An assessment of the anaerobic vial of paired NR 6A and NR 7N Bactec blood cultures

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OBJECTIVE: To determine the number of obligate anaerobes recovered in anaerobic blood culture vials and to determine if their recovery had a significant impact on patient care.
DESIGN: Retrospective review.
SETTING: Tertiary care teaching hospital.
MAIN RESULTS: Six thousand nine hundred and five pairs of Bactec blood cultures were submitted (each set consisted of one 6A and one 7N vial). Of these, 690 sets were culture-positive in at least one of the vials (10% of pairs). Both vials were positive in 406 (58.8%). The aerobic vial alone was positive in 176 (25.5%) and the anaerobic vial alone was positive in 107 (15.5%). Of these, most were facultative anaerobes; however, 20 blood culture sets from 18 patients were positive for obligate anaerobes. In five of the 18, the isolate was judged to be a contaminant. In 11 of 13 patients, the clinically significant obligate anaerobic bacteremia might have been predicted on clinical grounds, and in eight patients, empirical antianaerobic antibiotics had been started before the results of blood cultures were known.
CONCLUSIONS: Clinical laboratories should carefully examine the use of the routine anaerobic blood culture and consider its replacement with larger volume aerobic blood culture vials.

Key Words: *Blood cultures, Obligate anaerobes*

Évaluation du flacon anaérobique pour hémocultures appariées NR 6A et NR 7N de Bactec

OBJECTIF : Déterminer le nombre d'anaérobies obligatoires récupérés dans des flacons d'hémocultures anaérobiques et vérifier si leur présence a eu des répercussions importantes sur les soins administrés aux patients.
MODÈLE : Étude rétrospective.
CONTEXTE : Centre hospitalier universitaire de soins tertiaires.
PRINCIPAUX RÉSULTATS : Six mille neuf cent cinq paires d'hémocultures Bactec ont été soumises (chaque paire consistant en un flacon 6A et un 7N). Six cent quatre-vingt-dix paires se sont révélées positives dans au moins l'un des deux flacons (10% des paires). Les deux flacons se sont révélés positifs dans 406 cas (56,8%). Le flacon aérobique seul s'est révélé positif dans 176 cas (25,5%) et dans le flacon anaérobique seul, dans 107 cas (15,5%). Parmi ces derniers, la plupart étaient des anaérobies facultatifs. Toutefois, 20 paires d'hémocultures obtenues de 18 patients se sont révélées positives à l'égard d'anaérobies obligatoires chez cinq de ces 18 cas, l'isolat a été jugé contaminant; chez 11 patients sur 13, la bactériémie anaérobique obligatoire cliniquement significative aurait pu être établie sur des bases cliniques et chez huit patients, des antibiotiques anti-anaérobiques empiriques avaient été amorcés avant l'obtention des résultats des hémocultures.
CONCLUSION : Les laboratoires cliniques doivent examiner attentivement le recours à l'hémoculture anaérobique de routine et envisager son remplacement par des flacons d'hémoculture aérobique de plus fort volume.

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THE INCIDENCE OF ANAEROBIC BACTEREMIA HAS DECLINED in many hospitals (1-4). Reasons for this decline are probably multifactorial and are not well understood (3). In the past 25 years it has become customary for blood cultures to be collected in pairs consisting of both an aerobic and an anaerobic vial, despite the observation that blood cultures are often collected from patients in whom the likelihood of anaerobic infection is low; for example, in patients with urinary tract infections, community acquired pneumonia, line and device related infections, meningitis and septic arthritis.

In recent years, there has been increasing pressure on laboratories to use their resources more efficiently. The introduction of new instrumentation and media formulations for blood culturing has led many laboratories to reexamine the manner in which blood cultures are collected and to question the role of a routinely collected anaerobic vial (5). A decision to perform anaerobic blood cultures more selectively may permit institutions to reduce costs without adversely affecting patient care. A one-year retrospective review of anaerobic blood cultures was performed to determine the yield of obligate anaerobic bacteria from the anaerobic vial and to determine the clinical significance of these isolates. The present study was also intended to determine if patients with anaerobic bacteremia had underlying conditions that might allow physicians to predict anaerobic bacteremia and, as a result, give empirical antianaerobic antibiotic therapy and to use anaerobic blood vials selectively.

MATERIALS AND METHODS

The results of all blood cultures performed in 1991 in the Department of Microbiology, Victoria General Hospital, Halifax, Nova Scotia were reviewed. The Victoria General Hospital is a 735-bed adult tertiary care teaching hospital. Excluded from this analysis were single aerobic or anaerobic vials submitted during the study period. Because of the retrospective nature of this study, the exact volume of blood in vials was not available for analysis. Blood cultures were monitored using the NR 6A and NR 7N Bactec 660 nonradiometric instrument (Becton-Dickinson Diagnostic Instrument Systems, Maryland). Blood cultures were processed and isolates identified using conventional procedures.

In brief, aerobic vials were monitored twice daily for the first two days, then daily for three days. Anaerobic vials were monitored daily for five days. If the cut-off growth value was exceeded by either the aerobic or anaerobic vial, both were removed from the instrument, Gram-stained, inoculated onto appropriate media and incubated both aerobically and anaerobically. Vials negative after subculture were reincubated and placed back into the routine testing protocol. Obligate anaerobes were identified using methods described by Sutter et al (6).

Medical records of patients with obligate anaerobic bacteremia were reviewed using a standardized data collection form to determine the nature of the underlying condition and the use of empirical antimicrobial therapy with agents primarily directed towards anaerobes, ie, clindamycin, metronidazole, cefoxitin or imipenem. An organism was considered to be clinically significant or to be a contaminant based on the judgement of an infectious disease consultant who reviewed the patient's medical record.

To determine whether species or genera of organisms displayed a 'preference' for the aerobic or anaerobic vial, positivity rates for organisms growing only in one of the aerobic and anaerobic vials were compared using the McNemar's χ^2 for matched pairs.

TABLE I
Summary of isolates from aerobic and anaerobic blood culture vials processed at the Victoria General Hospital in 1991

Organism	Vials positive		
	Both vials	Aerobic only	Anaerobic only
Obligate anaerobes			
Bacteroides species	1	0	9
Clostridium species	0	0	1
Eubacterium species	0	0	1
Fusobacterium species	0	0	1
Peptostreptococcus species	0	1	1
Porphyromonas species	0	0	1
Proprianobacterium acnes	0	0	6
Aerobes and facultative anaerobes			
Enterobacteriaceae	106	30	21
Pseudomonas aeruginosa	10	10*	0
Staphylococcus aureus	62	8	6
Coagulase-negative staphylococci	133	94*	47
Pyogenic streptococci	20	2	3
Streptococcus pneumoniae	31	3	2
Viridans streptococci	32	10	3
Yeast	11	19*	1
Enterococcus species	24	3	4
Other	2	14	0
Total	432	194	107

**Significantly more grew in aerobic vial (P<0.05) using McNemar's χ^2 for matched pairs*

RESULTS

During the study period, 6905 pairs of aerobic and anaerobic blood cultures were submitted to the Victoria General Hospital laboratory. Of these, 690 (10%) were positive in one or both of the vials. Four hundred and six were positive in both, 176 were positive in the aerobic vial alone, and 107 were positive in the anaerobic vial alone. Of 107 vials positive in the anaerobic vial

TABLE 2
Patients with obligate anaerobic bacteremia: Clinical setting and antibiotic management

Patient number	Organism identified	Clinical setting	Antianaerobic antibiotics: Started empirically	Antianaerobic antibiotics: Started subsequent to culture report
	Presumed pathogens			
1	*Clostridium septicum*	Abdominal pain, cervical carcinoma fistula formation	Y	
2	*Bacteroides fragilis*	Obstructed T tube	N	N*
3	*Bacteroides oralis*	Fever, diarrhea, cough	N	Y
4	*Fusobacterium nucleatum*	Orofacial infection, neutropenia	Y	
5	*Bacteroides fragilis*	Repair aorto-enteric fistula	Y	
6	*Bacteroides distasonis*	Colostomy, pericolostomy infection	Y	
7	*Eubacterium* species	Intra-abdominal abscess	Y	
8	*Peptostreptococcus* species	Neutropenia, bone marrow transplantation	N	Y
9	*Bacteroides fragilis*	Bowel resection, colon cancer	N	Y
10	*Bacteroides buccae*	Diabetic foot infection	N	Y
11	*Bacteroides* species	Penetrating abdominal trauma	Y	
12	*Bacteroides thetaiotaomicron*	Appendical abscess	Y	
13	*Porphyromonas* species	Sacral ulcer	Y	
	Presumed contaminants			
14	*Proprionobacterium acnes*	Congestive heart failure	N	
15	*Proprionobacterium acnes*	Drug overdose	N	
16	*Proprionobacterium acnes*	Polycythemia vera	N	
17	*Proprionobacterium acnes*	Pneumonia, urinary tract infection	N	
18	*Proprionobacterium acnes*	Carbon monoxode poisoning	N	

*Palliation only

alone, 87 contained facultative anaerobes and 20 contained obligate anaerobes.

A total of 18 patients had 20 anaerobic vials containing obligate anaerobes in the anaerobic vial alone. Two patients had the same organism in two anaerobic vials. Five patients had *Proprionobacterium acnes* and 13 had presumed pathogens. A summary of all blood culture results for the year are shown in Table 1. Significantly more *Pseudomonas aeruginosa*, yeast and coagulase-negative *Staphylococcus* species grew in the aerobic vials ($P<0.05$). Table 2 summarizes patients with obligate anaerobic bacteremia, the clinical setting in which bacteremia occurred, information relating to empirical antianaerobic coverage and whether a change in antibiotics occurred as a result of the positive blood culture.

In 11 cases, the clinical setting was deemed to be one in which anaerobic infection would be considered likely. In two patients this was not the case. One patient (patient 8) had neutropenia and fever without an identifiable source following bone marrow transplantation. Anaerobic infection was not suspected. Empirical therapy with ceftazidime and gentamicin was commenced. The second patient (patient 3) was an elderly female who presented to the emergency room with fever, chills, diarrhea, urinary incontinence and a nonproductive cough. Her fever was attributed to a respiratory tract infection, and she was discharged on trimethoprim-sulfamethoxazole. When the blood culture was reported to be growing *Bacteroides oralis*, the patient was readmitted, and subsequent investigations led to the diagnosis of acute diverticulitis. Five patients with obligate anaerobic isolates considered to be clinically significant did not receive empirical antibiotics with antianaerobic activity; in four cases, an effective agent was added when blood cultures were reported positive. One patient who had biliary tract obstruction resulting from a carcinoma did not receive antibiotics after a decision was made to offer palliative care only. This was the only patient to die as a result of infection. The clinical response to therapy was satisfactory in those receiving both empirical and culture-directed antibiotics.

DISCUSSION

In the present study, the yield of obligate anaerobic bacteria from anaerobic vials was only 0.3%. A large number of isolates grown only from the anaerobic vial were facultative anaerobes, and their recovery from the anaerobic vial is likely attributable to the additional volume of blood (usually 5 mL) collected in the anaerobic partner. Several newer blood culture systems, eg, the Organon Teknika BacTAlert (Organon Teknika Corp, North Carolina), Bactec 9240 and 660 system, allow for the collection of 8 to 10 mL of blood per vial, and evaluations of these systems show significant improvement in yield when 10 mL of blood is drawn per

blood culture rather than 5 mL (7-9). Marcelis et al (8) recently showed that a single Bactec BP26 high volume (8 to 10 mL) resin vial detected 26% more organisms than a pair of Bactec NR 6A and NR 7A (5 mL) vials did. In a similar comparative study, Koontz et al (7) detected 18% more positives using a single aerobic Bactec 10 mL vial compared with a standard aerobic and anaerobic Bactec 5 mL pair. The increased yield was likely attributable, in part, to the presence of resin in the high volume vial. It seems likely that if, in our study, 10 mL rather than 5 mL aerobic culture vials had been used, a significant proportion of the facultative anaerobic organisms would also have been recovered aerobically.

Our study shows that, in most cases, patients with obligate anaerobic bacteremia are usually identifiable by clinical syndrome recognition. Lombardi et al (10) found that the source of anaerobic infection was usually predicted by the clinical setting, and that most patients were given empirical antibiotic therapy for anaerobes. In our study, empirical antianaerobic therapy was started in eight of 13 patients with obligate anaerobe bacteremia around the time that blood cultures were collected. Of the five who did not receive empirical antianaerobic antibiotics, four were subsequently treated after the positive culture was reported. In those settings in which bacteremia occurred it is likely that, in many patients, negative blood culture reports would not have led to the discontinuation of empirical antianaerobic antibiotics.

Selective culturing for anaerobes, as might be used for fungal blood or mycobacterial blood cultures, may allow laboratories to switch from small volume to larger volume blood culture vials and to reduce the number of vials processed. Based on our observations, anaerobic blood cultures are most useful in patients with suspected or proven intra-abdominal infections. Our hospital does not do a large number of gynecological surgical procedures. This may explain the absence of patients with pelvic infections from our study. Since pelvic infections are frequently due to both aerobic and anaerobic bacteria, inclusion of these patients in guidelines for the collection of anaerobic blood cultures would seem reasonable. Our data suggest that patients with infected decubitus or ischemic ulcers should also be included. While it is difficult to make a recommendation based on a single case, we suggest aerobic blood cultures be performed in febrile neutropenic patients with orofacial or perianal disease. Studies by Chow and Guze (11) and by Lombardi and Engleberg (10) suggest that most anaerobic bacteremias arise in patients with the above underlying diseases, but suggest also that there is a need to make decisions on a case-by-case basis since a large proportion of bacterial infections may, on occasion, be due to obligate anaerobes.

Such a change in policy relating to anaerobic blood culturing might allow for the purchase of smaller volume instruments or, in the case of modular units, fewer modules. Further studies evaluating paired blood cultures versus single aerobic cultures with selective anaerobic culturing may help to define the usefulness of this approach further.

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