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The assessment of anaerobic blood culture in children

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Over the past 20 years, there has been a decline in the percentage of positive blood cultures yielding anaerobic organisms. Due to the limited blood volume drawn from pediatric patients, we have assessed the value of routine anaerobic blood cultures in children. From January 1994 to December 1998, 9886 paired aerobic and anaerobic blood cultures were analyzed in the pediatric microbiology laboratory at the Taipei Veterans General Hospital. Six hundred and eighteen (6.25%) isolates were considered to be clinically important microorganisms. Staphylococci, streptococci, aerobic gram-negative bacilli, and yeasts showed more significant growth within the aerobic culture than that within the anaerobic culture. Significantly more aerobic gram-positive cocci, aerobic gram-negative bacilli, and yeasts were detected at least 1 day earlier by using the aerobic culture. Three patients with documented anaerobic bacteremia had obvious symptoms related to anaerobic infections. Our study concludes that routine use of anaerobic blood culture in pediatric patients is not necessary. Anaerobic blood cultures should be reserved for patients with diseases like intra-abdominal or oral infections, neutropenic patients on steroid therapy, pressure sores, cellulitis, and human bite wounds.

Key words: Anaerobic blood culture, bacteremia, pediatrics

Currently, routine use of both aerobic and anaerobic blood cultures for pediatric patients suspected of having infections are common. However, over the past 20 years, there has been a decline in the percentage of positive blood cultures yielding anaerobic organisms from 18% to less than 4% [1-3]. Furthermore, blood volume drawn from pediatric patients is limitedly available for blood cultures. To assess the value of routine anaerobic blood cultures for pediatric patients, we retrospectively analyzed the blood culture results from the pediatric department at the Taipei Veterans General Hospital.

Materials and Methods

Study period

Laboratory records of all blood cultures sent to the pediatric microbiology laboratory at the Taipei Veterans General Hospital from January 1994 to December 1998 were reviewed.

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Obtaining blood specimens

Puncture sites were disinfected with 70% isopropylalcohol followed by 10% povidone-iodine solution before venipuncture. The septa of blood culture bottles were disinfected with 70% isopropyl alcohol and allowed to dry. The volume of blood inoculated into each bottle varied from 0.5 mL to 5 mL.

Blood culture systems

Blood samples were inoculated into both aerobic (NR6A) and anaerobic (NR7A) broth media for processing with the BACTEC NR 730 nonradiometric blood culture system (Becton Dickinson Diagnostic Instrument Systems, Sparks Md, USA). BACTEC NR6A and NR7A bottles contain 30 mL of 2.75% soybean-casein digest broth with 0.035% sodium polyanetholesulfonate. The atmosphere in NR6A bottles contains 2.5% CO_2 in 97.5% oxygen; the atmosphere in NR7A bottles contains 5% CO_2 in 95% nitrogen.

Identification of isolates

We reviewed all blood cultures showing positive results. Positive cultures were considered not to be contaminants if the patient had symptoms and signs of bacteremia and had one of the followings: two or more

bottles positive for the same microorganism; one bottle positive for microorganisms rarely considered as contaminants. Charts of the patients with anaerobic bacteremia were reviewed to identify the presenting illnesses, the clinical findings, and the outcomes.

Statistical analysis

The statistical significance was analyzed by Student's t-test, Fisher's exact test, and Chi-square analysis. A p value less than 0.05 was considered as statistically significant.

Results

From January 1994 to December 1998, 9886 paired aerobic and anaerobic blood cultures were received at the pediatric microbiology laboratory. Of these, 796 (8.05%) showed microorganism isolates, and 178 (1.8%) were sought as contaminants. Therefore, 618 (6.25%) isolates were considered to be clinically important microorganisms.

Of the 618 clinically important isolates, 161 (26.1%) isolates were detected during aerobic incubation and three (0.5%) were detected during anaerobic incubation. The rest 454 (73.5%) isolates were detected during both aerobic and anaerobic incubation. Staphylococci, streptococci, aerobic gram-negative bacilli, and yeasts showed more significant growth within the aerobic culture than that within the anaerobic culture. Anaerobic gram-negative bacilli, on the other hand, showed no significant growth within the anaerobic culture only (Table 1).

Table 2 compares the recovery time between aerobic and anaerobic blood cultures. Three hundred and ninety-eight (64.4%) isolates were detected on the same day. Among the rest 223 isolates, significantly more aerobic gram-positive cocci, aerobic gram-negative bacilli, and yeasts were detected at least 1 day earlier by using the aerobic culture.

Table 3 describes the clinical features and underlying diagnoses for the three patients who had

Table 1. Isolates from aerobic and anaerobic blood culture bottles

Microorganism		No. of isolates	Both aerobic and anaerobic	Aerobic only	Anaerobic only	p^b
Aerobic gram-positive cocci						
Catalase-positive	*Staphylococcus aureus*	66	48	18	0	< 0.001
	Coagulase-negative staphylococci	207	190	17	0	< 0.001
	Micrococcus spp.	2	2	0	0	NS
Catalase-negative	Streptococci[a]	44	37	7	0	< 0.05
	Pneumococci	16	11	5	0	< 0.05
Aerobic gram-positive bacilli	*Bacillus* spp.	1	1	0	0	NS
Aerobic gram-negative bacilli						
Enterobacteriaceae	*Enterobacter* spp.	55	31	24	0	< 0.001
	Escherichia coli	51	40	11	0	< 0.005
	Salmonella spp.	30	28	2	0	NS
	Klebsiella pneumoniae	65	36	29	0	< 0.001
	Proteus vulgaris	1	1	0	0	NS
	Citrobacter spp.	3	3	0	0	NS
	Serratia odoriferae	1	1	0	0	NS
Nonenterobacteriaceae (nonfermentative)	*Pseudomonas aeruginosa*	24	7	17	0	< 0.001
	Acinetobacter spp.	26	10	16	0	< 0.001
	Xanthomonas maltophilia	1	0	1	0	NS
	Flavobacterium indologenes	1	1	0	0	NS
Anaerobic gram-negative bacilli	*Bacteroides* spp.	3	0	0	3	NS
Yeasts	*Candida* spp.	21	7	14	0	< 0.001
Total number		618	454	161	3	< 0.001

[a] Includes *Streptococcus agalactiae* (8 isolates), *Streptococcus mitis* (3), *Streptococcus pyogenes* (16), viridans streptococci (4), enterococci (19)

[b] p value compares the "aerobic only" with the "anaerobic only"

NS = non-significant

Table 2. Comparison between aerobic and anaerobic blood isolate recovery time

Microorganism	Both on the same day	Aerobic first	Anaerobic first	p^a
Aerobic gram-positive cocci (n = 335)	51	278	6	< 0.001
Aerobic gram-positive bacilli (n = 1)	0	1	0	NS
Aerobic gram-negative bacilli:				
Enterobacteriaceae (n = 206)	132	73	1	< 0.001
Nonenterobacteriaceae, nonfermentative (n = 52)	28	24	0	< 0.001
Anaerobic gram-negative bacilli (n = 3)	0	0	3	NS
Yeasts (n = 21)	2	19	0	< 0.001

[a] *p* value compares the numbers of positive results detected first from aerobic or anaerobic culture bottles
NS = non-significant

Table 3. Clinical features of patients with anaerobic bacteremia

Patient no.	Sex	Age (yr)	Blood isolates	Clinical symptoms	Underlying disease	Outcome
1	Male	9	*Bacteroides fragilis* Coagulase-negative staphylococci	Fever,abdominal pain	Recurrent ALL[a] and chemotherapy-induced neutropenia	Cured
2	Male	5	*Bacteroides thetaiotaomicron* *Escherichia coli*	Fever, abdominal pain	Ruptured acute appendicitis; peritonitis	Cured
3	Female	12	*Bacteroides fragilis* Coagulase-negative staphylococci	Nausea, fever, and abdominal pain	Medulloblastoma and chemotherapy-induced neutropenia	Died

[a] ALL = acute lymphocytic leukemia

documented anaerobic bacteremia. One patient had recurrent acute lymphocytic leukemia with chemotherapy-induced neutropenia. The other had ruptured acute appendicitis and peritonitis. Both patients lived. The third patient with medulloblastoma and chemotherapy-induced neutropenia died.

Discussion

Anaerobes have played an important role in human microbial infection since its discovery in 1897 [4]. However, over the past 20 years, there has been a decline in the proportion of positive blood cultures yielding anaerobic organisms. Some series even reported that only 0% to 3% of the isolates were strict anaerobes [5]. The reason for this decrease is not known. However, many proposals have been made, including preoperative use of antibiotics before bowel surgery [6]; earlier recognition of anaerobic infection; and empiric use of antibiotics for patients with anaerobic characteristic [7]. Furthermore, anaerobic bacteremia is even less common in pediatric patients [8]. Therefore, can we reserve these anaerobic blood cultures for the specific clinical situations where anaerobes are likely to be found?

Our study showed that most microorganisms were cultured from the aerobic or aerobic and anaerobic bottles. Except for the strict anaerobes, most microorganisms were seldom cultured only from the anaerobic bottles. Aerobic bottles are also superior to anaerobic ones in terms of the recovery speed of the microorganisms. This result is compatible with others [5,9].

Blood volume is another factor to consider. Many studies have pointed out that the amount of blood volume inoculated is significantly correlated with the positive culture rate of the microorganisms [10,11]. In the pediatric field, it is well-known that blood volume drawn are usually limited to 1 mL to 3 mL. Therefore, equal division of specimen among the aerobic and anaerobic bottles may lead to decreased yield of microorganisms from the aerobic bottle.

Moreover, our data showed that yeasts were never cultured from the anaerobic blood bottles. Murray *et al* has reported a 10-fold increase in the incidence of fungemia over the past 13 years [7]. Since anaerobic incubation is deleterious to the recovery of fungi, it is not hard to understand why yeasts were never cultured from our anaerobic blood bottles.

The incidence of anaerobic bacteremia in adult patients is also decreasing [1,12]. Many studies for adults have shown that anaerobic bacteremia is not important to be documented by positive blood cultures [13,14]. According to Lombardi *et al*, some patients with anaerobic infections have negative blood cultures;

moreover, patients with clinical findings to suggest anaerobic infections were treated empirically at the time the cultures were obtained [2]. Therefore, subsequent blood cultures positive for anaerobes rarely influenced clinical management. Morris *et al* suggested using two aerobic bottles with selective culturing for anaerobes instead of inoculating an aerobic bottle and an anaerobic bottle for adult patients [13].

Our patients with anaerobic infections had underlying diseases related to immunodeficiencies and intra-abdominal infections. With regard to our results and others' suggestions [9,12,15,16], anaerobic blood cultures should be reserved for patients with the following conditions: 1. intra-abdominal infections, 2. oral, dental, and pleuropulmonary infections, 3. neutropenic patients on steroids, 4. pressure sores, cellulitis, human bite wounds, and crushing trauma, and 5. newborns with prolonged rupture of membranes and maternal chorioamnionitis.

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