Diagnostic Stewardship's
Significant Impact On

Hospital-Onset Bacteremia & Fungemia (HOB) Rates and Patient Quality Outcomes

Learning Objectives

Identify the driving factors for the HOB measure development and planned implementation

Recognize the importance of diagnostic stewardship related to the root causes and preventability of HOB

Explain the impact of poor diagnostic stewardship and blood culture contamination as one of the major causes of (false-positive) HOB

Differentiate between skin common commensal and pathogenic organisms with blood culture contamination

Estimate the clinical and economic impact that diagnostic error with blood culture contamination may have on the patient,
the hospital and public health

The Six Pillars of Healthcare Quality

Safety

- First do no harm
- Do not add to the burden of healthcare

Effectiveness

- Match science to care; avoid use of what is not helpful and ensure use of what is helpful
- Evidence-based care

Patient-Centeredness

- People should be in control of their own care

Timeliness

- Avoid delays; misdiagnoses
- Communicate accurate and timely diagnoses to patients

Efficiency

- Avoid waste

Equity

- Close the gap of inequitable care
- The biggest predicter of life expectancy is race and geographic location

Institute of Medicine (IOM). Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, D.C: National Academy Press; 2001.

At the 2022 SHEA Spring Conference HOB was introduced.

The target launch date was **Spring 2023**

HOB

(Hospital-Onset Bacteremia/Fungemia or Blood Stream Infection)

Purpose:

Surveillance for broader reduction of BSI regardless of organism (eg. MRSA) or association with Device (eg. CLABSI)

Definitions:

HOB Blood culture collected on day 4 or later with pathogenic bacteria or fungi

Timeline:

Voluntary reporting now

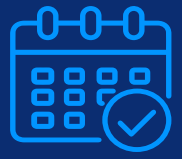
HOB

(Hospital Onset Blood Stream Infection)

Serious:

24% patient mortality compared to patients without HOB (negative cultures)

- ELOS: 27 vs. 13 days
- Higher cost $44k vs $26k



Common:

Up to 77,000-115,000 annual US events (0.23%-0.34% of admissions)

Preventability:

Multiple studies now available

CMS' Continued Focus on Decreasing HAIs and Increased Utilization of EHRs

Perspectives

The Patient Perspective: Healthcare should not make me sicker. I should not acquire a BSI after I come into the hospital whether or not it is related to a specific organism (MRSA) or a CVC. The only BSIs that are tracked now

CMS Perspective: Objective determination of BSI with minimal data collection burden

Casts a broader net (beyond CLABSI and MRSA BSI) to address patient safety outcomes in hospitals

Increases awareness and promotes EBP to encourage hospitals to track and improve upon their practices and outcomes

CMS MUC;

Measures Under Consideration 2021

This is meant to track new bacteremia/fungemia in in-patients on day 4 and beyond

This is meant to track many HAI BSI not currently under surveillance by CDC and NHSN - we only track CLABSI and MRSA now

This is expected to have minimum collection burden for hospitals- they are already tracking MRSA and CLABSI. They may have one bucket; BSI or break this down into MRSA, CLABSI and HOB

CMS Goal

FHIR: Fast Healthcare Interoperability Reporting

Making the Connection

The National Healthcare Safety Network's (NHSN) effort to modernize hospital surveillance through Digital Quality Measure (dQMs) using Fast Healthcare Interoperability Reporting (FHIR) will transform hospital reporting. FHIR will utilize NHSNLink to exchange hospital data between facilities and NHSN.

The Goal: To move to fully digital quality measurement in their quality reporting and VBP programs including the HAC Reduction Program.

A Call for Action and Research of Acceptability:

SHEA members (Researchers) were surveyed, and the results were:

HOB is thought of as largely preventable

HOB reflects quality of care

HOB is potentially acceptable as a publicly reported quality metric.

How Hospitals Will Calculate HOB

Numerator and Denominator

- **N** Bacteremia or Fungemia from blood culture after day 3 or later (on day 4 it is a HOB)
- **N** Must not be a common commensal organism
- **N** May also be identified by genus and species by non-culture based microbiologic testing

- **D** Expected number of HOB events based on predictive models and location data as predictors (like CLABSI SIR)

Complementary Metrics

- Blood Culture
- Blood Culture Contamination
- Community –onset HOB
- Matching Commensal HOB
- Non-measure HOB

NHSN HOB: Surveillance Metrics

Measure	Numerator	Denominator
Primary Metric: HOB Event		
HOB Event	Pathogenic bacteria or fungi from blood culture on hospital day ≥4 (excluding patients with prior matching cultures and HOB events)	Total no. of inpatient admissions
Complementary Metrics: For Quality Improvement, NHSN Risk Adjustment		
Blood Culture Utilization	Testing Prevalence: Admissions with at least 1 blood culture Testing Intensity: Total blood culture patients with at least 1 blood culture	
Blood Culture Contamination	Skin commensal organism in 1 of 2 blood cultures sets	Total no. of blood culture sets
Community-Onset Bacteremia & Fungemia Event	Pathogenic bacteria or fungi from blood culture prior to hospital day 4 (excluding patents with prior cultures and COB events)	Total no. of inpatient admissions
Matching Commensal HOB Event	Skin commensal from ≥2 blood cultures AND ≥4 days of antibiotic treatment	Total no. of inpatient admissions
Non-Measure HOB Event	HOB events among patients with conditions that highly predict non-preventability	Total no. of inpatient admissions

Study Review

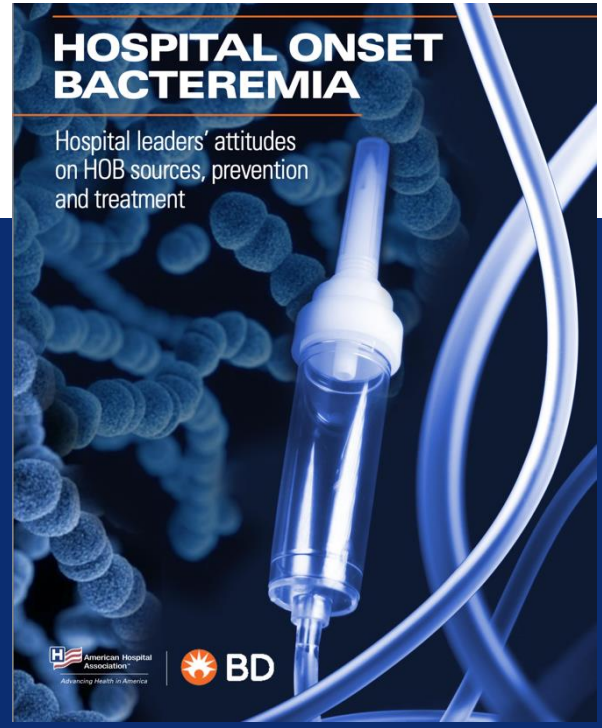
Incidence of HOB is at least double that of CLABSI

Acute care units have the highest percentage of HOB

34% of HOBs did NOT meet criteria due to a positive blood culture taken on admission. THIS IS NOT IN CONFLICT WITH THE SEP ONE TO TAKE BLOOD CULTURES ON PRESENTATION

48% of HOBs occur in the presence of peripheral lines only. Our PIV practice must be evidence-based. Follow INS Practice Guidelines.

Preventability BMJ 3.2024




ORIGINAL RESEARCH

OPEN ACCESS

Evaluation of hospital-onset bacteraemia and fungaemia in the USA as a potential healthcare quality measure: a cross-sectional study

Surbhi Leekha,[1] Gwen L Robinson,[1] Jesse T Jacob,[2] Scott Fridkin,[2] Andi Shane,[3] Anna Sick-Samuels,[4] Aaron M Milstone,[4] Rajeshwari Nair,[5] Eli Perencevich,[5] Mireia Puig-Asensio,[5] Takaaki Kobayashi,[5] Jeanmarie Mayer,[6] Julia Lewis,[6] Susan Bleasdale,[7] Eric Wenzler,[7] Alfredo J Mena Lora,[7] Jonathan Baghdadi,[1] Gregory M Schrank,[1] Eli Wilber,[2] Amalia A Aldredge,[2] Joseph Sharp,[2] Kelly E Dyer,[2] Lea Kendrick,[8] Viraj Ambalam,[4] Scott Borgetti,[7] Anna Carmack,[1] Alexis Gushiken,[1] Ashka Patel,[1] Sujan Reddy,[9] Clayton H Brown,[1] Raymund B Dantes,[2,9] Anthony D Harris,[1] On behalf of the CDC Prevention Epicenters Program

ABSTRACT

Background Hospital-onset bacteraemia and fungaemia (HOB) is being explored as a surveillance and quality metric. The objectives of the current study were to determine sources and preventability of HOB in hospitalised patients in the USA and to identify factors associated with perceived preventability.

Methods We conducted a cross-sectional study of HOB events at 10 academic and three community hospitals using structured chart review. HOB was defined as a blood culture on or after hospital day 4 with growth of one or more bacterial or fungal organisms. HOB events were stratified by commensal and non-commensal organisms. Medical resident physicians, infectious disease fellows or infection preventionists reviewed charts to determine HOB source, and infectious disease physicians with training in infection prevention/hospital epidemiology rated preventability from 1 to 6 (1=definitely preventable to 6=definitely not preventable) using a structured guide. Ratings of 1–3 were collectively considered 'potentially preventable' and 4–6 'potentially not preventable'.

Results Among 1789 HOB events with non-commensal organisms, gastrointestinal (including neutropenic translocation) (35%) and endovascular (32%) were the most common sources. Overall, 636/1789 (36%) non-commensal and 238/320 (74%) commensal HOB events were rated potentially preventable. In logistic regression analysis among non-commensal HOB events, events attributed to intravascular catheter-related infection, indwelling urinary catheter-related infection and surgical site infection had higher odds of being rated preventable while events with neutropenia, immunosuppression, gastrointestinal sources, polymicrobial cultures and previous positive blood culture in the same admission had lower odds of being rated preventable, compared with events without those attributes. Of 636 potentially preventable non-commensal HOB events, 47% were endovascular in origin, followed by gastrointestinal, respiratory and urinary sources; approximately 40% of those events would not be captured through existing healthcare-associated infection surveillance.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Hospital-onset bacteraemia and fungaemia (HOB) represents clinically significant events that can be measured using objective, electronically captured data, but our knowledge on the sources and preventability of HOB to inform its development as a surveillance and quality metric is limited.

WHAT THIS STUDY ADDS

⇒ The perceived preventability of HOB events caused by non-commensal (pathogenic) organisms is similar to or higher than other accepted measures of healthcare quality. A notable proportion of potentially preventable HOB events were associated with sources that would not be currently included in routine healthcare-associated infection surveillance at most US hospitals.

BMJ Qual Saf: first published as 10.1136/bmjqs-2023-016831 on 23 May 2024. Downloaded from http://qualitysafety.bmj.com/ on June 25, 2024 by guest. Protected by copyright.

"In a pilot study of HOB cases at three US academic hospitals, 49% of 43 HOB cases with a non-skin commensal organism were considered potentially preventable."

Most HOB cases were viewed as preventable or partially preventable, especially those from Central Line or urinary sources[1]

The BMJ article agrees: "..among non-commensal HOB events, events attributed to intravascular catheter-related infection, indwelling urinary catheter-related infection and surgical site infection had higher odds of being rated preventable."

1. HOB; hospital leaders' attitudes on HOB sources, prevention and treatment BD/AHA Executive Summary

Preventability BMJ 3.2024

Did not use NHSN definitions for higher generalizability

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► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/bmjqs-2023-016831).

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Higher odds of preventability:

- Intravascular catheter-related infection
- Indwelling urinary catheter–related infection
- Surgical site infection

Lower odds of preventability:

- Neutropenia
- Immunosuppression
- GI sources
- Polymicrobial cultures
- Previous positive BC in the same admission

"Of 636 potentially preventable non-commensal HOB events, 47% were endovascular in origin, followed by gastrointestinal, respiratory and urinary sources; approximately 40% of those events would not be captured through existing healthcare-associated infection surveillance."

Preventability

AJIC 2024

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Major Article

Etiology and utility of hospital-onset bacteremia as a safety metric for targeted harm reduction

Matthew A. Stack MD [a,*], Lana Dbeibo MD [a], William Fadel PhD [a], Kristen Kelley RN, CIC [b], Joshua Sadowski [b], Cole Beeler MD [a]

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Key Words:
Hospital-acquired infections (HAIs)
CLABSIs
Bloodstream infections (BSIs)
Quality improvement
Hospital reimbursement
National Health Care Safety Network (NHSN)

Background: Hospital acquired infections (HAIs) are a major driver of morbidity and cost in health systems. Central line–associated bloodstream infections (CLABSIs) require intensive surveillance and review. All-cause hospital-onset bacteremia (HOB) may be a simpler reporting metric, correlates with CLABSI, and is viewed positively by HAI experts. Despite the ease in the collection, the proportion of HOBs that are actionable and preventable is unknown. Moreover, quality improvement strategies targeting it may be more challenging. In this study, we describe the bedside provider-perceived sources of HOB in order to provide insight into this new metric as a target for HAI prevention.

Methods: All cases of HOBs in 2019 from an academic tertiary care hospital were retrospectively reviewed. Information was collected to assess provider-perceived etiology and associated clinical factors (microbiology, severity, mortality, and management). HOB was categorized as preventable or not preventable based on the perceived source from the care team and management decisions. Preventable causes included device-associated bacteremias, pneumonias, surgical complications, and contaminated blood cultures.

Results: Of the 392 instances of HOB, 56.0% (n = 220) had episodes that were determined not preventable by providers. Excluding blood culture contaminates, the most common cause of preventable HOB was secondary to CLABSIs (9.9%, n = 39). Of the HOBs that were not preventable, the most common sources were gastrointestinal and abdominal (n = 62), neutropenic translocation (n = 37), and endocarditis (n = 23). Patients with HOB were generally medically complex with an average Charlson comorbidity index of 4.97. This translated into a higher average length of stay (29.23 vs 7.56, $P < .001$) and higher inpatient mortality (odds ratio 8.3, confidence interval [6.32-10.77]) when compared to admissions without HOB.

Conclusions: The majority of HOBs were not preventable and the HOB metric may be a marker of a sicker patient population making it a less actionable target for quality improvement. Standardization across the patient mix is important if the metric becomes linked to reimbursement. If the HOB metric were to be used in lieu of CLABSI, large tertiary care health systems that house sicker patients may be unfairly financially penalized for caring for more medically complex patients.

The number one cause of preventable HOB is blood culture contamination:

"Preventable causes included device-associated bacteremias, pneumonias, surgical complications, and contaminated blood cultures."

"**Excluding blood culture contaminates (14%)**, the most common cause of preventable HOB was secondary to CLABSIs."

Preventable HOB cause	N (%)
Contaminant	**55 (14.0%)**
Central venous catheter (CVC)	**39 (9.9%)**
Surgical Intervention (Surg)	**26 (6.6%)**
HAP/VAP	**16 (4.1%)**
PIV catheter-related infection (PIV)	**13 (3.3%)**
Miscellaneous*	**9 (2.3%)**
CAUTI	**7 (1.8%)**
No source defined	**4 (1.0%)**

HOB: A Gateway for Sepsis

(

Surgical Patients:

Over 15% of admissions with HOB were related to surgery (13-28%)

Preoperative Care

- **Patient Cleansing:** Shower/bathe with soap (antimicrobial or regular) the night before and/or morning of surgery.
- **Skin Prep:** Use chlorhexidine-alcohol for skin antisepsis.
- **Hair Removal:** Use electric clippers if hair removal is necessary; avoid razors.
- **Antibiotics:** Administer prophylactic antibiotics within one hour before incision; stop within 24 hours post-op (48 for cardiac).
- **Glycemic Control:** Target blood glucose below 200 mg/dL (or <150 mg/dL for general surgery).
- **Normothermia:** Maintain body temperature (e.g., using warmed fluids/air).

Infection Control Hospital Epidemiology 2025 Feb 26;46(5):472–480. doi: 10.1017/ice.2025.29

HOB: A Gateway for Sepsis

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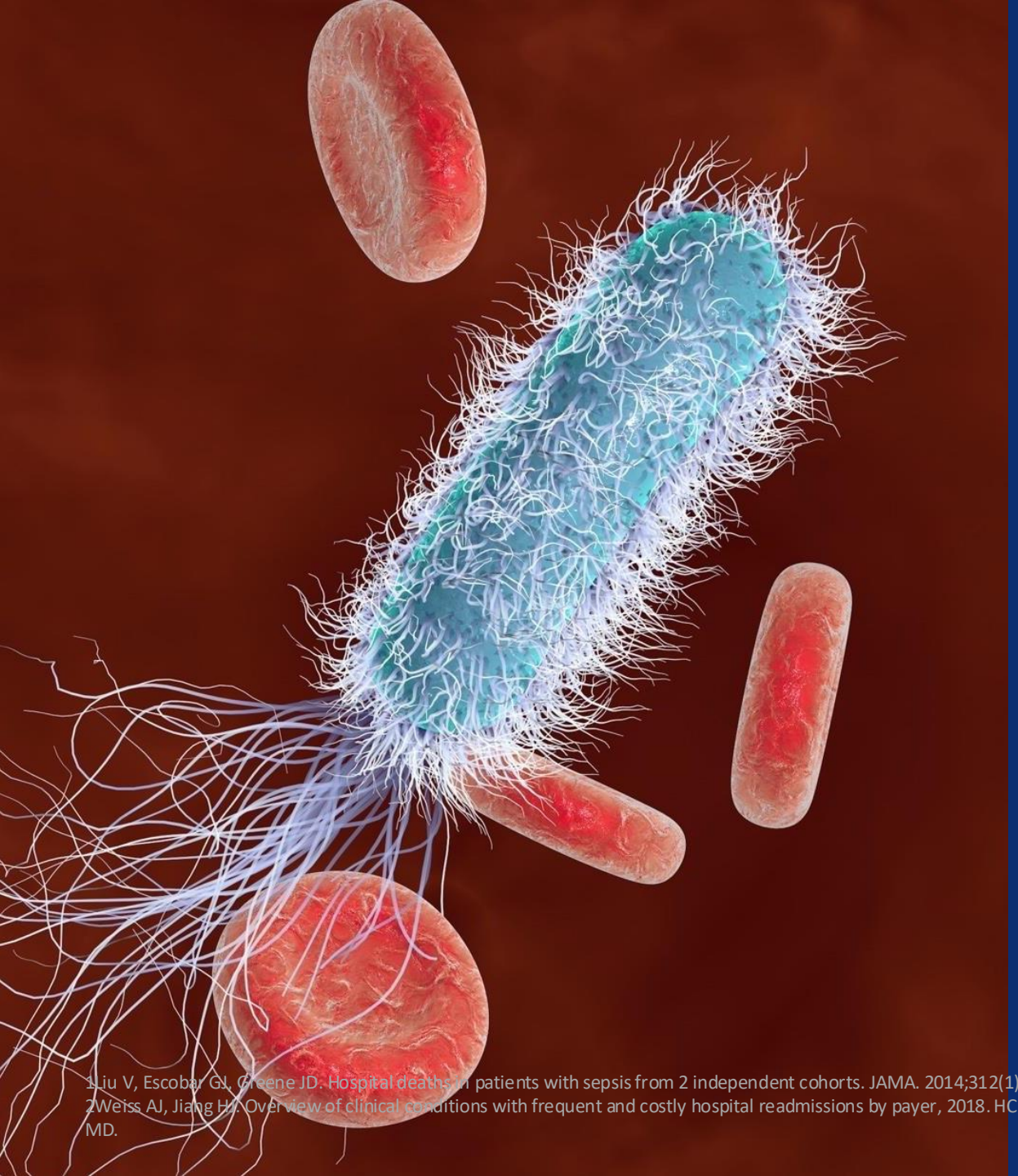
Surgical Patients:

Intraoperative & Postoperative Care

- **Sterile Technique:** Strict adherence to sterile practices (gloves, drapes).
- **Wound Management:** Keep wound clean, manage drainage, use appropriate sterile dressings. Avoid skin cleansers like alcohol or peroxide directly on the wound.
- **Mobilization:** Encourage early movement to improve circulation.
- **Nutrition/Hydration:** Ensure adequate protein, vitamins, fluids, and oxygenation.
- **Patient Education:** Teach patients to recognize infection signs (redness, swelling, pain, discharge) and manage lifestyle factors like smoking.

Infection Control Hospital Epidemiology 2025 Feb 26;46(5):472–480. doi: 10.1017/ice.2025.29



Sepsis is the **#1 cause of death**, readmissions, and costs in U.S. hospitals[1,2]

… and blood cultures remain the gold standard for diagnosing bacteremia/fungemia which may lead to sepsis

1.Liu V, Escobar GJ, Greene JD. Hospital deaths in patients with sepsis from 2 independent cohorts. JAMA. 2014;312(1):90 -92. doi:10.1001/jama.2014.5804.
2Weiss AJ, Jiang HJ. Overview of clinical conditions with frequent and costly hospital readmissions by payer, 2018. HCUP Statistical Brief #278. July 2021. Agency for Healthcare Research and Quality, Rockville, MD.

Sepsis; A New Definition: “A life threatening organ dysfunction caused by a dysregulated host immune response to infection”: *AND detailed report on its cause is fundamental*[3]

- Effects 1.7 million in the US annually
- 350,000 US Adult Patients Deaths
- 11 million deaths worldwide = 20% of all deaths(2017)
- AHRQ: US cost: $20 billion as of 2011 increasing to $62 billion with inpatient and SNF care of sepsis patients in 2019
- 50% of survivors experiencing post-sepsis syndrome and other lingering effects, including amputations
- Readmissions are 3 times more likely and 3 times more costly

National Institute of General Medical Sciences Sepsis

HHS Study: Journal of Critical Care Medicine, 2019

Nature, Scientific Report 2021

Sepsis Alliance

HOB: A Gateway for Sepsis

Sepsis Incidence within HOB Cases

While not every case of bacteremia automatically becomes full-blown sepsis, the rates of organ dysfunction (sepsis) and mortality in HOB cases are high:

- **Proportion of severe cases**: In some studies, nearly half (48.7%) of all hospital-acquired (HA) sepsis cases with organ dysfunction originated as HOB.
- **Mortality rates**: Sepsis resulting from HOB is associated with high mortality, with in-hospital death rates around 33-35% (compared to approximately 17-25% for community-onset sepsis).
- **ICU cases**: Among hospital-onset sepsis patients, a large proportion (over 60% in one study) require ICU admission.

Context of Hospital-Onset Sepsis

Hospital-onset (HO) sepsis accounts for a substantial portion of all sepsis cases treated in hospitals:

- Overall cases: HO-sepsis accounts for approximately 12% to 23.6% of all sepsis cases within a hospital setting.
- Incidence: HO-sepsis complicates about 1 in every 200 hospitalizations.

Infection Control Hospital Epidemiology 2025 Feb 26;46(5):472–480. doi: 10.1017/ice.2025.29

Five Factors Improving the Delivery of Recommended Sepsis Practices

- Healthcare knowledge of recommended practices
- Healthcare understanding of the risks and benefits of treatments
- Healthcare team strong collaboration
- Healthcare staff being empowered and supported
- Adequate staffing

Improving Outcomes

Recognize sepsis early

Implement evidence-based management of sepsis

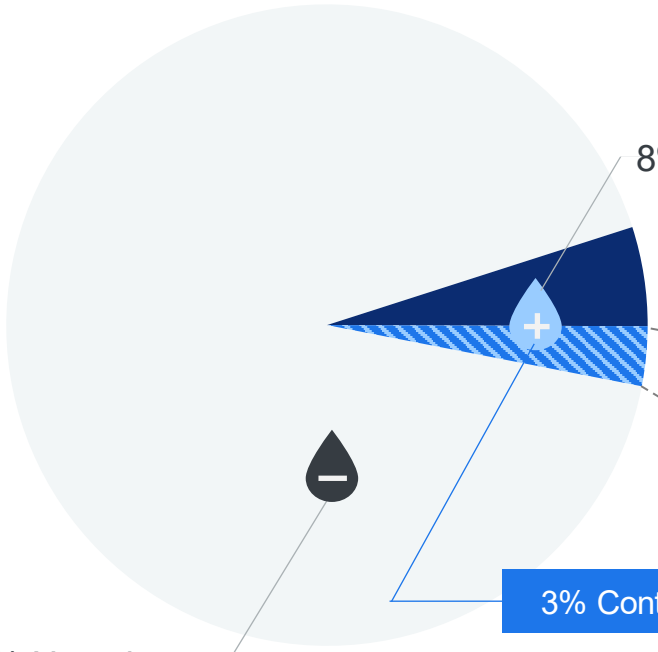
Support the recovery of patients after sepsis

Monitor the impact of hospital-based interventions to improve care and outcomes

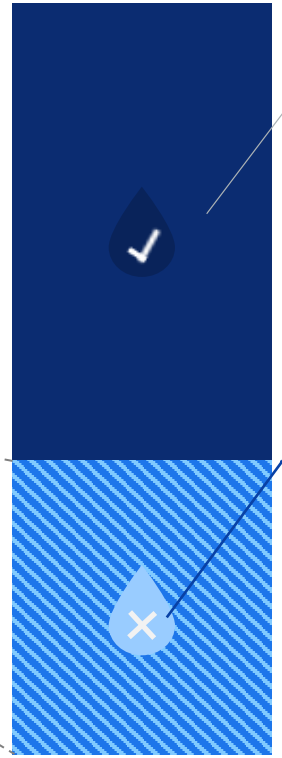
CDC Hospital Sepsis Program Core Elements 2023

Test Results for Sepsis are Frequently Wrong, which can lead to Misdiagnosis and Probable Mistreatment

ALL BLOOD CULTURES



POSITIVE BLOOD CULTURES



Nearly half of all positive blood cultures **are actually *false* positive**

False positives are a **preventable error** and can lead to a misdiagnosis of sepsis

1. Zwang O, Albert RK. Analysis of strategies to improve cost effectiveness of blood cultures. J Hosp Med. 2006;1(5):272-6. doi:10.1002/jhm.115.

CDC Representative referred to Blood Culture Contamination as a “Patient Safety” Eve0nt

“Blood culture contamination is considered to be a patient safety event. So, we need to think about what you would do if there was a patient fall, which is also a patient safety event.”

Bunn, JD. Diagnostic Excellence: A New Quality Tool to Prevent Blood Culture Contamination [PowerPoint Presentation]. Presented December 13, 2023. https://reach.cdc.gov/event/diagnostic-excellence-new-quality-tool-prevent-blood-culture-contamination

Journal of Applied Laboratory Medicine;

Bunn and Cornish, Blood Culture Contamination and Diagnostic Stewardship January 2025

Given that diagnostic stewardship (DS) is an approach to reduce diagnostic errors, it is integral to antibiotic stewardship. DS can also be incorporated with antibiotic stewardship efforts to ensure the proper test is performed for the right patient at the right time (28). DS aims not just to ensure the correct test is done but also to ensure the right test is done correctly. Hospitals and healthcare

SPECIAL REPORT

Blood Culture Contamination and Diagnostic Stewardship: From a Clinical Laboratory Quality Monitor to a National Patient Safety Measure

Jake D. Bunn [a,*] **and Nancy E. Cornish**[a]

Laboratory analysis of blood cultures is vital to the accurate and timely diagnosis of bloodstream infections. However, the reliability of the test depends on clinical compliance with standard operating procedures that limit the risk of inconclusive or incorrect results. False-negative blood culture results due to inadequate volumes of blood can result in misdiagnosis, delay therapy, and increase patients' risk of developing or dying from bloodstream infections. Likewise, commonly occurring bacteria or fungi on human skin (i.e., commensal organisms) can contaminate the blood culture during collection and increase the risk of false positives, compromising care and leading to unnecessary antibiotic therapy and prolonged hospitalization.

In December 2022, a Centers for Medicare & Medicaid Services (CMS) consensus-based entity (CBE) endorsed the Centers for Disease Control and Prevention's (CDC) proposal for a new patient safety measure to address these concerns. CDC developed this quality measure to promote the standardization of blood culture best practices and improve laboratory diagnosis of bloodstream infections nationally. This special report will emphasize the importance of standardizing blood culture collection and describe the need for a national patient safety measure, new quality tools, and next steps.

INTRODUCTION

Blood cultures are the gold standard of bloodstream infection diagnosis and are based on the detection of viable microorganisms present in blood. The process begins when a blood culture test request is entered by the clinical care team. The clinical or laboratory staff then draw blood from the patient and inoculate the blood into blood culture bottles. These bottles are then incubated for a predetermined period, usually 5 days. If a viable microorganism is present in the bottles, the laboratory will detect it and will use gram stain to perform initial organism identification.

A positive gram stain from a blood culture is considered a panic or alert value also known as a critical value (1). Panic values are test results that a laboratory must immediately alert to the individual or entity requesting the test when any test result indicates an imminently life-threatening condition. Timely reporting of panic values is required by the Clinical Laboratory Improvement Amendments of 1988 (CLIA) (2). Once the clinical care team notification is complete and

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*Address correspondence to this author at: Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, NE, MS V24-3, Atlanta, GA 30329-4027, United States. E-mail qxh1@cdc.gov.
Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of Centers for Disease Control and Prevention.
Received June 07, 2024; accepted October 07, 2024.
https://doi.org/10.1093/jalm/jfae132
Published by Oxford University Press on behalf of Association for Diagnostics & Laboratory Medicine 2025.

CDC and CMS Action Plan

CBE ID 3658
Title Adult Blood Culture Contamination Rate; A national measure and standard for clinical laboratories and antibiotic stewardship programs
Endorsement Status Endorsed

2026

Review blood culture contamination and volume literature and update measure as needed Once 3% contamination rate benchmark has been in place for 3 years ask for evidence that institutions are putting interventions into place to reduce contamination rates in collaboration with their antibiotic stewardship program.

Interventions such as education and training programs, use of initial specimen diversion devices, adjusting skin disinfectants used prior to phlebotomy, or other interventions described in the following CMR article Table 2.

Begin collecting blood culture contamination rate data for patients ≤18 years of age.

2026 – 2029

Review blood culture contamination and volume literature and update measure as needed. **Collect contaminated blood culture and single set blood culture data with intervention implemented**.

Introduce blood volume as a required measure with at least 40 to 60 mL collected per septic episode (per 24-hour period) as the goal

2029

Review blood culture contamination and volume literature and update measure as needed **Complete actions to make this measure required by CMS for hospitals to measure and report blood culture contamination rate and volume for all blood cultures collected, and act on the results to improve quality by reducing the contamination rate and optimizing the volume collected.**

Doern GV, et al Practical Guidance for Clinical Microbiology Laboratories: A Comprehensive Update on the Problem of Blood Culture Contamination and a Discussion of Methods for Addressing the Problem. Clin Microbiol Rev. 2019 Oct 30;33(1):e00009-19. doi: 10.1128/CMR.00009-19. PMID: 31666280; PMCID: PMC6822992.

BMJ

Conclusion

An estimated **795,000** Americans become permanently disabled or die annually across care settings **because dangerous diseases are misdiagnosed**.

Just 15 diseases account for about half of all serious harms, so the problem may be more tractable than previously imagined

ORIGINAL RESEARCH

Burden of serious harms from diagnostic error in the USA

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ABSTRACT

Background Diagnostic errors cause substantial preventable harms worldwide, but rigorous estimates for total burden are lacking. We previously estimated diagnostic error and serious harm rates for key dangerous diseases in major disease categories and validated plausible ranges using clinical experts.

Objective We sought to estimate the annual US burden of serious misdiagnosis-related harms (permanent morbidity, mortality) by combining prior results with rigorous estimates of disease incidence.

Methods Cross-sectional analysis of US-based nationally representative observational data. We estimated annual incident vascular events and infections from 21.5 million (M) sampled US hospital discharges (2012–2014). Annual new cancers were taken from US-based registries (2014). Years were selected for coding consistency with prior literature. Disease-specific incidences for 15 major vascular events, infections and cancers ('Big Three' categories) were multiplied by literature-based rates to derive diagnostic errors and serious harms. We calculated uncertainty estimates using Monte Carlo simulations. Validity checks included sensitivity analyses and comparison with prior published estimates.

Results Annual US incidence was 6.0 M vascular events, 6.2 M infections and 1.5 M cancers. Per 'Big Three' dangerous disease case, weighted mean error and serious harm rates were 11.1% and 4.4%, respectively. Extrapolating to all diseases (including non-'Big Three' dangerous disease categories), we estimated total serious harms annually in the USA to be 795 000 (plausible range 598 000–1 023 000). Sensitivity analyses using more conservative assumptions estimated 549 000 serious harms. Results were compatible with setting-specific serious harm estimates from inpatient, emergency department and ambulatory care. The 15 dangerous diseases accounted for 50.7% of total serious harms and the top 5 (stroke, sepsis, pneumonia, venous thromboembolism and lung cancer) accounted for 38.7%.

Conclusion An estimated 795 000 Americans become permanently disabled or die annually across care settings because dangerous diseases are misdiagnosed. Just 15 diseases account for about half of all serious harms, so the problem may be more tractable than previously imagined.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Diagnostic errors are known to be common, costly and often catastrophic in their health outcomes for patients.
⇒ Nevertheless, current estimates of the aggregate burden of serious harms resulting from medical misdiagnosis vary widely.

WHAT THIS STUDY ADDS

⇒ This study provides the first national estimate of permanent morbidity and mortality resulting from diagnostic errors across all clinical settings, including both hospital-based and clinic-based care (0.6–1.0 million each year in the USA alone).
⇒ It does so via an approach that extrapolates from disease-based estimates for the most common dangerous conditions that often cause serious harms when missed—vascular events, infections and cancers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Because the overall burden of serious misdiagnosis-related harms is quite large, improving diagnosis of dangerous diseases most often responsible—stroke, sepsis, pneumonia, venous thromboembolism and lung cancer—constitutes an urgent public health imperative.

Linked

► http://dx.doi.org/10.1136/bmjqs-2023-016496

Check for updates

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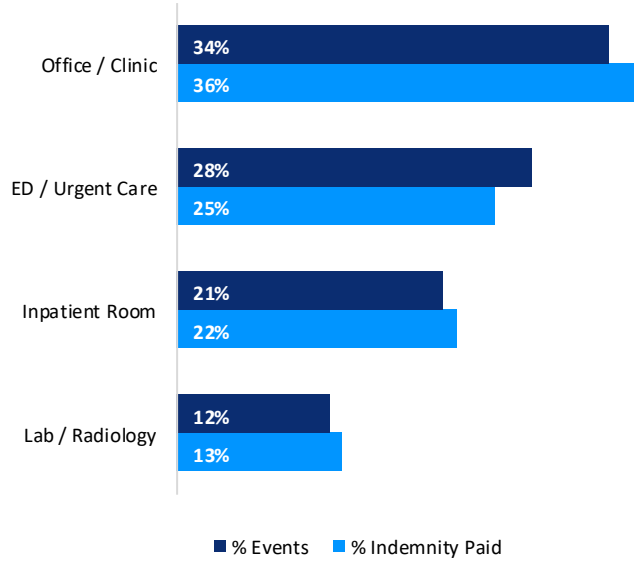
INTRODUCTION

Diagnostic error is a major source of preventable harms worldwide across clinical settings,[1–6] but epidemiologically valid estimates of overall misdiagnosis-related morbidity and mortality are lacking. The US National Academy of Medicine describes improving diagnosis in healthcare as a 'moral, professional, and public health imperative'.[7] In its 2015 report, the National Academy concluded that 'most people will experience at least

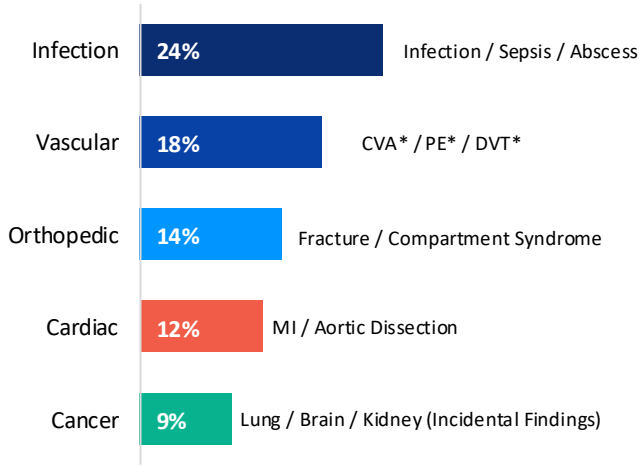
Location, Top Categories and Average Indemnity Paid for Diagnostic Error

TOP LOCATIONS FOR DIAGNOSTIC-RELATED EVENTS



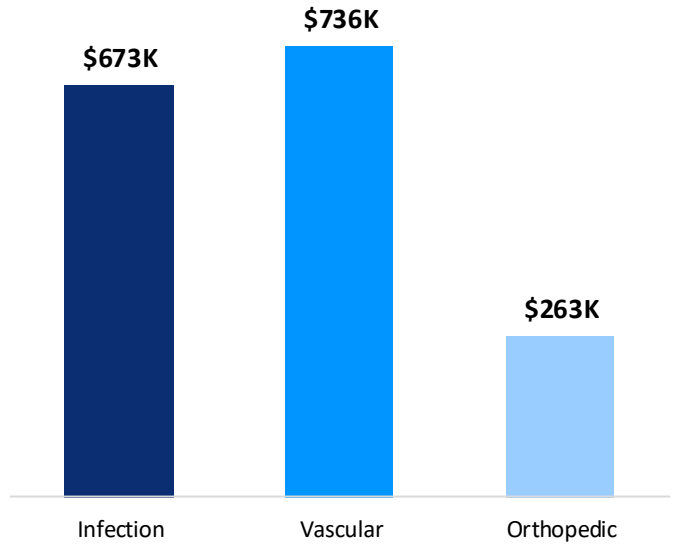
N=1,610 diagnostic-related events closed 2019-2023

TOP MISSED DIAGNOSTIC CATEGORIES IN THE ED



N=40 missed diagnoses in ED events closed 2019-2023.
An event can have more than one final diagnosis.
*Cerebral Vascular Accident (CVA), Pulmonary Edema (PE), Deep Vein Thrombosis (DVT)

AVERAGE INDEMNITY PAID FOR TOP 3 DIAGNOSTIC CATEGORIES



N=89 missed diagnosis events in the ED closed 2019-2023 with an indemnity payment

Why Can’t We Get Blood Cultures Right?

The Purpose of Blood Cultures

Confirm

the presence of microorganisms in the bloodstream

Identify

the microbial etiology of the bloodstream infection

Help

determine the source of infection (e.g., endocarditis)

Provide

an organism for susceptibility testing and optimization of antimicrobial therapy

Blood Culture Definitions

01 Blood culture contamination (BCC) is defined as the recovery of **normal skin flora (common commensal)** from a **single blood culture. More than one set should be obtained**

02 Culture is defined as a specimen of blood that is submitted for bacterial or fungal culture. **This is irrespective of the number of bottles or tubes into which THE specimen is divided.**

03 A BCC rate represents **common commensal organism occurrence in one set of blood cultures**

04 **Blood Culture Set:** the combination of blood culture bottles or tubes **into which a single blood specimen is inoculated**

05 **Required volume is essential and assumed**

Hall and Lyman, CMR: Updated Review of Blood Culture Contamination; 2006
CLSI: M47A Principles and Procedures for Blood Cultures, Approved Guideline

Identity of the Organism

Bates et al. found that the identity of the organism was the most important predictor for differentiating contaminated blood culture results from results indicating bacteremia

Common Commensal Organisms or Probable Contaminants:

- Coagulase-negative staphylococci (CoNS)
- Propionibacterium spp. (Cutibacterium)
- Aerococcus
- Micrococcus
- Bacillus spp. [not B. anthracis]
- Corynebacterium spp. [diphtheroids]
- Alpha-hemolytic streptococci

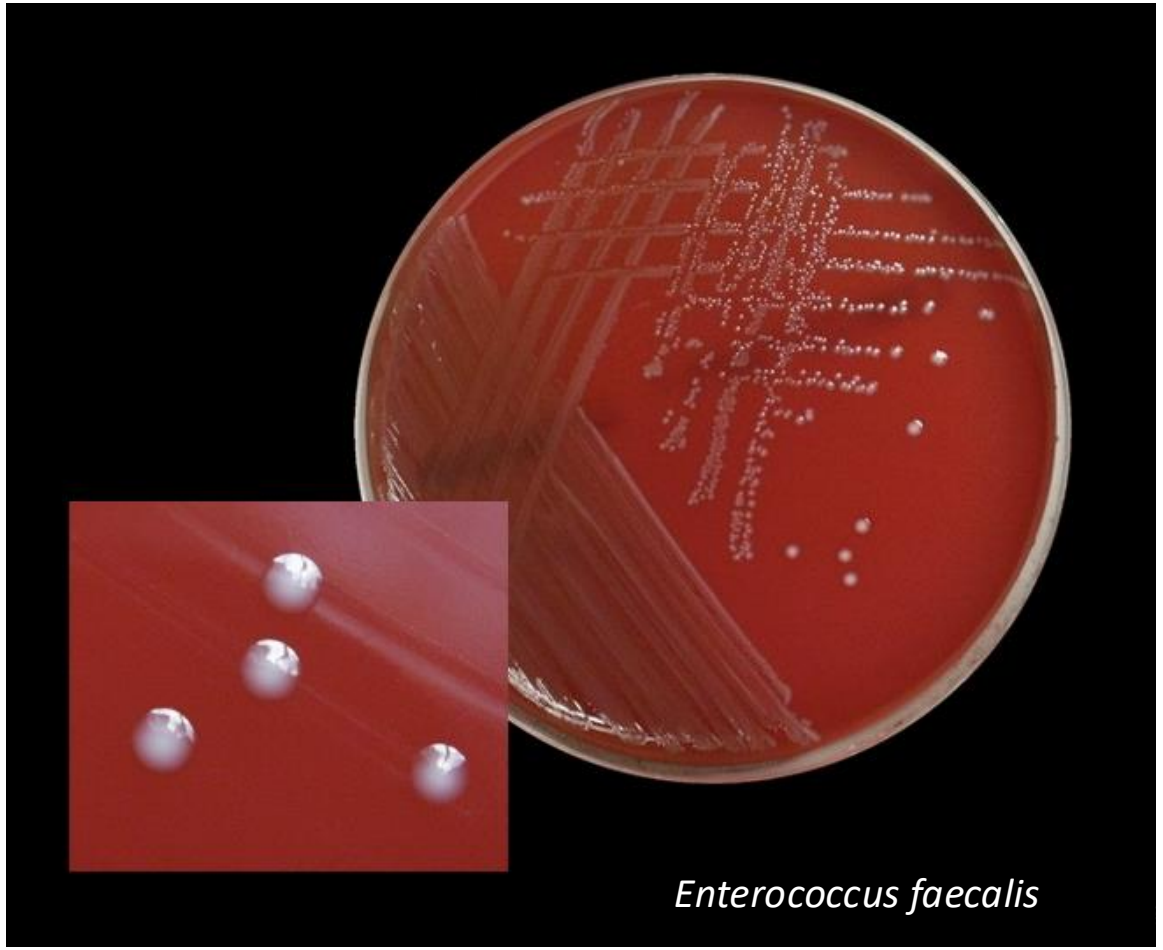
Identity of the Organism - Usually a True Bacteremia or Fungemia

However: these organisms when ONLY skin dwelling and captured as part of the blood sample for culture, may cause a False-positive CLABSI on our CVC Patients. Capturing MRSA when only skin-dwelling may cause a FP MRSA.
With HOB reporting they may also cause a FP HOB

Non-Common Commensal Organisms:

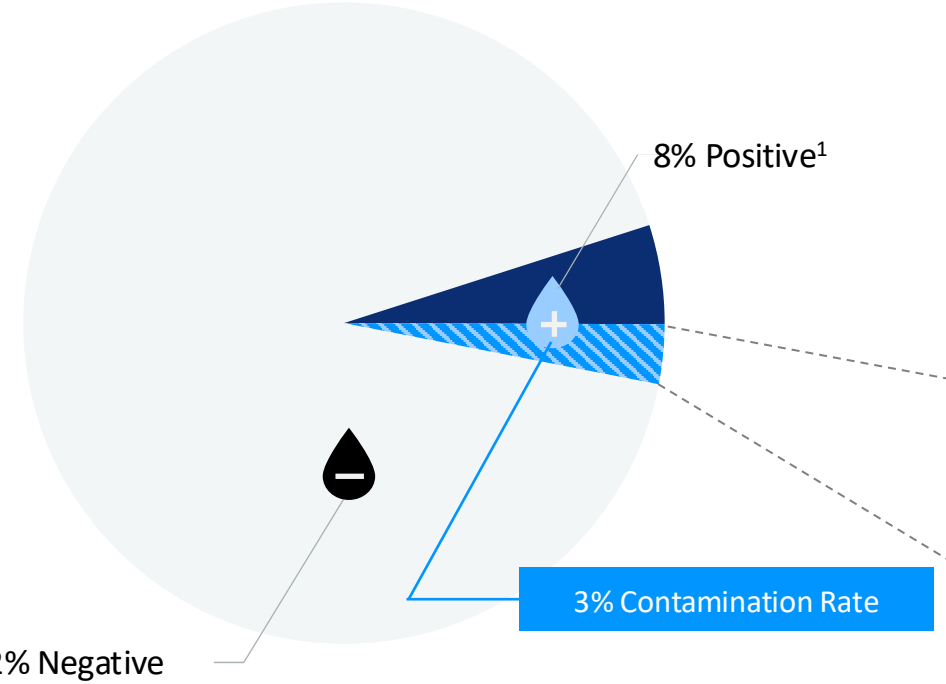
- Enterococcus
- VRE
- MRSA
- Candida
- E.coli

Any organism NOT found on the NHSN Common Commensal list is considered a recognized pathogen for NHSN reporting purposes

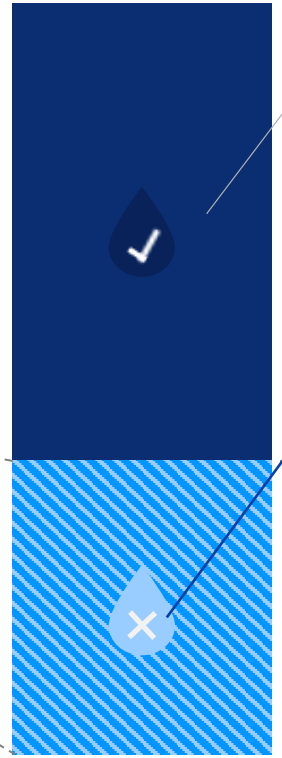


Test Results for Sepsis are Frequently Wrong, which can lead to Misdiagnosis and Mistreatment

ALL BLOOD CULTURES



POSITIVE BLOOD CULTURES



Nearly half of all positive blood cultures **are actually *false* positive**

False positives are a **preventable error** and can lead to a misdiagnosis of sepsis

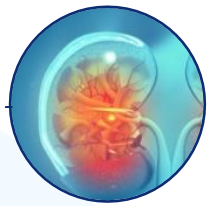
1. Zwang O, Albert RK. Analysis of strategies to improve cost effectiveness of blood cultures. J Hosp Med. 2006;1(5):272-6. doi:10.1002/jhm.115.

False-positive blood cultures increase many harmful patient safety risks and mortality

The Impact

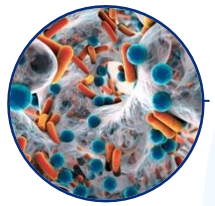
Unnecessary Antibiotics

Up to 200,000 course of unneeded antibiotics



Acute Kidney Injury (AKI)

36%-40% incidence with Vancomycin and Zosyn
1.2 million acquire AKI during hospital stay, 300,000 deaths. 3.5 das ELOS and $7 K cost



Antibiotic-Resistant Infections

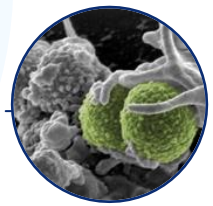
>2.8 million AR infections each year >35,000 deaths

Extended Length of Stay

avg. 2.2 days
Nearly 1M extra hospital days

Risk of C. *difficile*

30% reduction in broad-spectrum antibiotics could lower CDI by 26%. Prolonged use = 11% daily increase for CDI. The higher the ASI (broader spectrum), the higher the risk, each daily unit = 22% increase in hCDI risk AJIC 2026



Exposure to HAIs & HACs

Prevalence of 1 in 31 patients on any given day
11.5% mortality rate

Misdiagnosed Patient

Black patients have a 30% increased risk for blood culture contamination

False-Positive CLABSIs

Incidence 30-45% of all CLABSI. Consider FP MRSA, FP HOB.
For every increase of 1% in BCC, CLABSI increases 9%, Valeria Fabre, Hopkins JCM, 52 hospitals, 19 states 360,000 blood cultures 2025

Increased Mortality

Increase of 74% in patient mortality rate from 4.6% to 8%

Klucher J, Davis K, Lakkad M, Painter JT, Dare RK. Risk factors and clinical outcomes associated with blood culture contamination. Infect Control Hosp Epidemiol. 2022;43(3):291-297. doi:10.1017/ice.2021.111
Lewington, et al. Kidney Int. 2013. DOI: 10.1038/ki.2013.153
https://www.qualityforum.org/Qps/MeasureDetails.aspx?standardID=1980&print=1&entityTypeID=1
Tompkins, getting to zero ICHE https://doi.org/10.1017/ice.2022.284
Doern GV, Carroll KC, Diekema DJ, et al. A comprehensive update on the problem of blood culture contamination and a discussion of methods for addressing the problem. Clin Microbiol Rev 2020;33:1–21.
IHME University of Washington, https://www.healthdata.org/antimicrobial-resistance.
CDC HAI and Antimicrobial Use Prevalence Surveys EMERGING INFECTIONS PROGRAM: HAI - COMMUNITY INTERFACE (HAIC)
HCUP Statistical Brief #145 2009 AHRQ CDI Readmission Rate
Verheyen High 30 Day Readmission Rates AJIC 2019
Huang , Shao-Tsung, Utilizing antibiotic spectrum index to calculate hospital-onset CDI in treating adults with CO BSI, AJIC, Volume 54, Issue 3 P267-27 March 2026

Hospitals report HACs to NHSN

- CAUTI
- SSI
- CLABSI
- *C. difficile*
- MRSA BSI

CLABSI, CDI and MRSA BSI are significantly impacted by **BC contamination**
(non-common & common commensal organisms)

National SIR for CLABSIs increased 46% / 47% during COVID (24% 2020 average increase)

(Q3/Q4 '20 vs. Q3/Q4 '19)[1] AND remained 7% higher than pandemic levels for 2021. 2022 had a 9% decrease still leaving us at a 22% average increase over pre- pandemic levels. **2023 had a 13% decrease and we remain 9% over pre-pandemic rates.**

2024 we had a 9% decrease in CLABSI rates putting us at a pre-pandemic levels.

National SIR for MRSA increased 23% / 34% during COVID (15% 2020 average increase)

(Q3/Q4 '20 vs. Q3/Q4 '19[1] AND remained 14% higher than pandemic levels for 2021. 2022 saw a 16% decrease still leaving us at an average 13% increase over pre-pandemic levels. **2023 had a 16% decrease making us finally below our pre-pandemic rates. 2024 had another 7% decrease in MRSA HAI.**

CDI decreased by 11% in 2024

[1]Weiner-Lastinger LM, Pattabiraman V, Konnor RY, et al. The impact of coronavirus disease 2019 (C
healthcare-associated infections in 2020: summary of data reported to the NHSN.
Infect Control Hosp Epidemiol. 2021;1-14. doi:10.1017/ice.2021.362.A39:B40.
CDC 2023 and 2024 HAI Progress Report

Overlooked Impact of Diagnostic Error with Blood Culture Contamination

Condition	Impact	Average Cost
Unnecessary Antibiotics	• Up to 450% more Vancomycin • Antibiotic utilization may lead to resistant organism development	• Incalculable resistant organism HAI cost • AU and AR reporting

Risk of CDI	• 30% reduction in broad-spectrum antibiotics could lower CDI by 26%
	• Vancomycin and Zosyn both implicated in causation of CDI
	• Vancomycin and Zosyn are the "go to" therapy for rule out Sepsis patients
		• HAC CDI cost of care and treatment ~$20K/event
		  • $17K cost of care (as last reported by AHRQ)
		  • $3K cost of DIFICID to treat
		• Incalculable cost of HAC SIR penalty, up to 1% of CMS total revenue

Acute Kidney Injury	• Up to a 40% increase in risk of AKI with Vancomycin and Zosyn tx • 1.2million patients acquire during hospital stay; 300,000 die in US annually • 30% of AKI patients need dialysis making that patient 100Xs more likely to have a Staph BSI • Vancomycin and Zosyn are the "go-to" tx for rule out Sepsis patients	• HAC CLABSI cost of care ~$48K/event (as last reported by AHRQ) • Incalculable cost of HAC SIR penalty, up to 1% of CMS total revenue • 2025 IPPS e-quality reporting measure for hospital onset AKI • AKI alone $7K without a CVC/Dialysis
Extended Length of Stay	• Avg. 2.2 days of extended stay, impacting bed availability • Mitigating BCC could free 1,000,000 bed days in the U.S. • For each HAC patient prevented, bed could turn over 4.6x making the • hospital more revenue and more profitable	• Avg. cost of BCC ~$4K/event (inclusive of ELOS, Lab, ABTx, etc.) • Incalculable bed opportunity cost
Exposure to HAIs & HACs	• 1/31 patients develop an HAI/HAC • 10% die during hospitalization • 33% are readmitted within 30 days, which counts as an all cause • 30-day readmission	• HAC readmission penalty, up to 3% total CMS revenue • Incalculable readmissions cost
False-Positive CLABSI **False-Positive MRSA**	• 30-45% of all CLABSIs are found to be false-positive CLABSIs • Financial cost to a hospital = # CLABSIs x 0.4 x $48,000 minimum cost • FP MRSA per AHRQ Strategies to Prevent HAI	• HAC CLABSI cost of care CLABSI ~$48K/event (as last reported by AHRQ) • Incalculable cost of HAC SIR penalty, up to 1% of CMS total revenue • Invasive MRSA cost of care ~$30K per CID VA Study by Nelson 2021
In-Patient Mortality Risk	• 74% increase in in-patient mortality risk with BCC from 4.6% to 8%	• Incalculable cost of mortality risk
Medical Liability Risk **HCAPHS** **CMS Star Ratings**	• Increased risk of medical liability with HAC • Star Ratings Mortality, Safety, Readmission, Patient Experience, • Timely and Effective Care	• Incalculable cost

J. Shepard et al. / Could the prevention of health care lassociated infections increase hospital cost? The financial impact of health care-associated infections from a hospital management perspective American Journal of Infection Control 48 (2020) 255!260
Murray, The Lancet: Global burden of bacterial AMR in 2019 a systematic analysis; 2016
Frœhlich M, Maymonah B, Bailey L, Ford F, LeMaitre B, Psevdos G. Antimicrobial stewardship programachieved marked decrease in clostridium difficile infections in a veterans hospital. Am J Infect Control. 2020;48(9):1119-1121.doi:10.1016/j.ajic.2019.12.023.
Owens RC, Donskey CJ, Gaynes RP, Loo VG, Muto CA. Antimicrobial-associated risk factors for Clostridium difficile infection. Clin Infect Dis. 2008;46(Suppl1):S19-31.doi:10.1086/521859.
Khalili H, Bairami S, Kargar M. Antibiotics induced acute kidneyinjury: incidence, risk factors, onset time and outcome. Acta Med Iran. 2013;51(12):871-8.
Zwang O, Albert RK. Analysis of strategies to improve cost effectiveness of blood cultures. J Hosp Med. 2006;1(5):272-6.doi:10.1002/jhm.115.
Rha B, See I, Dunham L, et al.*Vital Signs:* Health Disparities in Hemodialysis-Associated*Staphylococcus aureus*Bloodstream Infections — United States, 2017–2020. MMWR Morb Mortal Wkly Rep 2023; 72:153–159. DOI: http://dx.doi.org/10.15585/mmwr.mm7206e1.
Klucher J, Davis K, Laikad M, Painter JT, Dare RK. Risk factors and clinical outcomes associated with blood culture contamination. Infect Control Hosp Epidemiol. 2022;43(3):291-297. doi: 10.1017/ice.2021.111.
1Tompkins, LS, et al. Getting to zero: impact of a device to reduce blood culture contamination and false-positive central line-associated blood stream infections, ICHE 2022, 1-5. doi: 10.1017/ice.2022.284
2Boyce JM, Nadeau J, Dumigan D, et al. Obtaining blood cultures by venipuncture versus from central lines: impact on blood culture contamination rates and potential effect on central line-associated bloodstream infection reporting. Infect Control Hosp Epidemiol. 2013;34(10):1042-7. doi:10.1086/673142.
3Shuman EK, Washer LL, Arndt JL, et al. Analysis of central line-associated bloodstream infections in the intensive care unit after implementation of central line bundles. Infect Control Hosp Epidemiol. 2010;31(5):551-3. doi: 10.1086/652157
Nelson et al., National Estimates of Healthcare Costs Associated With Multidrug-**Resistant Bacterial Infections Among Hospitalized Patients in the United** *Clinical Infectious Diseases*, Volume 72, Issue Supplement_1, 1 January 2021, Pages S17–S26, https://doi.org/10.1093/cid/ciaa1581
AHRQ Prevent HAIs Strategies to Prevent Blood Culture Contamination ICUs and non-ICUs

Training and Education on “Best Practices” Alone Will Not Solve the Problem

Controllable

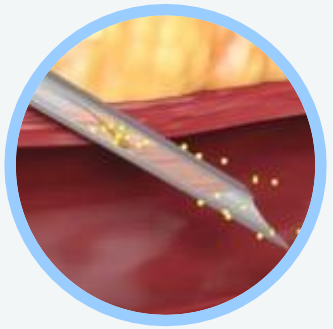
Human Factor(s)

Risk of contamination during assembly, preparation of supplies and skin prep

Uncontrollable

Skin Flora

You can disinfect but not sterilize the skin. Up to 20% of skin flora remains viable in the keratin layer of the skin even after skin prep[1]



Skin Plug and Fragments

will enter the culture specimen bottle and commonly will contain viable microorganisms (when present)

Active diversion of the **initial 1.5-2.0 mL of blood** using a closed system ISDD has been clinically proven to reduce blood culture contamination[2,3]

[1]Anjanappa T, Arjun A. Preparative skin preparation and surgical wound infection. J Evid Based Med. 2015;2(2):131-154. [2]Rupp ME, Cavalieri RJ, Marolf C, Lyden E. Reduction in blood culture contamination through use of Initial Specimen Diversion Device. Clin Infect Dis. 2017;65(2):201-205. [3]Bell M, Bogar C, Plante J, Rasmussen K, Winters S. Effectiveness of a novel specimen collection system in reducing blood culture contamination rates. J Emerg Nurs. 2018;44(6):570-575.

Blood Culture Contamination and Hospital-Onset Bacteremia/Fungemia

Blood Cultures grow out MRSA, Staph. aureus, Enterococcus, Candida…

Are they always a **true** BSI?

CBE ID: 3658
Title: Adult Blood Culture Contamination Rate; A national measure and standard for clinical laboratories and antibiotic stewardship programs
Endorsement Status: Endorsed

Partnership for Quality Measurement
Powered by Battelle

"This measure supports the Hospital Onset Bacteremia & Fungemia measure currently in development by the National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) Division of Healthcare Quality Promotion (DHQP) and the National Healthcare Safety Network (NHSN) Hospital Onset Bacteremia & Fungemia module slated to be implemented late 2022 – early 2023.

It does this in 2 ways:

A. **The BCC measure monitors blood culture contamination rate, which will rise, resulting in false positive blood cultures, when blood cultures are not collected correctly. False positive blood culture results may result in an artificial rise in the Hospital Onset Bacteremia (HOB) rate**."

ICHE:

Preventability of HOB

"The role of skin commensal organisms in an HOB measure must also be considered; nearly one-third of bacteremia events in this study and 38% of bacteremias among already hospitalized patients in another study were due to skin commensal organisms."

"Because skin commensal bacteremia events most often do not represent true infection, arguably these may not "count" the same as non commensal bacteremias in a quality measure. "

"However, blood cultures with skin commensals are often initially interpreted as true infections, and they frequently result in unnecessary antibiotic use and prolonged hospitalization."

"Furthermore, skin commensal contamination is preventable with proper blood culture collection techniques, and reduction of blood culture contamination is a relevant goal for quality improvement."

Dantes et al**Preventability of hospital onset bacteremia and fungemia:A pilot study of a potential healthcare-associated infection outcome measure.** Infect Control Hosp Epidemiol . 2019 March ; 40(3): 358–361. doi:10.1017/ice.2018.339.

Study Review: HOBSI Organisms and Prevalence
Do these all represent a true BSI?

ICHE 2023

Microorganism[a]	CLABSI (N=403), No. %	Non-CLABSI HOB (N=1,574), No. %	All HOB including CLABSI (N=1,977), No. %
Enterobacteriaceae	67 (16.6)	575 (36.5)	642 (32.5)
S. *aureus*	50 (12.4)	403 (25.6)	453 (22.9)
Enterococcus spp.	64 (15.9)	248 (15.8)	312 (15.8)
Environmental GNB	34 (8.4)	179 (11.4)	213 (10.8)
Candida albicans and C. *auris*	52 (12.9)	123 (7.8)	175 (8.9)
Other *Candida* spp[a]	53 (13.2)	117 (7.4)	170 (8.6)
CoNS	83 (20.6	0	83 (4.2)
Other GPB	33 (8.2)	0	33 (1.7)
Other GNB	18 (4.4)	0	17 (0.9)
Other commensal	17 (4.2)	0	17 (0.9)
No microorganism	12 (3.0)	0	12 (0.6)

Note. CLABSI, central-line-associated bloodstream infection; CoNS, coagulase-negative staphylococci; GNB, gram-negative bacteria; GNP, gram-positive bacteria; HOB, hospital-onset bacteremia.
[a]See Supplementary Table S2 (online) for a full list of included microorganisms.

Table 3. Microorganisms Identified in CLABSI and Non-CLABSI HOB Admissions

ICHE 2019 Study

- **Staph aureus: 15%**
- 30% of our hospitalized patients carry SA on their skin
- **Escherichia coli:** 12%
- **CoNS:** 11% (Matching Commensal HOB Event)
- **Klebsiella:** 10%
- **Enterococcus:** 9%
- **Strep:** 8%
- **Candida:** 8%
- **Enterobacter** 5%

BMJ 2023 Study

S. aureus

23% academic and community hosp.

36% community hospitals

Followed by:

- Enterococcus
- Escherichia coli
- Candida
- Klebsiella pneumoniae
- P aeruginosa

Yu, ICHE: https://doi.org/10.1017/ice.2023.132 Published online by Cambridge University Press
,Dantes, R. et al. Infect Control Hosp Epidemiol . 2019 March ; 40(3): 358–361. doi:10.1017/ice.2018.339.
Leekah, S. et al. BMJ Qual Saf 2024;0 1-12: doi 10.1136/bmjqs 2023-016831

Remember this Stat? Preventability

AJIC 2024

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Etiology and utility of hospital-onset bacteremia as a safety metric for targeted harm reduction

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Key Words:
Hospital-acquired infections (HAIs)
CLABSIs
Bloodstream infections (BSIs)
Quality improvement
Hospital reimbursement
National Health Care Safety Network (NHSN)

Background: Hospital acquired infections (HAIs) are a major driver of morbidity and cost in health systems. Central line–associated bloodstream infections (CLABSIs) require intensive surveillance and review. All-cause hospital-onset bacteremia (HOB) may be a simpler reporting metric, correlates with CLABSI, and is viewed positively by HAI experts. Despite the ease in the collection, the proportion of HOBs that are actionable and preventable is unknown. Moreover, quality improvement strategies targeting it may be more challenging. In this study, we describe the bedside provider-perceived sources of HOB in order to provide insight into this new metric as a target for HAI prevention.

Methods: All cases of HOBs in 2019 from an academic tertiary care hospital were retrospectively reviewed. Information was collected to assess provider-perceived etiology and associated clinical factors (microbiology, severity, mortality, and management). HOB was categorized as preventable or not preventable based on the perceived source from the care team and management decisions. Preventable causes included device-associated bacteremias, pneumonias, surgical complications, and contaminated blood cultures.

Results: Of the 392 instances of HOB, 56.0% (n = 220) had episodes that were determined not preventable by providers. Excluding blood culture contaminates, the most common cause of preventable HOB was secondary to CLABSIs (9.9%, n = 39). Of the HOBs that were not preventable, the most common sources were gastrointestinal and abdominal (n = 62), neutropenic translocation (n = 37), and endocarditis (n = 23). Patients with HOB were generally medically complex with an average Charlson comorbidity index of 4.97. This translated into a higher average length of stay (29.23 vs 7.56, $P < .001$) and higher inpatient mortality (odds ratio 8.3, confidence interval [6.32-10.77]) when compared to admissions without HOB.

Conclusions: The majority of HOBs were not preventable and the HOB metric may be a marker of a sicker patient population making it a less actionable target for quality improvement. Standardization across the patient mix is important if the metric becomes linked to reimbursement. If the HOB metric were to be used in lieu of CLABSI, large tertiary care health systems that house sicker patients may be unfairly financially penalized for caring for more medically complex patients.

The number one cause of preventable HOB is blood culture contamination:

"Preventable causes included device-associated bacteremias, pneumonias, surgical complications, and contaminated blood cultures."

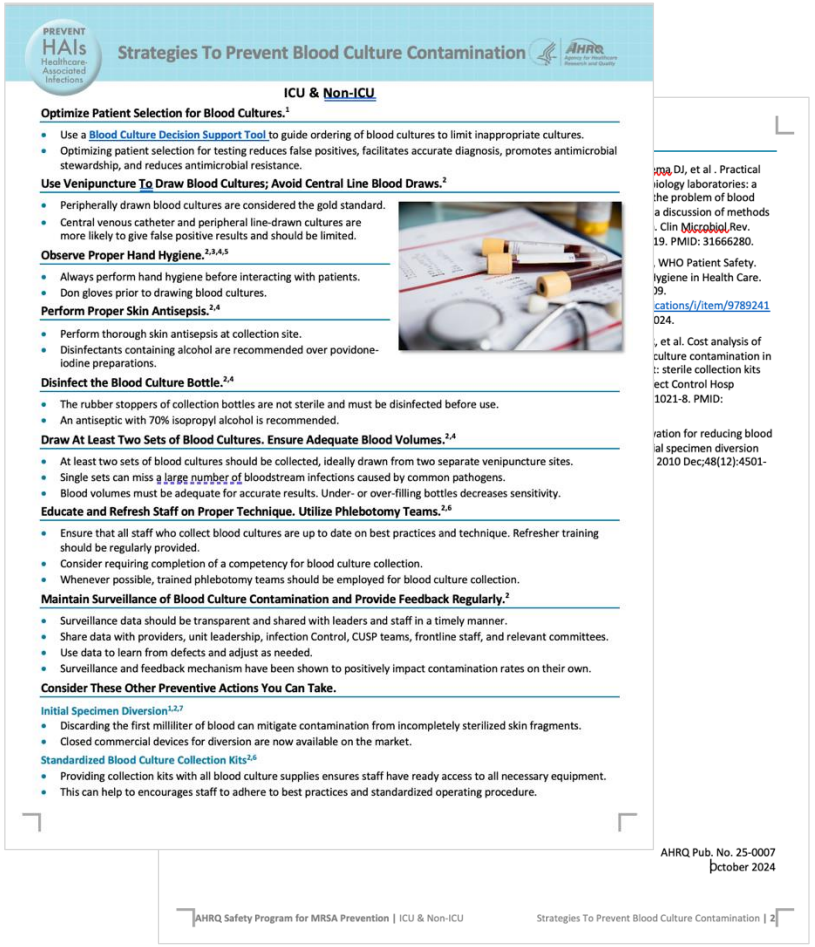
"**Excluding blood culture contaminates (14%),** the most common cause of preventable HOB was secondary to CLABSIs".

Preventable HOB cause	N (%)
Contaminant	**55 (14.0%)**
Central venous catheter (CVC)	**39 (9.9%)**
Surgical Intervention (Surg)	**26 (6.6%)**
HAP/VAP	**16 (4.1%)**
PIV catheter-related infection (PIV)	**13 (3.3%)**
Miscellaneous*	**9 (2.3%)**
CAUTI	**7 (1.8%)**
No source defined	**4 (1.0%)**

Agency for Healthcare and Research Quality

Released “Strategies to Prevent Blood Culture Contamination” in 2024, as part of its MRSA Prevention Toolkit for ICUs & Non-ICUs

Summarizes evidence-based best practice techniques and technologies to reduce contamination events



PREVENT HAIs Healthcare-Associated Infections

Strategies To Prevent Blood Culture Contamination

AHRQ Agency for Healthcare Research and Quality

ICU & Non-ICU

Optimize Patient Selection for Blood Cultures.[1]

- Use a Blood Culture Decision Support Tool to guide ordering of blood cultures to limit inappropriate cultures.
- Optimizing patient selection for testing reduces false positives, facilitates accurate diagnosis, promotes antimicrobial stewardship, and reduces antimicrobial resistance.

Use Venipuncture To Draw Blood Cultures; Avoid Central Line Blood Draws.[2]

- Peripherally drawn blood cultures are considered the gold standard.
- Central venous catheter and peripheral line-drawn cultures are more likely to give false positive results and should be limited.

Observe Proper Hand Hygiene.[2,3,4,5]

- Always perform hand hygiene before interacting with patients.
- Don gloves prior to drawing blood cultures.

Perform Proper Skin Antisepsis.[2,4]

- Perform thorough skin antisepsis at collection site.
- Disinfectants containing alcohol are recommended over povidone-iodine preparations.

Disinfect the Blood Culture Bottle.[2,4]

- The rubber stoppers of collection bottles are not sterile and must be disinfected before use.
- An antiseptic with 70% isopropyl alcohol is recommended.

Draw At Least Two Sets of Blood Cultures. Ensure Adequate Blood Volumes.[2,4]

- At least two sets of blood cultures should be collected, ideally drawn from two separate venipuncture sites.
- Single sets can miss a large number of bloodstream infections caused by common pathogens.
- Blood volumes must be adequate for accurate results. Under- or over-filling bottles decreases sensitivity.

Educate and Refresh Staff on Proper Technique. Utilize Phlebotomy Teams.[2,6]

- Ensure that all staff who collect blood cultures are up to date on best practices and technique. Refresher training should be regularly provided.
- Consider requiring completion of a competency for blood culture collection.
- Whenever possible, trained phlebotomy teams should be employed for blood culture collection.

Maintain Surveillance of Blood Culture Contamination and Provide Feedback Regularly.[2]

- Surveillance data should be transparent and shared with leaders and staff in a timely manner.
- Share data with providers, unit leadership, infection Control, CUSP teams, frontline staff, and relevant committees.
- Use data to learn from defects and adjust as needed.
- Surveillance and feedback mechanism have been shown to positively impact contamination rates on their own.

Consider These Other Preventive Actions You Can Take.

Initial Specimen Diversion[1,2,7]

- Discarding the first milliliter of blood can mitigate contamination from incompletely sterilized skin fragments.
- Closed commercial devices for diversion are now available on the market.

Standardized Blood Culture Collection Kits[2,6]

- Providing collection kits with all blood culture supplies ensures staff have ready access to all necessary equipment.
- This can help to encourages staff to adhere to best practices and standardized operating procedure.

AHRQ Pub. No. 25-0007
October 2024

AHRQ Safety Program for MRSA Prevention | ICU & Non-ICU

Strategies To Prevent Blood Culture Contamination | 2

Initial Specimen Diversion

- Discarding the first milliliter of blood can mitigate contamination from incompletely sterilized skin fragments.
- Closed commercial devices for diversion are now available on the market.

Agency for Healthcare Research and Quality (AHRQ). Strategies to prevent blood culture contamination. 2024. Retrieved on February 10, 2025 at https://www.ahrq.gov/hai/tools/mrsa-prevention/toolkit/blood-culture.html

Hospital-Onset Bacteremia and Fungemia Playbook

Standard of Care

NATIONAL QUALITY FORUM
Driving measurable health improvements together

"…guide to help organizational leaders and clinical care teams in acute care settings implement or improve HoB prevention, identification, and treatment initiatives.

The release of the HOB Playbook comes as the Centers for Disease Control and Prevention (CDC) is taking steps to address HOB by refining a recently endorsed quality measure"[1]

"Implement training targeted to reduce blood culture contamination, false negatives, or specimen rejection (e.g., low volume) and track contamination rates and care team adherence to best practices."

Page 39

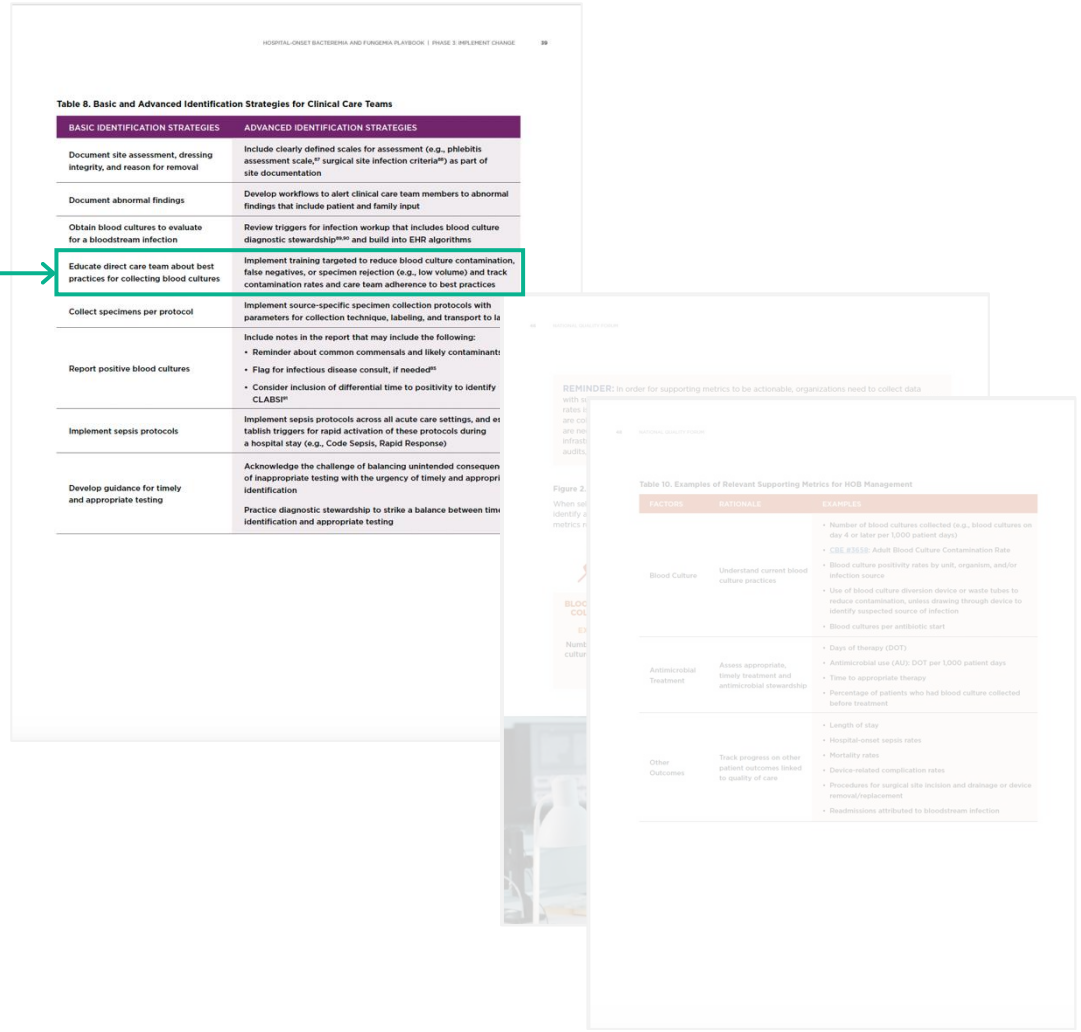


Table 8. Basic and Advanced Identification Strategies for Clinical Care Teams

BASIC IDENTIFICATION STRATEGIES	ADVANCED IDENTIFICATION STRATEGIES
Document site assessment, dressing integrity, and reason for removal	Include clearly defined scales for assessment (e.g., phlebitis assessment scale,[47] surgical site infection criteria[48]) as part of site documentation
Document abnormal findings	Develop workflows to alert clinical care team members to abnormal findings that include patient and family input
Obtain blood cultures to evaluate for a bloodstream infection	Review triggers for infection workup that includes blood culture diagnostic stewardship[49,50] and build into EHR algorithms
Educate direct care team about best practices for collecting blood cultures	Implement training targeted to reduce blood culture contamination, false negatives, or specimen rejection (e.g., low volume) and track contamination rates and care team adherence to best practices
Collect specimens per protocol	Implement source-specific specimen collection protocols with parameters for collection technique, labeling, and transport to la
Report positive blood cultures	Include notes in the report that may include the following: • Reminder about common commensals and likely contaminants • Flag for infectious disease consult, if needed[51] • Consider inclusion of differential time to positivity to identify CLABSI[52]
Implement sepsis protocols	Implement sepsis protocols across all acute care settings, and es tablish triggers for rapid activation of these protocols during a hospital stay (e.g., Code Sepsis, Rapid Response)
Develop guidance for timely and appropriate testing	Acknowledge the challenge of balancing unintended consequen of inappropriate testing with the urgency of timely and appropri identification Practice diagnostic stewardship to strike a balance between time identification and appropriate testing

1. National Quality Forum (NQF). Hospital Onset-Bacteremia and Fungemia Playbook. Washington, DC: NQF, 2024.

Hospital-Onset Bacteremia and Fungemia Playbook

Standard of Care

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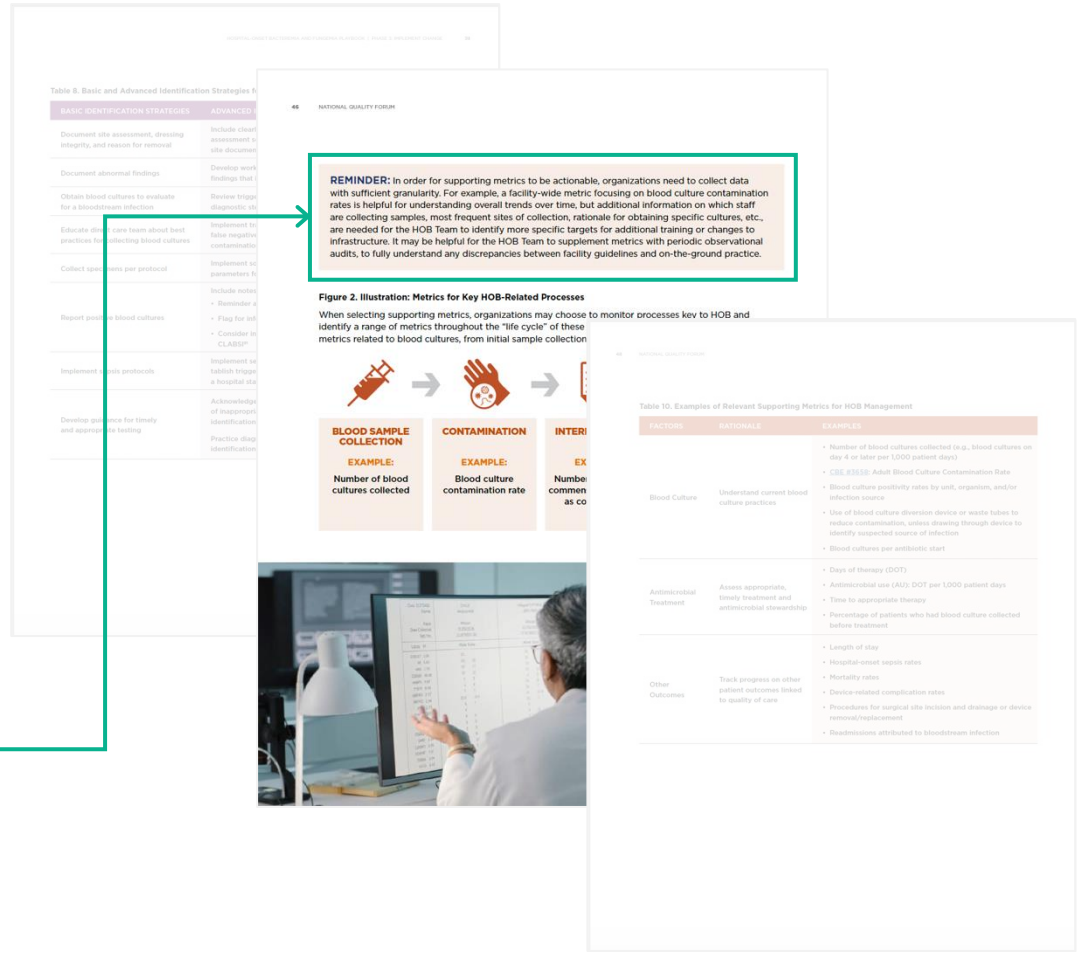
"In order for supporting metrics to be actionable, organizations need to collect data with sufficient granularity…a facility-wide metric focusing on blood culture contamination rates is helpful…but additional information on which staff are collecting samples, etc. are needed…to identify more specific targets for additional training…"

Page 46



1. National Quality Forum (NQF). Hospital Onset-Bacteremia and Fungemia Playbook. Washington, DC: NQF, 2024.

Hospital-Onset Bacteremia and Fungemia Playbook

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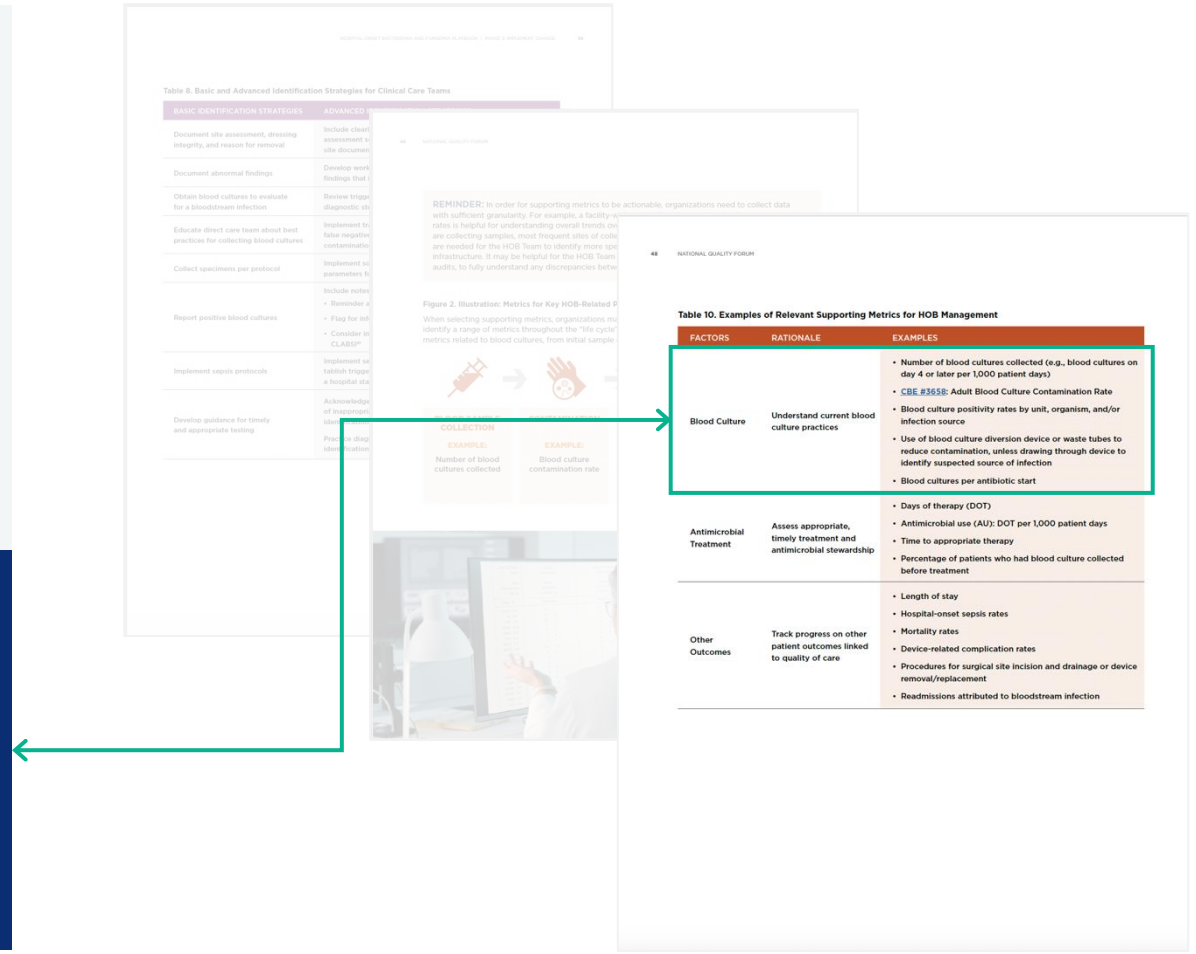
"Use of blood culture diversion device or waste tubes to reduce contamination, unless drawing through device to identify suspected source of infection"

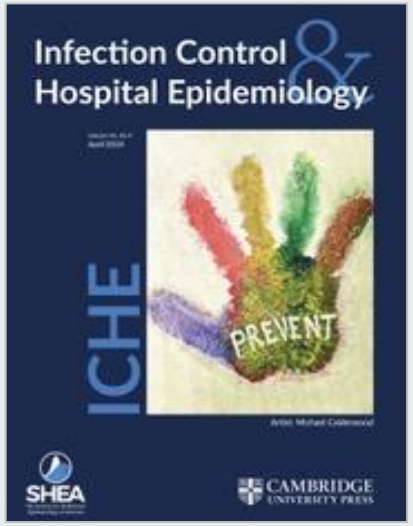
Page 48



1. National Quality Forum (NQF). Hospital Onset-Bacteremia and Fungemia Playbook. Washington, DC: NQF, 2024.

Remember: False Positive Blood Cultures may Artificially Increase Hospital-Onset Bacteremia (HOB) rate

2019
Infection Control & Hospital Epidemiology



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Infect Control Hosp Epidemiol. Author manuscript; available in PMC 2024 February 07.

Published in final edited form as:
Infect Control Hosp Epidemiol. 2019 March ; 40(3): 358–361. doi:10.1017/ice.2018.339.

Preventability of hospital onset bacteremia and fungemia: A pilot study of a potential healthcare-associated infection outcome measure

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[3]Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland
[4]Division of Infectious Diseases, Department of Pediatrics, Johns Hopkins University School of Medicine, Baltimore, Maryland
[5]Division of Infectious Diseases, Department of Medicine, Emory University School of Medicine, Atlanta, Georgia
[6]University of Maryland School of Medicine, Baltimore, Maryland, for the CDC Prevention Epicenter Program

Abstract

Hospital-onset bacteremia and fungemia (HOB), a potential measure of healthcare-associated infections, was evaluated in a pilot study among 60 patients across 3 hospitals. Two-thirds of all HOB events and half of nonskin commensal HOB events were judged as potentially preventable. Follow-up studies are needed to further develop this measure.

Rates of central-line–associated bloodstream infections (CLABSIs) decreased 50% between 2008 and 2014 in the United States.[1] CLABSI reporting to the Centers for Disease Control and Prevention's National Healthcare Safety Network (NHSN) and use of the CLABSI data in Centers for Medicare and Medicaid Services (CMS) public reporting and pay for performance programs likely prompted enhanced infection prevention efforts to reduce CLABSI rates, though reductions since 2014 have diminished.[2]

CLABSIs are a subset of all hospital-onset bacteremia and fungemia (HOB). Prior studies have speculated whether HOB could replace CLABSI as a performance measure that better

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Conflicts of interest. The authors report no financial conflicts of interest related to this article.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Skin contamination was the second most common source of HoB at 18% (11 out of 60 HOB reported events)[1]

2024
American Journal of Infection Control

American Journal of Infection Control

Major Article

Etiology and utility of hospital-onset bacteremia as a safety metric for targeted harm reduction

Matthew A. Stack MD[a,*], Lana Dbeibo MD[a], William Fadel PhD[a], Kristen Kelley RN, CIC[b], Joshua Sadowski[b], Cole Beeler MD[a]

BACKGROUND

Blood culture contamination was identified in **14% of reported HOBs** (55 out of 392 HOB reported events)[2]

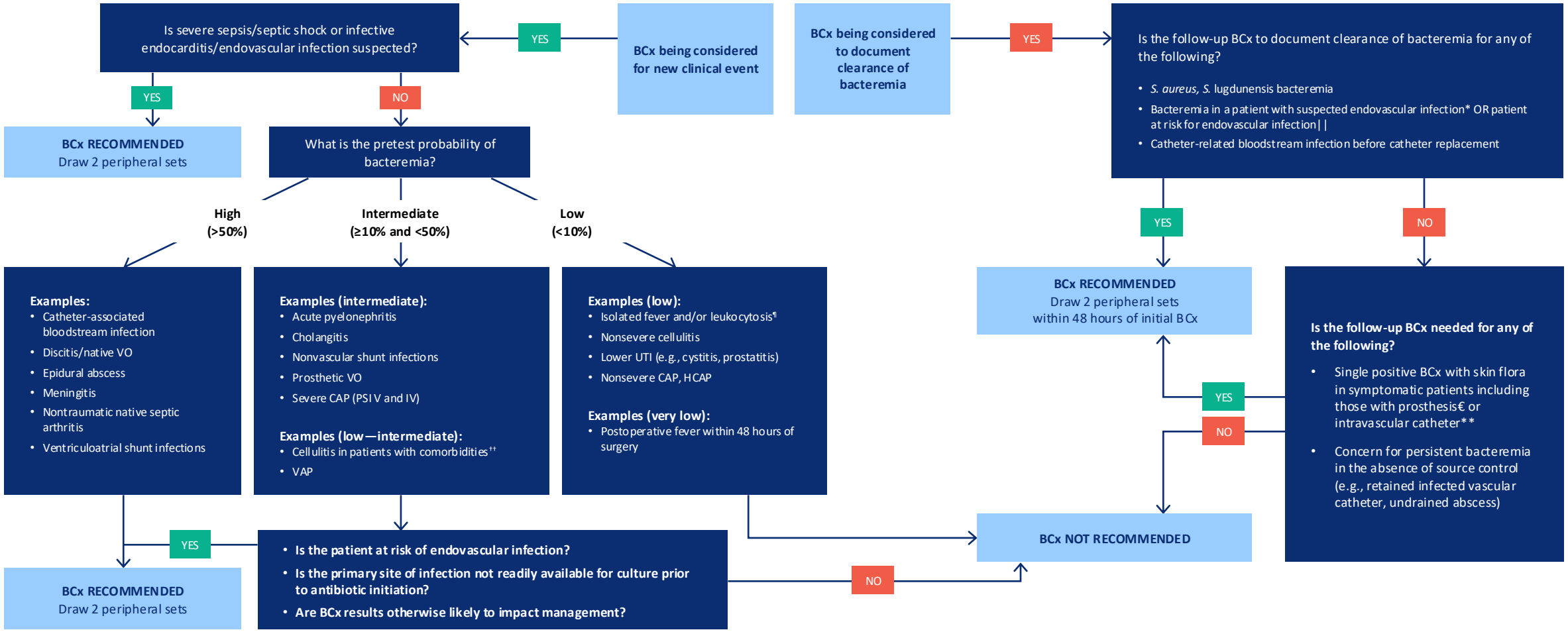
1. Dantes RB, Rock C, Milstone AM, et al. Preventability of hospital onset bacteremia and fungemia: A pilot study of a potential healthcare-associated infection outcome measure. Infection Control & Hospital Epidemiology. 2019;40(3):358-361. doi:10.1017/ice.2018.339. 2. Stack MA, Dbeibo L, Fadel W, et al. Etiology and utility of hospital-onset bacteremia as a safety metric for targeted harm reduction. Am J Infect Control. 2024;52(2):195-199. doi: 10.1016/j.ajic.2023.06.002.

Evidence-Based Blood Culture Best Practices

Patient Selection	Blood cultures should only be performed in patients with a reasonable likelihood of bacteremia/fungemia
Skin Disinfection	Use a CHG and alcohol-containing disinfectant to scrub the phlebotomy site; allow for adequate scrub and drying time
Blood Culture Bottle Top Disinfection	Disinfect blood culture vial tops with alcohol by scrubbing with friction for 15 seconds
Consideration	Leave an IPA or sterile pad on top of the BC bottle until ready to inoculate with blood; IPA takes 5 seconds to dry
Phlebotomy Site	Do not draw blood cultures through indwelling vascular catheters unless the catheter is thought to be the source of infection; draw a second set from a peripheral venipuncture; consider time to positivity
Sets	Always draw two sets from different sites
Volume	Is the single most important factor for organism detection
Standardized Kits	Use of standardized kits and procedures has proven helpful in preventing contamination
Phlebotomy Teams	Educate and train individuals who perform blood cultures in aseptic technique
Surveillance and Feedback	Monitor blood culture contamination and provide data to individuals and patient care units
Multidisciplinary Teams	Sustained improvement in blood culture contamination is best achieved through a team approach
ISDD	Use of ISDDs that divert 1mL or more of blood have been shown to decrease contamination to less than 1%

Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th edition. J Infus Nurs. 2021 Jan-Feb 01;44(1S Suppl 1): S1-S224.doi: 10.1097/NAN.0000000000000396 ENA Clinical Practice Guidelines
Doern GV, Carroll KC, Diekema DJ, et al. Practical guidance for clinical microbiology laboratories: a comprehensive update on the problem of blood culture contamination and a discussion of methods for addressing the problem. Clin Microbiol Rev. 2020;33(1):e00009-19. doi: 10.1128/CMR.00009-19.
Rupp ME, Cavalieri RJ, Marolf C, Lyden E. Reduction in blood culture contamination through use of Initial Specimen Diversion Device. Clin Infect Dis. 2017;65(2):201-205. doi:10.1093/cid/cix304.
Novak S, Dunne WM. Blood Culture: a key investigation for diagnosis of bloodstream infections. bioMerieux
CLSI. Principles and Procedures for Blood Cultures; Approved Guidelines. CLSI document M47-A. Wayne, PA: Clinical and Laboratory Standards Institute; 2007.

Algorithm for bacterial blood cultures in nonneutropenic inpatients



Fabre V, Sharara SL, Salinas AB, Carroll KC, Desai S, Cosgrove SE. Does This Patient Need Blood Cultures? A Scoping Review of Indications for Blood Cultures in Adult Nonneutropenic Inpatients. Clin Infect Dis. 2020;71(5):1339-1347.

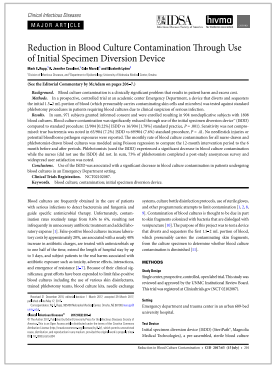
Theophanous R, Ramos J, Calland AR, Krcmar R, Shah P, da Matta LT, Shaheen S, Wrenn RH, Seidelman J. Blood culture algorithm implementation in emergency department patients as a diagnostic stewardship intervention. Am J Infect Control. 2024;52(9):985-991.

Evidence-Based Checklist for Adult Peripheral Blood Culture Collection Summary

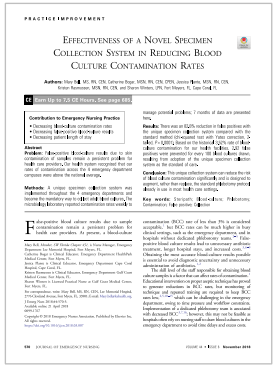
- Utilize astute patient selection and check order.
- Identify and inform patient.
- Ensure environmental surfaces used are disinfected.
- Perform hand hygiene. Use aseptic non touch technique throughout entire process.
- Mask self and patient.
- Prepare to draw 2-3 sets of blood cultures within a short time frame. Each set to be drawn from a different site. Avoid single bottle sets and drawing more than 3 sets within a 24 hour period if possible.
- Select a site opposite of any infusion or if not possible, distal to any infusion. The cubital fossa is a preferred site.
- Each set to be drawn from a different venipuncture or new start PIV and include one aerobic and one anaerobic bottle per policy.
- Mark bottles for fill volume and fill to that volume. Most manufacturers require 8-10mL per bottle.
- Disinfect venipuncture site with 2% Chlorhexidine and Alcohol product per manufacturer's directions.
- Remove bottle cap and scrub bottle septum with a 70% alcohol prep pad for a full 15 seconds.
- Consider covering bottle top with a sterile 1x1 or new alcohol prep pad and leave on until placing bottle in adapter.
- Select site and apply single patient tourniquet - validate site, then remove tourniquet and don clean gloves.
- Consideration: Sterile set up with sterile barrier, gloves and tourniquet. Don gloves, apply barrier, apply tourniquet and perform venipuncture procedure.
- Draw blood cultures first, making sure to draw the recommended volume into the aerobic bottle first.
- Divert and sequester initial milliliter of blood drawn for culture into a sterile receptacle to minimize the risk of contamination. Use of ISDDs have been shown to reduce blood culture contamination rates to less than 1%.
- Finish procedure, applying a sterile dressing and light pressure after completing blood draw. Place sharps in sharp's disposal containers compliant with local and federal regulations.
- Label bottles in presence of the patient, agitate gently per manufacturer's instructions, and place in biohazard bag and send to lab immediately.

ISDD: Nine Peer-Reviewed Published Studies

Clinical Infectious Diseases
2017 (July)


Clinical Infectious Diseases
MAJOR ARTICLE
IDSA
Reduction in Blood Culture Contamination Through Use of Initial Specimen Diversion Device

Journal for Emergency Nursing
2018 (Nov)


PRACTICE IMPROVEMENT
Effectiveness of a Novel Specimen Collection System in Reducing Blood Culture Contamination Rates

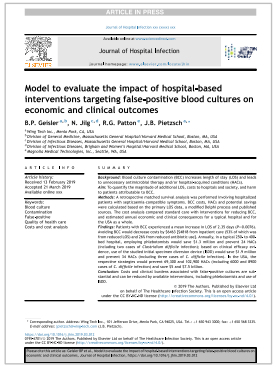
Journal of Clinical Microbiology
2019 (Jan)


Journal of Clinical Microbiology
Estimated Clinical and Economic Impact through Use of a Novel Blood Collection Device To Reduce Blood Culture Contamination in the Emergency Department: a Cost-Benefit Analysis

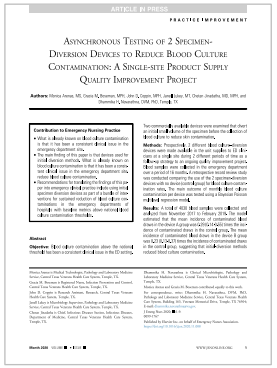
American Journal Infection Control
2019 (Jan)


ARTICLE IN PRESS
American Journal of Infection Control
Reducing blood culture contamination using an initial specimen diversion device

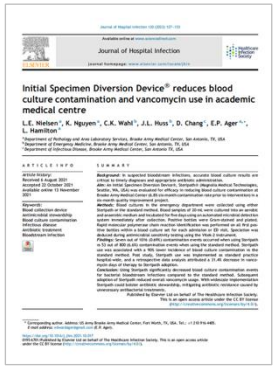
Journal of Hospital Infection
2019 (Mar)


ARTICLE IN PRESS
Journal of Hospital Infection
Model to evaluate the impact of hospital-based interventions targeting false-positive blood cultures on economic and clinical outcomes

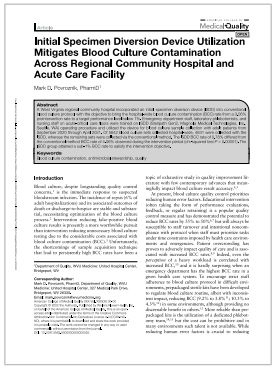
Journal for Emergency Nursing
2021 (Mar)


ARTICLE IN PRESS
PRACTICE IMPROVEMENT
Asynchronous Testing of 2 Specimen-Diversion Devices to Reduce Blood Culture Contamination: A Single-site Product Supply Quality Improvement Project

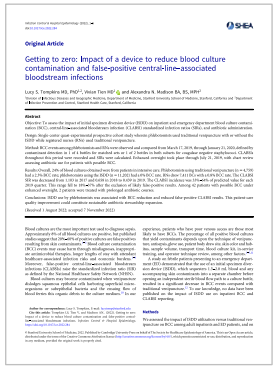
Journal of Hospital Infection
2021 (Nov)


Journal of Hospital Infection
Initial Specimen Diversion Device® reduces blood culture contamination and vancomycin use in academic medical centre

American Journal Medical Quality
2022 (April)


Medical Quality
Initial Specimen Diversion Device Utilization Mitigates Blood Culture Contamination Across Regional Community Hospital and Acute Care Facility

Infection Control & Hospital Epidemiology
2022 (December)


SHEA
Original Article
Getting to zero: Impact of a device to reduce blood culture contamination and false-positive central-line–associated bloodstream infections

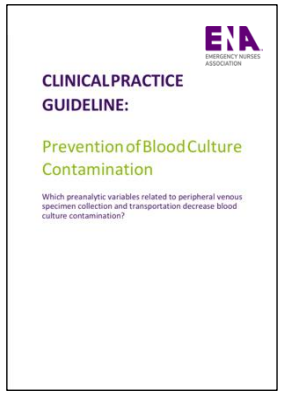
ISDD Peer-Reviewed Published Studies and Clinical Study Presentations at Major Medical Conferences

#	Institution	Publication or Conference Presentation	Date	Duration	Baseline or Control Rate	ISDD Rate	BCC Reduction	Ann. Savings
1	**Stanford Health Care**	Infection Control & Hospital Epidemiology	2022	10 months	2.3%	**0.0%**	**100%**	NR
2	**Central Texas VA Medical Center**	Journal of Emergency Nursing	2021	5 months	2.2%	**0.0%**	**100%**	NR
3	**Univ. of Nebraska Medical Center**	Clinical Infectious Diseases	2017	12 months	1.8%	**0.2%**	**88%**	$1,800,000
4	**Baylor Scott & White Med Ctr.**	Emergency Nurses Association (ENA)	2021	4 months	3.2%	**0.2%**	**93%**	NR
5	**Kern Medical Center**	APIC - Submitted for publication	2021	18 months	2.4%	**0.4%**	**83%**	NR
6	**Lee Health System (4 sites)**	Journal of Emergency Nursing	2018	7 months	3.5%	**0.6%**	**83%**	$1,100,000
7	**Brooke Army Medical Center**	Journal of Hospital Infection	2021	6 months	6.6%	**0.7%**	**90%**	NR
8	**Medical Univ. of South Carolina**	Institute for Healthcare Improvement (IHI)	2016	8 months	4.2%	**0.6%**	**86%**	NR
9	**Rush University Medical Center**	IDSA - IDWeek	2017	3 months	4.3%	**0.6%**	**86%**	NR
10	**Inova Fairfax Hospital**	Emergency Nurses Association (ENA)	2019	12 months	4.4%	**0.8%**	**82%**	$932,000
11	**WVU United Hospital Center**	American Journal for Medical Quality	2021	8 months	4.1%	**0.8%**	**81%**	NR
12	**SCL St. Mary's Medical Center**	American Organization for Nursing Leadership (AONL)	2020	6 months	3.3%	**0.8%**	**76%**	NR
13	**Beebe Healthcare**	American Society for Microbiology (ASM)	2018	4 months	3.0%	**0.8%**	**75%**	NR
14	**Medical Univ. of South Carolina**	Institute for Healthcare Improvement (IHI)	2017	20 months	4.6%	**0.9%**	**80%**	$447,000
15	**Ascension Via Christi (3 sites)**	Society of Hospital Epidemiology of America (SHEA)	2021	3 months	4.3%	**0.9%**	**79%**	NR
16	**VA Houston**	Emergency Nurses Association (ENA)	2018	7 months	5.5%	**0.9%**	**83%**	NR
17	**Shaare Zedek Medical Center**	American Journal of Infection Control	2019	6 months	5.2%	**1.0%**	**81%**	NR
18	**Brooke Army Medical Center**	Journal of Hospital Infection	2021	14 months		**31% reduction in vancomycin DOT**		
19	**University of Houston**	Journal of Clinical Microbiology	2019	ISDD can save the hospital **2.0 bed days** and **$4,739 per false-positive** blood culture event				
20	**Mass General/ Harvard/ WingTech**	Journal of Hospital Infection	2019	ISDD can save the hospital **2.4 bed days**, **$4,817 per false-positive** blood culture event and **prevent 34 HACs including 3 C.*diff***				**$1.9M annually and**

National Peer-Reviewed Publication Best Evidence-Based Project Peripheral IV Start

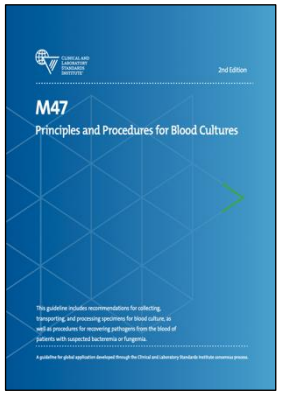
Evidence-Based Best Practice Guidelines and Strategy Reports

EMERGENCY NURSES ASSOCIATION



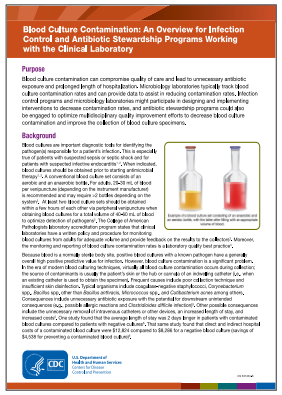
1.0–2.0 mL
diversion volume

CLSI



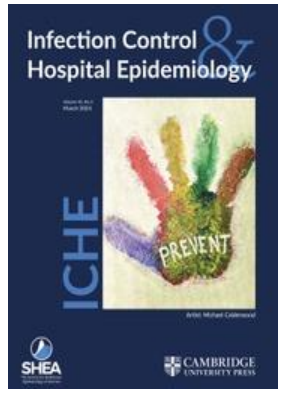
1% goal for blood culture contamination

CDC



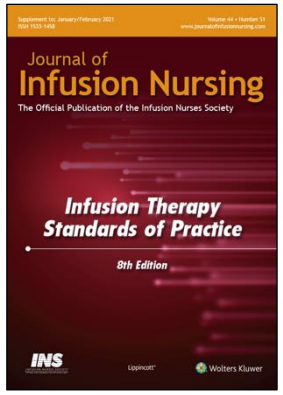
1% goal for blood culture contamination

SHEA
The Society for Healthcare Epidemiology of America



Blood Culture **Diversion** Technique and **Devices**

INS
INFUSION NURSES SOCIETY
SETTING THE STANDARD FOR INFUSION CARE



Diversion Devices
"…demonstrated reduction in blood culture contamination"

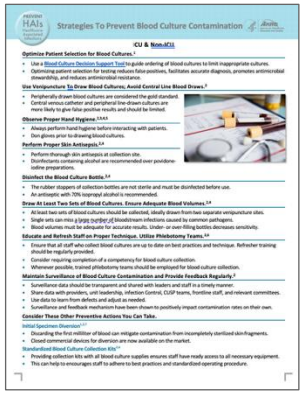
AMERICAN SOCIETY FOR MICROBIOLOGY

"…should implement using a **Diversion Device** as part of the procedure for drawing peripheral BCs"

IDSA
Infectious Diseases Society of America

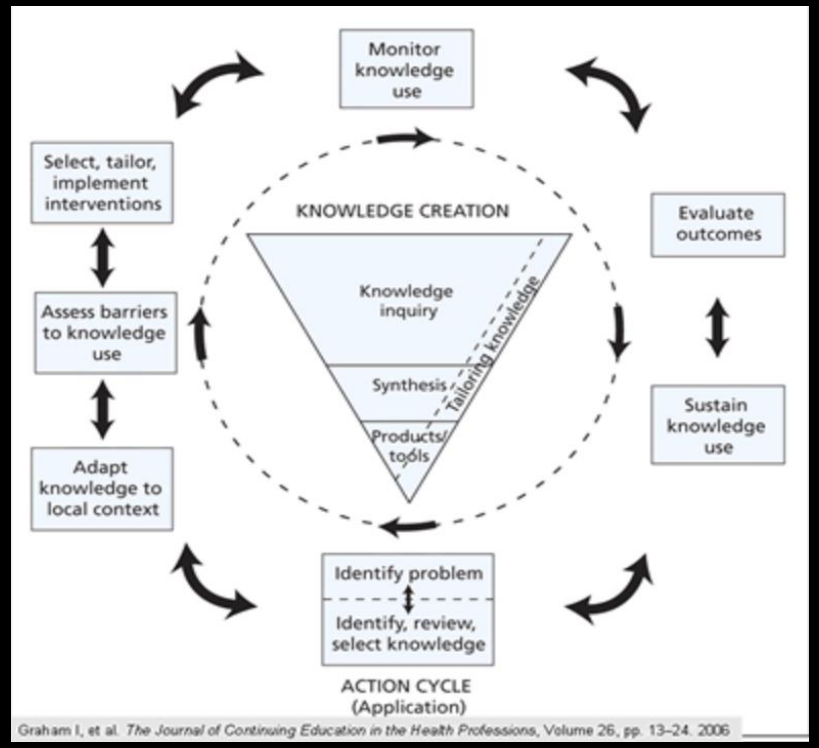
"…[products] allow diversion and discard of the **first few milliliters of blood**…"

AHRQ



"Discarding the **first milliliter of blood**…"

Implementation Science: Key Steps of Implementation Process



- Identify the evidence-based practice
- Assess the context of the proposed environment implementation; culture, capabilities and potential barriers
- Stakeholder engagement: ALL LEVELS
- Implementation Strategy: Tailor the approach in consideration of barriers
- Implementation Monitoring
- Evaluation: Efficacy, adoption, fidelity, impact of change, sustainability

Note on fidelity: Changes/products must be made or used as intended to have the impact experienced in the evidence. P values tell us of the likelihood of experiencing the same outcomes IF we do the same thing in the same way.

Measure fidelity first ;THEN AND ONLY THEN can you accurately measure changes in patient clinical outcomes, efficiencies and economic returns on investment.

Why implementation fails

When evidence doesn't translate:

Common failure points:

- Education without system change
- Workflow barriers
- Unclear clinical ownership
- No measurement of fidelity
- No sustainability plan

Evidence fails when it is added on top of existing systems rather than embedded into them.

Most health systems rely heavily on education — but education alone rarely produces sustained practice change.

We used to assume:
"If we teach it, it will happen."

Education integrated with clear policy and multidisciplinary coordination is associated with better adherence to evidence-based practices

15 Steps to Make it Stick: A Hybrid Design!

Implementation Science > Collaborative Implementation >Project Management > Continuous Improvement

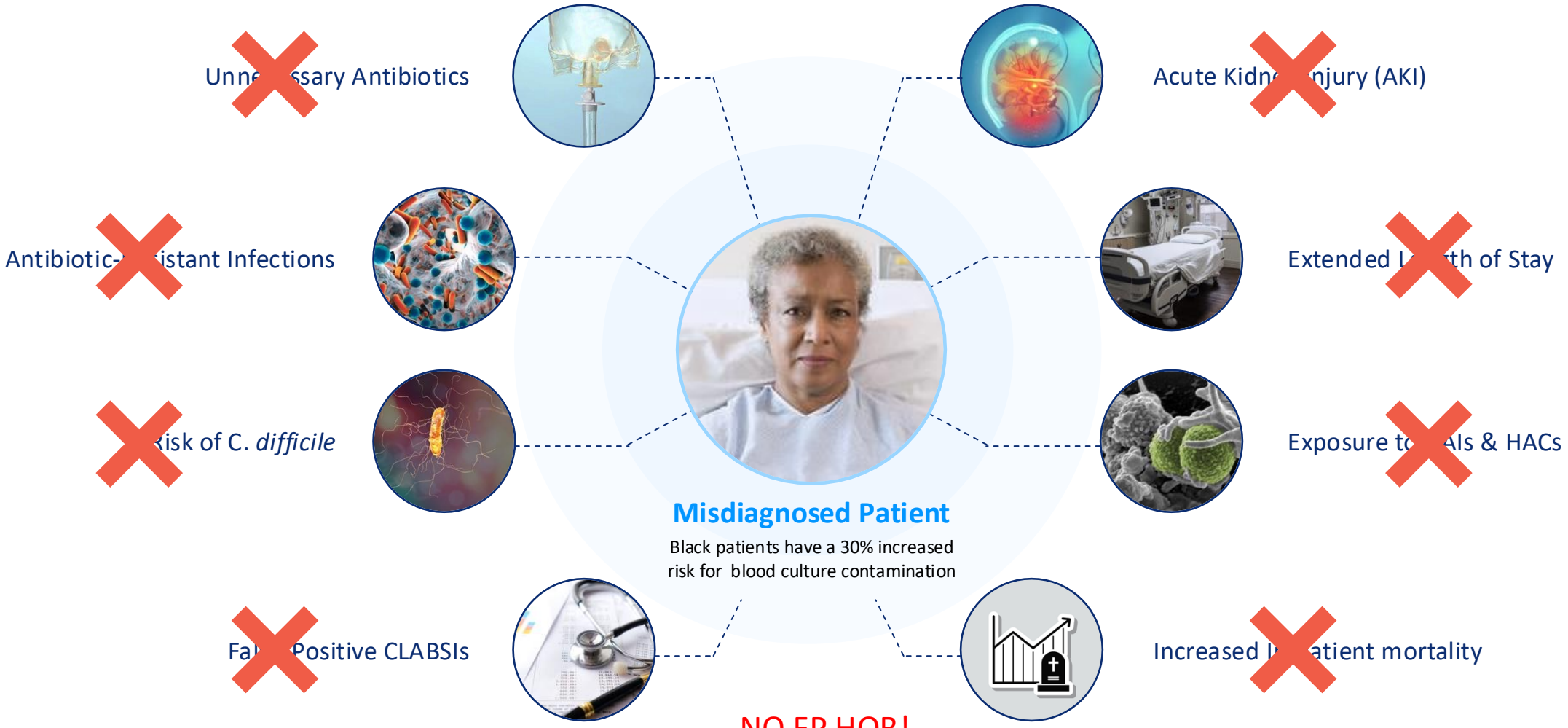
All Key Stakeholders at Planning Meeting including C-suite Who are the Facilitators What are the barriers	Tell the story WIFM Align Goals and Assign Roles	Assignment champions at C suite, mid-management and every unit level	Communicate clearly and frequently and close the loop of communication	Standardize
Place new EBP on Policy	Mandatory Pre-Training LMS AND Hands-on Training Re-training/New Hire Training/Temp Workforce Competency Testing	Super User group trained and enabled in each unit and on each shift	New products must be placed within workflow and easily found	Establish par levels and ensure re-ordering and re-stocking processes are in place
Continuously establish a Safety Culture Measure accountability for compliance-	Monthly tracking, auditing and reporting with feedback and accountability Tiered **HUDDLES***	Evaluate: RCA if results don't meet the metrics chosen Dashboards for Mgmt.	Communicate and Celebrate	Continuous evaluation of adoption, efficacy, fidelity and sustainability

Koshiol, Mallory, Optimizing Organizational Safety: The Role of Tier 4 Huddles in Escalation Management, American Journal of Medical Quality, Jan 2026

*"Tiered safety huddles are forums for surfacing weak signals and escalating risk concerns from the frontline unit to executive leadership. Retrospective and prospective review is necessary for continuous improvement.

False-positive blood cultures increase many harmful patient safety risks and mortality

The Impact



“The names of the patients whose lives we save can never be known. Our contribution will be what did not happen to them. And, though they are unknown, we will know that mothers and fathers are at graduations and weddings they would have missed, and that grandchildren will know grandparents they might never have known, and holidays will be taken, and work completed, and books read, and symphonies heard, and gardens tended that, without our work, would never have been.”

Donald Berwick, MD, Founder of IHI

THANK YOU

FOR ALL OF YOUR WORK ON BEHALF OF PATIENT SAFETY AND QUALITY!

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