



Reducing Central Line Associated Bloodstream Infections (CLABSIs) by Reducing Central Line Days

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Abstract

Purpose of Review While reducing unnecessary days present of central venous catheters (CVCs) is part of central line associated bloodstream infection (CLABSI) best practices, there is limited information regarding compliance with this recommendation as well as addressing barriers to compliance.

Recent Findings Significant work has been directed towards daily audits of necessity and improving communication between members of the medical team. Other critical interventions include utilization of the electronic health record (EHR), leadership support of CLABSI reduction goals, and avoiding CVC placement over more appropriate vascular access.

Summary Institutions have varied approaches to addressing the issue of removing idle CVCs, and more standardized approaches in checklists as well as communication, particularly on multidisciplinary rounds, will be key to CVC removal. Utilization of the EHR for reminders or appropriate documentation of necessity is a factor. Avoidance of placing a CVC or appropriateness of the CVC is also important to consider.

Keywords Central line associated bloodstream infections · Infection prevention · Central line days · Midline catheters

Introduction

There is a renewed focus on patient safety and delivering high-quality health care, with the elimination of healthcare associated infections (HAIs) as a significant goal [1, 2]. “Getting to zero” is a difficult target; while HAIs are preventable, it is unclear if zero HAIs is achievable. Regardless, approximately 65 to 70% of both catheter associated urinary tract infections (CAUTI) and central line associated blood stream infection (CLABSI) may be preventable, as well as 55% of ventilator associated pneumonia [3]. Using the National Health Safety Network (NHSN) data, the

Centers for Disease Control and Prevention (CDC) reported a 50% drop in central line associated blood stream infections (CLABSIs) between 2008 and 2016, emphasizing the collaborative effort amongst healthcare providers for safer and reduced central line use [1]. New Health and Human Safety (HHS) goals included a further 50% reduction in CLABSI by 2020 [1].

The elimination of HAIs has significant impact on the American healthcare system. Estimates vary on the number of patients individually affected; estimates in 2018 had approximately 160,000 Americans dying from medical errors, of which HAIs contribute a significant percentage [4]. Failure to remove a central venous catheter (CVC) in patients who have been audited for removal was strongly associated with 30-day all-cause mortality, albeit in patients who had multi-drug resistant CLABSIs [5]. Aside from the personal impact, HAIs have significant financial impact, with CLABSI costing anywhere between \$40,412 and \$100,980 [6]. CLABSIs contribute 18.9% towards the estimate \$9.8 billion HAIs cost the US healthcare system [7].

Approximately 29% of inpatients have CVCs in one point prevalence study; it ranges from 43 to 80% in intensive care unit (ICU) patients and 7 to 39% in non-ICU patients [8].

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While the range is lower in the non-ICU setting, the actual number is higher due to the volume of patients hospitalized outside the ICU. A key point in prevention of CLABSI is removal of nonessential catheters, an aspect of infection prevention noted in the literature from the 1990s and emphasized in the latest Society for Healthcare Epidemiology of America (SHEA) and Infectious Diseases Society of America (IDSA) *Strategies to Prevent Central Line-Associated Bloodstream Infections in Acute Care Hospitals: 2014 Update*. At that time, the quality of evidence for removal of the idle catheter was only deemed of “moderate” quality, which indicates limited studies or significant variation in studies [9].

Various well-known measures, such as procedures and protocols in hospital, have been established to eliminate CLABSI. Examples include avoidance of vascular catheters in the femoral area in obese patients as well as performing appropriate hand hygiene and using aseptic technique throughout insertion; all are part of CDC guidance to prevent CLABSI [10]. As healthcare systems implement insertion bundles and checklists, limiting the number of times the central line is accessed and ensuring sterilization of the caps of the lumens, attention turns to the necessity of the central line.

Limiting CVC “days present” is a critical aspect of prevention of CLABSI; if a central line is not present, a patient cannot get a CLABSI. Interventions to reduce unnecessary CVC use significantly decreases rates of CLABSI, from 24.4 to 100%; however, there are few studies given over to strategies limiting unnecessary CVC use [11•]. A total of 4.8% of catheters days present in the ICU were deemed unnecessary in one review [12]. Idle catheters pose significant risk for infection: 26.2% of catheters are unused after intensive care unit (ICU) discharge [13]. 63% of patients with CVC had at least 1 day of idleness [14]. Mean dwell time is longer once patients leave the ICU: on average, they dwell for 8 days (range 3–15), compared to 4 days (2–7) in the ICU [12]. Patients also may have retained CVC despite having a working peripheral intravenous access, with 3.4 days of overlap in one study [14]. Continued infusion of parenteral antibiotics is usually utilized as the reason for continued presence. While there are complex patient care issues at play, the convenience of the central line for blood draws and continued infusions should not be a factor in its continued presence.

One study demonstrated that 8.3% of physicians and nurses were unaware of the CVC clinical necessity in non-ICU settings, while 21.2% of clinicians were completely unaware of the CVC presence through all levels of care [12, 15]. One of the obstacles to overcome to achieve timely removal of unnecessary central lines is that some providers are unaware that their patient has a central line in place. This lack of awareness was more common in clinical areas

outside the ICU, and peripherally inserted central catheter (PICC) lines were the type of CVC that providers were most frequently unaware of; teaching attendings and hospitalists were more frequently unaware of the presence of CVCs than interns and residents (25.8% and 30.5%, respectively, vs. 16.4%). Critical care physicians were more likely to be aware of CVC presence than general medicine physicians (12.6% vs. 26.2%; $P=0.003$) [15].

Limiting days present for CVC is as an essential adjunct to other CLABSI prevention tools. Themes identified as barriers for timely removal include catheter data are hard to find or inaccurate; catheter removal is not a priority; confusion exists over who has the authority to remove catheters or who “owns” the catheter; there is a lack of awareness, as well as agreement, on indications for removal; and communication barriers amongst clinicians create challenges [16••]. Interventions frequently target several of these themes. Concepts addressed here are line audits, safety culture, and alternative lines as these are the primary motifs in the literature to address limiting the days present of CVC.

Daily Audits

Daily review of central line necessity by an interdisciplinary team is one of the five standard practices to mitigate risk of CLABSI [17, 18]. Discussion of device presence only occurs in approximately 50% of audited rounds in the ICU [18]. The risk of infection increases with extended duration of the CVC; thus, one critical intervention is employing a strategy to discuss clinical indication for necessity and promptly remove unnecessary CVCs [19]. One study that implemented the utilization of an evidence-based checklist in daily rounds found their ICU’s percentage of unnecessary CVC days dropped from 51 to 26% [20]. They also found that the CLABSI rate decreased concurrently, though admit that other factors, including improvement in hand hygiene compliance, may also play a role in the infection reduction [20].

Another study used the “On the CUSP: Stop BSI” program and the CLABSI Prevention Bundle [21]. One key feature of the program was creating a daily goal regarding removal of the CVC, supporting the daily assessment of line necessity. Unit leaders were responsible for reporting adherence to the program and central line removal on a monthly basis [21]. The results demonstrated an estimated 21.7 fewer line days compared with the baseline by the 6th quarter of participation. They acknowledged that although a patient may have a CVC removed, the ‘line days’ may not reflect this due to the CVC days counted as one day even if the line is removed early in the day and also may have multiple venous catheters [21]. The study also demonstrated a decrease in CLABSI rate immediately after the first quarter

of interventions, and a 43% reduction after 18 months at the completion of the program (10 quarters); this corresponded also to a reduction of 4% of days present by the end of the program [21].

Audits may not always be successful in decreasing days present, but may impact CLABSI regardless. Leadership implementation of a program called “health care failure mode and effect analysis” (HFMEA) which analyzes central line insertion, maintenance, and removal practices emphasized the discussion of CVC necessity during daily rounds and implemented an updated worksheet for team members to use from patient to patient [22]. After the implementation of HFMEA, the data showed that the CLABSI rate was reduced from 2.6 to 0.8; however, there was essentially no change in the CVC rate [22]. As previously noted, the CDC checklist for prevention of CLABSI includes performing daily audits to assess whether each central line is still needed [10]. While in this HFMEA project, they instituted their own worksheet, utilization of a worksheet or checklist that can be individualized to each institution is essential for CLABSI prevention as well as limiting excess days present. These checklists may also help ensure the line is actually removed if it is unnecessary, something that may not occur despite the audit.

Multidisciplinary Rounds

Ideally, the patient’s nurse and their medical providers would communicate during daily rounds and jointly assess the necessity of the CVC. Several qualitative studies reviewed demonstrated similar findings that there are several barriers to this interdisciplinary communication. Interviews and direct observations revealed nurses were often unable to attend team rounds and discuss line presence due to higher patient care ratios, workload, or timing and awareness of physician rounds [16••, 17, 23•]. Non-ICU nurses encounter greater challenges with communication as most are considered open units, meaning physician teams have patients on several floors of the hospital, leading to difficulty aligning schedules [17, 23•]. More studies need to be done to provide data surrounding the open units in non-ICU areas.

One ICU-based program created a toolkit to improve nursing presence and communication during rounds within the ICU. The study utilized Lean Six Sigma health care principles which involved the application of A3 Thinking, PDCA (Plan-Do-Check-Act), and DMAIC (Define, Measure, Analyze, Improve, Control) methodologies [24•]. This format created a system where nurses were notified based on a schedule of rounds, physicians required nursing input, and an action plan for the patient was created prior to moving to the next room. Nursing attendance in rounds increased to 91.0% and also resulted in increased communication and engagement from nurses to physicians [24•]. This study method can be used in future studies to verify validity in

decreasing the rate of unnecessary CVCs; however, this did not correlate if this type of toolkit can be utilized in the reduction of patient harm or line days [24•].

Utilizing the Electronic Health Record

Approximately 20% of healthcare workers are unaware of their patient’s CVC, and some clinicians claim that they had a lack of awareness of the CVC due to difficulty navigating the EHR or lack of electronic documentation due to paper usage [16••, 23•]. During physician rounding, another common communication barrier reported revolved around location of CVC information within the EHR. This was termed a cognitive complexity due to the increased efforts by clinicians to first recall where to locate the necessity information, then create a decision about the ongoing need [16••, 23•]. Nurses reported that when they were available during rounds, the discussion regarding CVC access and removal was not appropriately entered into the EHR which further complicated the continuity of care and decisions for future team members [17]. There is a necessity to standardize the documentation around CVCs as a method to combat inconsistent verbal communication [17]. Quinn et al. did suggest measures to facilitate improvement between EHR and CVC awareness by incorporating alerts based on specified days in place, electronic reminders, checklists, and tools for generating discussions [16••]. Other studies were able to identify barriers regarding data identification in the EHR; however, they did not give suggestions or test strategies to improve this process.

Reminder systems may take the many formats: verbal, written, infographics, printed, electronic, and embedded in the EMR; seven of fourteen studies in a systematic review included daily reminders [11•]. Reminder systems can be implemented to help raise awareness of lines and aid in appropriate removal. These reminders can prompt staff to conduct a daily assessment of need to assess for appropriateness of line use, which we have already addressed. This remains an area for addressing, and as attention towards utilizing the EHR in a human factors engineering approach to work smarter, utilizing reminders or other tools within the EHR is critical. It is also relevant to acknowledge physicians and nurses, including infection preventionists, frequently have different views or settings to their EHR, which limits generalizability of some of the functions within the EHR.

Safety Culture: It Starts with Leadership

It is well established that senior management is responsible for ensuring the healthcare system supports infection prevention programs that effectively prevent HAIs and that all

healthcare personnel are adequately trained to ensure they can perform their job. It is ultimately the responsibility of leadership to ensure evidence-based practices are used, and both senior and unit leadership are responsible for holding staff accountable for their actions [9].

In the *A Framework for Safe, Reliable, and Effective Care* white paper, the Institute for Healthcare Improvement outlines a framework for creating a “system of safety” [25]. This framework involves leadership providing feedback to staff to demonstrate their commitment to building a safety culture. One way to provide this feedback is by sharing the CVC device utilization at the unit level. Feedback at the unit level was also a critical element of the “On the CUSP: Stop BSI” program by “measuring and providing feedback about CLABSI rates and results of unit-level patient safety culture scores to unit-based improvement teams and senior leaders” [21]. While data is frequently shared with leadership, it does not always get presented to frontline staff, leaving them blind to how their actions affect patient safety, positively or negatively.

The commitment by leadership can be one tool to create a culture of safety and demonstrates a priority for removing CVCs when no longer necessary. In addition to unit-based CVC rounds, some healthcare systems have had success by having system-wide daily CVC rounds including unit leaders, infection preventionists, and hospital administrators. Including leaders on the “daily interdisciplinary safety huddle” (DISH) and ensuring the leaders helped eliminate barriers after the infection preventionist recommends removal of device lead to reduced CLABSI and CAUTI, with estimated cost avoidance of \$688,050 in a 151-bed community hospital [26]. The additional attention from leadership can help to overcome barriers that may have been insurmountable to frontline staff alone. The financial savings can be a powerful incentive for leadership.

Dedicated time for CLABSI-reduction initiatives, supportive by hospital leadership, is critical to success [27, 28]. Recognition and celebration of milestones has been noted to foster a sense of pride, mission, and value amongst all the various stakeholders, including bedside nursing staff [27]. Staff champions are a well-recognized feature of many infection prevention or quality improvement measures which also helps drive accountability on a group or unit level, which can create a connection between a leadership quality goal and the individual units making up that healthcare system.

Policy

Some hospitals may have set a “zero harm” policy as well, in an effort to get to the elusive goal of elimination of HAIs. There must be written policies to support these HAI reduction efforts. However, few hospital policies specifically

address removal or retention of CVCs [29]. Bianco found that written policies in addition to staff training and staff with fewer years of practice increased the knowledge, best practices, and positive staff attitudes around CLABSI prevention initiatives. Adding evidence-based best practices, such as timely removal of unnecessary CVCs, into a written organizational policy can be an important element to implement best practice more quickly into frontline practice [30•].

As many healthcare systems deploy quality improvement and emphasize improving patient care via Lean Six Sigma, Team STEPPS, Plan-Do-Study-Act cycles, and other tools in attempts to become high reliability organizations, it is a worthwhile endeavor for these projects’ successes become embedded in policy, driving ongoing improvement efforts and no lost ground when the projects are “complete.”

Standardization of care is critical, another acknowledgment of healthcare’s goals towards becoming high reliability organizations for whom errors are rare rather than commonplace. Written policies establishing standards could be helpful: standardize safety huddles or standardize hand offs between peers, something that can be achieved via written policies at an institution.

Alternative Catheters

To reduce days present for central lines, other lines arise as potential targets: get the central line out but place a different kind of line. Midline catheters are vascular access devices that are inserted in the peripheral veins of the upper extremity. While avoiding the central venous veins but being longer and coursing deeper than traditional peripheral catheters, midline catheters are a unique alternative for vascular access [31]. Midline catheter programs are used by hospitals to avoid CLABSIs and associated financial penalties, an attractive benefit for any healthcare system [31]. Midline catheters can be associated with significantly fewer central line days, as well as significant cost savings (insertion of a midline being < \$90), with multiple teams possibly being utilized for their placement (house staff, vascular access nurses, interventional radiology) [32–34].

Pathak showed that in their community hospital, they were able to decrease the incidence of CLABSI with implementation of CDC-based recommendations, including a CVC insertion and maintenance bundle, but achieved a greater and statistically significant decrease in CLABSI with the addition of a midline program led by a vascular access team. CLABSI rate was 0.289% pre-intervention and decreased to 0.047% post intervention [35].

Similarly, DeVries et al. demonstrated that a midline catheter program can decrease CLABSI when coupled with device selection algorithms. In their organization, the midline program was launched to reduce unnecessary

central line days and decrease CLABSI. During the first 2 years of the program, there were zero blood stream infections associated with a midline [36]. Complications in the midlines were as follows: dislodgment rates were similar between PICCs and midlines (7% versus 8%) and better than what was seen with peripheral IVs (14%). Infiltration rates were lower in midline catheters (1.4%) than peripheral catheters (17%) [36].

Midline catheters, when appropriately selected, can be a safe alternative to CVC. Mustaq et al. sought to evaluate the incidence of bloodstream infections and other complications related to the use of midline catheters compared to CVC. In a retrospective review of 411 patients across 12 hospitals, more BSIs were seen in patients with a CVC (10/282) versus a midline catheter (1/411) (3.5% versus 9.2%; $P=0.0008$). However, more mechanical complications were associated with midline catheters (2.6% versus 0.3% in CVC). The most common mechanical complication occurring in midline catheters was leakage [37]. Midline catheters have decreased rates of phlebitis and bloodstream infection when compared to peripheral IVs and CVCs respectively. A review noted the incidence of bloodstream infection in midline catheters in the range of 0.2–2.5% and found midline catheter programs result in decreased CLABSI overall [38]. While midlines were more likely to be associated with mechanical complications, serious complications like CLABSI and thrombosis are not significantly different in midlines compared to CVC (including PICCs and other CVCs) [34, 39].

Sween et al. through a quality improvement project, decreased utilization of multilumen PICC catheters by modifying the electronic order for PICCs, defaulting PICC line orders to a single lumen and adding an informational screen to help providers select the appropriate line, which included the choice of a midline catheter. The program decreased the incidence of multilumen PICCs with a downward trend in CLABSI related PICCs, but not a statistically significant decrease [40].

A midline program, at its core, decreases CLABSI by reducing the use of central lines. Literature supports a decrease in CLABSI in midline catheters when coupled with other CLABSI reduction strategies, such as insertion and maintenance bundles and device selection strategies. Studies to better define indications for use, optimal insertion technique, and best care and maintenance practices for vascular access are needed [31]. Larger studies are needed to weigh benefit of reduced CLABSI versus increased mechanical complications in midline catheters [37]. Institution wide improved vascular access decision making is needed overall, to include the consideration of midline catheter program as a tool [38]. Institutions should consider midline catheters as a tool in multilevel vascular access strategy.

Avoid CVC Placement

To avoid any days present of CVCs and thus CLABSIs, it is also worth recognizing whether the most appropriate venous access point was utilized upfront. The Michigan Appropriateness Guide from Intravenous Catheters (MAGIC) outlines standards for placing a PICC, as there was significant variation in provider's knowledge about appropriate indications for vascular access, as well as presence of the devices. The implication and potential broad application of these guidelines help quantify appropriate use of venous access devices and therefore improve quality and safety of venous access in hospitalized adults [41••]. Many CVCs may be placed due to reported difficulty in vascular access in particular patients; however, ultrasound guided peripheral IVs also remain a good alternative in patients with difficult venous access [11•].

Conclusions

There is significant work to do regarding awareness of the idle CVC but the tools exist: improved communication and awareness, potentially via the EHR; awareness of alternative lines and guidelines on which vascular access may be most appropriate; and promotion of a safety culture. As low hanging fruit for CLABSI prevention is (or should be) standard of care in the modern era, it is time to tackle these more complex issues. CVC removal to prevent CLABSI is an obvious solution with complex interventions, but tools exist for improvement in reducing days present and decrease CLABSI rates.

Compliance with Ethical Standards

Conflict of Interest ASMB, DH, GV, and PB all declare no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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