Is hospital-onset bacteraemia and fungaemia an actionable quality measure?

Chanu Rhee ,[1] Payal Patel,[2] Julia Szymczak [3]

[1]Department of Population Medicine, Harvard Medical School / Harvard Pilgrim Health Care Institute, Boston MA, USA, Boston, Massachusetts, USA
[2]Division of Infectious Diseases, Departement of Medicine, Intermountain Healthcare, Murray, Utah, USA
[3]Division of Epidemiology, Department of Internal Medicine, University of Utah School of Medicine, Salt Lake City, Utah, USA

Correspondence to
Dr Chanu Rhee, Harvard Medical School Department of Population Medicine, Boston, Massachusetts, USA; crhee@bwh.harvard.edu

Accepted 2 April 2024
Published Online First 27 May 2024

► https://doi.org/10.1136/bmjqs-2023-016831

To cite: Rhee C, Patel P, Szymczak J. *BMJ Qual Saf* 2024;**33**:479–482.

Healthcare-associated infections (HAIs) are one of the most common complications of hospital care and a leading cause of death worldwide.[1] Many countries have therefore implemented surveillance systems for HAIs and multifaceted infection prevention and control programmes to reduce their burden. In the USA, regulators have made HAI prevention a national priority by requiring hospitals to report key infections, including central line-associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections, certain surgical site infections, methicillin-resistant *Staphylococcus aureus* bacteraemia, and *Clostridioides difficile* infections, to the Centers for Medicare & Medicaid Services (CMS) via the US Centers for Disease Control and Prevention's National Healthcare Safety Network (NHSN) tracking system.[2] These data are used to benchmark hospitals and inform CMS's pay-for-performance programmes.

The result in the USA has largely been a success story that demonstrates the potential impact of coordinated local and federal patient safety efforts, coupled with patient advocacy and advances in the science of infection prevention. The widespread uptake of infection prevention efforts to include central line insertion and maintenance bundles, for example, has contributed to a substantial decline in CLABSI rates.[3] National point prevalence surveys also demonstrated a 16% relative reduction in the overall risk of HAIs between 2011 and 2015.[4] Although the COVID-19 pandemic led to a resurgence in HAIs, recent data suggest that infection rates are beginning to return to pre-pandemic levels.[5]

Despite these successes, current HAI measures have important limitations. Several conditions, including CLABSIs, require trained personnel to retrospectively apply complicated NHSN definitions using detailed medical record reviews. This is resource intensive and introduces potential variability across hospitals, undermining their utility as a quality metric.[6] More broadly, there is increasing recognition that the HAIs that are currently reportable in the USA only account for a fraction of all serious HAIs. They do not include, for example, bloodstream infections not associated with central lines (which are far more common than CLABSIs), hospital-acquired pneumonia, or the full array of surgical site infections.[7] These non-reportable HAIs are largely neglected as they are neither tracked nor targeted for prevention.

In response to these limitations, hospital-onset bacteraemia and fungaemia (HOB) has been proposed as a new target for HAI surveillance. The HOB case definition—growth of a bacterial or fungal pathogen from a blood culture collected on day 4 of hospitalisation or later (where the date of inpatient admission is day 1)—is simple, objective and easily extracted from electronic medical systems. HOB can arise from a multitude of potential infections and, unlike CLABSIs and several other currently tracked HAIs, there is no need to make potentially subjective determinations about the source nor even whether or not the positive blood culture represents a true infection or contaminant.

HOB's potential utility as a quality measure is supported by a growing body of literature. In a small pilot study, two-thirds of all HOB events were judged as potentially preventable by physicians with infection prevention experience.[8] Correspondingly, a survey study found that most hospital epidemiologists and infection preventionists thought that HOB events are largely preventable and reflective of

a hospital's quality of care.[9] A large multicentre analysis demonstrated that HOB events are associated with similar increases in costs, length of stay and mortality as CLABSIs, yet are four times as common.[10] These findings led to endorsement from the former (National Quality Forum) and current (Batelle) contractors for the CMS Consensus Based Entity while it is being considered for adoption by CMS quality initiatives. In the meantime, HOB reporting will be voluntary for all acute care hospitals currently enrolled in NHSN.

Despite the gathering momentum for a HOB measure, there remain important gaps in our knowledge about the underlying sources of HOB, their potential preventability, and factors associated with preventability, particularly as the initial US pilot estimating preventability only included 60 HOB cases from three academic hospitals.[8] This information is critical to guide specific prevention measures, inclusion/exclusion criteria, risk-adjustment methods, and expectations around potential improvements in HOB rates.

In this issue of *BMJ Quality & Safety*, Robinson and colleagues provide important data that help address these gaps.[11] The investigators trained internal medicine residents, infectious disease fellows, and infection preventionists to conduct detailed medical record reviews of HOB events at 10 academic and 3 community hospitals in the USA to extract patient characteristics, procedures, devices, clinical culture results, a narrative summary of the hospital course, and the likely source of HOB. Infectious disease physicians with training in infection prevention and hospital epidemiology then served as secondary reviewers to make a final determination of HOB source and estimate preventability on a 6-point Likert scale using a previously validated guide that provides a framework to account for both intrinsic and hospital-based factors.[12]

The study included a total of 2109 HOB events in 2085 unique patients, including both adults (83%) and children (17%). As expected, illness severity was high: median hospital length of stay prior to the positive blood culture was 11 days, 32% required ICU care in the 48 hours preceding the culture, 37% of patients were immunosuppressed, and 23% died in-hospital. The most common isolated pathogen for non-commensal HOB was *S. aureus* (23%) and the most common sources of bacteraemia were gastrointestinal (35%, of which nearly a third were from neutropenic gut translocation) and endovascular (32%, most commonly due to central venous catheters). Among the 1789 HOB events with non-commensal organisms, 36% were rated potentially preventable; importantly, 40% of these potentially preventable events would not be captured through existing HAI surveillance. Multivariable analysis demonstrated that non-commensal HOB events attributed to intravascular catheters, indwelling urinary catheters, and surgical site infections were more likely to be rated as potentially preventable, while neutropenia, immunosuppression, gastrointestinal or bone/joint or unidentified sources, polymicrobial cultures, and previous positive blood cultures were associated with a lower likelihood of being rated preventable. Among the 320 HOB cases due to commensal organisms, 57% were attributed to contaminated blood cultures and 74% were considered potentially preventable.

Overall, this study represents an impressive body of work that makes several important contributions. First, it underscores the nuances around preventability of HAIs. At first glance, the finding that a majority of HOB events are unlikely to be preventable under current medical standards might argue against its utility as a quality measure. However, recent work suggests that less than a quarter of adverse events in hospitalised patients are preventable, and the estimated preventability of HOB events in this study is similar or higher than other widely used quality measures such as hospital readmissions and hospital mortality.[13] Furthermore, the fraction of HAIs that are generally considered to be potentially preventable has been estimated to be in a similar range of 35–55%.[14] Second, the analysis of factors associated with lower preventability ratings should help guide refinement of the HOB quality measure. The low preventability in patients with neutropenia and immunosuppression, in particular, suggests that HOBs in these hosts may need to be considered differently or perhaps excluded altogether, analogous to how mucosal barrier injury laboratory-confirmed bloodstream infections are currently tracked by NHSN but not incorporated into the CMS metrics.[15] The other factors identified as predictors of low preventability should be factored into risk-adjustment models. Third, the finding that HOB events due to commensal organisms (the majority of which were considered contaminants) had a high preventability rating points to an achievable target in initial efforts to reduce HOB rates by improving adherence to best practices for blood culturing.[16] This is a true patient safety issue as contaminated blood cultures are well known to have important adverse consequences including unnecessary antibiotic exposure, additional blood culture draws, and increased length of stay.[16 17] Finally, the study confirms that CLABSIs constitute a minority of hospital-onset bloodstream infections and that many serious HAIs are missed by current surveillance targets. This underscores the promise of HOB surveillance to identify new opportunities for patient harm reduction.

The study does have important limitations. First, the study was focused only on US hospitals. Second, despite using a sampling strategy that enriched the cohort for HOB events from community hospitals, most cases were still drawn from academic hospitals. This limits generalisability and may skew the overall estimation of preventability. However, subgroup analysis suggested that only a slightly greater proportion of HOB cases

in community hospitals (40%) were preventable compared with academic hospitals (35%). Third, the study relied completely on retrospective case reviews of medical record documentation to estimate HOB preventability, a process that is invariably uncertain, subjective, and susceptible to multiple potential biases. For example, hindsight bias may predispose clinicians to label a poor outcome as preventable on retrospective case review because they are relying on knowledge gained after an event to critique it when that information was not available for those involved during care delivery.[18] There are also important clinical nuances that can be difficult to ascertain retrospectively from medical records, and variability in the completeness and clarity of documentation between hospitals may also confound assessments. However, the use of a standardised review process, demonstration of high agreement between primary and secondary reviewers in source determination, and concordance with prior studies is supportive of the validity of the primary findings.[19 20]

More broadly, the study still leaves unanswered key questions about how best to use HOB to drive improvement across a range of diverse hospitals. For a quality measure to be actionable, organisations need clear guidance on steps that can be taken to improve performance. Decades of work in infection prevention has led to the establishment of an evidence base about what works to prevent well-studied HAIs such as CLABSIs. Without similar knowledge about how to prevent HOB from other sources, infection prevention teams could be left without a clear way forward beyond doubling down on efforts to reduce blood contamination rates, CLABSIs, and other current HAI targets.

In sum, the study by Robinson represents an important advance in our understanding of the nuances of HOB and its suitability as a quality metric while laying the groundwork for additional research. In particular, we hope that future investigations will focus on developing, validating and refining patient-level risk-adjustment tools; providing more insight into the root causes of HOB events; developing evidence-based HOB prevention interventions; and demonstrating that reductions in HOB events leads to better patient outcomes. With further investment in research, HOB could be a robust metric that identifies new targets for improvements in care delivery that ultimately catalyses better patient outcomes.

X Julia Szymczak @JulieSzymczak

Contributors CR drafted the manuscript. PP and JS critically revised the manuscript and provided important intellectual content.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests CR reports grant funding from the Centers for Disease Control and Prevention and Agency for Healthcare Research and Quality to conduct research related to sepsis and healthcare-associated infections, and royalties from UpToDate, Inc. JS reports grant funding from the Agency for Healthcare Research and Quality unrelated to this work.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Commissioned; internally peer reviewed.

ORCID iDs
Chanu Rhee http://orcid.org/0000-0002-9537-4245
Julia Szymczak http://orcid.org/0000-0002-3230-8670

REFERENCES

1 World Health Organization. Global report on infection prevention and control. Geneva, 2022. Available: https://www.who.int/publications/i/item/9789240051164
2 Classen DC, Rhee C, Dantes RB, *et al*. Healthcare-associated infections and conditions in the era of digital measurement. *Infect Control Hosp Epidemiol* 2024;45:3–8.
3 Centers for Disease Control and Prevention (CDC). Vital signs: central line-associated blood stream infections--United States, 2001, 2008, and 2009. *MMWR Morb Mortal Wkly Rep* 2011;60:243–8.
4 Magill SS, O'Leary E, Janelle SJ, *et al*. Changes in prevalence of health care-associated infections in U.S. *N Engl J Med* 2018;379:1732–44.
5 The Leapfrong Group. New fall 2023 hospital safety grades from the leapfrog group find improved infection rates following major spike during COVID-19 pandemic [press release]. 2023.
6 Keller SC, Linkin DR, Fishman NO, *et al*. Variations in identification of healthcare-associated infections. *Infect Control Hosp Epidemiol* 2013;34:678–86.
7 Page B, Klompas M, Chan C, *et al*. Surveillance for healthcare-associated infections: hospital-onset adult sepsis events versus current reportable conditions. *Clin Infect Dis* 2021;73:1013–9.
8 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. *Infect Control Hosp Epidemiol* 2019;40:358–61.
9 Dantes RB, Abbo LM, Anderson D, *et al*. Hospital epidemiologists' and infection preventionists' opinions regarding hospital-onset bacteremia and fungemia as a potential healthcare-associated infection metric. *Infect Control Hosp Epidemiol* 2019;40:536–40.
10 Yu KC, Jung M, Ai C. Characteristics, costs, and outcomes associated with central-line-associated bloodstream infection and hospital-onset bacteremia and fungemia in US hospitals. *Infect Control Hosp Epidemiol* 2023;44:1920–6.
11 Leekha S, Robinson GL, Jacob JT, *et al*. Evaluation of hospital-onset bacteremia and Fungemia in the USA as a potential Healthcare quality measure: a cross-sectional study. *BMJ Qual Saf* 2024;33:487–98.
12 Schrank GM, Sick-Samuels A, Bleasdale SC, *et al*. Development and evaluation of a structured guide to assess the preventability of hospital-onset bacteremia and fungemia. *Infect Control Hosp Epidemiol* 2022;43:1326–32.
13 Bates DW, Levine DM, Salmasian H, *et al*. The safety of inpatient health care. *N Engl J Med* 2023;388:142–53.
14 Schreiber PW, Sax H, Wolfensberger A, *et al*. The preventable proportion of Healthcare-associated infections 2005-2016:

systematic review and meta-analysis. *Infect Control Hosp Epidemiol* 2018;39:1277–95.
15 See I, Iwamoto M, Allen-Bridson K, *et al*. Mucosal barrier injury laboratory-confirmed bloodstream infection: results from a field test of a new national healthcare safety network definition. *Infect Control Hosp Epidemiol* 2013;34:769–76.
16 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* 2019;33.
17 Schinkel M, Boerman A, Carroll K, *et al*. Impact of blood culture contamination on antibiotic use, resource utilization, and clinical outcomes: a retrospective cohort study in Dutch and US hospitals. *Open Forum Infect Dis* 2024;11.
18 Caplan RA, Posner KL, Cheney FW. Effect of outcome on physician judgments of appropriateness of care. *JAMA* 1991;265:1957–60.
19 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;52:195–9.
20 Bonnal C, Mourvillier B, Bronchard R, *et al*. Prospective assessment of hospital-acquired bloosdstream infections: how many may be preventable *Qual Saf Health Care* 2010;19:e30.