, tooth, and lung infections, and drug or alcohol consumption. He was an active smoker. The patient had a history of performing the *Mebat* tradition and had consumed red *lawar* 4 days before admission to the hospital. He also often consumed red *lawar* and had pigs in his backyard and was directly exposed to pigs. Two other persons who participated in the *Mebat* traditional activity along with this patient also experienced the same complaint but were treated in different hospitals 1 day earlier. Informed consent was obtained from the patient for the publication of this case report after the administration of treatment.

The Glasgow coma scale (GCS) score was 14/15 with respective scores of 3, 5, and 6 for eye, verbal, and motor response. On admission, the patients had a fever (38.5°C), blood pressure of 130/80 mmHg, heart rate of 92 times per min, and respiratory rate of 20 breaths per min. He had positive meningeal irritation sign (nuchal rigidity) without any focal neurological deficit. Chest x-ray revealed increased bronchovascular pattern. Brain computed tomography (CT) scan with contrast demonstrated leptomeningeal enhancement with the impression of meningoencephalitis were shown in Figure 1.

Blood sample and cerebrospinal fluid (CSF) sample were also collected on admission day before administration of antibiotic. There was an increase of leukocyte count (15.33 × 10^3/µl) with 92.7% neutrophils, thrombocytopenia (105.10 × 10^3/µl), and an increased erythrocyte sedimentation rate (40.2 mm/hour). CSF analysis showed a cloudy appearance, mononuclear-predominant pleocytosis (300 cells/mm^3 with 90% mononuclear cells), low glucose level (4 mg/dl), a ratio of CSF glucose to serum blood glucose of 4.4%, and elevated protein levels (222.8 mg/dl). There was gram-positive cocci in Gram staining of the CSF. Culture of CSF on 5% defibrinated sheep blood agar (SBA) plate revealed growth of small colonies with α-hemolysis in 7 days observation (Figure 2). The catalase and optochin tests of the colonies revealed a negative catalase result and optochin resistance. Identification and drug sensitivity test of these bacteria were conducted using VITEK® 2 Compact (bioMérieux SA F-69280 Marcy l'Etoile, France), and the organism was identified to be *S. suis* with a probability of 99% and still sensitive to ceftriaxone. Polymerase chain reaction (PCR) was then performed to confirm the bacteria using species-

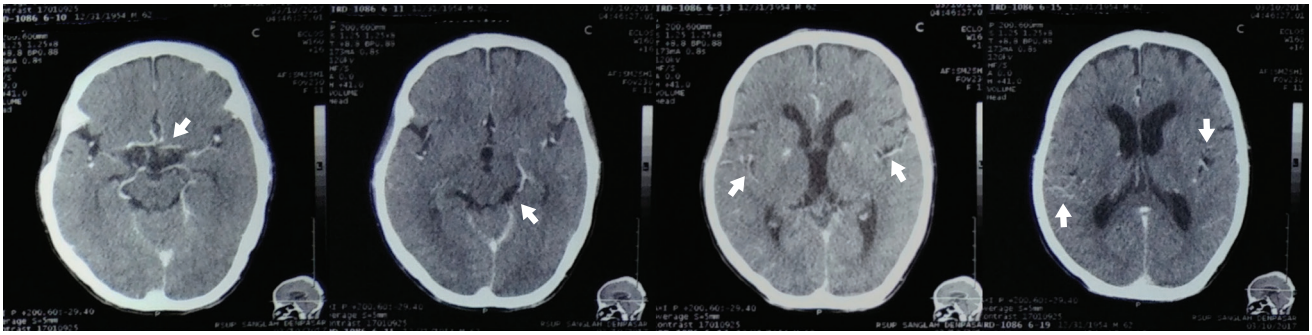

Figure 1. Contrast-enhanced brain computed tomography (CT) scan demonstrated leptomeningeal enhancement (white arrows)

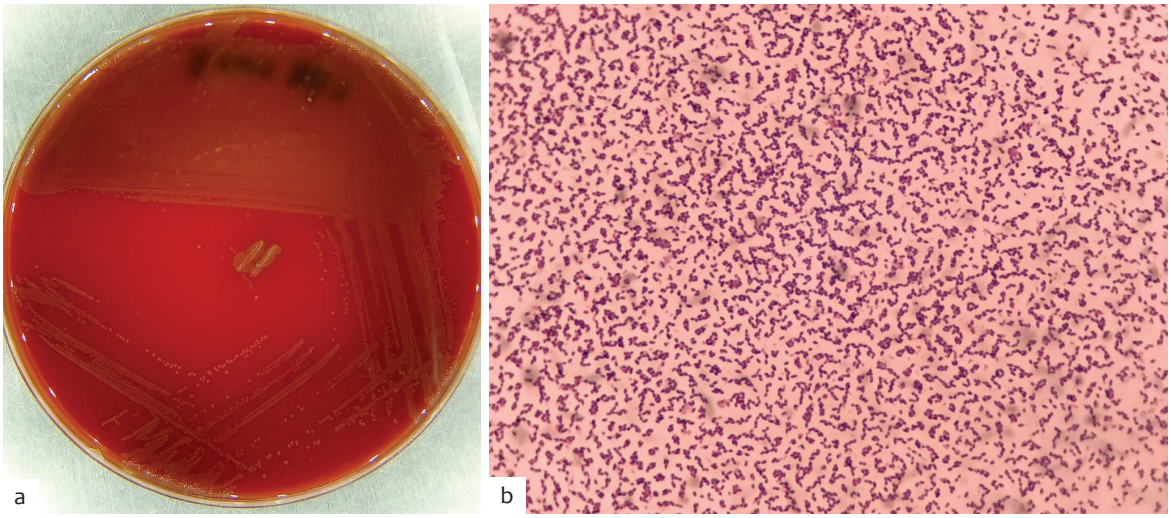

Figure 2. (a) Cerebrospinal fluid (CSF) culture on 5% defibrinated sheep blood agar (SBA) plate revealed colonies with α-hemolysis; (b) Gram stain from subculture showed gram-positive cocci (1,000× magnification)

specific primer and JP4/JP5 band to amplify the glutamate dehydrogenase (*gdh*) gene (Figure 3).[9]

He was treated empirically with 2 g of intravenous (IV) ceftriaxone twice-daily (BID) for 14 days, started from the admission day after CSF was collected. He was also given 10 mg of IV dexamethasone daily for 5 days, 30 mg lansoprazole BID, and 1 g paracetamol three times daily (TID). His GCS score was 15/15 after the third day of treatment. Subsequent observations of the patient revealed clinical improvement, and the results of the lumbar puncture examination on the 13th day returned to normal limits. The patient was discharged on day 14.

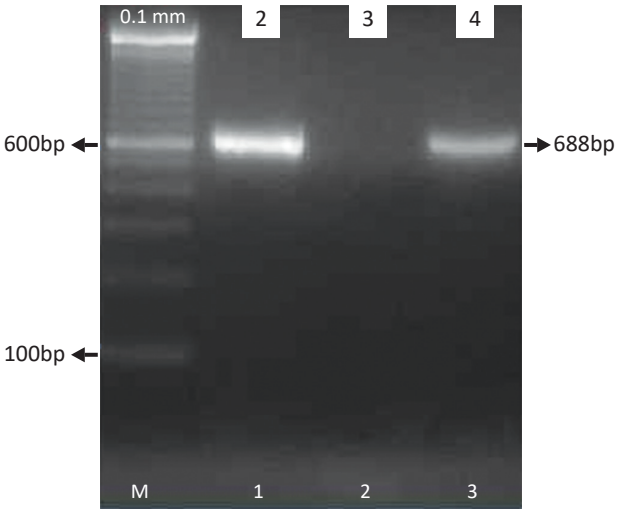

Figure 3. Polymerase chain reaction for *gdh* gene detection. Lanes 4 (the patient) was positive for *gdh* gene (688bp). Amplicon was electrophoresed on 1.5% agarose gel. lane 1=marker 100 bp, lane 2=positive control, lane 3=negative control, bp=base pair

DISCUSSION

S. suis meningitis has the same clinical manifestations as those of other acute bacterial meningitis infections; however, it tends to manifest with hearing loss more often than others.[1] In the present case, the patient had no complaint of hearing loss. He had decreased consciousness since 8 hours before admission and severe headache, nausea, vomiting, high fever, and neck stiffness since 4 days before admission. Meningitis was the major clinical manifestation of *S. suis* infection (68%).[1]

In this case report, the patient had *S. suis* meningitis with risk factor of ingestion of undercooked pork during the Balinese tradition, *Mebat*. *S. suis* infection is transmitted by pigs with natural habitats of the respiratory tract, the gastrointestinal tract, and genitalia. Other than raw pork consumption within 2 weeks (include fresh blood, tonsils, tongue, intestines, stomach, and uterus), skin injuries directly exposed to raw pork, and having a sick pig at home since the past 4 weeks before symptoms appear have also been risk factors for *S. suis* infection.[5] In our case, he had a history of *Mebat* and the consumption of red *lawar* 4 days before hospital admission. Pork processing during *Mebat* is still traditional. Participants also never use personal protective equipment to avoid direct contact with the pork. An outbreak of *S. suis* infection in China's Sichuan province during 2003–2005 was slaughtering pigs without using personal protective equipment such as gloves.[7]

The presences of transmission risk factors were similar to those found in Vietnam, Thailand, and China.[5–7] *Tiết canh* is a Vietnamese dish prepared from fresh pork blood. It is a special dish served at traditional wedding celebrations. This is similar to red *lawar* and *komoh* soup used in Bali. By multivariate analysis, risk factor identified for *S. suis* infection between undercooked pig blood and control group had an odd ratio of 2.22 (95% confidence interval [CI] = 1.15–4.28).[5]

Pork processing in Bali and Vietnam is also done using traditional processes and also involves minimal personal protective equipment. It has been reported that direct contact with the pig's body parts, especially when the person has skin lesions, is an important risk factor for *S. suis* transmission, with an odds ratio of 7.48 (95% CI = 1.97–28.44).[5]

Previous report in Bali also reported a case of bacterial meningitis caused by *S. suis* with bilateral sensorineural hearing loss, with the risk factor being ingestion of undercooked pork products.[10] In our case, two of his friends who participated in the *Mebat* and ate the raw food also experienced the same symptom as that of the patient. This supports the possibility of *S. suis* transmission from pigs processed in the tradition.[1,5,11]

In the presented case, patient sign was consistent with classic triad of acute meningitis which are fever, neck stiffness, and altered mental status.[12] Physical examination of the patient showed increased axillary temperature (38.5°C), and the neurological examination revealed somnolence, positive neck stiffness, and positive Kernig's sign, with no other focal neurological deficits. CT scan of the head demonstrated leptomeningeal enhancement, which was consistent with meningoencephalitis. Analysis of CSF revealed the presence of a bacterial infection. Confirmation of the diagnosis was done by CSF culture and antibiotic sensitivity test, followed by PCR.

The colonies with α-hemolysis in CSF culture on SBA media suggested α-hemolytic Streptococcus (Figure 2a) and with the Gram staining suggested gram-positive cocci (Figure 2b). From both examinations, we can conclude the bacteria was *S. suis*. Moreover, we also did the identification using VITEK® 2 Compact (bioMérieux SA F-69280 Marcy l'Etoile, France) and it showed the same bacteria. Confirmation was also done by PCR. It was difficult to differentiate *S. suis* from other Streptococcus species by culture method, particularly *Streptococcus mitis*. Therefore, confirmation by PCR is necessary.[13] Okwumabua et al[9] conducted a study that identified 306 *S. suis* isolates using PCR method through identification of the encoding gene *gdh*. GDHs are highly conserved and have a low rate of point mutations compared with several other genes, and have been successfully used in the diagnosis of certain bacterial infections.[9]

The patient was treated with 2 g ceftriaxone empirically BID for 14 days and 10 mg of IV dexamethasone daily for 5 days as an adjuvant therapy. Due to bacterial meningitis has poor prognosis on delayed treatment, therefore the antibiotic must be given as soon as the diagnosis be made. The first choice is to give empirical antimicrobial therapy after CSF or blood culture were collected.[12] The culture and sensitivity tests revealed susceptible to ceftriaxone. Ceftriaxone is a third-generation cephalosporin, which is recommended as the drug of choice for bacterial meningitis.[14] Susilawathi et al[8] also reported that *S. suis* is still sensitive to ceftriaxone.

Clinical improvement was found on the third day. The result of subsequent lumbar puncture examination on day 13 was within normal limits. The recommended administration of intravenous antibiotic for bacterial meningitis is for 2–4 weeks.[15] Because of the improvement in clinical and CSF examination after 13 days, the patient can be discharged after 2 weeks of antibiotic administration.

Hearing problem was not found in this patient, although it is the most common sequelae. A meta-analysis study conducted by van Samkar et al[1] reported that 53% of meningitis *S. suis* cases experienced hearing loss. This discrepancy might be due to the early administration of antimicrobial drugs, so *S. suis* was uncultivable.[8] The administration of dexamethasone was reported to decrease a mortality and a complication on bacterial meningitis i.e. hearing loss.[1]

S. suis infection in Bali potentially become an outbreak due to the habit of the Balinese community. However, it is also necessary to preserve *Mebat* tradition of the Balinese Hindu society. The government along with the communities needs to advocate the prevention of this infection to reduce the morbidity and mortality due to *S. suis* infection. First, personal protective equipment such as gloves has to be used during slaughtering pigs and processing pork into dishes. Second, the

food served at the ceremony must be well-cooked. Third, the pork and pig products used in the cooking process should be obtained from healthy pigs. There are alternatives for well-cooked dishes such as well-cooked *lawar* (without using fresh pig blood) and other well-cooked dishes. We need to educate the community to serve and eat well-cooked pork dishes in daily consumption or during ceremonial events such as *Mebat*. It must also advise to avoid processing pork products obtained from sick pigs. These preventive measures can be taught through community education at primary health care centers in the neighborhood. The government should also improve the regulation of pig raising in Bali and educate the farmers.

In conclusions, *S. suis* meningitis is a zoonotic disease, with pigs being the animal reservoir. People who handle or eat undercooked pork and do home farming are at maximum risk. Patients with these risk factors and presenting with meningitis should be suspected to have *S. suis* meningitis. *Mebat* is an original ceremonial custom of the Balinese society and must be preserved. Promoting the primary prevention of *S. suis* transmission through *Mebat* activity can be done by an educational approach to the high-risk community. The risk of transmission of *S. suis* infection, especially during *Mebat*, can be reduced by appropriate pig breeding and with regular assessment of pigs' health, using protective tools such as gloves during pork processing, and consuming cooked pork products.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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