The clinical comparison of Oxoid Signal with Bactec blood culture systems for the detection of streptococcal and anaerobic bacteraemias

NICOLETTE A. HUTCHINSON, F. D. THOMAS* and D. C. SHANSON

Department of Medical Microbiology, Charing Cross and Westminster Medical School, 17 Horseferry Road, London SW1P 2AR and *Queen Elizabeth Military Hospital, Woolwich

Summary. Blood cultures were taken from 47 patients 1–2 min after dental extraction. These samples were tested by the radiometric Bactec 460 and Oxoid Signal systems for the detection of streptococcal and anaerobic bacteraemias. Streptococci were isolated from 19 (40%) patients and anaerobes from 15 (32%). In this study the Oxoid Signal system was significantly better for isolating oral anaerobes than the Bactec system; five isolates were obtained with the Bactec system and 14 with the Signal system. There was no significant difference in the isolation of streptococci between these two systems (Bactec 14, Oxoid Signal 10). The contamination rate was 4.1% for Bactec and 7.5% for the Oxoid Signal system.

Introduction

Oxoid Signal® is a single bottle blood-culture system that uses a defined medium capable of supporting growth of both aerobic and anaerobic bacteria. Once a bottle has been inoculated and received in the laboratory, a clear plastic upper cylinder, the Signal device, is attached *via* its needle which is inserted through the bottle hub. Microbial growth generates gas that forces medium up the needle into the cylinder, thus signalling a positive culture.

Blood cultures are essential in the diagnosis of infective endocarditis; therefore, blood-culture systems must be effective in the prompt detection of viridans-type streptococci—the most common causative agents of endocarditis. In this study the Oxoid Signal blood culture system was compared with the radiometric Bactec 460® for the isolation of streptococci. The detection of anaerobic bacteraemia was also studied, as blood culture media vary greatly in their ability to support growth of inocula of non-sporing anaerobes. A number of previous studies by Shanson *et al.*^{1–3} showed that streptococci could be isolated from 25–47% of blood cultures taken within 2 min of dental extraction. For this reason we have investigated patients undergoing dental extraction as our source of blood cultures.

Materials and methods

Blood culture media

In this study the Bactec bottles used were the aerobic

6B and the anaerobic 7D, each containing 30 ml of Soybean-caesul digest broth incorporating sodium polyanetholsulphonate 0.025%. The Oxoid Signal bottle contained 80 ml of Oxoid Special Broth with sodium polyanetholsulphonate 0.03%.

Blood collection methods

Adults undergoing extraction of impacted wisdom teeth (third molars) under general anaesthesia at Queen Elizabeth Military Hospital, Woolwich were studied. Patients who had received antibiotics within the week before surgery were excluded. A volume (20 ml) of blood was drawn 1–2 min after extraction of the first tooth and, from this, samples were inoculated aseptically into each of the Bactec bottles (5 ml) and into the Signal bottle (10 ml). The order in which the bottles were inoculated was varied. The bottles were then transported at the end of the operation list to Westminster Hospital Microbiology Laboratory.

Processing of blood cultures

Upon arrival in the laboratory all cultures were processed immediately. The Bactec vials were incubated at 37°C; the 6B aerobic bottles were agitated for the first 48 h. Both Bactec bottles were examined macroscopically and radiometrically twice on the first 2 days and once daily thereafter to day 7. Gram-stained films and subcultures were made from bottles giving a positive growth index, i.e., exceeding the aerobic and anaerobic predetermined thresholds of 30 and 25 respectively. Terminal subcultures were performed on those vials remaining negative after 7 days.

On receipt of the Oxoid Signal culture bottles, the

Signal device was attached and the bottle was incubated at 37°C with agitation for the first 48 h. The Signal bottles were examined for macroscopic evidence of growth and for a positive signal (fluid in the upper cylinder) twice daily for the first 2 days and once daily thereafter to day 7. Any bottles that were positive by macroscopic examination or the Signal device were subcultured aerobically and anaerobically. Terminal subcultures were performed on those that remained negative after 7 days. All blood agar plates for anaerobic culture were incubated for 7 days in an anaerobic cabinet (N₂ 80 %, CO₂ 10 %, H₂ 10 %).

Identification of isolates

Suspected anaerobes were subcultured aerobically and anaerobically for up to 7 days. Isolates that grew only anaerobically and were sensitive to metronidazole were confirmed as anaerobes. These organisms were further identified by colonial morphology, reaction with Gram's stain and antibiotic sensitivity test with the anaerobic identification Mastring (Diamed Diagnostics) that includes penicillin 2 units, erythromycin 60 µg, rifampicin 15 µg, colistin 10 µg, kanamycin 1000 µg and vancomycin 5 µg disks.

Colonies from the aerobic plate were examined morphologically and by Gram's stain. Appropriate colonies that were coagulase- and catalase-negative were presumptively identified as streptococci. These were further identified by the API 20 Streptococcal identification test (bioMérieux UK Ltd, Basingstoke, Hants) and optochin sensitivity.

Results

Twenty-four strains of streptococci were obtained from 19 (40 %) blood culture sets; 15 were isolated from Bactec bottles and 12 from the Signal system (table I). There was no significant difference between the Signal and radiometric Bactec systems in their overall isolation of streptococci. The same streptococcal species was isolated with both systems on only three occasions.

Nineteen strains of anaerobes were isolated from 15 (32 %) samples, with the Bactec detecting five anaerobes and the Signal system 14 (table II). In 10 (21 %) samples an anaerobe was detected by the Signal alone; in contrast only one anaerobe was detected by the Bactec alone. Using the comparison of proportions, these results show that the Oxoid Signal system is significantly better at the 5 % level in the recovery of non-spore-forming anaerobes than the radiometric Bactec system. In the three cases in which the same anaerobe was isolated by both systems there was no difference in the time taken to detect the pathogen.

In three cases the Oxoid Signal system showed macroscopic evidence of bacterial growth but the "Signal" was negative. These samples were also found

Table I. Isolation of streptococci from the two blood culture systems

Case no.	Bactec	Signal
1	<i>S. mitis</i>	—
2	<i>S. sanguis</i> + <i>Aerococcus viridans</i>	—
3	—	<i>S. sanguis</i>
4	<i>S. milleri I</i>	<i>S. mitis I</i>
5	<i>S. sanguis</i>	—
6	<i>S. mitis</i>	<i>S. mitis</i>
7	<i>S. milleri</i>	—
8	<i>S. milleri II</i>	<i>S. milleri II</i>
9	<i>S. milleri</i>	—
10	—	<i>S. mitis</i>
11	<i>S. morbillorum</i>	<i>S. morbillorum</i>
12	—	<i>S. sanguis</i>
13	<i>S. mitis</i>	—
14	<i>S. sanguis II</i>	<i>S. milleri I</i>
15	<i>S. milleri II</i>	—
16	—	<i>S. mitis</i> + <i>S. sanguis</i>
17	<i>S. sanguis</i>	—
18	<i>S. sanguis</i>	—
19	—	<i>S. milleri</i> + <i>S. mitis</i>

Table II. Isolation of anaerobes from the two blood culture systems

Case no.	Bactec	Signal
1	<i>Fusobacterium</i> sp.	<i>Fusobacterium</i> sp. + anaerobic coccus
2	—	BPGNA +
3	—	anaerobic coccus
4	—	<i>Fusobacterium</i> sp.
5	<i>Prevotella oralis</i> BPGNA <i>Bacteroides ureolyticus</i> (<i>Actinomyces</i> sp.)	—
6	—	<i>B. oralis</i>
7	—	<i>Fusobacterium</i> sp.
8	—	Anaerobic coccus
9	—	BPGNA
10	—	BPGNA
11	<i>P. oralis</i>	BPGNA
12	—	Anaerobic coccus
13	—	<i>B. ureolyticus</i>
14	<i>B. ureolyticus</i>	<i>B. ureolyticus</i>
15	Anaerobic coccus	Anaerobic coccus

BPGNA, black-pigmented gram-negative anaerobe.

to be leaking. One false negative result, i.e., growth only on terminal subculture, occurred with both each system. The contamination rates for both systems were higher than in earlier studies⁴⁻⁶ with a rate of 4 % for the Bactec and 7.5 % for the Oxoid Signal.

Discussion

The Oxoid Signal system was significantly better for detecting oral anaerobes than the radiometric Bactec 460. This has not been noted in earlier trials.⁴⁻⁶ Previous studies comparing Oxoid Signal with radiometric Bactec showed that without agitation the Oxoid Signal was significantly poorer for detecting streptococci,⁴ but with agitation this difference disappeared.

Our study confirms these findings, showing no significant difference between the two systems for the detection of viridans-type streptococci. However, the greater number of streptococcal isolates was noted with the Bactec system and it is possible that a much larger study might have shown a significant difference between the two systems.

The Oxoid Signal blood culture system employs a single bottle and has the advantage of not requiring expensive equipment. Our trial showed that the Oxoid Signal gave similar results to the radiometric Bactec 460 for the detection of viridans-type streptococci but was significantly better in the recovery of oral anaerobes.

There are two main alternative explanations for the superior results for the detection of anaerobes by the Signal system: (a) difference in media composition and (b) different blood volumes. The medium in the Signal system includes a type of thioglycollate broth that could be more effective than the medium used in the anaerobic Bactec bottle. Alternatively the difference may be explained by the fact that the whole 10-ml sample of blood is examined for the presence of anaerobes by the Signal bottle whereas only half the sample (5 ml) is investigated for anaerobes by the two bottle Bactec system.

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