Gemella haemolysans was identified in 1938, initially under the genus Neisseria, and has been considered a commensal in the human upper respiratory tract. Commensals are natural inhabitants on or within another organism, deriving benefit without harming or benefiting the host. Opportunistic infection of the CNS by the species is exceedingly rare. In the present case, a 16-year-old boy was admitted with a ventriculoperitoneal shunt infection, which was confirmed to be due to G. haemolysans. Following antibiotic treatment, removal of the old shunt, and delayed insertion of a new shunt, the patient made a full neurological recovery. To the authors’ knowledge, this is the eighth case of CNS infection with G. haemolysans. Although prosthesis-related infections have been reported in other systems, this is the first case of CNS infection by the bacterium associated with an implant. Previous reported cases of CNS infection by G. haemolysans are reviewed. Due to the variable Gram staining property of the organism, the difficulty in diagnosing G. haemolysans infection is emphasized.

**Case Report**

*History and Examination.* This 16-year-old boy had a history of Dandy-Walker syndrome, learning difficulty, and 10 previous CSF surgeries, the first one at 6 months of age and the last one 3 weeks before presentation. He presented with a 1-day history of vomiting, reduced oral intake, and a 6-hour history of drowsiness. On examination he had a fluctuating temperature, which reached as high as 37.7°C. His Glasgow Coma Scale score was 7: his eyes were not opening, he made incomprehensible verbal responses, and he flexed to painful stimulus. The recent left cranial and abdominal wounds and the shunt tract showed no signs of infection. The abdomen was soft and nontender, although bowel sounds were reduced.

*Investigations.* Full blood count results revealed a hemoglobin level of 14.9 g/dl and a WBC count of 7.9 × 10^3/μl. The C-reactive protein value was 118 mg/dl (normal range <10 mg/dl). A CT scan of the brain revealed longstanding ventricular dilation, similar to previous imaging. The CSF obtained from a shunt tap was turbid. Microscopy showed a WBC count of 30 cells/mm³ (a differential count of WBCs was not available) and a red blood cell count of 159 cells/mm³. Gram staining showed gram-negative cocci. Empirical intravenous antibiotics (vancomycin, ceftazidime, and gentamicin) were commenced.

*Operation.* In the same evening, the boy underwent removal of the entire left VP shunt and insertion of an EVD, through which a single dose of intrathecal gentami-
cin was given. An old ventricular catheter was identified in a separate, slightly more inferior bur hole. An attempt to remove it was unsuccessful due to adherence of the device to the underlying brain. Further attempts risked hemorrhage or damage to the parenchyma. Therefore, the old catheter was left in situ.

**Postoperative Course.** On postoperative Day 1 the boy returned to his normal self, with a Glasgow Coma Scale score of 12 (E4, V3, M5). The C-reactive protein had also reduced to 14 mg/dl. The initial CSF specimen grew colonies on blood agar without a clear zone of hemolysis aerobically as well as anaerobically after 48 hours of incubation. On Gram staining the organism was found to be a gram-negative coccus that was oxidase negative. An API 20 Strep strip (BioMerieux) identified the organism as *G. haemolysans* (API Profile 002000—an API strip is a panel of biochemical tests for species-level identification of bacteria, a standard test in hospital laboratories). By the disc diffusion method the organism was found to be susceptible to penicillin, cefotaxime, rifampicin, vancomycin, chloramphenicol, and ciprofloxacin.

Therefore, the antimicrobial treatment was changed to intravenous benzylpenicillin. Five more CSF specimens were cultured over the next 10 days (starting from postoperative Day 3), which showed very low WBC counts (1–4 x 10³/μl), and none of them grew any organism. On Day 14, the boy underwent removal of the EVD and insertion of a new left VP shunt, without any complications. Because the patient made a full neurological recovery with no further clinical features of infection, the retained old ventricular catheter adherent to underlying brain tissue was left in situ. He received intravenous benzylpenicillin for 3 more days before discharge. He remained well 6 months afterward.

**Discussion**

The clinical course in this patient is consistent with infection from the shunt revision 3 weeks before. Contamination from the commensal *G. haemolysans* may have occurred at the time of surgery or during the early postoperative period.31 Species of the *Gemella* genus consist of catalase-negative, facultative anaerobic, gram-positive cocci arranged in pairs, often with adjacent sides flattened or arranged in tetrads, short chains, or small, irregular clusters. The organisms are nonmotile and nonspore-forming.6,28 The *G. haemolysans* microbe was originally classified under the gram-negative genus *Neisseria*.5,30 Subsequent nucleic acid hybridization studies showed that the organism was biochemically incompatible with the genus *Neisseria*. Therefore a new genus, *Gemella*, was created. It is easily decolorized and may appear gram-negative. The *G. haemolysans* organism is a commensal of the upper respiratory tract.1,4

*Gemella haemolysans* has increasingly been identified as the opportunistic pathogen of different conditions, including infective endocarditis,12,13,20,29 pneumonia,9 pleural infection,10,31 liver abscesses,15 glomerulonephritis,15 peritonitis,12 bacteremia,24,34 endophthalmitis,21,23,26 spondylodiscitis,1,16 and arthroplasty infection.9,27 In general, predisposing factors can be identified in patients with *Gemella* infection, including immunocompromised state, poor dental health, cardiovascular disease, steroid therapy, sinusitis, previous surgical procedures, prosthetic devices in situ, and intravenous drug use.

**Review of Previous CNS Cases and Predisposing Factors**

Human CNS infection by *G. haemolysans* is rare. Only 7 cases have been reported so far (Table 1); 5 of the cases were meningitis and 2 were cerebral abscesses. The first 2 reported cases were both related to percutaneous neurosurgical interventions. Mitchell and Teddy29 described a 73-year-old woman who developed meningitis following radiofrequency trigeminal rhizotomy. There was continuous CSF leakage throughout the procedure, but it was ascertained that the needle never transfixed the buccal mucosa. However, the authors suggested that it was possible that the organisms were present in the submucosa and entered the foramen ovale. Aspevall et al.3 reported a similar case in which an 82-year-old man with dementia developed meningitis after retroauricular glycerol injection.

The remaining 3 cases of meningitis were not caused by neurosurgery. May et al.17 reported a case of meningitis in a 29-year-old woman who was subsequently diagnosed with a meningeal defect related to an ethmoidal osteoma, which required removal of the bone splinter and duraplasty. Petit et al.23 reported the case of a 75-year-old woman who developed meningitis following a facial injury secondary to a recent fall. The likely mechanism was a transient bacteremia. Therefore, direct contamination of the CSF is not necessary for *G. haemolysans* meningitis to occur. Anil et al.2 reported another case of a 17-month-old boy who had a history of ventricular septal defect and patent ductus arteriosus. In all of the cases of meningitis, the patients were treated with antibiotics and achieved full recovery.

In addition to meningitis, *G. haemolysans* has been reported to cause cerebral abscesses. Lee et al.14 reported on a 60-year-old man who developed a parietal abscess 1 month after treatment for his periodontitis. Following craniotomy and drainage of the abscess, the patient made a full recovery. Results of the microbiological studies confirmed mixed growth of *Bacteroides* species and *G. haemolysans*. Díaz-Pedroche et al.7 reported on a 30-year-old man who developed a frontal abscess 2 weeks after the onset of a frontomaxillary sinusitis. Stereotactic aspiration of the abscess followed by antibiotics resulted in a good neurological outcome. In all the previously reported cases, a predisposing factor was identified.

The patient in our case was immunocompetent and had no cardiac abnormality. The recent shunt revision was the only identifiable predisposing factor for his current shunt infection. *Gemella haemolysans* infections associated with foreign bodies have been previously reported. They were secondary to prosthetic valves10,29 and arthroplasty.9,27 No case of *G. haemolysans* CNS infection related to a foreign body or implant has been reported previously. Considering that shunt infection is relatively common (5%–15%) and *Gemella* species are ubiquitous,1 W. B. Lo et al.
<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Age (yrs), Sex</th>
<th>Condition</th>
<th>Source &amp; Comorbidities</th>
<th>Organism*</th>
<th>Surgical Intervention</th>
<th>Empirical Antibiotics</th>
<th>Definitive Antibiotics</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitchell &amp; Teddy, 1985</td>
<td>73, F</td>
<td>meningitis</td>
<td>radiofrequency trigeminal rhizotomy</td>
<td><em>G. haemolysans</em> (gram-negative diplococci)</td>
<td>no</td>
<td>chloramphenicol, sulphadiazine</td>
<td>chloramphenicol, sulphadiazine</td>
<td>good</td>
</tr>
<tr>
<td>Aspevall et al., 1991</td>
<td>82, M</td>
<td>meningitis</td>
<td>percutaneous glycerol instillation into trigeminal cistern</td>
<td><em>G. haemolysans</em> (gram-variable cocci, in clusters)</td>
<td>no</td>
<td>cefotaxime, ampicillin</td>
<td>benzylpenicillin</td>
<td>good</td>
</tr>
<tr>
<td>May et al., 1993</td>
<td>29, F</td>
<td>meningitis</td>
<td>meningeal defect probably related to ethmoidal osteoma</td>
<td><em>G. haemolysans</em> (gram-variable)</td>
<td>removal of splinter &amp; duraplasty</td>
<td>piperacillin</td>
<td>not reported</td>
<td>good</td>
</tr>
<tr>
<td>Petit et al., 1993</td>
<td>75, F</td>
<td>meningitis</td>
<td>facial injury</td>
<td><em>G. haemolysans</em> (gram-variable cocci)</td>
<td>no</td>
<td>amoxicillin, rifampicin, ciprofloxacin</td>
<td>cefotaxime</td>
<td>good</td>
</tr>
<tr>
<td>Lee et al., 2004</td>
<td>60, M</td>
<td>parietal abscess</td>
<td>periodontitis</td>
<td><em>G. haemolysans</em> (gram-variable cocci) &amp; <em>Bacteroides</em> species</td>
<td>craniotomy</td>
<td>ceftriaxone, metronidazole</td>
<td>ampicillin, metronidazole</td>
<td>good</td>
</tr>
<tr>
<td>Díaz-Pedroche et al., 2005</td>
<td>30, M</td>
<td>frontal abscess</td>
<td>frontomaxillary sinusitis</td>
<td><em>G. haemolysans</em> (gram-positive cocci)</td>
<td>stereotactic aspiration</td>
<td>ceftriaxone, metronidazole</td>
<td>ceftriaxone, metronidazole, switched to amoxicillin</td>
<td>good</td>
</tr>
<tr>
<td>Anil et al., 2007</td>
<td>1.4, M</td>
<td>meningitis</td>
<td>ventricular septal defect, patent ductus arteriosus</td>
<td><em>G. haemolysans</em> (gram-negative)</td>
<td>no</td>
<td>ampicillin, cefotaxime</td>
<td>ampicillin, vancomycin, cefazidime, gentamicin</td>
<td>good</td>
</tr>
<tr>
<td>present study</td>
<td>16, M</td>
<td>VP shunt infection</td>
<td>recent shunt revision</td>
<td><em>G. haemolysans</em> (gram-negative)</td>
<td>removal of old shunt, EVD insertion, new shunt insertion</td>
<td>benzylpenicillin</td>
<td>benzylpenicillin</td>
<td>good</td>
</tr>
</tbody>
</table>

* Gram staining result presented in parentheses.
perhaps more cases of *G. haemolysans* shunt infection could be expected. The rarity may be explained by the low pathogenicity, the indirect transfer of organism from the respiratory tract to the operation site, and the potential underdiagnosis of the organism.

**Variable Gram Staining of *G. haemolysans***

The microscopic investigation of the CSF sample in our case showed gram-negative cocci, and later culture confirmed *G. haemolysans*. Although Gemella species possess gram-positive cell wall structure, cells are easily decolorized and therefore have appeared variable or negative, probably due to the relatively thin cell walls (10–20 nm).6,13,18,25 In 7 of the 8 reported cases, including the present one, the initial Gram staining was either negative or variable (Table 1).2,3,4,17,19,22 Such a property of variable staining can potentially misguide initial antimicrobial treatment. It may also explain the small number of cases diagnosed.

**Conclusions**

We have described the first case of VP shunt infection due to *G. haemolysans*, and also the first case of CNS infection by the bacterium associated with an implant. This case has highlighted the following aspects.

1. Clinicians should be aware of *G. haemolysans* as a possible opportunistic pathogen of CNS and shunt infection. Of the 8 reported cases of *G. haemolysans* CNS infection, a predisposing factor was identified in all of them. They included concurrent infection, cardiac abnormality, facial trauma, meningeal defect, and recent invasive surgery.

2. Implants, including VP shunts, have now been identified as another risk factor for CNS infection by *G. haemolysans*. This has not been previously reported.

3. The colony morphology of Gemella species resembles *Streptococcus viridans*. In addition, the Gram staining characteristics of these organisms are variable. Therefore, if a clinically significant organism resembles *S. viridans* in terms of morphology, a further biochemical identification with the appropriate battery of tests (for example, the API 20 Strep strip) is essential for the accurate diagnosis of the organism. Until a definitive result is available, a broad-spectrum antibiotic or a combination should be continued.

**Disclosure**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Lo. Analysis and interpretation of data: Patel. Drafting the article: Lo. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Lo.

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