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Advantage of Combining Resin with Lytic BACTEC Blood Culture Media

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The BACTEC 9240 (Becton Dickinson, Sparks, Md.) automated blood culture system is based on the continuous monitoring of CO_2 production by means of a fluorescent sensor attached to the bottom of a culture vial. We compared two media for this system, resin-containing Plus aerobic/F and Lytic anaerobic/F. Sets of Plus aerobic/F and Lytic anaerobic/F vials inoculated with similar volumes (9 ± 2.5 ml) were evaluated. In the laboratory, the vials were introduced into the system in accordance with the recommendations of the manufacturer and incubated at 35°C for 5 days. A total of 10,914 sets consisting of two bottles each were obtained from 3,674 patients (2.97 cultures per patient). Of these, 1,233 (11%) were culture positive, including 1,074 (10%) yielding at least one pathogen, and 178 (2%) were contaminated. A total of 1,135 isolates were considered clinically relevant in 624 septic episodes; we isolated 894 from Plus aerobic/F and 852 from Lytic anaerobic/F ($P = 0.06$ [not significant]). More *S. aureus* isolates ($P = 0.05$), *Pseudomonas* spp. ($P < 0.0001$), other gram-negative bacteria ($P = 0.004$), and yeasts ($P < 0.0001$) were isolated from Plus aerobic/F medium, but more streptococci ($P < 0.0001$), *E. coli* ($P = 0.02$) strains and anaerobes ($P < 0.0001$) were detected with Lytic anaerobic/F medium. Lytic anaerobic/F vials were significantly ($P < 0.0001$) more often positive at least 6 h before Plus aerobic/F vials ($n = 112$ versus 52, respectively). Significantly more ($P < 0.0001$) Plus aerobic/F vials ($n = 210$; 1.9%) than Lytic anaerobic/F vials ($n = 42$; 0.4%) were unconfirmed positives. Plus aerobic/F and Lytic anaerobic/F proved to be a valuable pair of blood culture media. Plus aerobic/F performs better for patients under antibiotic treatment, due to the antimicrobial-neutralizing effect of resins. For patients without antibiotic therapy, more microorganisms could be isolated from Lytic anaerobic/F due to cell lysis.

The rapid and reliable detection of blood-borne microorganisms is one of the most important duties of a clinical microbiology laboratory. To improve the yield, the detection time, and the work flow, manufacturers have developed instruments that automatically and continuously detect positive blood cultures (5, 7, 9, 13, 19, 20). Most of these systems are based on the detection of CO_2 produced in culture media or in the gas phase of vials during microbial metabolism. One of these systems, BACTEC 9240 (Becton Dickinson Diagnostic Instrument Systems, Sparks, Md.), relies on noninvasive CO_2 detection by means of a fluorescent CO_2 sensor attached to the bottom of each bottle. The sensor is monitored by the BACTEC 9240 instrument every 10 min. Cultures are recognized as positive by computer algorithms or delta values. In a BACTEC 9240 instrument, up to 240 vials can be monitored, incubated at 35°C, and rocked back and forth at 30 cycles/min. BACTEC Plus aerobic/F medium contains resins capable of neutralizing antimicrobials that may be present in blood samples. With this medium, significantly more microorganisms could be isolated from patients receiving antimicrobial therapy (3, 4, 8, 10). Blood samples of up to 10 ml can be inoculated into these vials. Lytic anaerobic/F medium does not contain resins but is supplemented with 0.26% saponin. We observed previously that significantly ($P = 0.004$) more pathogens could be detected in another saponin-supplemented broth (Septi-Chek Release) than in the same broth without saponin (Septi-Chek BHI-S) (17). In the present study, we compared the performance of resin-containing BACTEC Plus aerobic/F medium to that of saponin-supplemented, nonresin BACTEC Lytic anaerobic/F medium in recovering microorganisms from adult patients with suspected septicemia.

(These results have been partially presented at the 8th European Congress of Clinical Microbiology [21].)

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MATERIALS AND METHODS

Ward personnel was asked to inoculate Plus aerobic/F and Lytic anaerobic/F vials (Becton Dickinson) with 10 ml each of blood from adult patients with suspected septicemia in all wards of the University Hospital of Geneva (1,500 beds). A vacutainer blood collection device (Becton Dickinson) was used to directly inoculate the vials.

BACTEC Plus aerobic/F vials contain 25 ml of supplemented soybean casein broth, 0.05% sodium polyanetholesulfonate, 16% nonionic adsorbing resins, and 1% cationic exchange resins. The atmosphere is enriched with oxygen, so no transient venting after inoculation is needed. Lytic anaerobic/F bottles contain 40 ml of supplemented soybean casein broth, 0.035% sodium polyanetholesulfonate, and 0.26% saponin. The headspace atmosphere of Lytic anaerobic/F vials contains CO_2 and N_2.

The volume of blood added to each vial was determined by comparing the liquid levels to levels of noninoculated vials and considering the volume graduation on the bottle label. Only sets with vials containing adequate volumes of blood (>5 ml) and with differences in volume of <2.5 ml were included in the comparison.

During the operating hours of the laboratory from 7 a.m. to 7 p.m., and after an average delay of 8 h 5 min (median, 6 h 27 min) after vial inoculation, BACTEC vials were introduced into the BACTEC 9240 instrument in accordance with the instructions of the manufacturer. The software used in the BACTEC computer (version 3.45D) allowed delayed vial entry and needed no calibration of the wells into which vials were entered. All vials were incubated for at least 5 days; for rare exceptions, the incubation period was prolonged to 15 days as recommended in reference 15. Vials indicated as positive by the instrument were punctured to obtain blood-medium samples for Gram stain and for subcultures onto two plates of sheep blood (5%) agar (one incubated aerobically with 5% CO_2 and the other incubated anaerobically) and one of chocolate agar (incubated aerobically with 5% CO_2). We incubated agar media for aerobic microorganisms for 48 h and those for anaerobic cultures for 10 days. Isolates were identified, and their susceptibility to antimicrobials was determined as recommended in reference 15. Microorganisms were classified as pathogens or

TABLE 1. Comparison of clinically relevant microorganisms isolated per septic episode from the BACTEC Plus aerobic/F or Lytic anaerobic/F blood culture system

Organism(s)	Total no.	No. detected in:			*P* value[a]
		Plus aerobic/F and Lytic anaerobic/F	Plus aerobic/F only	Lytic anaerobic/F only	
Staphylococcus aureus	87	63	12	12	1 (NS)
Coagulase-negative staphylococci[b]	76	64	7	5	0.77 (NS)
Streptococcus pneumoniae	46	34	5	7	0.77 (NS)
Beta-hemolytic *Streptococcus* spp.[c]	18	11	2	5	0.45 (NS)
Enterococcus spp.[d]	26	17	4	5	1 (NS)
Other *Streptococcus* spp.[e]	23	15	0	8	0.013
Gram-positive rods[f]	6	2	2	2	1 (NS)
Neisseria meningitidis	3	0	3	0	0.25 (NS)
Escherichia coli	138	88	16	34	0.016
Other *Enterobacteriaceae*[g]	72	45	13	14	1 (NS)
Pseudomonas spp.[h]	45	9	36	0	<0.0001
Other gram-negative bacteria[i]	7	1	6	0	0.04
Gram-positive anaerobes[j]	17	2	0	15	0.0003
Gram-negative anaerobes[k]	29	2	0	27	<0.0001
Yeasts[l]	31	7	20	4	0.002
Total	624	360	126	138	0.5 (NS)

[a] NS, not significant ($P > 0.05$).
[b] Three *Staphylococcus capitis*, 5 *Staphylococcus hominis*, 2 *Staphylococcus warneri*, 64 *Staphylococcus epidermidis*, and 2 *Staphylococcus haemolyticus* isolates.
[c] Four *Streptococcus* group G, one *Streptococcus equisimilis*, eight *Streptococcus agalactiae*, and five *Streptococcus pyogenes* isolates.
[d] Twenty-two *Enterococcus faecalis* and four *Enterococcus faecium* isolates.
[e] Seven *Streptococcus anginosus*, four *Streptococcus constellatus*, three *Streptococcus intermedius*, three *Streptococcus mitis*, and six *Streptococcus bovis* isolates.
[f] Two *Lactobacillus* sp., three *Listeria monocytogenes*, one *Nocardia asteroides* isolates.
[g] One *Citrobacter freundii*, 1 *Enterobacter agglomerans*, 3 *Enterobacter aerogenes*, 11 *Enterobacter cloacae*, 5 *Klebsiella oxytoca*, 29 *Klebsiella pneumoniae*, 6 *Proteus mirabilis*, 3 *Proteus vulgaris*, 4 *Salmonella enteritidis*, 1 *Salmonella* group B, 2 *Salmonella* group D, 1 *Salmonella typhi*, 1 *Salmonella typhimurium*, 2 *Serratia marcescens*, 1 *Shigella flexneri*, and 1 *Shigella sonnei* isolates.
[h] Twenty-seven *Pseudomonas aeruginosa*, 11 *Burkholderia cepacia*, 4 *Pseudomonas fluorescens*, 1 *Pseudomonas paucimobilis*, and 2 *Stenotrophomonas maltophilia* isolates.
[i] Two *Acinetobacter baumannii*, one *Alcaligenes xylosoxidans*, one *Brucella melitensis*, one *Campylobacter fetus*, one *Gardnerella vaginalis*, and one *Haemophilus influenzae* isolates.
[j] One *Clostridium bifermentans*, three *Clostridium clostridiiforme*, one *Clostridium butyricum*, one *Clostridium perfringens*, five *Peptostreptococcus magnus*, one *Eubacterium lentum*, and five *Peptostreptococcus micros* isolates.
[k] Four *Bacteroides thetaiotaomicron*, 1 *Bacteroides distasonis*, 13 *Bacteroides fragilis*, 1 *Bacteroides ovatus*, 1 *Bacteroides uniformis*, 1 *Bacteroides vulgatus*, 2 *Fusobacterium necrophorum*, 3 *Fusobacterium nucleatum*, 1 *Prevotella bivia*, 1 *Prevotella melaninogenica*, and 1 *Veillonella parvula* isolates.
[l] Twenty-two *Candida albicans*, 7 *Torulopsis glabrata*, and 2 *Cryptococcus neoformans* isolates.

contaminants with the aid of an infectious disease specialist (25). Identical microorganisms detected in different blood culture sets, drawn within an interval of 48 h, were considered only once for the evaluation of septic episodes. Culture bottles considered negative by the BACTEC 9240 instrument were not subcultured, since we have previously determined that this instrument reliably detects microbial growth (20). For statistical analysis, the McNemar exact test was applied.

RESULTS

We received 10,914 blood culture sets, consisting of two bottles each, for which BACTEC Plus aerobic/F and Lytic anaerobic/F were considered suitable. Blood was drawn from 3,674 patients, resulting in an average of 2.97 cultures per patient. Of these cultures, 1,233 (11.3%) revealed at least one organism from 624 patients; 178 cultures (1.6%) were considered to be contaminated. Of the 10,914 sets, 3,968 (36%) were inoculated with blood from patients receiving antimicrobials when blood was drawn.

Of the 1,343 organisms identified from BACTEC aerobic/F and Lytic anaerobic/F, 1,135 were considered clinically relevant in 624 septic episodes. As illustrated in Table 1, no significant difference ($P = 0.5$) was noticed in the overall recovery of microorganisms per septic episode from Plus aerobic/F ($n = 486$) and Lytic anaerobic/F ($n = 498$). However, septic episodes with *Pseudomonas* spp., other gram-negative bacteria (*Acinetobacter baumannii*, *Alcaligenes xylosoxidans*, *Brucella melitensis*, *Campylobacter fetus*, *Gardnerella vaginalis*, and *Haemophilus influenzae*) and yeasts were detected significantly more often ($P <= 0.002$) in Plus aerobic/F, but *E. coli*, streptococci, and anaerobic bacteria were recovered more often in Lytic anaerobic/F ($P < 0.016$; Table 1).

Overall, we isolated 894 pathogens from BACTEC Plus aerobic/F and 852 from Lytic anaerobic/F ($P = 0.06$ [not significant]). More *S. aureus* isolates ($P = 0.05$), *Pseudomonas* spp. ($P < 0.0001$), other gram-negative bacteria ($P = 0.004$), and yeasts ($P < 0.0001$) were isolated from Plus aerobic/F medium. On the other hand, more streptococci ($P < 0.0001$), *E. coli* ($P = 0.02$) isolates, and anaerobes ($P < 0.0001$) were detected from Lytic anaerobic/F medium (Table 2).

From the 3,968 blood cultures inoculated with blood from patients receiving antimicrobial therapy, 302 (7.6%) pathogenic microorganisms were isolated. Of these, we isolated 136 only from Plus aerobic/F and 52 only from Lytic anaerobic/F ($P < 0.0001$). However, in the remaining 7,090 blood cultures drawn from patients not receiving antimicrobials at the time of samples collection, we isolated 138 only from Plus aerobic/F and 179 only from Lytic anaerobic/F ($P = 0.025$).

Similar numbers of isolates in Plus aerobic/F ($n = 132$) and Lytic anaerobic/F ($n = 129$) were considered to be contaminants. Of the 10,914 Plus aerobic/F vials, 210 (1.9%) were declared positive by the instrument and no microorganism could be cultured, whereas only 42 (0.4%) Lytic anaerobic/F vials were instrument false positives ($P < 0.0001$).

TABLE 2. Comparison of all clinically relevant microorganisms isolated from the plus aerobic/F or Lytic anaerobic/F blood culture system

Organism(s)	Total no.	No. isolated from:			*P* value[a]
		Plus aerobic/F and Lytic anaerobic/F	Plus aerobic/F only	Lytic anaerobic/F only	
Staphylococcus aureus	195	126	43	26	0.054
Coagulase-negative staphylococci[b]	175	128	25	22	0.77 (NS)
Streptococcus pneumoniae	81	61	10	10	1 (NS)
Beta-hemolytic *Streptococcus* spp.[c]	29	20	4	5	1 (NS)
Enterococcus spp.[d]	37	23	5	9	0.42 (NS)
Other *Streptococcus* spp.[e]	43	26	0	17	0.0001
Gram-positive rods[f]	11	2	4	5	1 (NS)
Neisseria meningitidis	4	0	4	0	0.13 (NS)
Escherichia coli	227	131	36	60	0.02
Other *Enterobacteriaceae*[g]	117	68	24	25	1 (NS)
Pseudomonas spp.[h]	93	12	81	0	<0.0001
Other gram-negative bacteria[i]	11	1	10	0	0.004
Gram-positive anaerobes[j]	22	4	0	18	<0.0001
Gram-negative anaerobes[k]	40	2	0	38	<0.0001
Yeasts[l]	50	7	37	6	<0.0001
Total	1,135	611	283	241	0.07 (NS)
Contaminated	208	53	79	76	0.87 (NS)

[a] NS, not significant ($P > 0.05$).
[b] Five *Staphylococcus capitis*, 8 *Staphylococcus hominis*, 4 *Staphylococcus warneri*, 152 *Staphylococcus epidermidis*, and 6 *Staphylococcus haemolyticus* isolates.
[c] Six *Streptococcus* group G, 1 *Streptococcus equisimilis*, 14 *Streptococcus agalactiae*, and 8 *Streptococcus pyogenes* isolates.
[d] Thirty-two *Enterococcus faecalis* and five *Enterococcus faecium* isolates.
[e] Five *Streptococcus constellatus*, 8 *Streptococcus mitis*, 12 *Streptococcus anginosus*, 14 *Streptococcus bovis*, and 4 *Streptococcus intermedius* isolates.
[f] Five *Lactobacillus* sp., five *Listeria monocytogenes*, and one *Nocardia asteroides* isolates.
[g] Four *Citrobacter freundii*, 1 *Enterobacter agglomerans*, 4 *Enterobacter aerogenes*, 24 *Enterobacter cloacae*, 5 *Klebsiella oxytoca*, 49 *Klebsiella pneumoniae*, 7 *Proteus mirabilis*, 5 *Proteus vulgaris*, 6 *Salmonella enteritidis*, 1 *Salmonella* group B, 3 *Salmonella* group D, 2 *Salmonella typhi*, 1 *Salmonella typhimurium*, 3 *Serratia marcescens*, 1 *Shigella flexneri*, and 1 *Shigella sonnei* isolates.
[h] Forty-seven *Pseudomonas aeruginosa*, 36 *Burkholderia cepacia*, 6 *Pseudomonas fluorescens*, 2 *Pseudomonas paucimobilis*, and 2 *Stenotrophomonas maltophilia* isolates.
[i] Four *Acinetobacter baumannii*, two *Alcaligenes xylosoxidans*, one *Brucella melitensis*, two *Campylobacter fetus*, one *Gardnerella vaginalis*, and one *Haemophilus influenzae* isolates.
[j] One *Clostridium bifermentans*, four *Clostridium clostridiiforme*, one *Clostridium butyricum*, four *Clostridium perfringens*, five *Peptostreptococcus magnus*, one *Eubacterium lentum*, and six *Peptostreptococcus micros* isolates.
[k] Five *Bacteroides thetaiotaomicron*, 1 *Bacteroides distasonis*, 21 *Bacteroides fragilis*, 1 *Bacteroides ovatus*, 1 *Bacteroides uniformis*, 1 *Bacteroides vulgatus*, 2 *Fusobacterium necrophorum*, 3 *Fusobacterium nucleatum*, 1 *Prevotella bivia*, 2 *Prevotella melaninogenica*, and 2 *Veillonella parvula* isolates.
[l] Thirty-eight *Candida albicans*, nine *Torulopsis glabrata*, and three *Cryptococcus neoformans* isolates.

The clinically important organisms were detected in BACTEC Plus aerobic/F bottles an average of 28 ± 18 h) after inoculation and in Lytic anaerobic/F bottles 24 ± 13 h after inoculation. The median detection times were 22 and 21 h, respectively. Within 24 h after blood sampling, 52% of the Plus aerobic/F and 63% of the Lytic anaerobic/F vials were recognized as positive (Fig. 1). Of the 611 organisms detected in both Plus aerobic/F and 112 sooner in Lytic anaerobic/F ($P <$ 0001; Table 3). Considering a difference of ≥12 h, no significant difference was observed between the two media ($P = 0.5$).

DISCUSSION

With resin-containing media for former BACTEC instruments, more microorganisms could be isolated, in general, than with the corresponding standard (nonresin) media (3, 4, 8, 10). The advantage of resin-containing media was observed mainly for patients receiving antimicrobial therapy. Also for patients not receiving antibiotics at the time when blood was drawn for cultures, advantages for the resin-containing media were reported. It has been speculated that resins adsorb nonspecific microbial inhibitors present in blood. In addition, leukocytes are lysed by the resins in the earlier BACTEC instruments, which shake the media orbitally at 160 rpm (8, 24). We speculate that this lysing effect may be less effective in the BACTEC 9240 instrument we used in this study, which rocks media back and forth at 30 cycles/min.

Another means of lysing blood cells is the use of saponin, as it is applied in the lysis centrifugation system Isolator (Wampole Laboratories, Cranbury, N.J.). Comparisons of this system to resin-containing media showed the superiority (6, 14, 23) of the latter or its equivalence (1) for the isolation of pathogenic organisms. A further system using saponin as a lysing agent,

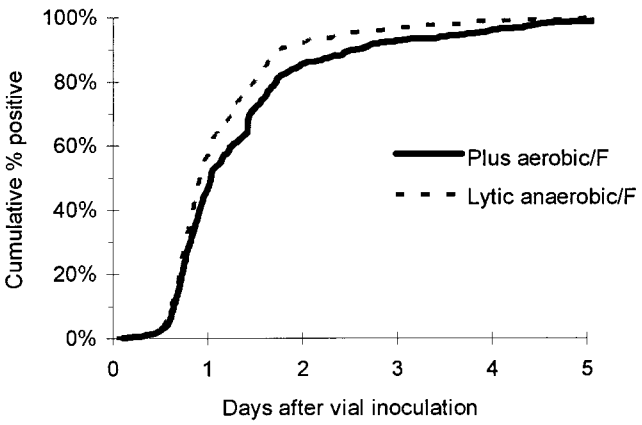

FIG. 1. Cumulative detection times for 894 pathogens detected with Plus aerobic/F blood culture medium and 852 detected with Lytic anaerobic/F BACTEC blood culture medium.

TABLE 3. Comparison of detection times for 611 clinically important microorganisms isolated in both Plus aerobic/F and Lytic anaerobic/F blood culture systems

Organism(s)	No. isolated from:			*P* value[a]
	Plus aerobic/F and Lytic anaerobic/F at same time	Plus aerobic/F >6 h earlier	Lytic anaerobic/F >6 h earlier	
Staphylococcus aureus	81	18	27	0.23 (NS)
Coagulase-negative staphylococci	88	13	27	0.04
Streptococcus pneumoniae	57	1	3	0.6 (NS)
Beta-hemolytic *Streptococcus* spp.	17	0	3	0.25 (NS)
Enterococcus spp.	19	1	3	0.6 (NS)
Other *Streptococcus* spp.	22	0	4	0.12 (NS)
Gram-positive rods	1	0	1	1 (NS)
Escherichia coli	99	13	19	0.38 (NS)
Other *Enterobacteriaceae*	44	4	20	0.002
Pseudomonas spp.	11	0	1	1 (NS)
Other gram-negative bacteria	1	0	0	
Gram-positive anaerobes	1	2	1	1 (NS)
Gram-negative anaerobes	1	0	1	1 (NS)
Yeasts	5	0	2	0.5 (NS)
Total	447	52	112	<0.0001

[a] NS, not significant ($P > 0.05$).

i.e., Septi-Chek Release medium, has been favorably evaluated against other nonlytic media (11, 17, 18), as well as against resin-containing media (20).

In many respects, a resin-containing aerobic medium in conjunction with a lytic anaerobic medium should be complementary. Microbial growth is hardly visible in lytic liquid media. Therefore, other means to identify positive blood cultures are required, like attachment of solid media to detect colonies of aerobic microorganisms for the Septi-Chek system or detection of CO_2 production. Therefore, the pair Plus aerobic/F and Lytic anaerobic/F should be ideal for an automated, continuous-monitoring instrument such as the BACTEC 9240.

In practice, our comparison has shown advantages of Plus aerobic/F resin medium for the isolation of aerobic bacteria (*S. aureus*, *Pseudomonas* spp., and yeasts). Furthermore, significantly ($P < 0.0001$) more microorganisms could be identified from this Plus aerobic/F medium inoculated with blood from patients receiving antibiotics. As in this present study, we reported previously that 36% of our patients receive antibiotics when blood is collected for culture (16). Resins neutralize the antimicrobial effect, allowing good growth conditions for aerobic microorganisms (*S. aureus*, coagulase-negative staphylococci, *Pseudomonas* spp., and yeasts), often causing nosocomial septicemia in these patients.

From Lytic anaerobic/F medium, we isolated not only anaerobes more frequently ($P < 0.0001$) than in from Plus aerobic/F, as expected, but also streptococci, especially the *Streptococcus milleri* group ($P = 0.001$), and certain members of the family *Enterobacteriaceae* like *E. coli* ($P = 0.02$). The 40-ml volume of broth in the Lytic anaerobic/F vials compared to the 25 ml of medium in the Plus aerobic/F vials may also contribute to the better growth of certain microorganisms. The relative proportion of anaerobes among clinically relevant microorganisms (5.5%) isolated in the current study indicates the favorable conditions in Lytic anaerobic/F medium for the growth of this group of organisms. In an earlier large evaluation in which we used Plus anaerobic/F resin-containing medium, anaerobes represented 4.1% ($n = 26$) of the 632 pathogens identified (20).

Furthermore, microorganisms detected in both Plus aerobic/F and Lytic anaerobic/F media were detected significantly more often 6 h earlier in Lytic anaerobic/F medium ($P < 0.0001$). Another beneficial effect of cell disruption in Lytic anaerobic/F medium is the significantly lower ($P < 0.0001$) rate of unconfirmed positive bottles than with Plus aerobic/F (0.4% versus 1.9%, respectively). We may therefore presume that most of the false-positive Plus aerobic/F vials were caused by cellular metabolism in this medium.

In a previous study, we evaluated Plus aerobic/F and Septi-Chek Release blood culture medium on 6,116 blood cultures (20). To ensure the isolation of anaerobic and certain facultatively anaerobic bacteria in this evaluation, a third vial of resin-containing Plus anaerobic/F medium was used on all 6,116 blood cultures. Comparing Plus aerobic/F with Plus anaerobic/F, we found that both vials detected 66.5% of the 632 pathogens isolated in that study and 16.9% were identified only from Plus anaerobic/F medium. In the current study, Lytic anaerobic/F medium was more complementary to the same Plus aerobic/F medium to the extent that only 53.8% of the 1,135 clinically relevant microorganisms were isolated from both media and 21.2% of these microorganisms were recovered from Lytic anaerobic/F medium only. We therefore favor the use of Lytic anaerobic/F medium in conjunction with Plus aerobic/F medium.

Controversy exists regarding the routine use of anaerobic blood culture media (2, 12, 22). In agreement with Cockerill et al. (2), our present study favors the routine use of an anaerobic medium, for reliable recovery of not only obligate anaerobic bacteria but also facultatively anaerobic bacteria like streptococci and *E. coli*. It may be worthwhile to develop a lytic aerobic medium and to determine its performance in conjunction with Plus anaerobic/F compared to the combination of Plus aerobic/F and Lytic anaerobic/F.

Several factors may explain the relatively low rate of contamination (1.6%) in the current study. Routine use of the Vacutainer blood collecting system in our hospital may help to keep the contamination low. In addition, this system reduces the risk of inadvertent needle sticks and the exposure of health care workers to blood-borne infections. The BACTEC vials we evaluated remain a closed system; i.e., no further manipulation

in the laboratory is required before incubation. It has been reported that additional manipulations of culture vials, like the attachment of agar-coated paddles for the Septi-Chek system or the transient venting of BacT/Alert aerobic vials, may be why these systems are more often contaminated (5, 20).

The BACTEC blood culture combination of Plus aerobic/F with Lytic anaerobic/F performed favorably for the detection of a wide range of microorganisms causing septicemia in our patient population. During the study period, no mechanical or software failures occurred. Also outside the study period, our three BACTEC 9240 instruments operated reliably for 4 years in the processing of some 20,000 blood culture sets we received annually.

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