Human Infective Endocarditis Caused by
Streptococcus suis Serotype 2

Martin C. Heidt,1 Walid Mohamed,2 Torsten Hain,2 Paul Robert Vogt,1
Trinad Chakraborty,2 and Eugen Domann*2

Department of Cardiovascular Surgery, Hospital of the Justus-Liebig University Giessen, Klinikstrasse 29,
D-35392 Giessen, Germany,1 and Institute of Medical Microbiology, Hospital of the
Justus-Liebig University Giessen, Frankfurter Strasse 107,
D-35392 Giessen, Germany2

Received 15 April 2005/Returned for modification 23 May 2005/Accepted 2 June 2005

Human infective endocarditis due to Streptococcus suis occurs infrequently. The case of a 43-year-old male
who sustained life-threatening infective endocarditis is reported. Since growth of S. suis on commonly used
sheep blood agar plates resembles viridans streptococci, diagnosis of S. suis constitutes a diagnostic pitfall.
Identification was accomplished by using molecular methods.

CASE REPORT

An otherwise healthy 43-year-old male complained of malaise, fever, dyspnea, and upper back pain. He was treated
with nonsteroidal drugs. Twelve days later, he was found to have severe orthopnea. Electrocardiography revealed sinus tachycardia
and a complete left bundle branch block. Finally, due to acute respiratory insufficiency, the patient was admitted to the hospital of the
Justus-Liebig University Giessen, Giessen, Germany, after emergency intubation. Transthoracic echocardiography revealed severe aortic regurgitation, huge aortic
valve vegetations, and a ventricular septal defect located immediately left of the membranous septum. Blood cultures were
taken, and intravenous antibiotic treatment with ceftazidime (2 g every 8 h), rifampin (1 g every 12 h), and vancomycin
was initiated (leukocytes/μl, 43,800; C-reactive protein, 189.7 mg/liter; body temperature, 38.5°C). The patient subsequently underwent emergency surgery consisting of aortic root debridement, aortic valve replacement
with a 23-mm mechanical heart valve, and sealing of the ventricular septal defect by use of autologous pericardium.
The perioperative and postoperative courses were uneventful. The patient was extubated 6 h after surgery, discharged home
10 days later, and prescribed a 6-week ambulatory intravenous antibiotic treatment. The 15-month follow-up was without
complications: neither reinfection- nor valve-related events

Discussion. Streptococcus suis, a gram-positive, facultatively anaerobic coccus, is the causative agent of a wide range of

* Corresponding author. Mailing address: Institute of Medical Microbiology, Hospital of the Justus-Liebig University Giessen, Frankfurter Strasse 107, D-35392 Giessen, Germany. Phone: 49 641-9941287. Fax: 49 641-9941259. E-mail: eugen.domann@ mikrobio.med.uni-giessen.de.
S. suis endocarditis in humans is a rare presentation worldwide, and only a few cases have been reported in the literature (3, 4, 9, 11, 15, 22, 24, 27). Infection with S. suis typically occurs via skin injuries, and in particular, farmers and workers involved in pork production are at risk. It is a known occupational disease occurring in people exposed to pigs or unprocessed pork (16). A detailed anamnesis of the patient disclosed that he was employed as a butcher in a slaughterhouse where only pigs were slaughtered. He occasionally removed abscesses from slaughtered pigs, and as a result, small skin lesions were inevitable during his work. Moreover, examination of his skin revealed that he suffered from very dry skin and fissured hands. A likely explanation for the fulminant and life-threatening disease was that an S. suis serotype 2 isolate derived from an infected pig entered the bloodstream of the patient via skin fissures or small lesions on his hands. Anamnestic reconstruction suggested that the microorganism disseminated very rapidly and destroyed his aortic valve and the ventricular septum within 10 to 14 days postinfection. The S. suis isolate was highly susceptible to the antibiotics used for treatment, and the patient responded very well and recovered rapidly after surgery.

Since growth of S. suis on sheep blood agar plates commonly used in routine diagnostic laboratories resembles viridans streptococci, diagnosis of S. suis constitutes a diagnostic pitfall. First, approximately 30% of all S. suis isolates harbor no suilysin and are therefore not beta-hemolytic. These isolates show alpha-hemolysis. Second, lysis of erythrocytes by suilysin depends on the origin of the red blood cells used. Human erythrocytes are the most susceptible, followed by horse, sheep, cow, and pig erythrocytes (5). Almost all isolates of S. suis are alpha-hemolytic on sheep blood agar plates and develop beta-hemolysis, if at all, only after prolonged incubation (17). Since sheep blood is the commonly used blood with agar plates for diagnosis, S. suis isolates (despite suilysin expression) resemble viridans streptococci after 24 h of incubation. Incubation of the most susceptible human blood agar plates showed that the S. suis isolate was beta-hemolytic after 24 h and that the hemolytic zone was more pronounced after a prolonged incubation of 48 h (Fig. 1). The presence of the suilysin gene was confirmed by employing a suilysin-specific PCR (12).

To confirm that the hemolytic activity observed was indeed due to suilysin of the S. suis isolate, the gene was heterologously expressed in the nonpathogenic gram-positive bacterium Listeria innocua. The entire gene was cloned into vector pSOG 34 (13) by using the primers sly-F SpeI (5’-CTC TCC TAA CTA GTT TTT TTT AAT AGG-3’) and sly-R XhoI (5’-AGT TTC TCG AGA ATA GTG TTT AGC-3’) (recognition sites of restriction endonucleases are underlined). The suilysin gene was inserted into the unique SpeI and XhoI restriction sites of vector pSOG 34. The plasmid was transformed to generate the recombinant strain L. innocua(pSOG::sly) as described previously (18).

The expression levels of suilysin in S. suis and in the recombinant strain L. innocua(pSOG::sly) were monitored by using cytotoxic and hemolytic assays as described previously (2). The cytotoxicity assay performed with Vero cells (African green monkey kidney cells) and the cell proliferation reagent...
WST-1, as recommended by the vendor (Roche Diagnostics, Mannheim, Germany), showed that bacterium-free supernatants of overnight cultures of *S. suis* and *L. innocua* (pSOG::sly) lysed the host cells within 3 hours. The hemolytic activity determined using human erythrocytes was 32 hemolytic U for both *S. suis* and *L. innocua* (pSOG::sly). The suilysin-negative strain *L. innocua* (pSOG) was neither hemolytic nor demonstrably cytotoxic.

We also detected suilysin in the supernatants of *S. suis* and *L. innocua* recombinant strains by employing a rabbit polyclonal antiserum raised against the conserved undecapeptide of listeriolysin, as specified previously (2). The polyclonal antiserum showed cross-reactivity with suilysin, and the toxin was detectable in the culture supernatants of both *S. suis* and *L. innocua* (pSOG::sly), with a calculated size of ~55 kDa. The negative control strain *L. innocua* (pSOG) expressed no suilysin. Transfer of the gene encoding suilysin to a nonhemolytic *L. innocua* strain imparted both novel hemolytic and cytotoxic properties to the recombinant strain.

The destructive case of infective endocarditis with a fulminant course described here and similar cases caused by *S. suis* serotype 2 strains are very typical for acute endocarditis caused by bacteria of high virulence potential, such as *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Enterococcus* species, or *Enterobacteriaceae*. Typical symptoms include high fever, leukocytosis, a high degree of aortic valve insufficiency, and generally a ventricular septal defect. Death occurs in several days to less than 6 weeks. On the other hand, viridans streptococci usually cause subacute or chronic endocarditis, a condition also called endocarditis lenta. Here the degree of valvular destruction may also be extensive, but infection occurs with a less acute onset of symptoms, with a low-grade fever, usually involving weeks to months, and with lower mortality (4, 25).

Since *S. suis* infection is a known occupational disease occurring in people with close contact to pigs or unprocessed pork, care to avoid generating skin lesions during meat processing procedures should be taken. The clear identification of *S. suis* as the causative agent of infective endocarditis enabled the appreciation of the infection as an occupational disease.


**REFERENCES**


