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The utility of anaerobic blood culture in detecting facultative anaerobic bacteremia in children☆

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ABSTRACT

Routine anaerobic blood culture is not recommended in children because obligate anaerobic bacteremia is rare in the pediatric population. However, a number of facultative anaerobic bacteria can cause community and hospital acquired infections in children and the utility of anaerobic blood culture for detection of these organisms is still unclear. We conducted a retrospective analysis of all blood culture samples (n = 24,356) at a children's hospital in Japan from October 2009 to June 2012. Among the samples that had paired aerobic and anaerobic blood cultures, 717 samples were considered clinically significant with 418 (58%) organisms detected from both aerobic and anaerobic cultures, 167 (23%) detected only from aerobic culture and 132 (18%) detected only from anaerobic culture. While most facultative anaerobes were detectable by aerobic culture, over 25% of Enterobacteriaceae and 15% of *Staphylococcus* sp. were detected from anaerobic cultures bottles only, suggesting its potential role in selected settings.

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1. Introduction

Blood culture is a useful method to diagnose a variety of infectious diseases. Routine use of both aerobic and anaerobic blood culture bottles has generally been recommended for adult patients suspected of bacterial infection although this is a controversial issue (Riley et al., 2003). Lassmann et al. (2007) reported that the incidence of anaerobic bacteremia has increased recently and concluded that anaerobic blood culture should be routinely performed (Lassmann et al., 2007). On the other hand, other reports conclude that routine anaerobic blood culture may be avoided if obligate anaerobic bacteremia is not suspected (Iwata & Takahashi, 2008; Saito et al., 2003). In the pediatric population, obligate anaerobic bacteremia is rare (Dunne et al., 1994; Lee et al., 2000) and blood volume available for blood culture is often limited. Therefore, the general consensus is that routine anaerobic blood culture is not necessary in children without special indication (Buttery, 2002). Still, a study reports that some streptococcal species, *Staphylococcus aureus* and enterobacteriaceae which are facultative anaerobic bacteria, potentially grow better in anaerobic bottles compared with aerobic bottles (Riley et al., 2003; Rosenblatt, 1997). In the pediatric population, several facultative anaerobic bacteria, such as *Streptococcus pneumoniae*, *S. aureus* and *Escherichia coli*, etc., are a common cause of community acquired infections in previously healthy children. Therefore, we hypothesized that the use of anaerobic blood culture bottles may increase the yield of blood cultures even in children. We retrospectively analyzed blood culture results in our hospital in order to assess the value of anaerobic blood cultures for pediatric patients with facultative anaerobic bacteremia.

2. Materials and methods

2.1. Study period and hospital setting

All cases under 18 years of age with positive blood culture results at the National Center for Child Health and Development (NCCHD) from October 2009 to June 2012 were evaluated. NCCHD is one of the largest children's hospitals in Japan consisting of 490 beds, devoted to pediatric medical/surgical ward, transplant center, pediatric intensive care unit, neonatal intensive care unit, and an obstetrical ward. We average approximately 35,000 emergency department visits and 12,000 hospitalizations per year. This publication was approved by institutional board of privacy and security.

2.2. Obtaining blood samples

Blood cultures were obtained from patients at the discretion of the individual physician. In general, blood cultures were taken aseptically

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by physicians primarily by venipuncture, or though a central venous line or an arterial line. Skin disinfection was performed with 70% isopropylalcohol before puncture. The recommended volume of blood inoculated into bottles for pediatric patients was 1–4 mL for each bottle.

2.3. Blood culture systems

A single blood sample was generally split and inoculated into both aerobic and anaerobic blood culture bottles. Aerobic blood culture was performed using the BacT/ALERT® FAN aerobic or pediatric FAN blood culture bottles. Anaerobic blood culture was performed using the BacT/ALERT® FAN anaerobic blood culture bottles. The blood culture bottles were incubated for seven days using the BacT/ALERT 3D™ system (Sysmex-Biomerieux, Tokyo, Japan). When one bottle form a paired blood culture became positive, the other bottle was kept in incubation for a total of seven days. Bacterial identification was performed by automated microbiology system; BD Phoenix™ 100 (Becton, Dickenson and Company Japan, Tokyo, Japan) or MicroScan WalkAway 96 SI (Siemens Japan K.K, Tokyo, Japan).

2.4. Case review

We reviewed all positive blood cultures obtained from patients under 18 years of age during the study period. The chart review was conducted by two physicians to differentiate between true bacteremia and contamination. The criteria for determining true bacteremia was modified from a previous report (Riley et al., 2003) and included (1) presence of clinical symptoms compatible with bacteremia and (2) at least 2 separate positive blood culture results for the same organism for organisms commonly considered contaminants (coagulase-negative staphylococci, *Bacillus* sp., *Corynebacterium* sp., viridians group streptococci) or (3) one or more samples positive for organisms other than those listed in (2). When it was difficult to distinguish between true bacteremia and contamination based on these criteria, we performed an in-depth review of the medical chart. When multiple organisms were isolated from the same bottle, each organism was counted as an individual episode. Age, sex, underlying disease, and patients settings (outpatient or hospitalized), were tabulated to analyze the characteristics of patients with obligate or facultative anaerobic bacteremia.

2.5. Statistical analysis

We used SPSS 20.0 software package (SPSS, Inc., Chicago, IL, USA) for all analyses. Categorical data was evaluated by the Chi-square test and continuous data was evaluated by Mann–Whitney *U* test.

3. Results

The breakdown of blood cultures is shown in Fig. 1. A sample obtained from a single blood draw was counted as a single culture result regardless of the type and number of bottles used. Additionally, multiple organisms were isolated from 29 samples yielding a total of 67 multiple organisms. In these cases each isolate was counted as a single culture result. From October 2009 to June 2012, 24,356 sets of blood cultures (23,536 pediatric FAN bottles, 820 FAN aerobic bottles and 15,175 FAN anaerobic bottles) from patients under 18 years of age were received at the microbiology laboratory. Of these, 1,098 (4.5%) cultures were positive. After the chart review, 255 (1.0%) cultures were judged as contaminants and were excluded. Therefore, 843 (3.5%) cultures were considered clinically relevant and we confirmed that 717 of these were evaluated using both aerobic and anaerobic blood culture bottles.

These 717 cultures were taken from 281 infectious episodes. Patient characteristics are shown in Table 1. Median age was 23 months and most (87%) had underlying diseases and were hospitalized (70%). These characteristics are in keeping with the patient demographics at our institution.

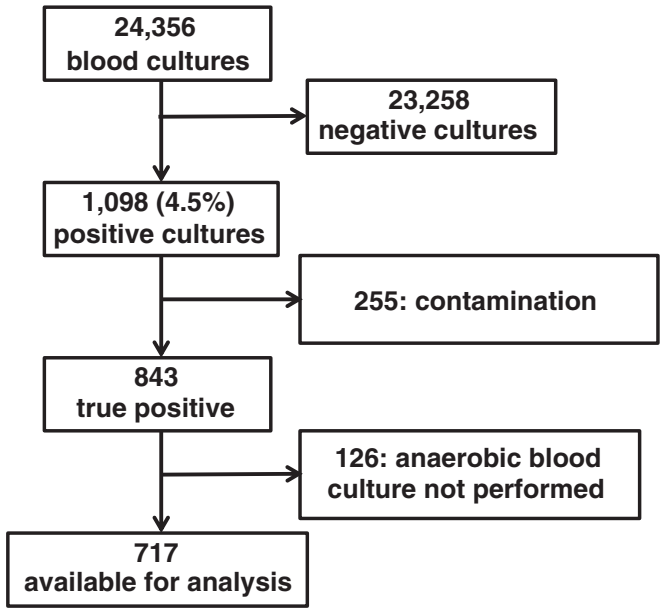

Fig. 1. Breakdown of blood culture results.

The distribution of these 717 true positive organisms were as follows; 418 (58%) organisms were detected by both aerobic and anaerobic cultures, 167 (23%) were detected only by aerobic culture and 132 (18%) were detected only by anaerobic culture. The most frequently isolated organism was *S. epidermidis* (153, 21%), second was *S. aureus* (80, 11%) and third was *Escherichia coli* (76, 10%). Obligate anaerobic organisms were positive in only 8 cultures (1.1%) from 4 cases.

Table 2 describes the clinical features, underlying disease and source of bacteremia for these four patients who had documented obligate anaerobic bacteria. All patients had underlying disease and were immunocompromised. One patient had rhabdomyosarcoma with chemotherapy induced neutropenia, another had chronic

Table 1
Characteristics of patients with bacteremia.

Variables	Number
Number of cases	281 cases
Age, median (months)	23 (0–215)
Male sex	163 (58%)
Underlying disease	
None	36 (13%)
Liver disease	54 (19%)
Gastrointestinal disease	54 (19%)
Hemato-oncologic disease	41 (15%)
Cardiovascular disease	27 (10%)
Renal disease	20 (7%)
Congenital disease	18 (6%)
Neurological disease	13 (5%)
Neonatal disease	7 (2%)
Pulmonary disease	6 (2%)
Endocrine disease	3 (1%)
Dermatologic disease	2 (1%)
Setting	
outpatients	83 (30%)
hospitalized	198 (70%)
general ward	104 (37%)
pediatric intensive care unit	75 (27%)
neonatal intensive care unit	19 (7%)

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