**Bordetella holmesii** Bacteremia in Asplenic Children: Report of Four Cases Initially Misidentified as *Acinetobacter lwoffii*\(^\text{⁠¹⁷⁰⁶⁹}\)

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Received 21 March 2010/Returned for modification 5 May 2010/Accepted 16 July 2010

*Bordetella holmesii* is a fastidious Gram-negative rod that was initially identified in 1995. It causes bacteremia, predominantly among patients with anatomical or functional asplenia. We report four cases of *B. holmesii* bacteremia in asplenic children occurring within the last 4 years. In all cases, *B. holmesii* was misidentified by an automated system as *Acinetobacter lwoffii*.

Four male adolescent patients, aged between 13 and 17 years, presented with mild febrile illness but no other clinically significant complaints within a period of 3.5 years. Three were suffering from sickle cell disease; two of them had undergone splenectomy. In the fourth patient, elective splenectomy was performed for an autoimmune hemolytic anemia. No epidemiological link was found between the four patients.

At the emergency department, they appeared well and had no remarkable findings on physical examination or initial laboratory workup. Blood cultures all grew Gram-negative bacilli. Two of the patients received intravenous (i.v.) ceftriaxone for 2 and 7 days, respectively. The remaining patients were treated with i.v. ceftriaxone followed by oral ciprofloxacin for a total of 10 days.

The clinical outcome was uniformly favorable. Clinical and laboratory findings are summarized in Table 1.

The Gram-negative bacilli isolated from the blood cultures (Bactec 9240, Peds Plus, and Plus Aerobic bottles; BD Diagnostics Inc., Sparks, MD) were small and coccoid. They tested negative for catalase, oxidase, nitrate reduction, and urease activity as well as indole spot and oxidative-fermentative (OF) glucose media. The mean incubation time was 40 h (range, 30 h to 47.3 h). Colonies grew well at 24 h when inoculated on 5% sheep blood agar plates and incubated in 5% CO\(_2\), whereas only three strains showed very limited growth after 48 h on MacConkey agar. While they were growing, they all produced a diffusible brown pigment which could have been mistaken for alpha-hemolysis on a sheep blood agar plate. We were unable to identify the isolates through routine laboratory protocols and inoculation into API 20E and API 20NE strips (bio-Mérieux Inc.). We finally used the Gram-negative card on a Vitek2 automated system (bioMérieux Inc.), which reported *Acinetobacter lwoffii* with 99% probability (excellent identification confidence level) for all isolates. Some basic characteristics did not match this result. *A. lwoffii* usually grows well on MacConkey agar, has a positive catalase activity, and does not produce any pigment. All isolates were subsequently identified as *Bordetella holmesii* by 16S rRNA gene sequence analysis performed at Quebec's Laboratory of Public Health, as previously described (2).

MICs determined by Etest on Mueller-Hinton agar were \(\leq 0.25\) μg/ml for piperacillin, ticarcillin-clavulananle, ceftazidine, meropenem, ciprofloxacin, trimethoprim-sulfamethoxazole, and polymyxin E; MICs for gentamicin and tobramycin were 2 μg/ml for one isolate and \(\leq 0.25\) μg/ml for the remaining three. Although all patients were treated with ceftriaxone, susceptibility testing for ceftriaxone was not performed.

The genus *Bordetella* belongs to the family of Alcaligenaceae and currently comprises eight species, including *B. holmesii*. *Bordetella pertussis* is the causative agent of whooping cough, while *Bordetella parapertussis* and *Bordetella bronchiseptica* are also implicated in respiratory tract infections in humans. *Bordetella avium* is considered a strict avian pathogen but has recently been isolated in the sputum of cystic fibrosis patients and others with respiratory disease (9, 19). *Bordetella hinzii* was found to colonize the respiratory tract in poultry and also in humans with cystic fibrosis. It can occasionally cause infection in immunocompromised patients (5, 19, 23). *Bordetella trematum* has been isolated from ear and wound infections and from a diabetic patient with a leg ulcer (3, 22). *Bordetella petrii* has been documented in patients with cystic fibrosis (19), in a patient with mandibular osteomyelitis, and in another with mastoiditis (7, 20). It is noteworthy that, in this last patient, the Vitek2 automated system misidentified the organism as *Pseudomonas fluorescens*. A recently proposed species is *Bordetella ansorpii*, which was first isolated in pus from an epidermal cyst and was also found to cause bacteremia in an immunocompromised patient (6, 10).

*B. holmesii* was first described in 1995 as a cause of septicemia in 15 patients, including at least three children with asplenia, without any further clinical information (24). The first detailed clinical case report was published later that year with the description of a 12-year-old male who had a history of
spleenectomy for an idiopathic thrombocytopenic purpura. He presented with fever but had an otherwise-normal physical examination. He quickly responded to i.v. ceftriaxone (11). Since then, B. holmesii has been reported as a cause of bacteremia, endocarditis, and pneumonia, mainly in immunocompromised and, more particularly, in asplenic patients (4, 8, 12, 13, 15, 18, 21). In the largest published series so far, describing 26 patients with B. holmesii bacteremia, 85% had anatomical or functional asplenia (18). The clinical course usually remained uneventful, and patients tended to recover without complications. However, an immunocompetent adolescent with B. holmesii bacteremia and lobar pneumonia developed empyema. He eventually evolved toward pulmonary fibrosis (17). In most published articles, failure of identification by commercial systems and identification ultimately made possible by using 16S rRNA gene sequence analysis are reported. None of the other studies clearly mentioned systematic misidentification as A. lwoffii or another bacterium using an automated identification system.

B. holmesii has been isolated from cultures of nasopharyngeal specimens in 0.6% of U.S. patients with pertussis-like symptoms (25) but was not demonstrated using B. holmesii-specific PCR on nasopharyngeal swabs from Dutch and Finnish patients with the same symptoms (1). The role of B. holmesii in respiratory tract colonization or infection remains to be elucidated. There is no known reservoir for B. holmesii. Modes of acquisition also remain to be identified. No person-to-person transmission has been described to date. B. holmesii reacts as an opportunistic pathogen with low virulence that tends to cause usually uncomplicated and often self-limited infection, such as that seen in our patients.

The increased susceptibility to infection and overwhelming sepsis, predominantly with encapsulated bacteria, is well recognized in asplenic patients. Sequencing of B. pertussis, B. parapertussis, and B. bronchiseptica genomes revealed the presence of a locus that is likely to encode a polysaccharide capsule, and a recent report demonstrated the presence of a capsule on the surface of B. pertussis (14, 16). Whether B. holmesii strains possess a capsule or not remains unknown. Nevertheless, overwhelming sepsis did not occur in our patients and are not reported in the literature. Because the microorganism is not included in its database. In addition, the system does not consider catalase activity or the presence of pigment. A. lwoffii was systematically erroneously reported with a high identification confidence level.

The above-described clinical cases and results of microbiological analysis support the growing evidence for the role of B. holmesii as a pathogen among asplenic patients and suggest that it should always be considered, especially when the Vitek2 automated system reports A. lwoffii.

REFERENCES

### TABLE 1. Clinical characteristics and laboratory findings for the 4 patients

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<tr>
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<td>Age (yr)</td>
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<tr>
<td>Medical condition</td>
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<tr>
<td>Duration of fever (days)</td>
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<td>Treatment</td>
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<td>Length of hospital stay</td>
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*a* U/S, ultrasound; Tc/Ga, technetium-gallium.


