



ORIGINAL ARTICLE

Reducing Blood Culture Contamination Rates by Educational Intervention and one-on-one Feedback in the Emergency Department

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Background/Purpose: Blood culture specimens collected from patients in the emergency department (ED) can subsequently give the clinical physicians useful information and references for diagnosis and medication selection. If the isolates are found to be contaminants, the consequences are increased antibiotic use and inpatient hospital fees. The purpose of this research is to reduce blood culture contamination (BCC) rates in the ED.

Methods: The effectiveness of educational intervention and one-on-one feedback to reduce BCC rates in the ED was assessed in a busy medical center in which blood cultures were obtained by nurses rather than trained phlebotomists.

The study comprised two phases. The first phase was to ensure understanding of the correct methods for performing blood culture, and to measure the effectiveness of the educational intervention. The second phase was to continue the educational intervention plus to give one-on-one feedback of the BCC rates to the ED and individuals weekly.

Results: The baseline BCC rate was 3.4% in the pre-intervention period. The BCC rate fell to 2.67% in Phase 1 (i.e., educational intervention only). The BCC rate fell to 2% in Phase 2 (i.e., educational intervention plus one-on-one feedback). Among the contaminants, coagulase-negative staphylococci (CoNS) fell from 62% before the intervention to 48% post-intervention.

Conclusion: Educational intervention plus one-on-one feedback for decreasing BCC rates was more effective than an educational intervention alone in our study.

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1. Introduction

Bacteremia or septicemia is the most serious infection clinically, so it is important to diagnose and treat it with the appropriate antibiotic. Furthermore, high rates of blood culture contamination (BCC) will create a number of subsequent problems. Zwang and Albert reported that a high BCC rate prolonged the hospital stay from 1450 days to 2200 days, increasing costs from 1.4 to 1.8 million dollars every year.¹ Based on Richter's research, the reduction of blood culture contaminants and unnecessary antimicrobial susceptibility testing can save the laboratory unit over 20,000 US dollars and reduce the inappropriate use of antibiotics.² The first priority of the emergency department (ED) on the front line is to take care of severely ill patients. However, specimens collected

from patients in the ED can subsequently give the clinical physicians useful information and references for diagnosis and medication selection. Therefore it is important in the ED to minimize the BCC rate to avoid wasting medical resources and antibiotics.

Blood culture contaminants are mainly derived from flora microorganisms from human skin, e.g., coagulase-negative staphylococci (CoNS), *Corynebacterium* spp., *Propionibacterium acnes*, *Bacillus* spp., *Micrococcus* spp., and viridans streptococci. In blood culture, CoNS are the most common contaminants and cause bacteremia. The accuracy of blood culture results is influenced by the sampling procedure, including the choice of puncture site, number of sets, skin disinfection, collection techniques, and use of collection tubes with antiseptic processes. The processing procedure at the laboratory will also influence the accuracy.

During specimen collection, if the nurse uses improper skin antiseptics and/or incompletely disinfects the blood draw site, skin flora microorganisms will appear in the blood culture isolates. When dedicated phlebotomists are substituted for clinical personnel for blood specimen collection, BCC rates are reduced.^{3,4}

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It is more effective if BCC rates feedback is periodically given to the dedicated phlebotomists.⁵ In the present study, the blood culture specimen was obtained by a nurse rather than by dedicated phlebotomists. The purpose of this research is to reduce BCC rates in the ED by use of an educational intervention and one-on-one feedback.

2. Methods

This research was done in the ED of a 732-bed medical center in the north of Taiwan. Each month, on average, the medical center takes 1800 sets for blood culture (11% positive rate of blood cultures), and performs 5500 patient services in the ED. All the blood cultures were collected by clinical nursing personnel, not by trained phlebotomists. Before the educational intervention in the ED, retrospective analysis was performed to review the previous year's blood culture reports, from January to December 2008.

In January 2009 all clinical nursing personnel at the ED were given relevant educational training for 1 month. The blood culture aseptic technique protocol (Table 1) was created for performance and educational posters were made for references and compliance for each nurse. In the subsequent 12 weeks, from February 1, 2009 to April 30, 2009, blood draw procedures and performance were checked to ensure that the personnel followed the aseptic technique protocol, and the person who performed each blood draw was recorded.

The study comprised two phases. The first phase was to ensure understanding of the correct methods for performing blood culture, and to measure the effectiveness of the educational intervention. The second phase was to continue the educational intervention plus to give one-on-one feedback of the BCC rates to the ED and individuals weekly. If the number of blood culture contaminants for an individual was higher more than once per week, they were interviewed once to remind them to follow the technique protocol. We used the Chi-square method to compare all data statistically.

The blood culture bottle used was BACTEC Plus Aerobic/F and BACTEC Plus Anaerobic/F (Beckton-Dickinson, Taiwan, R.O.C.). The bacteria identification analysis was implemented with BD Phoenix™9240 (BACTEC 9240; Beckton-Dickinson, Taiwan, R.O.C.) and complied with *Manuals of Clinical Microbiology* (9th edition) for discrimination.

Positive blood cultures were defined as the microorganism isolated in each blood culture. The contaminants were defined as one set positive from the single (1/1) or double blood culture (1/2)

Table 1 Protocol of aseptic phlebotomy technique for blood cultures

1. Prepare venepuncture devices.
2. Handwash for 15 ~ 30 s with 75% alcohol plus 0.5% chlorhexidine.
3. Put on disposable gloves.
4. Select the site of venepuncture. If the venepuncture site appears unclear, use a 75% alcohol swab before skin disinfection.
5. Scrub the venepuncture site firmly with a 75% alcohol swab, beginning in the center and continuing in an outward direction using a circular motion for an area 2–3 cm in diameter. Allow the area to dry completely.
6. Scrub the venepuncture site with a povidone–iodine swab, beginning in the center and continuing in an outward direction using circular motion for an area 2–3 cm in diameter. Allow the area to dry completely for at least 2 min.
7. Take the caps off the blood culture bottles and wipe the tops with a 75% alcohol swab.
8. Put on a tourniquet, taking care not to touch the prepared venepuncture area, and then draw 10 mL blood.
9. Inoculate 5 mL blood into an anaerobic bottle, then 5 mL into an aerobic bottle (do not change needles).
10. Handwash for 15 ~ 30 s with 75% ethanol plus 0.5% chlorhexidine following disposal of gloves.

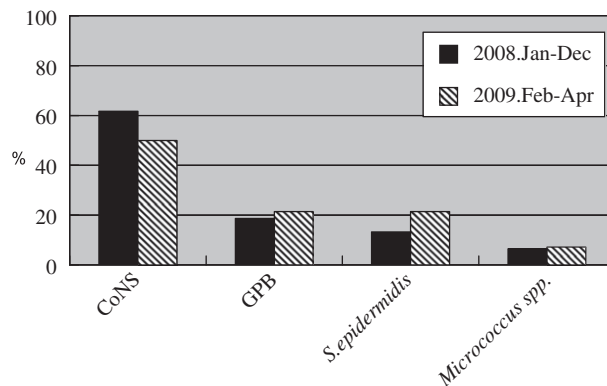


Figure 1 Analysis of species of blood culture contaminants before and during intervention. CoNS = coagulase-negative *staphylococci*; GPB = Gram-positive bacilli.

or two sets positive from the double blood cultures (2/2), from patients who clinically had no fever or systemic inflammatory response syndrome (SIRS). The catheter-related infections associated with bacteremia were excluded. These contaminant microorganisms included: coagulase-negative *Staphylococcus* (CoNS); *Micrococcus spp.*; *Staphylococcus epidermidis*; Gram-positive bacilli (GPB).

3. Results

In the analysis of contaminant strains of blood culture (Figure 1), the highest rate was seen with CoNS, followed by GPB, *Staphylococcus epidermidis* and *Micrococcus spp.* There was no prominent difference seen between the pre- and post-intervention samples. Among the contaminants, CoNS fell from 62% before the intervention to 48% post-intervention.

The duration of the intervention was 12 weeks, from February 1, 2009 to April 30, 2009. The BCC rates achieved in Phase 1 and 2 are shown in Table 2. In the first phase (Weeks 1–6), the rate was 1.8%, 2.3% and 2%, separately distributed in the first 3 weeks. However, during the next 3 weeks, the BCC rate was increased to 2.7%, 3.5% and 3.6%. It was an average of 2.7% (25/912) of the BCC rate in the first phase. The variation was not significant [$p = 0.23$, odds ratio (OR) 1.28, 95% confidence interval (CI) 0.84–1.98], compared with the BCC rate 3.5% (328/9317) before the intervention (January to December 2008).

The second phase (Weeks 7–12) commenced with the educational intervention plus one-on-one feedback. Each individual nurse was accountable for their BCC rates, in addition to the ED on the weekly promulgation of the BCC rates. The one-on-one feedback and individual re-education took place according to the BCC rates reported. From Weeks 7–12, the BCC rate was kept below 3%

Table 2 Blood culture contamination rates of the Phase 1 (educational intervention) and Phase 2 (educational intervention and one-on-one feedback) periods

Contaminants	Pre-intervention (duration 1 y)	Intervention period (duration 3 mo)	
	2008 average	Intervention Phase 1 (6 wk)	Intervention Phase 2 (6 wk)
		Feb 1–Mar 14, 2009	Mar 15–Apr 30, 2009
Contaminants	328	25	31
No contaminants	9317	912	1517
Total numbers	9645	937	1548
Contamination rate (%)	3.40	2.67	2.00

(1.2% ~ 2.6%.) The mean rate was 2.0% (31/1517) and consequential ($p = 0.003$, OR 1.72, 95% CI 1.17–2.55), compared with the BCC rate 3.5% (328/9317) before the intervention (January to December 2008). The BCC rates decreased significantly in the second phase. After the educational intervention and one-on-one feedback system was initiated, the instances of inappropriate procedure and inadequate disinfection were also reduced.

4. Discussion

According to the American Society for Microbiology, BCC rates should not be higher than 3%.⁶ If the isolates are derived from the contaminated specimen, the consequence is increased laboratory workload, antibiotic usages, and inpatient hospital fees and duration of hospital stay.^{1,2}

The most important way to minimize BCC rates is to ensure appropriate skin disinfection. The common antiseptics are povidone–iodine (PI), isopropyl–alcohol (IPA), tincture of iodine (TI), 22% chlorhexidine, 70% isopropanol (Chloraprep) etc. There have been many studies of which antiseptics are able to reduce BCC, but their conclusions are inconsistent. Calfee and Farr demonstrated that 10% PI, 70% isopropyl alcohol, tincture of iodine and Persist (alcohol iodine) are effective in disinfection and do not influence BCC rates statistically.⁷ Also, Trautner et al. confirmed that chlorhexidine is as effective at disinfection as tincture of iodine.⁸ Nevertheless, Dwayne et al. compared tincture of iodine and Chloraprep as an antiseptic agent and concluded that Chloraprep was better at reducing BCC rates ($p < 0.01$).⁹

Each antiseptic needs a certain amount of time to attain its best effect. The pressure of arduous clinical nursing work, especially when combined with the urgent status of patients in the ED, can cause phlebotomists to rush when using antiseptic resulting in a contaminant rate rise.¹⁰ In our study we did not change the original protocol for blood specimen collection, but merely emphasized the right procedures for blood specimen collection and the importance of the skin disinfection time and antiseptic duration. Moreover, during the educational intervention, the relevant educational posters were made to guide personnel in the ED.

Eskira et al. suggested that educational intervention can reduce BCC rates.¹¹ However, other studies report that educational intervention has limited effect on BCC rates and the reduction is better if the BBC feedback is given directly to the phlebotomist.^{11,12} We share this conclusion. In Phase 1 of our research, the educational intervention reduced BCC rates for only Weeks 1–3. During Weeks 4–6, all BCC rates were above 3%. It may be that the clinical personnel became gradually reluctant to undertake the intervention. However in Phase 2, when we started giving weekly BCC rate feedback to the nursing personnel and re-affirmed collection technique to individuals as necessary, the BCC rate decreased significantly to under 3% and remained so for 6 weeks until the end of the study. One of the limits to this study was that the nursing staff drawing blood had to take extra time to record each blood specimen, and one person collated the statistics of the individual BCC rates. Also, because of the arduous and urgent nature of ED

patient care compared with other clinical units, the study period was kept to only 3 months and could not measure the long-term performance of the interventions.

In a study by Bates et al., 22% of doctors only ordered a set of blood culture for fever patients.^{13,14} If a patient has only one blood specimen taken, even if skin flora microorganisms are separated, it is impossible to determine which is the contaminant organism and which is the meaningful pathogenic bacterium. The BCC caused the patient to suffer 20% higher examination fees and 39% higher antibiotic expenses.^{13,14} Since this research did not record the numbers of drawing blood from the doctor order, it could not evaluate any connection between the set numbers and the contamination rates.

In conclusion, 1 month of infection control education in January 2009 followed by practical application of the knowledge in the ED from February 2009 caused BCC rates to fall from 3.4% to 2.67%. It was possible to reduce the BCC rate further to 2.0% for 6 weeks when this educational intervention was combined with one-on-one feedback to adjust for correct individual technique. Therefore, an educational intervention and one-on-one feedback mechanism can reduce the BCC rate simply and cost-effectively.

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