

EFFECTIVENESS OF A NOVEL SPECIMEN COLLECTION SYSTEM IN REDUCING BLOOD CULTURE CONTAMINATION RATES

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Contribution to Emergency Nursing Practice

- Decreasing blood-culture contamination rates
- Decreasing false-positive blood-culture results
- Decreasing patient length of stay

Abstract

Problem: False-positive blood-culture results due to skin contamination of samples remain a persistent problem for health care providers. Our health system recognized that our rates of contamination across the 4 emergency department campuses were above the national average.

Methods: A unique specimen collection system was implemented throughout the 4 emergency departments and became the mandatory way to collect adult blood cultures. The microbiology laboratory reported contamination rates weekly

to manage potential problems; 7 months of data are presented here.

Results: There was an 82.8% reduction in false positives with the unique specimen collection system compared with the standard method (chi-squared test with Yates correction, 2-tailed, $P=0.0001$). Based on the historical 3.52% rate of blood-culture contamination for our health facilities, 2.92 false positives were prevented for every 100 blood cultures drawn, resulting from adoption of the unique specimen collection system as the standard of care.

Conclusion: This unique collection system can reduce the risk of blood culture contamination significantly and is designed to augment, rather than replace, the standard phlebotomy protocol already in use in most health care settings.

Key words: Steripath; Blood-culture; Phlebotomy; Contamination; False positive; Collection

False-positive blood culture results due to sample contamination remain a persistent problem for health care providers. At present, a blood-culture contamination (BCC) rate of less than 3% is considered acceptable,¹ but BCC rates can be much higher in busy clinical settings, such as the emergency department, and in

hospitals without dedicated phlebotomy teams.²⁻⁵ False-positive blood culture results lead to unnecessary antibiotic treatment, longer hospital stays, and increased costs.^{3,6-9} Obtaining the most accurate blood-culture results possible is essential to avoid diagnostic uncertainty and unnecessary administration of antibiotics.^{1,2}

The skill level of the staff responsible for obtaining blood culture samples is a factor that can affect rates of contamination.¹ Educational intervention on proper aseptic technique has proved to generate reductions in BCC rates, but monitoring of technique and repeated training are required to keep BCC rates low,^{4,5,10-15} which can be challenging in the emergency department, owing to time pressure and workflow constraints. Implementation of a dedicated phlebotomy team is associated with decreased BCC^{3,7,16}; however, this may not be feasible as hospitals often rely on nursing staff to draw blood cultures in the emergency department to avoid time delays and excess costs.

Common blood culture contaminants include coagulase-negative *Staphylococci*, viridans group *Streptococci*, *Propionibacterium acnes*, *Micrococci*, and *Corynebacterium* species (excluding *jeikeium*), all of which colonize the skin surface.¹⁷⁻¹⁹ Antibacterial chemical solution is applied to

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the venipuncture site to prevent contaminants from entering the blood-culture bottle,²⁰ but this is not 100% effective for eliminating contamination with skin-residing organisms (SROs).^{21,22} Even with proper aseptic technique, the act of piercing the epidermis always imparts some risk of contaminant inclusion in the initial aliquot of blood collected due to incomplete sterilization of the skin surface, subsurface skin bacteria, and/or the unintended capture of skin fragments by the needle lumen.^{23,24} Hospital surfaces can be contaminated with a significant number of pathogens,²⁵ so excess handling or assembly of blood-sampling equipment also imparts risks of contamination.

Nursing staff from our emergency departments attending a health care association annual meeting learned of a novel blood-culture specimen-collection device that had obtained promising results in reducing and sustaining decreased BCC rates. The Initial Specimen Diversion Device (ISDD), known as Steripath (Magnolia Medical Technologies, Seattle, WA), diverts and isolates the initial aliquot of the blood culture sample, which is most likely to be contaminated with SROs. Designed to augment the standard phlebotomy protocol, the manually actuated device draws the first 1.5 to 2 mL of blood into a

sequestration chamber, mechanically isolating it from the rest of the sample, which then flows through an independent sterile pathway into blood culture collection bottles (Fig. 1). The device is preassembled in a sterile kit that includes the culture bottle transfer adapter, as well as either an attached butterfly needle or a luer lock for connecting to a freshly inserted peripheral IV line. Preassembly reduces the risk of touch contamination by maintaining an end-to-end closed-loop sterile system. Anyone trained in standard phlebotomy procedures can learn to use the device with a short training session, and the device does not alter the actual venipuncture technique.

Product information was researched and reviewed by the ED Leadership Council, and a trial was authorized to use the device for blood-culture specimen collection in 4 emergency departments in our system, beginning in 2016, with the hypothesis that the ED BCC rates would decrease after implementation.

Methods

Blood cultures were collected using the ISDD over a 7-month period (May 2016 to November 2016) in 4 separate emergency departments in the Lee Health system. The ISDD was used to obtain all blood cultures during the study period except for those from pediatric patients (younger than 18 years of age) or from patients with pre-existing intravenous devices such as IV or central lines.

All staff responsible for obtaining blood cultures received training on how to use the ISDD during the first week of implementation. Observations and implementation of new standard-of-care procedures continued for 3 more weeks. Once trained, nursing staff and phlebotomists used the ISDD as the new “standard of care” for blood-culture collection. There was no additional training or observation during the remaining 6 months of the trial.

During the study period, specimen collection took place per standard protocol, with the only change being the use of the ISDD at the point of sample collection. Blood-culture bottle tops were disinfected with alcohol pads and a Chloraprep (BD Company, Franklin Lakes, NJ) scrub was used on the skin surface for 30 to 60 seconds to prepare the site for venipuncture. One blood culture set consisted of 20 mL venous blood split evenly between the first (aerobic) bottle and the second (anaerobic) bottle. The number of false positive events in all samples collected with the ISDD device during the 7-month period was measured in all 4 emergency departments. These results were

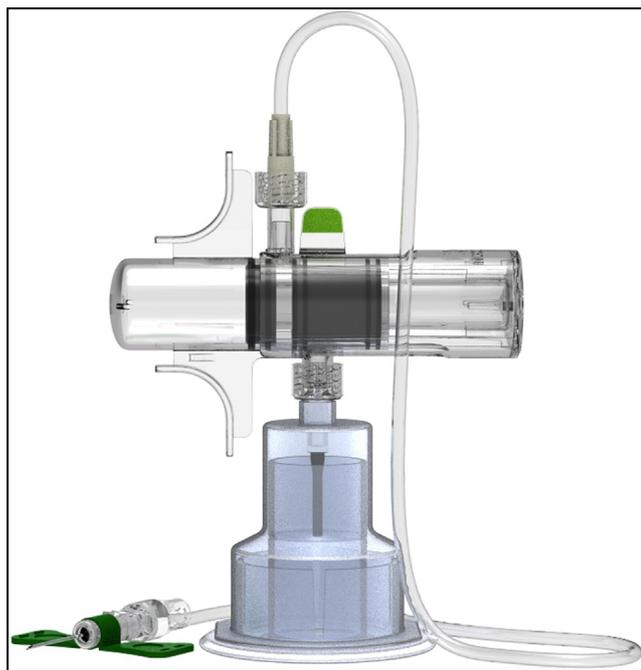


FIGURE 1

The Steripath device situated between a winged infusion set and a blood culture bottle adapter and cap.

TABLE 1
Blood culture contamination in Lee Health facilities (SM versus ISDD collection)

| Emergency Department | Standard Method | | Steripath Method | |
|----------------------|-----------------|---------------|------------------|---------------|
| | False Positive | Total Samples | False Positive | Total Samples |
| LMH | 279 | 6,853 | 14 | 2,453 |
| GCMC | 351 | 7,939 | 16 | 2,140 |
| CCH | 346 | 10,370 | 6 | 1,119 |
| HPMC | 270 | 10,230 | 2 | 581 |

compared with the number of false-positive events in samples collected with the standard method (SM) in the 4 emergency departments from October 2015 through November 2016.

Results

A combined total of 6,293 samples were obtained using the ISDD device in the 4 emergency departments over the 7-

month study period. A culture was considered a false positive if an SRO was present in either the anaerobic or aerobic bottle but not both. Thirty-eight of these samples were classified as contaminated with SROs. The individual data from each of the 4 emergency departments are listed in Table 1.

There was an 82.8% reduction in false-positive events after the implementation of the ISDD device compared with the historical BCC rate using SM (chi-squared test with Yates correction, 2-tailed $P < 0.0001$) (Fig. 2). Individually, each of the 4 trial sites had a decreased BCC

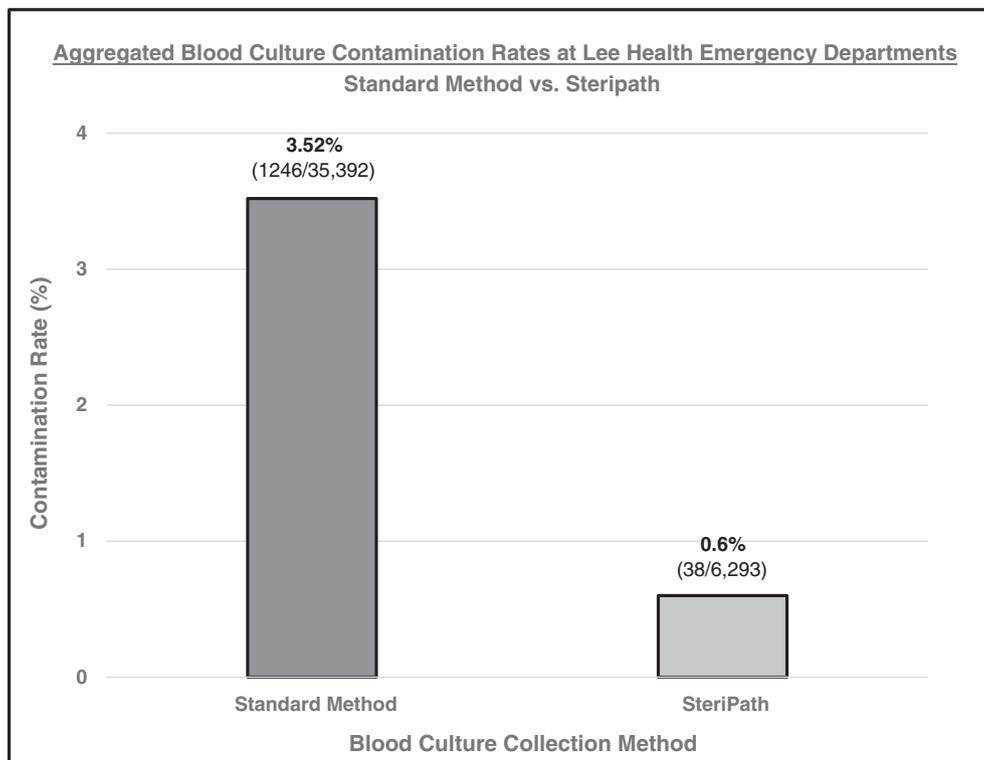


FIGURE 2

Combined Lee Health System ED blood-culture contamination rates before and after implementation of the ISDD. Standard method samples were collected from October 2015, through November 2016. ISDD samples were collected from May 2016, through November 2016.

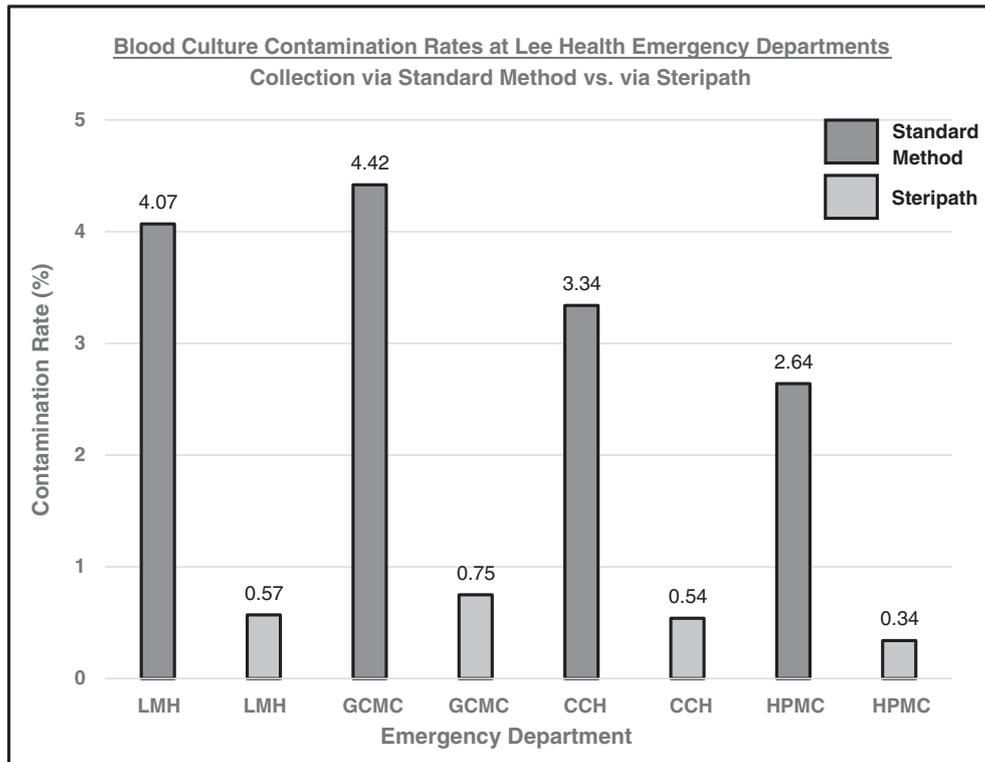


FIGURE 3

Emergency department bloodculture contamination rates within Lee Memorial Hospital (LMH), Gulf Coast Medical Center (GCMC), Cape Coral Hospital (CCH), and HealthPark Medical Center (HPMC). Standard method samples were collected from October 2015, through November 2016. ISDD samples were collected from May 2016, through November 2016.

rate during the ISDD period compared with the period using SM (Fig. 3). Implementation of the ISDD device prevented 2.92 false-positive events per 100 blood-culture samples obtained during the trial period, based on the historical combined 3.52% BCC rate from all 4 emergency departments.

Discussion

Implementation of this novel device facilitated a significant reduction (82.8%) in the rate of BCC compared with the historical 3.52% BCC rate for the participating emergency departments. The BCC rate of 0.60% achieved with the ISDD during this trial period is far below the 3% benchmark used by many hospital systems. On a system-wide annualized basis, this BCC rate equates to a prevention of 1,008 false-positive patient instances. BCC rate reduction was comparable across all 4 facilities, with each emergency department achieving a sustained sub-1% rate of contamination after adoption of the device.

False-positive blood culture events can be harmful to patients, leading to unnecessary antibiotic therapy and potential adverse reactions. Administration of nonessential broad-spectrum antibiotics is a major contributor to *Clostridium difficile* infection²⁶ and contributes to the problem of antibiotic-resistant organisms, which, according to The World Health Organization, is one of the top threats to human health. “Antimicrobial resistance (AMR) within a wide range of infectious agents is a growing public health threat of broad concern to countries and multiple sectors. Increasingly, governments around the world are beginning to pay attention to a problem so serious that it threatens the achievements of modern medicine. A post-antibiotic era—in which common infections and minor injuries can kill—far from being an apocalyptic fantasy, is instead a very real possibility for the 21st century,” according to Dr. Keiji Fukuda, Assistant Director-General Health Security, of the World Health Organization.²⁷ Patients with false-positive results undergo additional tests and experience longer hospital stays, increasing their risk for hospital

Metrics - Future State Based on FY15 Data

| Key Performance Indicator (KPI) | Measurement | Licensed Beds / Annual Visits | FY 2015 | Current Target | Potential Cost Avoidance (with device and contamination rate of 0%) |
|---------------------------------|-------------|-------------------------------|---------|----------------|---|
| Financial Viability | HPMC ED | 267 / 55,000+ | 2.2% | < 3% | \$683,805 - \$1,972,055 |
| Financial Viability | LMH ED | 355 / 50,000+ | 3.4% | < 3% | \$948,658 - \$2,345,121 |
| Financial Viability | CCH ED | 291 / 55,000+ | 4.4% | < 3% | \$1,636,892 - \$3,837,223 |
| Financial Viability | GCMC ED | 356 / 47,000+ | 3.4% | < 3% | \$1,082,059 - \$2,664,030 |

Total Lee Health Potential Cost Avoidance: \$4,351,414 - \$10,818,492

FIGURE 4

Total Lee Health Care potential cost avoidance: \$4,351,444–\$10,818,492

acquired infections. The cost of a single false-positive blood culture can approach \$10,000^{1,28} because of the cost and potential complications of subsequent antibiotic therapy. There are more than 800,000 false-positive events in the US annually.²⁹ During the observational period of this study, projected cost savings exceeded \$641,792 (approximately 184 prevented contaminations x \$3,488 (\$8,720 adjusted for charge-to-cost ratios of 40%).³ The potential cost-avoidance figures are provided in Figure 4.

In addition to being cost effective and improving patient safety, the ISDD device is easy to implement in busy clinical settings such as the emergency department. Both the ED nursing staff and tech staff, as well as the vascular access nurses and staffing resource nurses in these facilities, were able to use the device successfully with minimal training, greatly reducing the BCC rate during the study period. Refresher training could become necessary to maintain the same results over a longer span of time.

Conclusion

Current ENA guidelines recommend diverting the initial 1 to 2 mL of blood into a sterile container, as it has been shown to decrease blood-culture contamination in ED patients, inpatients, and outpatients older than 16 years of age.³⁰ This device is consistent with these guidelines.

Our experience suggests that the use of this novel device can significantly reduce BCC rates in the ED setting. Based on

these results, training both phlebotomists and non-phlebotomists alike to use this device in combination with periodic refresher training in standard aseptic technique could prove to be a very efficient and cost-effective way for hospitals to reduce their BCC rate significantly.

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