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Original Article

Practices to prevent central line-associated bloodstream infection: A 2021 survey of infection preventionists in US hospitals

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Abstract

Objective: To determine prevalence of technical and behavioral interventions aimed at preventing central line-associated bloodstream infection (CLABSI) following the COVID19 pandemic.

Design: Cross-sectional survey.

Setting: US acute care hospitals.

Participants: Infection preventionists at participating hospitals.

Methods: Surveys were sent to infection preventionists from a national random sample of 881 US acute care hospitals. Questions covered use of technical interventions to prevent CLABSI (eg, alcohol-containing chlorhexidine gluconate [CHG] for skin antisepsis, use of coated catheters), socio-adaptive interventions (eg, feedback of CLABSI rates, use of appropriateness criteria), and leadership support for CLABSI prevention.

Results: Survey response rate was 47% (415/881). Technical interventions such as maximal sterile barriers (99%) or CHG-impregnated dressings (92%) were highly prevalent, but routine use of CHG bathing was less common (68% indicated regular use in intensive care unit [ICU] vs 18% in non-ICU settings). Although 97% of respondents indicated use of systems to monitor CLABSI, feedback to providers on CLABSI events was reported by 89%. Only 53% of respondents indicated regular use of tools to determine appropriateness of central venous catheters (CVC). Three-quarters of respondents indicated their hospital assessed CVC necessity daily, but only 23% reported strategies to reduce routine blood cultures. CLABSI prevention was extremely important to hospital leadership at 82% of responding hospitals.

Conclusions: Most US hospitals continue to use evidence-based methods to prevent CLABSI as recommended by leading organizations. Opportunities to focus on socio-adaptive interventions such as feedback of infection rates, use of appropriateness criteria for CVC placement, and improving the "culture of pan-culturing" remain.

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Introduction

Despite reductions in the incidence of central line-associated bloodstream infection (CLABSI), an estimated 31,000 CLABSIs continue to occur in US hospitals annually.[1] Success in reducing CLABSI may be attributed to implementing technical interventions, including practices at the time of central venous catheter (CVC) insertion (eg, use of alcohol-containing chlorhexidine for skin antisepsis) and advances in ensuring optimal maintenance of the device (eg, antiseptic-impregnated dressings).[2,3] Additionally, several newer innovations such as advanced dressings for the catheter site and implementation of chlorhexidine bathing among high-risk patients have been shown to contribute to reductions in CLABSI events.[3]

Much of the success and many of the practices core to preventing CLABSI were interrupted during the COVID-19 pandemic, which corresponded with an increase in CLABSI rates.[4,5] Although there are many explanations for the increased rates during this period, a key reason is that CLABSI prevention is not solely about technical aspects or use of technology-based innovations. Rather, behavioral or socio-adaptive aspects such as feedback of infection rates to providers, removing CVCs when they are no longer clinically indicated and more recently use of appropriateness criteria prior to placing a CVC are also relevant.[3,6] As we emerge from the pandemic, understanding current practices for CLABSI prevention and practices related to behavioral initiatives remains important.

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In this study, we examine reported rates of adherence to CLABSI prevention tactics as recommended by practice recommendations published by Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America and the Association for Professionals in Infection Control and Epidemiology using national surveys of lead infection preventionists at US hospitals.[3] We specifically sought to understand the use of technical, behavioral and leadership practices in preventing CLABSI.

Methods

Study design and data collection

In 2021, we performed a comprehensive survey aiming to understand practices used by infection preventionists in US hospitals to prevent hospital acquired infections.[7–10] We used data from the American Hospital Association to identify a national random sample of 900 hospitals from all 2,655 non-federal, general medical and surgical hospitals, each of which had an intensive care unit (ICU). Hospitals that were identified as closed or ineligible by a pre-survey Internet search or returned mail were removed from the sample. A total of 881 hospitals were identified as eligible and included in the 2021 survey.

The survey followed a modified Dillman approach.[11] A pre-survey letter was sent to the "Infection Control Coordinator" at all hospitals, notifying them to expect the survey mailing in the next week. The initial surveys were mailed in mid-April 2021 and included $10 as an incentive to complete the survey. Two weeks after the initial mailing, a reminder letter was sent to all non-respondents. To increase participation, additional reminder surveys were mailed to non-respondents approximately 1, 2, and 3 months after the initial mailing. Respondents were given the option of completing the survey on paper and returning in a postage-paid envelope or completing the survey electronically using REDCap electronic data capture tools.[12] At hospitals that employ more than one infection preventionist, we asked that the lead infection preventionist serve as the primary respondent, although we encouraged consulting with others as needed to complete the questionnaire. Similarly, if infection preventionists worked in a healthcare system with more than one facility, they were asked to respond to questions with respect to their primary site. Respondents were told that there were no right or wrong answers to the infection control practices; rather, our interest was to understand strategies being used for infection prevention.

Study measures

The survey instrument included questions about general hospital characteristics and characteristics of the infection prevention and control (IPC) program (eg, number of acute vs ICU beds, affiliation with medical schools, presence of a hospital epidemiologist). With respect to technical elements related to preventing CLABSI, questions regarding use of CLABSI insertion bundle elements (eg, maximum sterile barriers, alcohol-containing chlorhexidine gluconate [CHG] for skin antisepsis), technology-based interventions (eg, advanced securement devices, antimicrobial coated catheters, antiseptic-impregnated dressings) were posed. With respect to behavioral/socio-adaptive aspects related to CLABSI prevention, questions regarding whether reporting of infection rates to providers, use of evidenced-based indications/appropriateness criteria for CVC placement were asked. To understand the role of leadership in a post-COVID era, we asked respondents to provide feedback on perceived support from leadership as it related to CLABSI prevention efforts.

The survey assessed many practices on a 5-point Likert scale (1 = "never use" through 5 = "always use"). Binary variables for each practice were generated with regular use defined as a rating of 4 (almost always) or 5 (always) coded as 1 and 0 otherwise. Other questions had yes/no responses, such as reporting of infection rates and use of appropriateness criteria for CVC selection. Our survey instrument is provided as a Supplementary Appendix.

Statistical analysis

Descriptive statistics—N (%) for categorical variables, and median and range for continuous variables—were calculated for hospital characteristics and use of specific CLABSI prevention practices. Missing values for each of the variables presented were excluded from denominators in the generation of all descriptive statistics.

Ethical and regulatory oversight

This study was reviewed by the institutional review board at the University of Michigan and received an "exempt" status.

Results

General characteristics of respondents

Of 881 hospitals who received the survey invitation, lead infection preventionists from a total of 415 acute care hospitals responded and completed the survey (response rate: 47%). Technical and behavioral/socio-adaptive elements on the survey and associated responses are shown in the table (Table 1). Respondents represented sites that had an average of 214 acute care beds (SD = 218, median = 150, range = 11–1506) and 24 intensive care unit beds (SD = 33, median = 14, range = 0–222). A total of 34% (141/412) of hospitals were affiliated with a medical school. On average, 80% of hospital beds were reported as private. A total of 40% (161/399) of hospitals had a hospital epidemiologist on staff. When asked about the level of support they received from hospital leadership for the IPC program, 64% (266/413) rated their level of support as very good or excellent.

A total of 34% (133/395) of respondents indicated that critical care physicians were responsible for placing the majority of acute non-peripherally inserted CVCs. Conversely, 67% (266/395) of respondents reported that the majority of peripherally inserted central catheters (PICCs) were placed by designated nurse-led vascular access teams at their sites.

Use of technical practices to prevent CLABSI

Respondents from hospitals almost universally reported that inserters of non-peripherally inserted CVCs and PICCs routinely used maximal sterile barriers and alcohol-containing chlorhexidine gluconate (CHG) for skin antisepsis at the time of device placement (99% for both practices, 390/395 and 388/392, respectively). Notably, a high percentage of respondents (92%, 355/388) also reported the use of chlorhexidine-containing dressings (eg, BIOPATCH™) at the catheter insertion site as part of their CLABSI prevention strategies. The use of advanced securement devices (eg, Tegaderm™ IV Advanced, SecurAcath®) was also highly prevalent, with 91% (357/392) of respondents indicating that they used such a device. However, only 5% (18/360) of hospitals reported use of cyanoacrylate glue to seal the catheter exit site for reducing CLABSI, a practice with mixed evidence. Additionally, slightly less

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Table 1. Survey item descriptions and raw responses (see Figure 1)

Figure ID	Survey item	Responses[a]
Technical		
T1	Chlorhexidine gluconate for antisepsis of the insertion site	388/392
T2	Maximum sterile barrier precautions during catheter insertion	390/395
T3	Antimicrobial dressing with chlorhexidine	355/388
T4	Advanced securement devices	357/392
T5	Daily chlorhexidine bathing of ICU patients	264/388
T6	Impregnated/antiseptic catheters	178/376
T7	Daily chlorhexidine bathing of non-ICU patients[b]	72/399
T8	Cyanoacrylate glue	18/360
Behavioral and socio-adaptive		
B1	Established surveillance system to monitor CLABSI	388/399
B2	Reports CLABSI rates to direct care providers	356/399
B3	Conducts daily rounds to assess ongoing CVC necessity	301/404
B4	Process for determining appropriateness of PICCs prior to insertion	274/394
B5	Restricted list of appropriate indications for CVC insertion	211/386
B6	Process for determining appropriateness of CVCs prior to insertion	211/395
B7	Guidelines to determine appropriateness of PICC use	189/391
B8	Reduce unnecessary blood cultures[b]	97/415
Leadership[b]		
L1	Monitor hand hygiene by direct observation	385/402
L2	Very/extremely important to hospital leadership to prevent CLABSI	334/408
L3	Hand hygiene very/extremely important	326/401

Note. CLABSI, central line-associated bloodstream infection; CVC, central vascular catheter; ICU, intensive care unit; PICC, peripherally inserted central catheter.
[a]Numerator/Denominator for percent calculations in Figure 1. Numerator indicates number of respondents answering affirmatively to the given survey item. Denominator indicates total number of surveys received with an answer to the given survey item.
[b]These survey items do not appear in the guidelines.

than half of respondents (47%, 178/376) reported using antibiotic impregnated or antiseptic coated catheters as part of their CLABSI prevention strategy.[13,14]

Chlorhexidine bathing to prevent hospital-acquired infections including CLABSI was reported as being performed daily for ICU patients by 68% (264/388) of respondents. In the non-ICU setting, CHG bathing was reported as being performed daily only by 18% (72/399) of respondents.

Use of behavioral and socio-adaptive practices to prevent CLABSI

Slightly over half of all respondents (53%, 211/395) reported that they employed an established process (checklist, guideline, computer-system based decision tool) to determine the appropriateness of a non-peripherally inserted CVC prior to placement of the device. Interestingly, a greater proportion of respondents (70%, 274/394) indicated that device appropriateness was evaluated prior to placement of PICCs. A little over half (55%, 211/386) of infection preventionists reported that appropriateness was operationalized via a restricted list of clinical indications for central access, whereas 48% (189/391) indicated they used guidelines such as the Michigan Appropriateness Guidelines for Intravenous Catheters to determine appropriateness of PICC use.[6] Almost all respondents (97%, 388/399) indicated having an established surveillance system to monitor CLABSI, and 89% (356/399) reported sharing this data back to direct care providers.

A total of 23% (97/415) of respondents stated that strategies to reduce the collection of unnecessary blood cultures as a measure to reduce CLABSI were in place at their sites. When asked about practices to remove unnecessary devices to prevent CLABSI, 75% (301/404) of respondents indicated that their hospital conducted daily rounds to assess ongoing necessity of central access.

Leadership practices

Respondents were queried across a host of practices to understand how important infection prevention was to hospital leadership following COVID-19. When asked whether hand hygiene is very or extremely important at their hospital, 81% (326/401) indicated this was the case and 96% (385/402) reported that this was being audited by direct observation. Most respondents (82%, 334/408) indicated that they felt it was very/extremely important to hospital leadership to prevent CLABSIs. When queried as to whether their hospitals experienced staff shortages due to absences or illnesses during the COVID-19 pandemic, 88% (355/403) of respondents indicated this was the case. Almost all respondents indicated that they experienced a shortage of basic equipment for preventing CLABSI such as gowns, gloves, face shields and masks.

The reported regular use of various CLABSI prevention practices is illustrated in Figure 1.

Discussion

In this nationally representative survey of infection preventionists performed following the delta wave of COVID-19, several insights emerged. First, we observed that many of the technical practices known to reduce rates of CLABSI remained in high use at most hospitals.[15] In view of the pandemic and disruption to healthcare delivery, infection prevention and patient safety—this is good news. However, gaps in some evidence-based practices which are known to reduce the risk of CLABSI—such as chlorhexidine bathing—were observed. Second, when querying behavioral aspects aimed to prevent CLABSI, we found several additional gaps including lack of routine feedback of infection rates to inserters of devices. Even fewer respondents indicated that appropriateness criteria or decision aids were in use before placing central access. Finally, although the perceived importance of CLABSI to leadership was rated as high by respondents, gaps in the form of staff shortages and lack of basic equipment emerged as opportunities for improvement. Collectively, these findings suggest that use of several behavioral practices for preventing this important infection remained suboptimal during the COVID-19 pandemic.

In 2022, the recommendations for strategies used to prevent CLABSI in the acute care hospital setting were updated.[3] The literature search supporting the recommendation update spanned from January 2012 through August 2021. As such, the evidence supporting the specific CLABSI prevention practices was temporally aligned with when our infection prevention surveys

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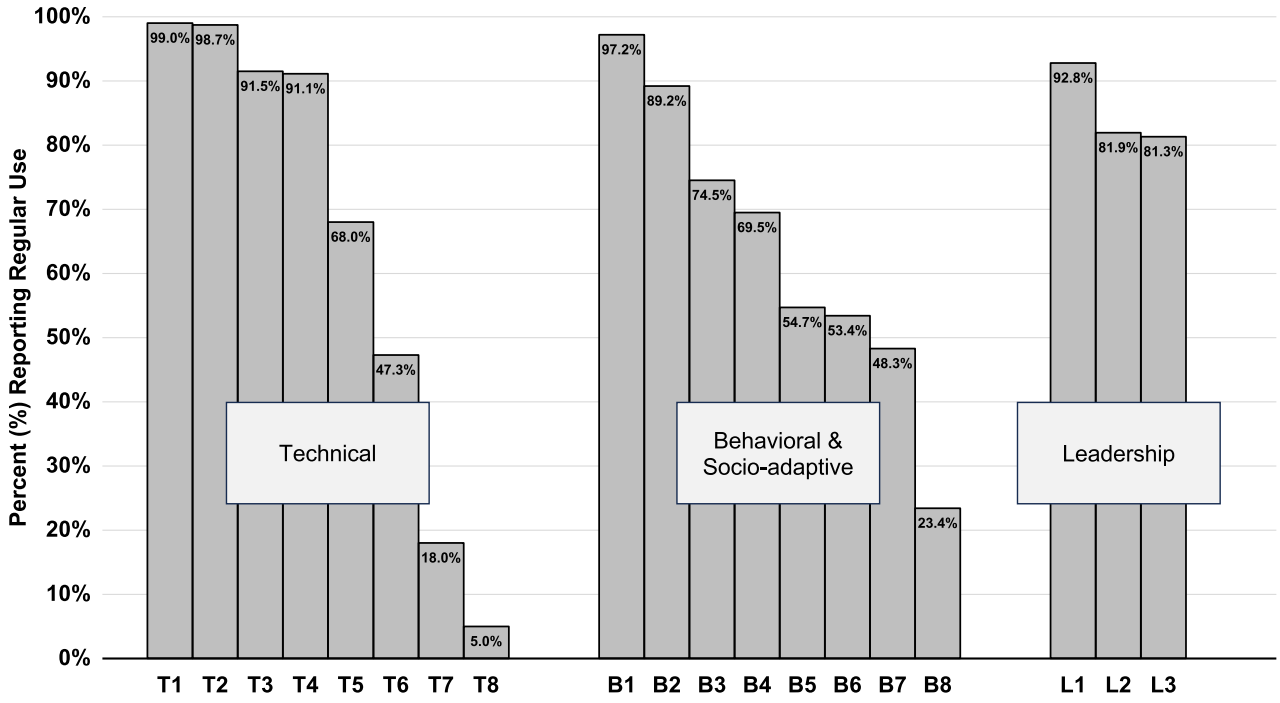

Figure 1. Proportion of respondents reporting regular use of infection prevention practices.

were distributed in 2021. A key change to the update was reclassifying various practices from "basic" to "essential" (practices which should be adopted by all hospitals) and "special" to "additional" (practices to be considered when CLABSI is not controlled after implementing essential practices). Our findings suggest that nearly all hospitals are implementing practices classified as essential with high strength of evidence supporting their use. For example, we found high reported use of antiseptic dressings with chlorhexidine—a practice previously listed as a special approach that became an essential practice in the 2022 update. Cross-sectional data from Saint et al. suggest that use of BIOPATCH® has steadily increased from approximately 78% in 2013 to nearly 92% in 2021.[15]

Technical innovations to prevent CLABSI such as use of alcohol-containing CHG offer relatively easy solutions to prevent these types of infections. Indeed, some have argued that they may be the most important component in reducing infection rates.[16] Results of this survey suggest that these practices remained in use across most of the sites surveyed. Despite the high utilization of dressings containing CHG, the practice of daily CHG bathing in critically ill patients is less prevalent, even though it is an essential practice supported by strong evidence showing its effectiveness and efficacy in reducing CLABSI.[17] In addition, use of some technical practices with mixed evidence (eg, advanced securement devices and cyanoacrylate glue) were reported.[18,19] One way to consolidate these findings in the context of COVID-19 is to consider the diffusion of these practices through the lens of provider burden. Chlorhexidine bathing, while effective, requires substantial nursing time and patient cooperation.[20,21] Even in times where staffing shortages were not a concern, compliance has remained suboptimal.[22] In contrast, technical interventions such as use of antibiotic impregnated or antiseptic coated catheters or using more advanced securement may be associated with a higher cost but are less time-intensive than behavioral strategies. Another essential practice that requires a behavioral intervention is the use of standard processes to determine the appropriateness of central line placement prior to insertion. However, only half of the respondents reported implementing this practice. It is therefore conceivable that there is a trend toward a pragmatic, albeit misguided over-reliance on technical aspects to prevent CLABSI.

Signals supporting the assertion that technical aspects may have overshadowed what is needed from harder to achieve behavioral changes are also present when examining use of appropriateness criteria or feedback of infection rates to providers. Although these elements are known to be effective at reducing rates of infectious and non-infectious complications from catheters, they require active engagement and human interaction to be successful. The best example of this paradigm is demonstrated by the fact that only a quarter of all respondents indicated that they had implemented practices to limit collection of routine blood cultures. The practice of "pan-culturing" that is heavily ingrained in many providers is known to contribute to high rates of CLABSI,[23,24] yet is among the hardest to eliminate when it comes to behavioral change. In an era where staff and supply shortages were experienced, one can understand why these behavioral changes were even more challenging to adhere to or implement.

Although this survey-based study sheds light on contemporary CLABSI prevention practices, our findings do have limitations. First, although we surveyed about one-third of all non-federal, medical/surgical US hospitals with ICU beds, employed a sampling strategy to obtain a nationally representative sample, and achieved a reasonable response rate (particularly during a pandemic), the hospitals choosing to participate may differ from those choosing not to participate, as highlighted by the high proportion of respondents who work at a facility associated with a medical school (34%). Additionally, the exclusion of acute care medical/surgical hospitals without an ICU, federally funded hospitals, and other hospital types (eg, psychiatric, OB/GYN, rehabilitation, orthopedics, various types of pediatric facilities, and acute long-term care facilities) from our sample impacts generalizability. Second, as

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with any survey-based study, bias in responses (eg, recall, social-desirability) may have occurred as we relied on a single respondent to report practices for their sites. We have no reason to believe that lead infection preventionists would be systematically unaware of practices to prevent CLABSI at their sites, but we cannot ascertain intra-facility differences. Third, while we asked about leadership practices, the extent these may have influenced CLABSI practices directly or indirectly is unclear. Our findings therefore should be viewed as hypothesis-generating in this respect.

Despite these limitations, our study has several strengths. First, we surveyed a large group of US infection preventionists during the COVID-19 pandemic to understand how CLABSI prevention practices were impacted. Insights from this study can help inform infection prevention policy and practice for US hospitals. For example, our findings related to promulgation of technical innovations perhaps at the expense of behavioral changes is important for sites struggling to reduce CLABSI. Second, we found that use of appropriateness criteria remains low and could represent an area for quality improvement, as has been shown by large scale studies.[6]

In conclusion, the results of our recent survey demonstrated high use of evidence-based technical interventions to prevent CLABSI, even during the COVID-19 pandemic when supply chains and staffing were strained. Moving forward, emphasis on behavioral interventions represents an area of opportunity for both practice and policy as human capital and leadership efforts can focus on quality initiatives.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/ice.2024.53.

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Competing interests. All authors report no conflicts of interest relevant to this article.

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