The next day, the blood culture was reported as positive with Gram-negative bacilli. The patient was admitted for the management of bacteremia and meningitis. The patient’s CSF studies showed low glucose and high protein levels, consistent with bacterial meningitis (see Table 2). However, there were no organisms seen on Gram-stained smear, despite the presence of leukocytes. CSF cultures were negative. The patient was treated with ceftriaxone and ampicillin. Careful review of the history revealed no potential direct animal exposures, although there were several household outdoor dogs. In addition, there was no history of travel.

The patient’s hospital course was complicated by persistent fevers and development of subdural effusions that were confirmed on radiographic imaging of head. These effusions required serial lumbar taps for relief.

In the laboratory, the Gram-stained smear of the positive blood culture bottle exhibited Gram-negative coccobacilli. The blood culture bottle was subcultured to chocolate and 5% sheep blood and MacConkey agar. The media incubated at 35°C in 5% CO₂ for 24 hours. Following incubation, multiple 0.5 cm diameter, grey, non-hemolytic colonies were noted to have grown on the chocolate and 5% sheep blood agar plates (Figure 1). The organism was subsequently identified, using the Remel Rapid NF testing kit for glucose-nonfermenting Gram-negative bacteria. Additional characteristics included: facultative anaerobe, positive oxidase and catalase tests. The spot indole test was also positive and confirmatory of the identification.

**TABLE 1**: Complete blood count and chemistry analysis of serum

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Value</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>16.3 x 10⁹/L</td>
<td>4.0-11.0 x 10⁹/L</td>
</tr>
<tr>
<td>WBC differential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutrophils</td>
<td>83%</td>
<td>55-70%</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>10%</td>
<td>20-30%</td>
</tr>
<tr>
<td>Monocytes</td>
<td>2%</td>
<td>2-5%</td>
</tr>
<tr>
<td>Red Blood Cells</td>
<td>5.6 mm/L</td>
<td>4.6-5.4 mm/L</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>15.4 g/dL</td>
<td>13.5-16.5 g/dL</td>
</tr>
<tr>
<td>Platelet count</td>
<td>315 x 10⁹</td>
<td>150-400 x 10⁹</td>
</tr>
</tbody>
</table>

**TABLE 2**: Analysis of specimen from lumbar puncture

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Value</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>White blood cell count</td>
<td>9.44 mm³</td>
<td>5.0-10.0 mm³</td>
</tr>
<tr>
<td>Differential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutrophils</td>
<td>91%</td>
<td>55-70%</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>8%</td>
<td>20-30%</td>
</tr>
<tr>
<td>Monocytes</td>
<td>1%</td>
<td>2-5%</td>
</tr>
</tbody>
</table>

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**Background**

*Pasteurella* spp. are normal flora of the respiratory and gastrointestinal tracts of many species of domestic and wild animals. They are etiological agents of hemorrhagic septicemia, gastrointestinal infections, and respiratory tract infections in many animals. The current taxonomy of this genus has recently changed with some members transferred to the genus Aggregatibacter and several new species being added. Currently there are 21 species listed within this genus.

Humans acquire *Pasteurella* primarily through animal exposure. Most human infection are associated with animal bites, but respiratory tract infections can be caused by inhalation of the organism. *Pasteurella multocida* includes three subspecies, *multocida*, *septica*, and *gallicida*. It is the most commonly isolated human pathogen from bite wounds but has been recovered from respiratory secretions from patients with pneumonia, cerebrospinal fluid, abscesses, biopsy specimens from patients with osteomyelitis, blood, joint fluid from septic arthritis, and many other sites. Other species of *Pasteurella* are more often associated with animal disease, although they have been reported from human cases of endocarditis, pneumonia, septicemia, and wounds, occasionally involving osteomyelitis. The biochemical reactions of the most common species of *Pasteurella* are listed in Table 1. For a more complete discussion of the taxonomy of *Pasteurella* spp., see ref. 1.

**Animal Reservoir**

*P. multocida* subsp. *multocida* is routinely isolated from the respiratory tract of household cats and dogs and from human infections after bites or close proximity to pets. It is also the most clinically significant *Pasteurella* subspecies. The frequency of *Pasteurella multocida* carriage varies by the animal species. Cats and dogs have the highest rates of colonization, 70-90% and 15-55%, respectively. Most animals carry the organism asymptptomatically, although *P. multocida* can cause sporadic and epidemic illness in animals, such as pneumonia and septicemia in cattle, sheep and swine, fowl cholera in chickens, turkeys and ducks. *P. multocida* subsp. *septica* and *gallicida* are also similar in distribution, although less commonly found as human pathogens. Identification to the subspecies level is of greatest clinical significance to veterinary medicine. *P. multocida* is also widely cultured from other animals, such as domesticated and wild, e.g., lions, panthers, and various birds. They have been attributed to atrophic rhinitis in pigs and “shipping fever” in cattle, when the animals were under stress and in close proximity while being herded across long distance.

**Clinical Presentation**

Humans do not usually harbor the organism. The majority of human infection is cellulitis and wound infection (direct contact with animal via licking or biting of hands or feet). Besides local infections, *P. multocida* is capable of causing systemic diseases such as meningitis, septicemia, peritonitis, arthritis, endocarditis, and osteomyelitis. Infections have also been reported with underlying medical conditions such as diabetes, steroid therapy, and immunosuppression. In one literature review, up to 68% of cases of *P. multocida* meningitis occurred after skull fracture or neurosurgery.

There have been case reports of neonates in close proximity to pets (cats and dogs) becoming infected with *P. multocida*. The routes of transmission often are ascribed to pets licking the fingers or faces of a young child, without a history of bites or trauma. In this case, the mother did not report a history of bites, although a clear history of a household pet was elicited.

Central nervous system infections by *P. multocida* has been well-characterized in the elderly, immunocompromised, and young children and infants. Examples include meningitis, subdural empyema, and brain abscess. CSF typically shows bacterial infection, with elevated WBC’s (neutrophils dominant), low glucose (<2.2 mmol/L), no RBC’s (non-traumatic tap), and increased protein (>0.45 g/L). Meningitis is an infection predominantly involving the subarachnoid space, but can refer to focal or generalized involvement of the brain tissue. Meningitis due to Gram-negative bacilli can also be a complication of neurosurgical procedures such as craniotomy.

**Pathogenesis**

Virulence of *Pasteurella* is related to the polysaccharide capsule that allows the organism to resist phagocytosis. Although some strains produce a cytotoxin, its role in the pathogenesis of disease is not clear. *P. multocida* appears to be the most virulent of the species. Virulence may be enhanced by the ability of the organism to utilize free iron, a factor in the pathogenicity of other bacterial species.

**Laboratory Identification**

*Pasteurella* spp. grow well on routine laboratory media, including blood agar. Growth is not enhanced by CO₂. Colonies are small and translucent and may be smooth or rough. A brown discoloration of the medium may develop around colonies. The organisms on blood agar have an “*E. coli*-like” smell, that may be recognizable to an olfactorily sophisticated microbiologist. Most species should be oxidase positive, nitrate reduction and catalase positive, alkaline phosphatase positive, and glucose fermenters. (Table 3)
Antimicrobial Susceptibilities

*P. multocida* usually is susceptible to penicillin, and it is the antimicrobial of choice for infections caused by this organism. Additional agents with proven efficacy include extended-spectrum cephalosporins, tetracycline and chloramphenicol. Although β-lactamase-producing strains are isolated from animal sources, for the most part human wounds have not been found to harbor β-lactamase-producing strains. In vitro susceptibility testing may not be necessary for isolates when multiple organisms are present since empiric therapy for mixed infections is usually effective against *Pasteurella* as well. Testing isolates from normally sterile body sites such as CSF, blood, joints, tissue or implanted devices may be appropriate. In 2006, The Clinical and Laboratory Standards Institute released the first international guidelines for testing a number of fastidious bacteria, including *Pasteurella* spp. In these guidelines, the following agents are suggested for testing if indicated: penicillin, a β-lactam/β-lactamase inhibitor combination (e.g., ampicillin/sulbactam or piperacillin/tazobactam), ceftriaxone, moxifloxacin, levofloxacin, doxycycline, erythromycin or azithromycin and trimethoprim-sulfamethoxazole.

Cation-adjusted Mueller-Hinton broth with 2 to 5% lysed horse blood is recommended for broth microdilution testing, while Mueller-Hinton agar with 5% sheep blood is recommended for diffusion disk testing. The recommended incubation is at 35°C for 18-24 hours in ambient air. The guidelines list a significant number of antimicrobial agents for both disk diffusion and dilution testing.

**Conclusion**

Bacterial meningitis caused by *Pasteurella multocida* is a rare infection, especially among young infants and children. Meningitis in this age group are difficult to detect via physical exam because their lack of classic physical signs and symptoms, which include headache, photophobia (eye sensitivity to light), stiff neck, skin rashes, and seizures. However, meningitis should be suspected in the presence of fever and an unknown source of infection. An identification of *Pasteurella* spp. requires laboratory identification, combined with a careful history and physical examination. In this particular case, *Pasteurella* infection most likely came from close contact to household pets.
References


Career Opportunity

Voluntary Service Overseas (VSO) is urgently looking for Medical Technologists to work in Ethiopia and Indonesia.

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Answer questions only on the official STEP answer sheet. If you do not have the official STEP answer sheet, a year’s supply can be obtained (at no cost), simply by writing to: STEP Program Answer Sheets, American Medical Technologists, 10700 W. Higgins Road, Suite 150, Rosemont, IL 60018, or by fax: 847/823-0458, or by e-mail: paula.simoncini@amt1.com.

In addition to marking your answers, be sure to include all the required information on the answer sheet and a processing fee of $3.00 per article.

In the following, choose the one best answer for each question.

1. What biochemical test results are consistent with *Pasteurella multocida*?
   A. Oxidase negative, Spot Indole positive, Catalase positive.
   B. Oxidase positive, Spot Indole positive, Catalase positive
   C. Oxidase positive, Spot Indole negative, Catalase negative
   D. Oxidase negative, Spot Indole negative, Catalase negative

2. What is the most common drug of choice used to treat *Pasteurella* infection?
   A. Ampicillin Sulbactum
   B. Pipercillin Tazobactam
   C. Penicillin
   D. Ceftriaxone

3. What animal has the highest rate of colonization by *Pasteurella*?
   A. Dogs
   B. Birds
   C. Cattle
   D. Cats

4. The virulence of *Pasteurella* can be attributed to which of the following?
   A. The polysaccharide capsule
   B. Its strong cytotoxin
   C. Polar Flagella
   D. Its utilization of free calcium

5. In the laboratory, growth of *Pasteurella* is enhanced by CO₂.
   A. True
   B. False

6. For the most part, human wounds have not been found to harbor β-lactamase producing strains.
   A. True
   B. False

7. *Pasteurella* is capable of causing which of the following infections?
   A. Wound
   B. Osteomyelitis
   C. Pneumonia
   D. All of the above

8. *Pasteurella* growing in the laboratory smells most like which of the following?
   A. *E. coli*
   B. *P. aeruginosa*
   C. *B. fragilis*
   D. *P. mirabilis*

9. The Clinical and Laboratory Standards Institute suggests testing which of the following antibiotics for susceptibility?
   A. Moxifloxacin
   B. Penicillin
   C. Doxycycline
   D. All of the above

10. Physical signs of meningitis can include which of the following?
    A. Seizures
    B. Skin rash
    C. Photophobia
    D. All of the above