JOURNAL OF CLINICAL MICROBIOLOGY, Oct. 1993, p. 2794–2795
0095-1137/93/102794-02$02.00/0

Vol. 31, No. 10

Utilization Review of the Use of BACTEC PLUS High-Volume Blood Culture Bottles

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Received 15 April 1993/Returned for modification 27 May 1993/Accepted 14 July 1993

The BACTEC PLUS 26 (NR26) (Becton Dickinson, Towson, Md.) high-volume blood culture bottle replaced the less expensive smaller-volume NR6A bottle in our hospital. An audit carried out several months after their introduction revealed that only 17.5% of the NR26 bottles received the required blood volume. Several audits and educational programs were required in order to achieve a compliance rate of >60%.

Several studies have shown that an increased volume of blood inoculated into blood culture bottles will increase the yield of positive cultures in bacteremic patients (1–3, 6–9). The BACTEC PLUS 26 (NR26) bottle, a resin-containing aerobic bottle, was introduced by Becton Dickinson (Towson, Md.) to function optimally with an inoculum of 8 to 10 ml of blood compared with the BACTEC NR6A low-volume (3- to 5-ml inoculum), non-resin-containing, aerobic blood culture bottles (4, 5). We replaced the NR6A bottles that we had been previously using with NR26 bottles. The NR7A low-volume (3- to 5-ml inoculum), non-resin-containing, anaerobic bottle was retained as part of the blood culture set. Staff responsible for the collection of blood cultures were notified of this change by a memorandum outlining the new blood volume requirements.

After several months of using the NR26 bottles, it became apparent that the observed volume frequently was less than optimal. This observation led to a series of audits and educational programs designed to improve compliance with the inoculum requirements, which we set at 8 to 12 ml for the NR26 and 3 to 6 ml for the NR7A bottles.

In the first four audits, the volume of blood inoculated into the bottles was determined by subtracting the mean weight of the uninoculated bottles (corrected for the removal of bottle caps and the addition of specimen labels) from the weight of the inoculated bottles. In order to minimize any variation that may have occurred because of weight differences between different lots of bottles, each uninoculated bottle was weighed before distribution in subsequent audits. The difference in weight between inoculated and uninoculated bottles was then converted into a volume by a blood density conversion factor of 0.985 ml per gram of blood. The conversion factor was determined from the mean weight of 10 ml of pooled human blood. The level of hemoglobin had no significant effect on the conversion factor (data not shown).

Nine audits were performed over a 19-month period (Table 1). As a result of the poor compliance found in audit 1a, a second memorandum was issued to all health care personnel involved in blood culture collection. This memorandum contained a color photograph of both the NR26 and the NR7A bottles and clearly indicated the required inoculum for each bottle (9 ml for the NR26 bottle and 4 ml for the NR7A bottle). The effect of this memorandum upon compliance was measured in audit 1b and again 3 months later in audit 1c. After the orientation for new residents and interns on the proper collection of blood cultures, audit 2a was performed. Audit 2b was performed midway into their rotation.

Since the results of these audits demonstrated continued poor compliance, a label containing the blood volume requirement, the expiration date, and the lot number was affixed to each blood culture bottle. Audits 3a, 3b, and 3c were performed to measure the effect of this relabelling at 3-month intervals. Audit 4 was carried out following an in-service training session with the intravenous nursing team whose responsibilities include collecting blood cultures during certain times and in certain areas of the hospital.

The extent of noncompliance following our initial memorandum (audit 1a) was unanticipated. Only 17.5% of the NR26 bottles were found to have received the required 8 to 12 ml. The second memorandum, which included color photographs of the bottles and excluded any extraneous information, improved compliance. The number of blood culture sets in which both bottles contained the appropriate volume increased from 1.5 to 23.6%. However, following the issuance of this memorandum, there was an increase in overinoculation (>6 ml) of the NR7A bottle. During the first series of audits, overinoculation of the NR7A bottle continued and was even more pronounced in audit 1c, in which only 28.7% of the NR7A bottles contained the required blood volume (3 to 6 ml). The second set of audits demonstrated increased compliance over the short term after the orientation of new staff (audit 2a). However, without constant reiteration of the blood volume requirements, the compliance rate returned to that found originally (audit 2b).

Improved labelling produced an immediate and significant improvement in compliance (audit 3a). This effect was maintained throughout the 8 months included in audits 3a, 3b, and 3c. Our in-house-designed labels, although inexpensive to produce ($0.01 each), required a significant amount of labor for application prior to issuance. The increased labor costs could be minimized through improved labelling on the part of the manufacturer. This may not be feasible, however, because of the regulations for product labelling.

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TABLE 1. Audits of the volume of blood inoculated into NR26 and NR7A blood culture bottles

Audit no.	Date	Comment	No. of sets	Vol. of blood inoculated in bottles[a]						
				NR26		NR7A		Distribution in NR26 and NR7A (%)		
				Mean (ml)	% Optimal	Mean (ml)	% Optimal	Optimal in both	Insufficient in both	NR26 insufficient, excess in NR7A
1a	Oct. 1990	Initial audit after NR26 introduction	280	5.5	17.5	5.1	66.4	1.5	16.5	40.3
1b	Jan. 1991	Post color-photo memorandum	233	7.9	45.9	6.3	60.9	23.6	2.2	12.5
1c	Mar. 1991	3 mo post color-photo memorandum	330	8.2	52.1	7.6	28.7	10.3	0.6	25.8
2a	July 1991	New intern rotation	265	8.5	63.0	6.0	57.4	35.2	4.2	9.1
2b	Sept. 1991	3 mo post new intern rotation	238	7.0	37.4	5.4	45.0	23.1	5.5	10.1
3a	Nov. 1991	Post labelling	361	7.6	53.5	4.4	83.9	46.5	7.2	2.5
3b	Jan. 1992	3 mo post labelling	515	7.7	61.9	4.0	81.9	55.7	11.3	0.6
3c	Apr. 1992	Blood cultures drawn by interns, residents, and unspecified staff	592	8.3	71.1	4.3	83.8	64.2	6.6	1.9
4	Apr. 1992	Blood cultures drawn by IV team[b]	190	9.3	91.6	4.5	93.7	86	0.0	0.5

[a] Optimal volume of blood: NR26A, 8 to 12 ml; NR7A, 3 to 6 ml.
[b] IV, intravenous.

Our use of blood culture bottles requiring different volumes may have contributed to the lack of compliance and may explain the overinoculation of the NR7A bottle. Also, technical problems in obtaining blood may limit the compliance rate.

Although it is difficult to define an acceptable compliance rate, a rate of >60% may be reasonable, since we were able to obtain this simply by modifying the blood culture bottle labels and in-service programs. Failure to achieve this rate with such a new system should prompt a reevaluation of its cost effectiveness.

REFERENCES

1. **Apri, M., M. W. Bentzon, and W. Frederiksen.** 1989. Importance of blood volume cultured in the detection of bacteremia. Eur. J. Clin. Microbiol. Infect. Dis. **8**:838–842.
2. **Hall, M. M., D. M. Ilstrup, and J. A. Washington.** 1976. Effect of volume of blood cultured on detection of bacteremia. J. Clin. Microbiol. **3**:643–645.
3. **Ilstrup, D. M., and J. A. Washington.** 1983. The importance of volume of blood cultured in the detection of bacteremia and fungemia. Diagn. Microbiol. Infect. Dis. **1**:107–110.
4. **Koontz, F. P., K. K. Flint, J. K. Reynolds, and S. D. Allen.** 1991. Multicenter comparison of the high volume (10 ml) NR BACTEC PLUS system and the standard (5 ml) NR BACTEC system. Diagn. Microbiol. Infect. Dis. **14**:111–118.
5. **Marcelis, L., J. Verhaegen, J. Vandeven, A. Bosmans, and L. Verbist.** 1992. Evaluation of BACTEC high blood volume resin media. Diagn. Microbiol. Infect. Dis. **15**:385–391.
6. **Plorde, J. J., F. C. Tenover, and L. G. Carlson.** 1985. Specimen volume versus yield in the BACTEC blood culture system. J. Clin. Microbiol. **22**:292–295.
7. **Reller, L. B., P. R. Murray, and J. D. MacLowry.** 1982. Cumitech 1A, blood cultures II. Coordinating ed., J. A. Washington II. American Society for Microbiology, Washington, D.C.
8. **Tenney, J. H., L. B. Reller, S. Mirrett, W. L. Wang, and M. P. Weinstein.** 1982. Controlled evaluation of the volume of blood cultured in detection of bacteremia and fungemia. J. Clin. Microbiol. **15**:558–561.
9. **Washington, J. A., and D. M. Ilstrup.** 1986. Blood cultures: issues and controversies. Rev. Infect. Dis. **8**:792–802.