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Beyond the Needle: Innovative Approaches for Reducing Blood Culture Contamination Rates in the Emergency Department

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Abstract

Aim

This quality improvement project aimed to evaluate the effectiveness of the Kurin Lock device, which diverts the initial 0.15 mL of blood, and ChloraPrep (2% alcoholic chlorhexidine) in reducing blood culture contamination rates in emergency departments.

Methods

The study was conducted across three phases: pre-intervention, intervention, and post-intervention. Before the intervention, alcohol or chlorhexidine wipes were used for skin antisepsis. The intervention phase introduced the Kurin Lock device and ChloraPrep, accompanied by staff training. Contamination rates were analyzed using the chi-square test.

Results

During the intervention phase, contamination rates significantly decreased from 18.4% (pre-intervention) to 4.9% ($p < 0.001$). However, in the post-intervention phase, contamination rates rebounded to 18.1%.

Discussion

The study demonstrates that combining specimen diversion systems with enhanced antisepsis protocols effectively reduces blood culture contamination. However, maintaining these improvements over time remains a challenge, emphasizing the need for sustained adherence to the intervention.

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Introduction

Blood cultures are essential for detecting microorganisms in the bloodstream, aiding in the diagnosis of conditions like bacteremia and sepsis. Accurate identification of pathogens is crucial for timely and appropriate antimicrobial therapy. However, contamination remains a major challenge, particularly in emergency departments (EDs), where urgent care can compromise sterility. Contaminated samples result in false-positive blood cultures, leading to unnecessary antibiotic administration, increased healthcare costs, and prolonged hospital stays. These factors contribute to antimicrobial resistance (AMR), a growing global health threat.

Efforts to minimize contamination have led to various quality improvement initiatives. The Clinical and Laboratory Standards Institute (CLSI) recommends a contamination benchmark of less than 3%.[1] This study aimed to improve blood culture collection in a tertiary care ED by introducing the Kurin Lock device and ChloraPrep (2% alcoholic chlorhexidine). The Kurin Lock diverts the initial 0.15 mL of blood, which is most likely contaminated by skin flora, while ChloraPrep provides enhanced antisepsis.

This quality improvement project assessed the impact of these interventions on contamination rates, aiming to reduce false positives, improve diagnostic accuracy, and enhance patient care through better antimicrobial stewardship.

Methods

The study was conducted in a high-volume tertiary care ED with over 50,000 annual patient visits. The study design involved three eight-week phases: pre-intervention (Sep–Oct 2022), intervention (Sep–Oct 2023), and post-intervention (Dec 2023–Jan 2024).

To address the issue of blood culture contamination, a dedicated multidisciplinary team was formed. The team included nursing leaders, frontline nursing staff, clinical surveillance scientists, clinical microbiology, and emergency medicine physicians.

Based on the Centers for Disease Control and Prevention (CDC) definition, a blood culture set, consisting of one or two bottles obtained from a single blood sample, was considered contaminated if any of the following organisms were present: coagulase-negative staphylococci, alpha-hemolytic streptococci, *Micrococcus* species, *Propionibacterium* species, *Corynebacterium* species, or *Bacillus* species, provided these organisms were not present in multiple sets collected from the same patient on the same day and deemed not to be clinically significant by the clinical microbiology team.[2] The blood culture contamination rate was

calculated by dividing the total number of contaminated blood culture sets by the total number of sets collected during the evaluation period.

This was a quality improvement project, not experimental research, and adhered to institutional standards for patient safety and data security.

Data analysis was performed using IBM SPSS Statistics for Mac, version 29 (IBM Corp). Categorical variables were expressed as frequencies and percentages. The chi-square test was used to compare categorical variables. Statistical significance was defined as a p-value less than 0.05 for all analyses.

Throughout the study, each blood culture set consisted of an aliquot of venous blood, which was divided equally between two types of media: BacT FA aerobic and BacT FN anaerobic. Institutional guidelines recommend collection of 8–10 mL of blood per bottle (≈20 mL per set); however, actual volumes are not routinely measured or verified in the laboratory. After collection, the blood cultures were immediately transported to the clinical microbiology laboratory, where they were incubated for five days using the automated microbial detection system BacT/Alert (bioMérieux). This system detects the presence of microorganisms in the culture medium by monitoring changes in carbon dioxide levels, which occur as microorganisms metabolize nutrients in the media.

Bacterial species identification was performed using Matrix-Assisted Laser Desorption-Ionization Time of Flight Mass Spectrometry (MALDI-TOF MS, Bruker Daltonics), a rapid and accurate method for identifying organisms. Antibiotic susceptibility testing was conducted using the Vitek-2 instrument (bioMérieux), which determines the sensitivity of the isolated bacteria to various antibiotics, guiding the selection of appropriate antimicrobial therapy.

The pre-intervention phase served as the baseline period, during which retrospective data was collected to establish the blood culture contamination rate under the existing standard practices. During this period, 625 blood culture samples were collected and analyzed from the ED. Out of these, 115 samples were found to be contaminated, resulting in a blood culture contamination (BCC) rate of 18.4%. This high contamination rate highlighted the need for a systematic approach to improve blood culture collection practices in the ED.

During this phase, traditional blood culture collection techniques were used. These techniques involved the use of vacutainer blood collection tubes, separate vacutainer needles, and traditional alcohol skin wipes for skin antisepsis. There was no strict surveillance or monitoring of the blood collection process, and healthcare professionals (HCPs) involved in collecting blood cultures had not received specialized training or guidance on best practices for reducing contamination.

The intervention phase marked the introduction of the Kurin Lock device in conjunction with ChloraPrep. By isolating this initial portion, the Kurin Lock reduces the likelihood of contaminating the blood culture sample with skin flora, thereby improving the accuracy of the results.

Healthcare professionals received comprehensive training prior to the introduction of the Kurin Lock device, ensuring they were fully equipped with the necessary knowledge and skills for its effective use upon implementation. All pre-intervention venipuncture devices were removed from the ED to ensure that all blood cultures would be collected using the newly introduced device. Blood-culture collection was restricted to ED physicians and to emergency-department nurses as per preexisting institutional policy.

During the intervention phase, blood culture samples were prospectively collected and marked to track those sent directly from the ED to the clinical microbiology laboratory. Two types of Kurin Lock products were utilized: one with “butterfly” access and another with “direct to cannula” access. Both products were issued in sterile packaging and attached to a 1 mL ChloraPrep applicator for ease of skin antisepsis.

To ensure accurate data collection and adherence to the new protocol, a new labeling system was implemented. Each sterile Kurin Lock pack was labeled with the patient’s unique Medical Registration Number (MRN), the date and time of blood culture sample collection, the name or initials of the HCP taking the blood cultures, and checkboxes to indicate the use of ChloraPrep and the Kurin Lock device. This labeling system facilitated the tracking of samples and ensured that the microbiology department could monitor the use of the Kurin Lock device and ChloraPrep.

The contamination rates during the intervention phase were compared to those from the corresponding months in the preceding year using statistical analysis, specifically the chi-square test. This analysis was conducted to determine whether the introduction of the Kurin Lock device and ChloraPrep had a statistically significant impact on reducing blood culture contamination rates compared to the baseline period.

The post-intervention phase involved the withdrawal of the Kurin Lock devices and ChloraPrep applicators, allowing the blood culture collection process to revert to the pre-intervention methods. This phase was designed to assess whether contamination rates would return to baseline levels after the removal of the intervention. By monitoring contamination rates during this phase, the study aimed to evaluate the sustainability of the improvements observed during the intervention phase and determine the long-term impact of the Kurin Lock device on blood culture accuracy.

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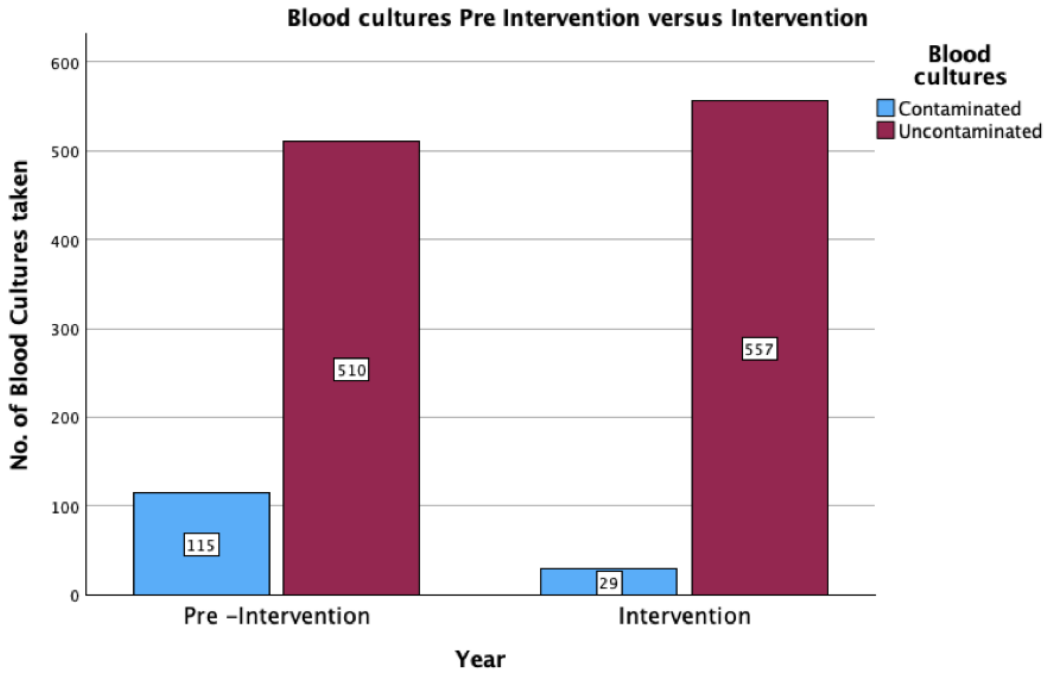
Results

The introduction of the Kurin Lock device and ChloraPrep led to a significant reduction in blood culture contamination rates, from 18.4% in the pre-intervention phase to 4.4% during the intervention phase ($p < 0.05$). (See *Table 1* and *Figure 1)* This reduction in contamination rates represented a nearly 75% improvement. The chi-square test confirmed the statistical significance of these findings, with a chi-square value of 52.30 and a p-value of <0.001.

Table 1: Blood Culture Contamination Rates Pre-Intervention versus Intervention

		No. of Blood Cultures Taken		
		Contaminated	**Uncontaminated**	**Total**
Period	**Pre-Intervention**	115	510	625
		18.4%	81.6%	100.0%
	Intervention	29	557	586
		4.9%	95.1%	100.0%



Notably, contamination rates returned to near-baseline levels during the post-intervention phase, with a contamination rate of 18.1%. (see Table 2).

Table 2. Post Intervention Blood Culture Contamination Rates

	Frequency	**Percent**
Contaminated	158	18.1
Uncontaminated	715	81.9
Total	873	100

Discussion

The significant reduction in blood culture contamination rates in this study has important implications for patient care, healthcare economics, and diagnostic quality. Accurate blood cultures guide effective antimicrobial therapy, crucial for treating systemic infections and preventing AMR. Contaminated cultures can lead to false-positive results, unnecessary treatments, and delayed identification of true pathogens. By reducing contamination, the Kurin Lock device and ChloraPrep enhance diagnostic accuracy, enabling better-informed clinical decisions.

Although the study did not achieve the CLSI benchmark of a 3% contamination rate, the observed improvement was statistically significant. The inability to reach the 3% benchmark may be attributed to several factors, including the busy and high-stress environment of the ED, variations in healthcare professionals' adherence to the new protocol, and the potential for human error during the blood culture collection process. Further training and education for healthcare professionals, along with continuous monitoring and feedback, may help to achieve even lower contamination rates in future studies.

This study's primary limitation is its single-site design in a high-volume tertiary ED, which may limit the generalizability of findings to other settings, such as smaller or resource-constrained hospitals. While the study demonstrates significant contamination rate reductions, achieving the CLSI benchmark of <3% remains a challenge, suggesting further refinements to protocols and additional support for healthcare staff may be necessary.

Blood specimen diversion systems, such as the Kurin Lock device, effectively reduce contamination by diverting the initial blood sample likely to contain skin contaminants, a method well-supported in the literature.[3-8] A recent review further highlights their role in improving diagnostic precision.[9] In April 2024 the National Institute for Health and Care Excellence (NICE) issued Medical Technologies Guidance 77, which recommends blood-diversion systems such as Kurin Lock for EDs with contamination rates > 2.4 %, providing a strong policy mandate for their use.[10]

Standardized practices for skin antisepsis remain lacking in the UK and Ireland, contributing to variability in contamination rates. Although studies on ChloraPrep show mixed results, its use often correlates with reduced contamination.[11-14] Optimizing and standardizing skin antisepsis protocols could further lower contamination rates and improve diagnostic outcomes.

While the Kurin Lock device costs approximately €20 per unit and ChloraPrep €0.4 per unit, these costs are likely offset by savings from fewer false positives, shorter stays, and reduced antimicrobial misuse.[15-16] Contaminated blood cultures increase healthcare costs through unnecessary tests, inappropriate treatments, and prolonged hospital stays. In one Northern Ireland hospital, Alahmadi et al. reported 254 false-positive cultures leading to 1,372 additional hospital days and excess costs of £1.27 million in one year.[17]

Education and adherence to aseptic techniques are critical for maintaining low contamination rates. Variability in training and compliance can affect outcomes, emphasizing the need for ongoing education and protocol reinforcement. Future research should evaluate the Kurin Lock device in varied healthcare settings, including ICUs, oncology wards, and outpatient clinics, where blood cultures are frequently collected. Long-term studies are needed to assess the sustainability of reduced contamination rates and the impact of integrating these devices into routine practice.

This study demonstrates the clinical and economic benefits of reducing blood culture contamination rates using the Kurin Lock device and ChloraPrep. These innovations improve diagnostic accuracy, enhance patient outcomes, and reduce healthcare costs. As healthcare systems face challenges like antimicrobial resistance and rising costs, interventions that improve precision and minimize unnecessary treatments are invaluable.

This project represents the first evaluation of the combined use of the Kurin Lock device and ChloraPrep in reducing blood culture contamination in a tertiary ED, and the first use of the Kurin device in an Irish hospital. Future research should explore cost-effectiveness, the

device's impact in varied settings, and the sustainability of these improvements to support wider adoption and maximize benefit.

Declarations of Conflicts of Interest:
The blood diversion devices used in this study were provided free of charge by Iskus Health. The company had no involvement in the study design, data collection, analysis, interpretation, or preparation of the manuscript.

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Figure Legend:

Figure 1.

This bar graph compares the number of blood cultures taken and their contamination status before and after an intervention aimed at reducing the contamination rates. The x-axis represents two time periods: Pre-Intervention and Intervention, while the y-axis shows the

total number of blood cultures obtained. The bars weare color-coded to differentiate between the contaminated (blue) and uncontaminated (maroon) cultures. Pre-iIntervention, 115 out of 510 cultures were contaminated, whereas during the iIntervention phase, only 29 out of 557 cultures were contaminated. This demonstrates a significant reduction in contamination rates post-intervention.

Table 1. Blood Culture Contamination Rates Pre-Intervention versus Intervention

This table compares the blood culture contamination rates during the pre-intervention and intervention phases. The data includes the number of blood cultures taken, the number of contaminated and uncontaminated samples, and the corresponding percentages. A significant reduction in contamination rates is observed during the intervention period.

Table 2. Post-Intervention Blood Culture Contamination Rates

This table presents the blood culture contamination rates during the post-intervention phase. It includes the frequency and percentage of contaminated and uncontaminated blood cultures, highlighting a return to pre-intervention contamination levels.