First Human Case of Meningitis and Sepsis in a Child Caused by *Actinobacillus suis* or *Actinobacillus equuli*

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We report the first human case of meningitis and sepsis caused in a child by *Actinobacillus suis* or *A. equuli*, a common opportunistic pathogen of swine or horses, respectively. Identification was performed by matrix-assisted laser desorption ionization–time of flight mass spectrometry and real-time PCR assay. A previous visit to a farm was suspected as the source of infection.

**CASE REPORT**

A previously healthy 13-year-old boy who had been suffering from otalgia for 24 h developed fever, headache, photophobia, drowsiness, and neck stiffness and was taken to the emergency department of a local hospital. No cranial traumas were reported. A physical examination found no other meningeal signs, neurological deficits, or papilledema. Otoscopic findings were normal. No petechiae were revealed. Laboratory tests showed neutrophilic leukocytosis (white blood cell [WBC] count, 17,700/μl; percentage of neutrophils [N], 85%) and a C-reactive protein (CRP) level of 1.0 mg/dl. Upon worsening drowsiness, non-contrast-enhanced magnetic resonance imaging of the head and neck was performed and the finding was normal. A lumbar puncture yielded opalescent cerebrospinal fluid (CSF) under normal pressure with 650 WBC/μl, mainly polymorphonuclear cells, an elevated total protein level (254 mg/dl), and a normal glucose level (49 mg/dl). The serum glucose level was 113 mg/dl. The patient was empirically given ceftriaxone intravenously (50 mg/kg) and transferred to our tertiary-referral Children's University Hospital.

Laboratory tests were repeated and showed increased neutrophilic leukocytosis (WBC count, 38,560/μl; percent neutrophil [N], 95%) and an elevated leukocytosis (white blood cell count, 17,700/μl; percentage of neutrophils [N], 85%) and a C-reactive protein (CRP) level of 1.0 mg/dl. Upon worsening drowsiness, non-contrast-enhanced magnetic resonance imaging of the head and neck was performed and the finding was normal. A lumbar puncture yielded opalescent cerebrospinal fluid (CSF) under normal pressure with 650 WBC/μl, mainly polymorphonuclear cells, an elevated total protein level (254 mg/dl), and a normal glucose level (49 mg/dl). The serum glucose level was 113 mg/dl. The patient was empirically given ceftriaxone intravenously (50 mg/kg) and transferred to our tertiary-referral Children's University Hospital.

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Lumbar puncture was then switched to meropenem at 40 mg/kg/dose three times a day, and dexamethasone at 0.1 mg/kg/dose four times a day was added.

Blood cultures carried out with the Bactec system with aerobic vials (Becton Dickinson, Milan, Italy) were positive for a Gram-negative bacillus. Ceftriaxone was then switched to meropenem at 40 mg/kg/dose three times a day, and dexamethasone at 0.1 mg/kg/dose four times a day was added.

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had visited a farm 3 days before the onset of symptoms, although close contact with horses or swine was denied.

Two days later, the patient’s condition improved, with fever resolution. Headache, neck stiffness, and drowsiness subsided in 4 days. Dexamethasone was reduced and discontinued in 1 week.

The child was discharged after 12 days of treatment, and a 6-month follow-up examination did not show any signs and symptoms of disease. A complete audiologic evaluation was performed, and the results were normal. T and B cell subsets, immunoglobulin levels, and neutrophil function were evaluated and were completely normal.

We report a case of sepsis and meningitis due to *A. suis* or *A. equuli* in a previously healthy 13-year-old boy. To the best of our knowledge, this is the first description of *A. suis* or *A. equuli* invasive infection of a child.

*Actinobacillus* is a Gram-negative coccobacillus, a member of the *Pasteurellaceae* family. Humans can be rarely colonized or infected by *A. hominis* or *A. ureae* (3, 4). *A. hominis* and *A. ureae* have been reported as uncommon commensals of the upper respiratory tract and can rarely cause severe infections in humans (3, 4). Twenty-seven cases of infection, including 14 cases of meningitis due to *A. ureae*, in humans have been reported in the literature (5).

### TABLE 1 Sequences of the primers and probe used in this study

<table>
<thead>
<tr>
<th>Gene&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Forward primer</th>
<th>Reverse primer</th>
<th>Probe</th>
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<tr>
<td>23S-rRNA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>CGG TAT TCG AAG TGT CTA TTG TGG TA&lt;sup&gt;324&lt;/sup&gt;</td>
<td>GAT GGT CCC CCC ATC TTC A&lt;sup&gt;567&lt;/sup&gt;</td>
<td>FAM-&lt;sup&gt;322&lt;/sup&gt; AAC GAC AAG TAG GGC GGG ACA CGA&lt;sup&gt;355&lt;/sup&gt; - TAMRA&lt;sup&gt;b&lt;/sup&gt;</td>
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<sup>a</sup> GenBank accession no. EU333989.1.

<sup>b</sup> TAMRA, 6-carboxy-tetramethylrhodamine.

*A. ureae* meningitis occurred mainly in immunocompromised patients or after skull injury (4).

*A. suis* is an opportunistic pathogen of swine. *A. suis* is an early colonizer of the upper respiratory airways of swine and can also cause a wide range of invasive infections, including arthritis, pleuropneumonia, septicemia, and meningitis in pigs of all ages (6, 7, 8). *A. equuli* is a commensal of horses and is a common cause of septicemia in foals (9). *A. suis* and *A. equuli* have been reported to cause wound infections in humans after pig or horse bites (10, 11). A case of *A. equuli* septicemia in a 53-year-old butcher after he sustained a cut has been described (12). However, *A. suis* and *A. equuli* have never been reported to cause meningitis and sepsis in children. The most likely source of *A. suis* or *A. equuli* is the farm visited by the child 3 days before the onset of symptoms, although physical contact with swine or horses was denied.

The patient presented sepsis and the hallmark symptoms of meningitis, i.e., fever, headache, photophobia, neck stiffness, and severe drowsiness. No alteration of coagulation was observed. No characteristic signs or symptoms that indicate *A. suis* or *A. equuli* infection were identified. Empirical treatment with ceftriaxone was started as soon as meningitis was suspected, in accordance with an international guideline (13). However, when Gram staining revealed a Gram-negative bacillus, an *Escherichia coli* infection was suspected. Therefore, as a high prevalence of extended-spectrum β-lactamase-producing bacteria has been reported in our country (14), a switch to meropenem was made. Nevertheless, *A. suis* or *A. equuli* antimicrobial susceptibility showed low MICs of all of the antibiotics tested, including cephalosporins and carbapenems.

The clinical response was optimal, and the patient recovered without any sequelae.

When *A. suis* or *A. equuli* was identified, an immunological defect was suspected. A careful immunological evaluation, including T and B cell subsets, immunoglobulin levels and immunoglobulin G subclasses, and neutrophil function, was performed, and the immunological profile was completely normal. Moreover, the patient had experienced no other significant condition suggestive of immunological defects in the past.

As identification by conventional biochemical profiling with Vitek2 yielded an identification of *A. ureae* while identification of *A. suis* or *A. equuli* could only be suspected on the basis of MALDI-TOF mass spectrometry and confirmed by molecular identification, we suggest that at least some of the previously reported invasive infections by *A. ureae* could have been caused by *A. suis* or *A. equuli*.

In conclusion, we report the first case of *A. suis* or *A. equuli* sepsis and meningitis in a child. We did not identify any clinical characteristics that indicate *A. suis* or *A. equuli* infection. Misdiagnosis of this pathogen by the Vitek2 system could be possible. MALDI-TOF mass spectrometry and molecular biology tech-
niques may provide the proper diagnosis of this uncommon pathogen.

ACKNOWLEDGMENT
We have no conflicts of interest to report.

REFERENCES