Meningitis Due to *Capnocytophaga canimorsus* after Receipt of a Dog Bite: Case Report and Review of the Literature

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We describe a case of meningitis due to *Capnocytophaga canimorsus* and review 18 cases with attention to risk factors, clinical features, diagnosis, treatment, and outcome. In most of the reported cases, contact with dogs and predisposing factors were found. Clinical manifestations and the findings of examinations of cerebrospinal fluid specimens were similar to those of classic bacterial meningitis; however, the mortality rate for *C. canimorsus* meningitis very low when compared with the rate for *C. canimorsus* septicemia (5% vs. 30%).

*Capnocytophaga canimorsus*, formerly known as “dysgonic fermenter 2” [1], is a slowly growing, capnophilic, fusiform, and filamentous gram-negative rod. In 1976, it was first reported to cause septicemia, endocarditis, and meningitis in humans [2]. It is part of the normal oral flora of dogs and cats and can cause human septicemia, usually after receipt of a dog bite or contact with dogs. Eighteen cases of *C. canimorsus* meningitis have been reported in the English-language literature [2–14]. We report an additional case of *C. canimorsus* meningitis and review the 18 cases with attention to risk factors, clinical features, diagnosis, treatment, and outcome, to contribute to the description and understanding of this condition.

**Case report.** A 45-year-old man with a history of several years of alcohol abuse was admitted to the hospital in December 2001 because of fever, headache, and confusion. He had been bitten on a finger by the family dog 9 days before admission. A physical examination conducted at the time of admission revealed a temperature of 40°C, photophobia, headache, and meningeal stimuli with Kerning’s and Brudzinski’s signs and without any focal neurologic deficit. A CT scan of the brain revealed no cerebral lesions. Laboratory studies performed at admission revealed the following hematological values: hemoglobin concentration, 12.5 g/dL; WBC count, 15.7 × 10^9^ cells/L, with 72% segmented neutrophils; and platelet count, 198 × 10^9^ platelets/L. The erythrocyte sedimentation rate was 75 mm/h, and the serum C-reactive protein level was 127 mg/L. A lumbar puncture performed at the time of admission revealed CSF. The meningitis diagnosis was confirmed by the CSF profile, for which the following values were noted: leukocyte count, 1240 × 10^9^ leukocytes/L, with 65% neutrophils; protein, 1.65 g/L; lactate concentration, 2.64 mM; and glucose, 1.8 mM (serum glucose, 8.5 mM).

Examination of a Gram stain of a CSF specimen revealed gram-negative bacilli. Cefotaxime therapy was initiated at a dosage of 200 mg/kg per day. Two days after admission to the hospital, the CSF culture (chocolate agar plate incubated aerobically in 5% CO_2_ and anaerobically in Rosenow liquid medium) yielded organisms. The Gram stain of flat and irregular colonies with fingerlike projections showed thin, spindleshaped, gram-negative rods. Attempts to grow subcultures on chocolate agar without 5% CO_2_ and on MacConkey agar were unsuccessful. The organism was oxidase positive and catalase positive. The API Neisseria 4H strip (bioMérieux) result was positive for acid production by glucose, maltose, and fructose but negative for acid production by sucrose. The rapid ID 32 A strip (bioMérieux) result was negative for indole, nitrate reductase, and arginine dihydrolase. The API 20 A strip (bioMérieux) result was positive for esculin and acid production from lactose but negative for acid production by raffinose.

These results allowed us to identify *Capnocytophaga canimorsus* on day 9 of hospitalization. Three days after the initiation of cefotaxime therapy, the patient was afebrile and in good clinical condition. Cultures of blood samples obtained at the time of admission were negative. Disk diffusion tests for antibiotic susceptibility were performed on chocolate agar incubated at 37°C in 5% CO_2_. On the basis of French interpretative standards [15], we found that the organism was susceptible to ampicillin, cephalothin, cefotaxime, pefloxacin, and vancomycin; it had intermediate resistance to erythromycin; and it was resistant to gentamicin, colistin, and trimethoprim-sulfamethoxazole. Etests performed on a chocolate agar plate...
yielded low MICs of penicillin (MIC, 0.094 μg/mL), ampicillin (MIC, 0.032 μg/mL), and cefotaxime (MIC, 0.064 μg/mL). On day 9 of hospitalization, on the basis of the definitive bacteria identification, cefotaxime was replaced with amoxicillin (200 mg/kg per day) until day 21 of hospitalization. A second CSF sample was obtained 19 days after admission, and examination of it revealed the following values: leukocyte count, $6 \times 10^4$ leukocytes/L, with 86% lymphocytes; protein concentration, 0.7 g/L; lactate, 1.8 mM; and glucose, 2.48 mM (serum glucose, 5.5 mM). Gram stain and culture of the CSF specimen yielded negative results. The patient fully recovered and was discharged from the hospital 21 days after admission.

**Discussion.** Since the first description by Bobo and Newton in 1976 [2], 19 cases of *C. canimorsus* meningitis have been reported in the English-language literature [2–14], including the present case. Table 1 summarizes the main features of the 19 cases of *C. canimorsus* meningitis. Exposure to dogs is closely related to *C. canimorsus* meningitis. Of the patients described, 11 (58%) of 19 reported a history of receipt of a dog bite, and 4 (21%) had been exposed to a dog. In one case, the meningitis followed a cat bite [6]; in another case, the patient was exposed to a dog and cat without being bitten [8]. For 2 patients, data about exposure to animals were not available [13]. The mean interval between the dog bite and admission to the hospital was 7.2 days (range, 3–14 days). The ratio of male to female patients was 3.75:1 (15 men and 4 women). The age range for patients with *C. canimorsus* meningitis was 17–83 years (mean, 50.6 years).

Risk factors, including alcoholism, splenectomy, and receipt of glucocorticosteroid therapy, have been previously described in association with *C. canimorsus* infection [16]. Of the 19 patients (i.e., our patient and 18 patients with *C. canimorsus* meningitis described in the literature), 5 (26%) were asplenic (i.e., had a history of alcohol abuse, 2 (11%) experienced cardiac failure, and 1 (5%) had rheumatoid arthritis. In 7 cases (37%), no obvious underlying condition was found.

The mortality rate for reported cases of *C. canimorsus* meningitis is very low (5% [1 of 19]). The single patient with *C. canimorsus* meningitis to have died experienced cardiac arrest 10 days after discharge from the hospital [11]. This fatal outcome was not formerly linked to the *C. canimorsus* infection. The mortality rate for *C. canimorsus* septicemia is far higher (30%–36%) [13, 14]. The clinical symptoms of all documented cases of *C. canimorsus* meningitis were very similar to the usual symptoms of bacterial meningitis: headache and meningismus [17]. The exception is fever (temperature, $>38^\circ C$), which was present in only 6 (32%) of 19 patients.

Two patients described in the literature had negative blood cultures, a finding we observed in our case. In our patient, at the time of admission to the hospital, 2 sets of blood samples were obtained for aerobic and anaerobic cultures in BacT/Alert FAN blood culture bottles (Organon Teknika). The bottles were incubated in a continuous-monitoring automated blood culture instrument (BacT/Alert; Organon Teknika). In our laboratory, blood cultures with no growth detected after 6 days of incubation are considered to be negative and are discarded.

This technique has allowed us to isolate 4–6 *Capnocytophaga* species per year. In the 12 reported cases in which blood cultures results were available, 2 were negative and 10 were positive. In case reports about *C. canimorsus* bacteremia, blood cultures have revealed growth after a mean of 6 days [16]. The slow growth of this fastidious bacteria and a low blood concentration in immunocompetent patients might explain the negative blood cultures for our patient. Bottles were discarded on the sixth day of incubation, but a longer duration of incubation should have permitted growth. Although it has been proposed that no more than 5 days are necessary to routinely incubate FAN blood culture bottles, fastidious organisms such as *C. canimorsus* require longer incubation periods for detection [18].

Lumbar puncture was performed for the 19 reported cases. CSF analysis is a common technique used to help diagnose bacterial meningitis. In 11 patients, detailed data from CSF examinations were available, with a WBC count range of 0–6000 cells/μL and a neutrophilic predominance in 8 patients (73%). The CSF protein level was elevated in the 9 patients for whom data were available, but it was <2.0 g/L in 8 of these patients. A decreased CSF glucose level (<0.4 g/L) was noted for almost all of the patients. The ratio of CSF glucose to serum glucose had decreased to <0.5 for 5 (71%) of 7 patients for whom data were available. Of the 19 described patients, Gram stain findings for CSF specimens were reported for 12. Gram stains showed gram-negative bacilli in 9 (75%) of these 12 patients. Three patients had negative CSF Gram stain results.

The culture media (chocolate agar) and culture conditions (temperature of 37°C and CO$_2$-enriched atmosphere) that are commonly used for CSF culture allowed the growth of *C. canimorsus*. The organism grows best at temperatures of 35°C–37°C in an aerobic atmosphere with 5%–10% CO$_2$ or in an anaerobic atmosphere and on Columbia agar with 5% sheep’s blood or standard chocolate agar. *Capnocytophaga* species cannot grow on MacConkey agar.

Gram stain of flat and irregular colonies with fingerlike projections showed thin, spindle-shaped, gram-negative rods. This cellular morphology is very similar to that of *Fusobacterium* species. However, the presence of *Fusobacterium* species, which are strictly anaerobic, is rapidly ruled out on the basis of culture conditions. The fingerlike projections along the agar surface are due to a particular motility of the bacteria. This gliding motility characterizes the movements of the organisms in the microscopic field. In one reported case, the gliding motility was observed during the primary microscopic evaluation of the CSF...
Table 1. Patients with meningitis caused by *Capnocytophaga canimorsus* described in the English-language literature.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Sex, age in years</th>
<th>Animal contact</th>
<th>Interval, days(^a)</th>
<th>Predisposing factor</th>
<th>Temperature, °C</th>
<th>WBC count, cells/μL (differential)</th>
<th>Protein level, g/L</th>
<th>Ratio of CG to SG</th>
<th>Treatment (duration, days)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>[2]</td>
<td>M, 42</td>
<td>Dog bite</td>
<td>7</td>
<td>Alcoholism</td>
<td>40.2</td>
<td>19 (70% lymph)</td>
<td>0.85</td>
<td>0.59</td>
<td>3, 3 Amp (14)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[4]</td>
<td>F, 66</td>
<td>Dog exposure</td>
<td>NA</td>
<td>None</td>
<td>37</td>
<td>575 (90% neutro)</td>
<td>2.4</td>
<td>0.24</td>
<td>NA 5 Ben (7), Chl (10)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[5]</td>
<td>M, 63</td>
<td>Dog bite</td>
<td>14</td>
<td>None</td>
<td>37.8</td>
<td>1121 (80% neutro)</td>
<td>1.75</td>
<td>0.45</td>
<td>2, 7 Chl, Amp</td>
<td>Recovered</td>
</tr>
<tr>
<td>[6]</td>
<td>M, 26</td>
<td>Cat bite</td>
<td>8</td>
<td>Splenectomy</td>
<td>38.4</td>
<td>520 (70% neutro)</td>
<td>1.43</td>
<td>0.2</td>
<td>NA NA Cftx, Pen (14)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[7]</td>
<td>M, 26</td>
<td>Dog exposure</td>
<td>NA</td>
<td>None</td>
<td>40</td>
<td>0</td>
<td>0.31</td>
<td>0.53</td>
<td>4 4 Chl→Pen (14)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[8]</td>
<td>F, 39</td>
<td>Dog and cat exposure</td>
<td>NA</td>
<td>None</td>
<td>38.2</td>
<td>480 (70% neutro)</td>
<td>0.32</td>
<td>NA</td>
<td>5 — None</td>
<td>Recovered</td>
</tr>
<tr>
<td>[9]</td>
<td>F, 47</td>
<td>Dog exposure</td>
<td>NA</td>
<td>Alcoholism</td>
<td>NA</td>
<td>820 (74% neutro)</td>
<td>4.65</td>
<td>— (^b)</td>
<td>NA NA Imi/Cil→Pen (14)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[10]</td>
<td>F, 75</td>
<td>Dog bite</td>
<td>9</td>
<td>Splenectomy</td>
<td>38</td>
<td>6000(^c)</td>
<td>NA</td>
<td>NA</td>
<td>— 4 Chl (11)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[12]</td>
<td>M, 57</td>
<td>Dog bite</td>
<td>9</td>
<td>None</td>
<td>38.5</td>
<td>43 (74% lymph)</td>
<td>1.53</td>
<td>0.3</td>
<td>5 5 Amox (21)</td>
<td>Recovered</td>
</tr>
<tr>
<td>[14]</td>
<td>M, 54</td>
<td>Dog bite</td>
<td>10</td>
<td>Alcoholism</td>
<td>40</td>
<td>1245 (65% neutro)</td>
<td>1.65</td>
<td>0.21</td>
<td>3 4 Amox</td>
<td>Recovered</td>
</tr>
</tbody>
</table>

*NOTE.* Amox, amoxicillin; Amp, ampicillin; Ben, benzyl penicillin; Cftx, ceftriaxone; Cftz, ceftazidime; CG, CSF glucose level; Chl, chloramphenicol; Cil, cilastin; Gm, gentamicin; gran, granulocytes; lymph, lymphocytes; Mtz, metronidazole; NA, not available; Net, netilmicin; neutro, neutrophils; Pen, penicillin; SG, serum glucose level; →, switch in therapy.

\(^a\) Interval between receipt of animal bite and admission to hospital.

\(^b\) CG level, 2.15 mM.

\(^c\) Mainly neutro.
specimen, raising the possibility that it was a *Capnocytophaga* species [11]. Culture conditions, colony morphology, Gram stain morphology, and gliding motility are the main characteristics that allow identification to the genus level.

The differentiation of *C. canimorsus* from other capnophilic bacilli may be difficult. Positive catalase, oxidase, and esculin reactions eliminate capnophilic organisms other than *C. canimorsus* and *Capnocytophaga cynodegmi* [19]. *C. canimorsus* can be distinguished on the basis of negative reactions for insulin and sucrose. *C. canimorsus* is positive for acid production by glucose, maltose, and fructose, negative for indole and nitrate reductase, and positive for acid production by lactose but negative for acid production by raffinose. *C. canimorsus* are positive for arginine dihydrolase. The inability to hydrolyze arginine in the API strip test was the only atypical reaction we found. This inability to hydrolyze arginine was already reported for *C. canimorsus* by Roblot et al. [20] in 1993 in our laboratory with the use of the same API strip test. The API *Neisseria* 4H strip (bioMérieux), the rapid ID 32 A strip (bioMérieux), and the API 20 A strip (bioMérieux) almost suffice for identification.

Because it is fashionable to own animals as pets and defense animals, the incidence of diseases transmitted by bites or scratches has increased. Among them, infections due to *C. canimorsus* are found in CSF specimens. Nevertheless, it is probably not optimal for treatment of *C. canimorsus* infections. In vitro susceptibility testing of *C. canimorsus* is difficult to perform reliably with any standardized procedure, because there is often slow or insufficient growth. However, *C. canimorsus* is reported to be susceptible to penicillins, imipenem, erythromycin, vancomycin, clindamycin, third-generation cephalosporins, chloramphenicol, rifampin, doxycycline, and quinolones, but it is reported to be resistant to aztreonam, polymyxin, metronidazole, trimethoprim, fosfomycin, and aminoglycosides [21–23].

There have been occasional reports of β-lactamase-producing *Capnocytophaga* species, but never for *C. canimorsus* species [24], and resistance to the fluoroquinolones group has very rarely been described [25]. On the basis of its MIC, pen-}

icillin is considered to be the drug of choice. However, to our knowledge, there has not been a controlled clinical study of any specific drug for treatment of *C. canimorsus* meningitis. The length of treatment differs according to the study (range, 14–21 days) [2–14]. The optimal duration of antibiotic treatment for patients with bacterial meningitis is unclear; traditionally, a long course (21 days) is recommended for infections involving gram-negative bacilli other than *Haemophilus influenzae* [26].

Prompt and appropriate antibiotic treatment is required for this meningitis. Therefore, *C. canimorsus* should be strongly suspected in any case of meningitis that occurs in patients who have received a dog bite. When confronted with patients who have meningitis and a recent history of dog bites or dog contact, a high level of awareness on the part of the clinicians and prompt consultation with the microbiologists for the possible presence of this fastidious gram-negative bacillus in CSF and blood culture may facilitate the diagnosis of *C. canimorsus* meningitis.

References


18. Bourbeau PP, Pohlman JK. Three days of incubation may be sufficient for routine blood cultures with BacT/Alert FAN blood culture bottles. J Clin Microbiol 2001;39:2079–82.


