ABSTRACT. The cases of 4 children who developed postthoracotomy sternal wound infection caused by anaerobic bacteria are presented. The predominate anaerobes were Peptostreptococcus species and pigmented Prevotella species. Polymicrobial infection was present in all cases, and aerobic bacteria also were recovered in 2 instances. All patients responded to surgical debridement and antimicrobials effective against the isolated aerobic and anaerobic bacteria. These findings highlight the potential importance of anaerobic bacteria in postthoracotomy sternal wound infection. Pediatrics 2001;108(1). URL: http://www.pediatrics.org/cgi/content/full/108/1/e17; anaerobic bacteria, Peptostreptococcus species, Prevotella species, Staphylococcus aureus, sternal wound.

ABBREVIATION. PTSWI, postthoracotomy sternal wound infection.

Postthoracotomy sternal wound infection (PTSWI) is a major complication after cardiac surgery in adults1–3 and children.4–8 The organisms that are recognized as causing most of these infections in adults and children are mostly Staphylococcus aureus, Staphylococcus epidermidis, and members of the family Enterobacteriaceae, such as Escherichia coli, Klebsiella species, Enterobacter species, and Proteus species.4,9,10 Although anaerobic bacteria were described in PTSWI in adults,11 their recovery has not been documented previously in children. This report describes 4 patients who developed PTSWI caused by anaerobic bacteria.

METHODS

The patients described were treated and studied by the author for PTSWI in hospitals in the metropolitan Washington, DC, area between 1983 and 1998 and did not include all of the patients who had PTSWI during this period. The hospitals included the Hospital for Sick Children and Georgetown University Hospital in Washington, DC. The total number of patients who had had a sternal thoracotomy procedure performed on them at these institutions during these years was not recorded. Included were only patients who had developed PTSWI caused by anaerobic bacteria. Patients’ medical and laboratory data were reviewed.

Antimicrobial agents were given as surgical prophylaxis to all patients and included a first-generation cephalosporin (patients 1–3; Table 1) and penicillin (patient 4).

Specimens were obtained by direct needle aspiration of the purulent contents into a syringe that was immediately sealed and transported to the laboratory within 30 minutes or by swab that was dipped into the pus and introduced into an anaerobic transport system (Port-A-Cul; BBL Microbiology Systems, Cockeysville, MD) or a Vacutainer (BD Vacutainer System, Rutherford, NJ) and transported to the laboratory within 2 hours.

Sheep’s blood (5%), chocolate, and MacConkey agar plates were inoculated at 37°C aerobically (MacConkey) or under 5% CO2 (blood and chocolate) and examined at 24 and 48 hours. For isolation of anaerobes, the specimen material was plated onto prerduced vitamin K1-enriched Brucella blood agar, an aerobic blood agar plate containing kanamycin and vancomycin, and an aerobic blood plate containing colistin and nalidixic acid and inoculated into an enriched thioglycolate broth,12 incubated in GasPak jars (BBL Microbiology Systems), and examined at 48 and 96 hours. Plates that showed growth were held until the organisms were processed and identified. All cultures that showed no growth were held for at least 5 days. Anaerobic and aerobic bacteria were identified as described previously.12,13

RESULTS

Polymicrobial infection was present in all instances. The number of isolates varied from 2 to 3. The predominant anaerobes were Peptostreptococcus species (3) and pigmented Prevotella (2). Anaerobic bacteria only were recovered in 2 patients (patients 1 and 4; Table 1), and mixed aerobic and anaerobic bacteria were isolated in the 2 others (patients 2 and 3).

A median sternotomy incision was performed for repair of congenital defects in all cases. The infections were diagnosed between 18 to 31 days after surgery. All patients had factors that have been shown to predispose to infection.4,7 These included a perfusion time in excess of 1 hour, prolonged ventilation time (>200 hours), delayed sternal closure (>1 day), and inappropriate antimicrobial prophylaxis.

Signs and symptoms associated with PTSWI included fever (38°C–40°C; in all patients), erythema or cellulitis (in all patients), purulent (3 patients) or sanguinous (1 patient) wound discharge, foul-smelling discharge (3 patients), and instability of the sternum (2 patients). A leukocytosis of 16,600/mm3 to 23,800/mm3 with neutrophil predominance (64%–80%) was present when the diagnosis of PTSWI was made in all cases.

Therapy for the PTSWI included open (3 cases) or local (1 case) debridement and parenteral and oral antimicrobial therapy for 28 to 44 days. All patients recovered without complications.

DISCUSSION

This report describes for the first time the isolation of anaerobic bacteria from PTSWI in children. These organisms were recovered as the sole isolates in 2
### TABLE 1

<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Age</th>
<th>Gender</th>
<th>Diagnosis</th>
<th>Surgical Procedure</th>
<th>Interval From Surgery to Repair</th>
<th>Predisposing Factor(s)</th>
<th>Isolate (Source)</th>
<th>Antimicrobial Duration</th>
<th>Outcome</th>
<th>Surgical Duration of Antibiotic Therapy</th>
<th>Isolate (Source)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7 y</td>
<td>F</td>
<td>Wound</td>
<td>Ventricular septal defect</td>
<td>23 d</td>
<td>Prolonged perfusion time</td>
<td>Prevalence of Gram-negative rods</td>
<td>Proventia intermedia, Peptostreptococcus micros (wound), Propionibacterium acnes (blood, wound)</td>
<td>Ticarcillin-clavulanate 14 d</td>
<td>Open debridement</td>
<td>Ticarcillin-clavulanate (PO) 14 d</td>
</tr>
<tr>
<td>2</td>
<td>3 y</td>
<td>F</td>
<td>Wound</td>
<td>Ventricular septal defect</td>
<td>18 d</td>
<td>Open debridement</td>
<td>Propionibacterium acnes (blood, wound), Peptostreptococcus prevotii (wound)</td>
<td>Amoxicillin-clavulanate 16 d</td>
<td>Open debridement</td>
<td>Clindamycin (IV, PO) 14 d</td>
<td>Peptostreptococcus micros</td>
</tr>
<tr>
<td>3</td>
<td>5 y</td>
<td>F</td>
<td>Wound</td>
<td>Wound infection</td>
<td>28 d</td>
<td>Prolonged ventilation time</td>
<td>Flexed's tetralogy</td>
<td>Escherichia coli, Peptostreptococcus (blood, wound)</td>
<td>Ticarcillin-clavulanate 14 d</td>
<td>Local debridement</td>
<td>Ticarcillin-clavulanate (PO) 16 d</td>
</tr>
<tr>
<td>4</td>
<td>24 mo</td>
<td>M</td>
<td>Wound</td>
<td>Wound infection, bacteremia</td>
<td>31 d</td>
<td>Inadequate antimicrobial prophylaxis, reexploration for bleeding</td>
<td>Clostridium perfringens (wound), Peptostreptococcus medionovaginalis (blood, wound)</td>
<td>Imipenem 14 d</td>
<td>Open debridement</td>
<td>Imipenem (IV) 30 d</td>
<td>Peptostreptococcus micros</td>
</tr>
</tbody>
</table>

IV indicates intravenously; PO, orally.

The isolation of these endogenous organisms from these infections may be attributable to their inoculation from the patient’s normal flora. *Peptostreptococcus* and *Prevotella* species are part of the oropharyngeal flora and have been recovered previously from breast abscesses and head and neck abscesses. Similarly, *Bacteroides fragilis* group and *E. coli* are part of the gastrointestinal flora and have been recovered previously from umbilical infections in newborns and from skin and soft-tissue infection in children.

These findings are similar to our previous data collected from adults. Specimens from 65 adult patients with PTSWI were studied for aerobic and anaerobic bacteria. Aerobic or facultative bacteria only were recovered in 50 specimens (77%); anaerobic bacteria only in 6 (9%); and mixed aerobic, facultative, and anaerobic bacteria in 9 (14%). The predominant aerobes were *S. epidermidis* (28 isolates), *S. aureus* (21 isolates), and members of the family Enterobacteriaceae (14 isolates). The predominant anaerobes were *Peptostreptococcus* species (10 isolates), *Bacteroides* species (4), and *Clostridium* species (3).

Part of the reason that anaerobic bacteria were not reported previously in children may be attributable to inadequate methods for transportation and cultivation of specimens in previous studies. One of these studies reported observing Gram-negative rods in Gram-stain preparation of sternal drainage without obtaining any bacterial growth.

Management of PTSWI includes surgical debridement and administration of systemic antimicrobials. Many of the antimicrobials that are effective against *S. aureus* and Enterobacteriaceae are not effective against all anaerobic bacteria. Anaerobic Gram-negative bacilli isolated from clinical infections can be resistant to penicillins through the production of β-lactamase. The presence of penicillin-resistant anaerobic organisms may require the use of agents that are effective against these bacteria. These antimicrobials include clindamycin, metronidazole, imipenem, cefoxitin, chloramphenicol, or the combination of a penicillin (eg, amoxicillin) and a β-lactamase inhibitor (eg, clavulanate).

Prospective studies are warranted to elucidate the role of anaerobic bacteria in PTSWI in children. It is recommended, however, that specimens from those sites be cultured for both aerobic and anaerobic bacteria so that when systemic antimicrobials are used, coverage for these organisms can be appropriate.

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Recovery of Anaerobic Bacteria From Four Children With Postthoracotomy Sternal Wound Infection
Itzhak Brook

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