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Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals: 2014 Update

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purpose

Previously published guidelines are available that provide comprehensive recommendations for detecting and preventing healthcare-associated infections (HAIs). The intent of this document is to highlight practical recommendations in a concise format designed to assist acute care hospitals in implementing and prioritizing their central line–associated bloodstream infection (CLABSI) prevention efforts. This document updates "Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals,"[1] published in 2008. This expert guidance document is sponsored by the Society for Healthcare Epidemiology of America (SHEA) and is the product of a collaborative effort led by SHEA, the Infectious Diseases Society of America (IDSA), the American Hospital Association (AHA), the Association for Professionals in Infection Control and Epidemiology (APIC), and The Joint Commission, with major contributions from representatives of a number of organizations and societies with content expertise. The list of endorsing and supporting organizations is presented in the introduction to the 2014 updates.[2]

section 1: rationale and statements of concern

I. Patients at risk for CLABSIs in acute care facilities
  A. Intensive care unit (ICU) population: the risk of CLABSI in ICU patients is high. Reasons for this include the frequent insertion of multiple catheters, the use of specific types of catheters that are almost exclusively inserted in ICU patients and associated with substantial risk (eg, pulmonary artery catheters with catheter introducers), and the fact that catheters are frequently placed in emergency circumstances, repeatedly accessed each day, and often needed for extended periods of time.[3,4]
  B. Non-ICU population: although the primary focus of attention over the last 2 decades has been the ICU setting, the majority of CLABSIs occur in hospital units outside the ICU or in outpatients.[5-10]
  C. Infection prevention and control efforts should include other vulnerable populations, such as patients receiving hemodialysis through catheters,[11] intraoperative patients,[12] and oncology patients.
  D. Besides central venous catheters (CVCs), peripheral arterial catheters also carry a risk of infection.[3]

II. Outcomes associated with hospital-acquired CLABSI
  A. Increased length of hospital stay.[13-17]
  B. Increased cost (the non-inflation-adjusted attributable cost of CLABSIs has been found to vary from $3,700 to $39,000 per episode[14,17-19]).

III. Independent risk factors for CLABSI (in at least 2 published studies)[20-25]
  A. Factors associated with increased risk.
    1. Prolonged hospitalization before catheterization
    2. Prolonged duration of catheterization
    3. Heavy microbial colonization at the insertion site
    4. Heavy microbial colonization of the catheter hub
    5. Internal jugular catheterization
    6. Femoral catheterization in adults

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7. Neutropenia
8. Prematurity (ie, early gestational age)
9. Reduced nurse-to-patient ratio in the ICU[26,27]
10. Total parenteral nutrition
11. Substandard catheter care (eg, excessive manipulation of the catheter)
12. Transfusion of blood products (in children)

B. Factors associated with reduced risk.
1. Female sex
2. Antibiotic administration[22,28]
3. Minocycline-rifampin-impregnated catheters[29,30]

SECTION 2: BACKGROUND—STRATEGIES TO DETECT CLABSI

I. Surveillance protocol and definition of CLABSIs
A. Use consistent surveillance methods and definitions to allow comparison to benchmark data.
B. Refer to the *National Healthcare Safety Network (NHSN) Manual: Patient Safety Component Protocol* for information on the appropriate surveillance methodology, including information about blood specimen collection, and for surveillance definitions of CLABSIs. The relevant sections of the manual are "Identifying Healthcare-Associated Infections (HAI) in NHSN," "Device-Associated Module: Methodology," and "Device-Associated Module: Central Line–Associated Bloodstream Infection (CLABSI) Event."[31]
1. Recent data suggest that interrater reliability using NHSN definitions is lower than expected.[32-34] This may also affect the reliability of public reporting. Additionally, the NHSN surveillance definition for CLABSI is different from the clinical definition for catheter-related bloodstream infection.[35]

SECTION 3: BACKGROUND—STRATEGIES TO PREVENT CLABSI

I. Existing guidelines and recommendations
A. Several governmental, public health, and professional organizations have published evidence-based guidelines and/or implementation aids regarding the prevention of CLABSI, including the following:
1. The Healthcare Infection Control Practices Advisory Committee (HICPAC), Centers for Disease Control and Prevention[36,37]
2. The Institute for Healthcare Improvement[38]
3. The Agency for Healthcare Research and Quality[39]
4. The American Pediatric Surgical Association Outcomes and Clinical Trials Committee[40]
5. The Joint Commission[41]
6. APIC[42]
7. The Infusion Nurses Society[43]

B. The recommendations in this document focus on CVCs unless noted otherwise. These recommendations
1. Are not stratified on the basis of catheter type (eg, tunneled, implanted, cuffed, noncuffed catheter, and dialysis catheter) and
2. May not be applicable for prevention of bloodstream infections with other intravascular devices.

II. Infrastructure requirements include the following:
A. An adequately staffed infection prevention and control program responsible for identifying patients who meet the surveillance definition for CLABSI.
B. Information technology to collect and calculate catheter-days as a denominator when computing rates of CLABSI and patient-days to allow calculation of CVC utilization. Catheter-days from information systems should be validated against a manual method, with a margin of error no greater than ±5%.
C. Resources to provide appropriate education and training.
D. Adequate laboratory support for timely processing of specimens and reporting of results.

SECTION 4: RECOMMENDED STRATEGIES FOR CLABSI PREVENTION

Recommendations are categorized as either (1) basic practices that should be adopted by all acute care hospitals or (2) special approaches that can be considered for use in locations and/or populations within hospitals when CLABSIs are not controlled by use of basic practices. Basic practices include recommendations where the potential to impact CLABSI risk clearly outweighs the potential for undesirable effects. Special approaches include recommendations where the intervention is likely to reduce CLABSI risk but where there is concern about the risks for undesirable outcomes, where the quality of evidence is low, or where evidence supports the impact of the intervention in select settings (eg, during outbreaks) or for select patient populations. Hospitals can prioritize their efforts by initially focusing on implementing the prevention approaches listed as basic practices. If CLABSI surveillance or other risk assessments suggest that there are ongoing opportunities for improvement, hospitals should then consider adopting some or all of the prevention approaches listed as special approaches. These can be implemented in specific locations or patient populations or can be implemented hospital-wide, depending on outcome data, risk assessment, and/or local requirements. Each infection prevention recommendation is given a quality-of-evidence grade (see Table 1).

Note that some of the following measures have been combined into a "prevention bundle" that focuses on catheter insertion (eg, measures B.2, B.3, B.6, B.7, and C.3).[44-46] Numerous studies have documented that use of such bundles is effective, sustainable, and cost-effective in both adults and children.[47-50] Bundles are most likely to be successful if implemented in a previously established patient safety culture, and their success depends on adherence to individual mea-

TABLE 1. Grading of the Quality of Evidence

Grade	Definition
I. High	Highly confident that the true effect lies close to that of the estimated size and direction of the effect. Evidence is rated as high quality when there is a wide range of studies with no major limitations, there is little variation between studies, and the summary estimate has a narrow confidence interval.
II. Moderate	The true effect is likely to be close to the estimated size and direction of the effect, but there is a possibility that it is substantially different. Evidence is rated as moderate quality when there are only a few studies and some have limitations but not major flaws, there is some variation between studies, or the confidence interval of the summary estimate is wide.
III. Low	The true effect may be substantially different from the estimated size and direction of the effect. Evidence is rated as low quality when supporting studies have major flaws, there is important variation between studies, the confidence interval of the summary estimate is very wide, or there are no rigorous studies, only expert consensus.

NOTE. Based on Grades of Recommendation, Assessment, Development, and Evaluation (GRADE)[257] and the Canadian Task Force on Preventive Health Care.[258]

sures.[51] However, recent data suggest that not all components of bundles may be necessary to achieve an effect on CLABSI rates.[52] After catheter insertion, maintenance bundles have been proposed to ensure optimal catheter care.[53] More data are needed to determine which components of the maintenance bundle are essential in reducing risk.[54,55]

I. Basic practices for preventing and monitoring CLABSI: recommended for all acute care hospitals
  A. Before insertion
    1. Provide easy access to an evidence-based list of indications for CVC use to minimize unnecessary CVC placement (quality of evidence: III).
    2. Require education of healthcare personnel involved in insertion, care, and maintenance of CVCs about CLABSI prevention (quality of evidence: II).[56-60]
      a. Include the indications for catheter use, appropriate insertion and maintenance, the risk of CLABSI, and general infection prevention strategies.
      b. Ensure that all healthcare personnel involved in catheter insertion and maintenance complete an educational program regarding basic practices to prevent CLABSI before performing these duties.[61,62] Periodic retraining with a competency assessment may be of benefit.[63]
      c. Ensure that any healthcare professional who inserts a CVC undergoes a credentialing process (as established by the individual healthcare institution) to ensure their competency before independently inserting a CVC.
      d. Reeducate when an institution changes components of the infusion system that requires a change in practice (eg, when an institution's change of the needleless connector requires a change in nursing practice).
      e. Consider using simulation training for proper catheter insertion technique.[64-66]
    3. Bathe ICU patients over 2 months of age with a chlorhexidine preparation on a daily basis (quality of evidence: I).[67-70]
      a. In long-term acute care hospitals, daily chlorhexidine bathing may also be considered as a preventive measure.[71]
      b. The role of chlorhexidine bathing in non-ICU patients remains to be determined.[72]
      c. The optimal choice of antiseptic agents is unresolved for children under 2 months of age. However, chlorhexidine is widely used in children under 2 months of age.[73] A US survey found that in the majority of neonatal ICUs (NICUs) chlorhexidine products are used for catheter insertion in this age group.[74] For chlorhexidine gluconate (CHG)–based topical antiseptic products, the Food and Drug Administration recommends "use with care in premature infants or infants under 2 months of age; these products may cause irritation or chemical burns." The American Pediatric Surgical Association recommends CHG use but states that "care should be taken in using chlorhexidine in neonates and premature infants because of increased risk of skin irritation and risk of systemic absorption."[40] Concerns in children under 2 months have been noted elsewhere.[75] Cutaneous reactions to CHG have also been reported in extremely-low-birth-weight neonates under 48 hours of age;[76] however, in a small pilot trial of neonates under 1,000 g and at least 7 days of age, severe contact dermatitis did not occur, although CHG was cutaneously absorbed.[77] These findings have not been replicated in a recent trial in neonates weighing more than or equal to 1,500 g.[78,79] Some institutions have used chlorhexidine-containing sponge dressings for CVCs[79] and chlorhexidine for cleaning CVC insertion sites in children in this age group with minimal risk of such reactions.[40] Providers must care-

fully weigh the potential benefit in preventing CLABSI in children under 2 months and the risks of CHG, recognizing that term and preterm infants may have different risks. Alternative agents, such as povidone-iodine or alcohol, can be used in this age group.[80]

B. At insertion
1. Have a process in place to ensure adherence to infection prevention practices at the time of CVC insertion in ICU and non-ICU settings, such as a checklist (quality of evidence: II).[45,81,82]
   a. Ensure and document adherence to aseptic technique.
      i. Checklists have been suggested to ensure optimal insertion practices. If used, the documentation should be done by someone other than the inserter.
      ii. Observation of CVC insertion by a nurse, physician, or other healthcare personnel who has received appropriate education (see above) to ensure that aseptic technique is maintained.
      iii. Such healthcare personnel should be empowered to stop the procedure if breaches in aseptic technique are observed.
2. Perform hand hygiene prior to catheter insertion or manipulation (quality of evidence: II).[83-87]
   a. Use an alcohol-based waterless product or antiseptic soap and water.
      i. Use of gloves does not obviate hand hygiene.
3. Avoid using the femoral vein for central venous access in obese adult patients when the catheter is placed under planned and controlled conditions (quality of evidence: I).[28,88-90]
   a. Additional factors may influence the risk of CLABSI in patients with femoral vein catheters.[91,92]
   b. Femoral vein catheterization can be done without general anesthesia in children and has not been associated with an increased risk of infection in this population.[93]
   c. Controversy exists regarding infectious and noninfectious complications associated with different short-term CVC access sites.[89,94] The risk and benefit of different insertion sites must be considered on an individual basis with regard to infectious and noninfectious complications (eg, patients with jugular access may have a higher infection risk if they have a concurrent tracheostomy[95]).
   d. Do not use peripherally inserted CVCs (PICCs) as a strategy to reduce the risk of CLABSI.
      i. The risk of infection with PICCs in ICU patients approaches that of CVCs placed in the subclavian or internal jugular veins.[96,97]
      ii. The majority of CLABSIs due to PICCs occur in non-ICU settings.[98] The PICC-associated CLABSI risk may be different outside the ICU.
4. Use an all-inclusive catheter cart or kit (quality of evidence: II).[45]
   a. A catheter cart or kit that contains all necessary components for aseptic catheter insertion has to be available and easily accessible in all units where CVCs are inserted.
5. Use ultrasound guidance for internal jugular catheter insertion (quality of evidence: II).[99]
   a. Ultrasound-guided internal jugular vein catheterization reduces the risk of CLABSI and of noninfectious complications of CVC placement.[100]
6. Use maximum sterile barrier precautions during CVC insertion (quality of evidence: II).[101-107]
   a. Use maximal sterile barrier precautions.
      i. A mask, cap, sterile gown, and sterile gloves are to be worn by all healthcare personnel involved in the catheter insertion procedure.
      ii. The patient is to be covered with a large ("full-body") sterile drape during catheter insertion.
   b. These measures must also be followed when exchanging a catheter over a guidewire.
   c. A prospective randomized study in surgical patients showed no additional benefit for maximal sterile barrier precautions;[105] nevertheless, most available evidence suggests risk reduction with this intervention.
7. Use an alcoholic chlorhexidine antiseptic for skin preparation (quality of evidence: I).[108-111]
   a. Before catheter insertion, apply an alcoholic chlorhexidine solution containing more than 0.5% CHG to the insertion site.[112]
      i. The antiseptic solution must be allowed to dry before making the skin puncture.

C. After insertion
1. Ensure appropriate nurse-to-patient ratio and limit the use of float nurses in ICUs (quality of evidence: I).[26,27,113,114]
   a. Observational studies suggest that there should be a nurse-to-patient ratio of at least 1 to 2 in ICUs where nurses are managing patients with CVCs and that the number of float nurses working in the ICU environment should be minimized.
2. Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter (quality of evidence: II).[115-119]
   a. Before accessing catheter hubs, needleless connectors, or injection ports, vigorously apply mechanical friction with an alcoholic chlorhexidine preparation, 70% alcohol, or povidone-iodine. Alcoholic chlorhexidine may have additional residual activity compared with alcohol for this purpose.[120]
   b. Apply mechanical friction for no less than 5 seconds to reduce contamination.[121,122] It is unclear whether this duration of disinfection can be generalized to needleless connectors not tested in these studies.

c. Monitor compliance with hub/connector/port disinfection since approximately half of such catheter components are colonized under conditions of standard practice.[117,121]

3. Remove nonessential catheters (quality of evidence: II).[123,124]
   a. Assess the need for continued intravascular access on a daily basis during multidisciplinary rounds. Remove catheters not required for patient care.
   b. Audits to determine whether CVCs are routinely removed after their intended use may be helpful.[125,126] Both simple and multifaceted interventions are effective at reducing unnecessary CVC use.[127,128]
4. For nontunneled CVCs in adults and children, change transparent dressings and perform site care with a chlorhexidine-based antiseptic every 5–7 days or immediately if the dressing is soiled, loose, or damp; change gauze dressings every 2 days or earlier if the dressing is soiled, loose, or damp (quality of evidence: II).[129-131]
   a. Less-frequent dressing changes may be used for selected NICU patients to reduce the risk of catheter dislodgement.
   b. If there is drainage from the catheter exit site, use gauze dressings instead of transparent dressings until drainage resolves.
5. Replace administration sets not used for blood, blood products, or lipids at intervals not longer than 96 hours (quality of evidence: II).[132,133]
   a. The optimal replacement intervals of intermittently used administration sets are currently unresolved.
6. Use antimicrobial ointments for hemodialysis catheter-insertion sites (quality of evidence: I).[134-140]
   a. Polysporin "triple" (where available) or povidone-iodine ointment should be applied to hemodialysis catheter insertion if compatible with the catheter material.
      i. Certain manufacturers have indicated that the glycol constituents of ointments should not be used on their polyurethane catheters.
   b. Mupirocin ointment should not be applied to the catheter-insertion site due to the risks of facilitating mupirocin resistance and the potential damage to polyurethane catheters.
7. Perform surveillance for CLABSI in ICU and non-ICU settings (quality of evidence: I).[6,7,141,142]
   a. Measure the unit-specific incidence of CLABSI (CLABSIs per 1,000 catheter-days) and report the data on a regular basis to the units, physician and nursing leadership, and hospital administrators overseeing the units.
   b. Compare CLABSI incidence with historical data for individual units and with national rates (ie, NHSN[143]).
   c. Audit surveillance as necessary to minimize variation in interobserver reliability.[32,33]
   d. Surveillance for CLABSI outside the ICU setting requires additional resources.[144] Electronic surveillance is an option in these settings.[145]

II. Special approaches for preventing CLABSI

A number of special approaches are currently available for use. Perform a CLABSI risk assessment before considering implementing any of these approaches, and take potential adverse events and cost into consideration. Although it is reasonable to evaluate the utility of technology-based interventions when CLABSI rates are above the institutional or unit-based threshold, this is also an opportunity to review practices and consider behavioral changes that may be instituted to reduce CLABSI risk. These special approaches are recommended for use in locations and/or populations within the hospital with unacceptably high CLABSI rates despite implementation of the basic CLABSI prevention strategies listed above. These measures may not be indicated if institutional goals have been consistently achieved.

1. Use antiseptic- or antimicrobial-impregnated CVCs in adult patients (quality of evidence: I).[29,30,146-152]
   a. The risk of CLABSI is reduced with some currently marketed antiseptic-impregnated (eg, chlorhexidine–silver sulfadiazine) catheters and antimicrobial-impregnated (eg, minocycline-rifampin) catheters. Use such catheters in the following instances.
      i. Hospital units or patient populations have a CLABSI rate above institutional goals despite compliance with basic CLABSI prevention practices. Some evidence suggests that use of antimicrobial CVCs may have no additional benefit in patient care units that have already established a low incidence of catheter infections.[153]
      ii. Patients have limited venous access and a history of recurrent CLABSI.
      iii. Patients are at heightened risk of severe sequelae from a CLABSI (eg, patients with recently implanted intravascular devices, such as a prosthetic heart valve or aortic graft).
   b. Monitor patients for untoward effects, such as anaphylaxis.[154]
2. Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age (quality of evidence: I).[80,155-160]
   a. It is unclear whether there is additional benefit to using a chlorhexidine-containing dressing if daily chlorhexidine bathing is already established and vice versa.
3. Use an antiseptic-containing hub/connector cap/port protector to cover connectors (quality of evidence: I).[161-165]
4. Use silver zeolite–impregnated umbilical catheters in preterm infants (in countries where it is approved for use in children; quality of evidence: II).[166]

a. Observational studies suggest that other antimicrobial-impregnated catheters appear to be safe and hold promise in pediatric ICU patients.[167-169]

5. Use antimicrobial locks for CVCs (quality of evidence: I).[170-175]
   a. Antibiotic locks are created by filling the lumen of the catheter with a supratherapeutic concentration of an antimicrobial solution and leaving the solution in place until the catheter hub is reaccessed. Such an approach can reduce the risk of CLABSI. Because of concerns regarding the potential for the emergence of resistance in exposed organisms, use antimicrobial locks as a preventative strategy for the following:
      i. Patients with long-term hemodialysis catheters.[176]
      ii. Patients with limited venous access and a history of recurrent CLABSI.
      iii. Patients who are at heightened risk of severe sequelae from a CLABSI (eg, patients with recently implanted intravascular devices, such as a prosthetic heart valve or aortic graft).
   b. To minimize systemic toxicity, aspirate rather than flush the antimicrobial lock solution after the dwell time has elapsed.[177-180] For additional guidance, see the IDSA's "Clinical Practice Guidelines for the Diagnosis and Management of Intravascular Catheter-Related Infection."[35]
6. Use recombinant tissue plasminogen activating factor once weekly after hemodialysis in patients undergoing hemodialysis through a CVC (quality of evidence: II).[181]

III. Approaches that should not be considered a routine part of CLABSI prevention
   1. Do not use antimicrobial prophylaxis for short-term or tunneled catheter insertion or while catheters are in situ (quality of evidence: I).[182-186]
      a. Systemic antimicrobial prophylaxis is not recommended.
   2. Do not routinely replace central venous or arterial catheters (quality of evidence: I).[187-189]
      a. Routine catheter replacement is not recommended.

IV. Unresolved issues
   1. Routine use of needleless connectors as a CLABSI prevention strategy before an assessment of risks, benefits, and education regarding proper use.[190-194]
      a. Multiple devices are currently available, but the optimal design for preventing infections is unresolved. The original purpose of needleless connectors was to prevent needlestick injuries during intermittent use. No data regarding their use with continuous infusions are available.
   2. Intravenous therapy teams for reducing CLABSI rates.[77,195]
      a. Studies have shown that an intravenous therapy team responsible for insertion and maintenance of peripheral intravenous catheters reduces the risk of bloodstream infections.[196] However, few studies have been performed regarding the impact of intravenous therapy teams on CLABSI rates.
   3. Surveillance of other types of catheters (eg, peripheral arterial or venous catheters).[3,4]
      a. Peripheral arterial catheters and peripheral venous catheters are not included in most surveillance systems, although they are associated with risk of bloodstream infection independent of CVCs.[197,198] Future surveillance systems may need to include bloodstream infections associated with these types of catheters.
   4. Estimating catheter-days for determining incidence density of CLABSI.
      a. Surveillance can be facilitated in settings with a limited workforce by estimating the number of catheter-days.[199-201]
   5. Use of silver-coated catheter connectors are associated with reduced intraluminal contamination in ex vivo catheters.[202]
      a. There is a paucity of clinical evidence regarding the risk reduction with their routine use or use of other antimicrobial catheter connectors.
   6. Standard, nonantimicrobial transparent dressings and CLABSI risk.
      a. A recent meta-analysis reported an association between CLABSI and transparent dressing use. However, the source studies for the meta-analysis reporting this association were of low quality.[203]
   7. Impact of the use of chlorhexidine-based products on bacterial resistance to chlorhexidine.
      a. Widespread use of chlorhexidine-based products (eg, use of chlorhexidine bathing, antisepsis, and dressings) may promote reduced chlorhexidine susceptibility in bacterial strains.[204] However, testing for chlorhexidine susceptibility is not standardized. The clinical impact of reduced chlorhexidine susceptibility in gram-negative bacteria is unknown.

SECTION 5: PERFORMANCE MEASURES

I. Internal reporting

These performance measures are intended to support internal hospital quality improvement efforts[205,206] and do not necessarily address external reporting needs. The process and outcome measures suggested here are derived from published guidelines, other relevant literature, and the opinion of the authors. Report process and outcome measures to senior hospital leadership, nursing leadership, and clinicians who care for patients at risk for CLABSI.

A. Process measures
   1. Compliance with CVC insertion guidelines as documented on an insertion checklist.
      a. Assess compliance with the checklist in all hospital settings where CVCs are inserted (eg, ICUs, emergency departments, operating rooms, radiology, and general nursing units) and assign a healthcare

personnel familiar with catheter care to this task.

i. For an example of a central catheter checklist, see http://www.ihi.org/knowledge/Pages/Tools/CentralLineInsertionChecklist.aspx.

b. Measure the percentage of CVC insertion procedures in which compliance with appropriate hand hygiene, use of maximal sterile barrier precautions, and use of chlorhexidine-based cutaneous antisepsis of the insertion site is documented:

i. Numerator: number of CVC insertions that have documented the use of all 3 interventions (hand hygiene, maximal barrier precautions, and chlorhexidine-based cutaneous antiseptic use) performed at the time of CVC insertion.

ii. Denominator: number of all CVC insertions.

iii. Multiply by 100 so that the measure is expressed as a percentage.

2. Compliance with documentation of daily assessment regarding the need for continuing CVC access.

a. Measure the percentage of patients with a CVC where there is documentation of daily assessment:

i. Numerator: number of patients with a CVC who have documentation of daily assessment.

ii. Denominator: number of patients with a CVC.

iii. Multiply by 100 so that the measure is expressed as a percentage.

3. Compliance with cleaning of catheter hubs and injection ports before they are accessed (or compliance with use of antiseptic-containing port protectors).

a. Assess compliance through observations of practice:

i. Numerator: number of times that a catheter hub or port (or port protector) is observed to be cleaned before being accessed.

ii. Denominator: number of times a catheter hub or port (or port protector) is observed to be accessed.

iii. Multiply by 100 so that the measure is expressed as a percentage.

B. Outcome measures

1. CLABSI rate.

a. Use NHSN definitions.

i. Numerator: number of CLABSIs in each unit assessed (using NHSN definitions).

ii. Denominator: total number of catheter-days in each unit assessed (using NHSN definitions).

iii. Multiply by 1,000 so that the measure is expressed as the number of CLABSIs per 1,000 catheter-days.

iv. Risk adjustment: stratify CLABSI rates by type of patient care unit.[207-209]

(a) Report comparisons based on historical data and NHSN data, if available.[143]

II. External reporting

There are many challenges in providing useful information to consumers and other stakeholders while preventing unintended consequences of public reporting of HAIs.[210,211] Recommendations for public reporting of HAIs have been provided by HICPAC,[212] the Healthcare-Associated Infection Working Group of the Joint Public Policy Committee,[213] and the National Quality Forum.[214]

A. State and federal requirements

1. Hospitals in states that have mandatory reporting requirements for CLABSI must collect and report the data required by the state.

2. For information on state and federal requirements, contact your state or local health department.

B. External quality initiatives

1. Hospitals that participate in external quality initiatives or state programs must collect and report the data required by the initiative or program.

2. Problems with interrater reliability may affect comparisons between different institutions.

SECTION 6: EXAMPLES OF IMPLEMENTATION STRATEGIES

Accountability is an essential principle for preventing HAIs. It provides the necessary translational link between science and implementation. Without clear accountability, scientifically based implementation strategies will be used in an inconsistent and fragmented way, decreasing their effectiveness in preventing HAIs. Accountability begins with the chief executive officer and other senior leaders who provide the imperative for HAI prevention, thereby making HAI prevention an organizational priority. Senior leadership is accountable for providing adequate resources needed for effective implementation of an HAI prevention program. These resources include necessary personnel (clinical and nonclinical), education, and equipment (Table 2).

Insertion of CVCs is one of the most common procedures performed at the patient's bedside. The insertion procedure represents only one aspect of the risk for CLABSI, with the risk extending to all aspects of nursing care and maintenance during the CVC dwell time. CLABSI prevention strategies have expanded as new studies are published. Additionally, experience with implementing these strategies is increasing. This discussion will focus on strategies for engagement, education, execution, and evaluation of CLABSI prevention efforts. Published literature and expert opinion form the basis for the following recommendations.

I. Engage

The first step toward successful reduction of CLABSIs is to engage both frontline and senior leadership champions in the process and outcome improvement plan.[215]

A. Develop a multidisciplinary team that sets goals, defines the steps in the implementation process, and monitors

table 2. Fundamental Elements of Accountability for Healthcare-Associated Infection Prevention

Senior management is responsible for ensuring that the healthcare system supports an infection prevention and control (IPC) program that effectively prevents healthcare-associated infections (HAIs) and the transmission of epidemiologically important pathogens
Senior management is accountable for ensuring that an adequate number of trained personnel are assigned to the IPC program and adequate staffing of other departments that play a key role in HAI prevention (eg, environmental services)
Senior management is accountable for ensuring that healthcare personnel, including licensed and nonlicensed personnel, are adequately trained and competent to perform their job responsibilities
Direct healthcare providers (such as physicians, nurses, aides, and therapists) and ancillary personnel (such as environmental service and equipment processing personnel) are responsible for ensuring that appropriate IPC practices are used at all times (including hand hygiene, standard and isolation precautions, and cleaning and disinfection of equipment and the environment)
Senior and unit leaders are responsible for holding personnel accountable for their actions
IPC leadership is responsible for ensuring that an active program to identify HAIs is implemented, that HAI data are analyzed and regularly provided to those who can use the information to improve the quality of care (eg, unit staff, clinicians, and hospital administrators), and that evidence-based practices are incorporated into the program
Senior and unit leaders are accountable for ensuring that appropriate training and educational programs to prevent HAIs are developed and provided to personnel, patients, and families
Personnel from the IPC program, the laboratory, and information technology departments are responsible for ensuring that systems are in place to support the surveillance program

progress in achieving the goals. Regular team meetings should be held.[216]

B. Focus on a culture of safety, which includes teamwork, technical processes, and promotion of accountability for prevention of CLABSI.

C. Make the problem real to all of those involved to increase buy-in. One strategy to accomplish this is to identify a patient in the unit who has suffered harm as a result of developing a CLABSI[217] and then share that story with the team.

D. Identify and involve local champions. Engage infusion nurses or vascular access specialists as team members. Include formal (eg, medical or nursing directors, charge nurses) and informal (eg, frontline) leaders.[218] Local champions increase the chance for success by engaging and educating peers, thereby increasing buy-in and ownership by all involved.[215] These champions can influence the development of strategies that are a good match with the unit culture. Frequent communication between champions and frontline staff is imperative if concerns are to be resolved and improvement sustained.[215]

E. Share the outcome data regularly with each unit. Data can be represented as the monthly CLABSI rate and/or the number of days since last infection.[217] Consider reporting CLABSI rates as the standardized infection ratio (SIR). Displaying a trend line is also useful.

F. Utilize peer networks. Voluntary peer networking between hospitals can promote and ensure compliance with evidence-based practices. It also facilitates collaboration, performance evaluation, and accountability. All can benefit from best practices being shared, and brainstorming can be done to solve shared problems.[219]

II. Educate

A. Change in human behavior is the goal of educational programs about CVC insertion, care, and maintenance. Various educational methods and strategies have been studied to reduce CLABSI. In general, these educational interventions showed improvements in CLABSI rates; however, more study is needed to clearly understand the most effective teaching strategies, content taught, length of presentation, and frequency for repeating the program.[220,221] Both extraluminal and intraluminal avenues for CVC infection should be addressed in the educational plan.

B. Educational programs for all healthcare personnel involved with the insertion and care of all types of CVCs should address knowledge, critical thinking, behavior and psychomotor skills, and attitudes and beliefs. Identifying and analyzing gaps in these areas leads to the selection of measureable learning objectives, course content, and corresponding appropriate teaching strategies. The value of infection prevention should be emphasized through all education efforts.[221,222]

C. Adult learners employ multiple ways to learn; therefore, multiple teaching strategies should be used. This includes self-directed study guides, instructor-led courses, and small- and large-group discussions. The planning group for the educational offering should have representatives from multiple professions, including physicians, nurse managers, staff nurses, infusion nurse specialists, and infection preventionists.[223-225] The learner should be actively involved with the teaching methods, as lecture alone has been shown to be less effective with retention of information and changes in behavior.[226,227] Delivery methods should be chosen on the basis of the learners' needs and availability, along with the technical capabilities of the facility. This includes printed learning packages; audiovisual formats, such as slide presentations and videos; skills labs; journal clubs and nursing grand rounds; and computer-, Internet-, or DVD-based

packages of learning materials.[58,224,228-231] Multiple delivery methods tailored to specific problems or issues and given intermittently over time produce greater reduction in CLABSI than a single structured offering or lecture.[61,232]

D. Other educational job aides should be readily accessible in the clinical setting for quick reminders and reinforcement of the appropriate procedures. This includes but is not limited to facility policies and procedures, posters, fact sheets, small pocket cards, e-mail messages, and messages via computer screen savers.[233,234]

E. To enhance patient safety, learning CVC insertion techniques requires a structured educational program focusing on knowledge acquisition and performance of insertions in a simulated environment, followed by supervised performance on patients.[43,235-237] A meta-analysis of 20 studies using simulation for CVC insertion showed benefits in learner performance, knowledge, and confidence.[66] Simulation for CVC insertion includes use of anatomical models and computer-based virtual reality.[238] Other approaches have tried to simulate the "feel" of tissue puncture.[239]

F. All healthcare professionals should have documented competency with CVC insertion, care, and maintenance before being allowed to practice without direct supervision. A standardized competency assessment checklist should be used to assess and document competency of each individual performing CVC insertion and procedures related to care and maintenance (eg, dressing changes). Competency assessment checklists should be evaluated for interrater reliability and validity. The professional performing competency assessment of the learner should be competent with the procedure being assessed.[220,240]

G. Changes of products, devices, or technology used in the insertion and care of CVCs require adequate device training for all healthcare personnel expected to use the product(s). This training follows a period of device evaluation and its impact on CLABSI. Most device manufacturers employ personnel with clinical experience to provide product training, and this resource should not be overlooked.

H. Healthcare professionals using CVCs for infusion should have documented competency with all procedures, including but not limited to catheter stabilization, catheter dressing changes, intravenous administration set management, disinfection of needleless connectors, accessing implanted ports, and flushing and locking the CVC.[43] This would involve demonstration of procedures in a simulation lab or in the clinical setting while being observed by a qualified professional.[241,242]

I. Assessment of educational programs includes the learner's satisfaction with the program, changes in knowledge, and changes in work performance. Written tests are the most common form of measurement; however, this is limited to knowledge acquisition only and may produce anxiety in many adult learners. Other forms of assessment include contributions to group discussions and observation of performance using simulation. Measurement of healthcare professionals' current level of knowledge about CVC insertion and care can provide valuable information for designing educational programs.[243,244]

J. Prior to an educational program, there should be planning for transfer of the learning from the classroom to the clinical setting. This includes patient care assignments to allow for application of new knowledge and practice of new skills, support and encouragement from leaders and managers, and the ability to follow up on issues or concerns that arise from clinical performance.

K. Education of the patient and/or family, as appropriate, is required for all CVC care procedures (eg, hand hygiene, dressing changes, intravenous administration set management, and flushing and locking), especially when transfer to an alternative setting (eg, home care, ambulatory setting) is planned.[43,242]

L. Education of facility administrators is necessary to ensure adequate funding and implementation of CLABSI prevention.[242] Additionally, the goal of zero tolerance for CLABSI may be set by the chief officers of an institution;[245] however, whether this goal can be reached depends on a number of factors.

III. Execute

A. Consider the use of quality improvement methodologies, such as Lean Six Sigma, Comprehensive Unit-Based Safety Program, Team STEPPS, Plan-Do-Study-Act, and the like, to structure prevention efforts. Various performance improvement tools can be used, such as dashboards and score cards, to share data with stakeholders.

B. Standardize care processes. This can be done through implementation of guidelines, bundles, and protocols that address both insertion and maintenance of central lines. Consider conducting structured daily multidisciplinary rounds. During rounds, discuss whether the patient still requires the central line, patient goals for the day, and potential barriers or safety issues.[217] Empower staff to report process defects or barriers to implementation encountered to appropriate leadership. This can facilitate rapid intervention and process improvement. Assign accountability for adherence to specific departments or functions.

C. Create redundancy. Build redundancy or independent checks into the care delivery process to increase staff compliance. This can be done by incorporating visual cues as reminders for proper procedures. Implement a line insertion and line maintenance checklist both inside and outside ICUs. Consider the use of screen-saver messages, posters, banners, fact sheets, preprinted order

sets, pocket cards, and the like to educate and serve as reminders for staff.[217,218]

D. Consider participating in a CLABSI reduction collaborative. Collaboratives provide an organization with the opportunity to discover and share best practices and utilize comparative outcome data.

IV. Evaluate

A. Multidisciplinary teams should be used to form quality improvement collaboratives to set goals and identify the key factors to be measured. This team should have representatives from administration, all professions, and clinical nursing units.[246,247] These teams may represent one hospital or many different hospitals.[54,248,249]

B. Evaluation involves both process and outcome measurement.[246] Differences between age groups should also be considered (eg, neonates, pediatrics, and adults).[54,249,250]

C. Process measurement includes but is not limited to compliance with insertion bundles, CVC utilization by insertion site or type (eg, femoral catheters vs other CVC sites; PICCs vs centrally inserted lines), the condition of CVC dressing and timely dressing changes, and integrity and appropriate management of needleless connectors, other add-on devices, and intravenous administration sets.[43,251,252] Device utilization is defined as the number of catheter-days divided by the number of patient-days.[245]

D. Establish baseline compliance with evidence-based practices for line maintenance, such as the presence of clean and intact dressings.

E. Outcome measurement is the incidence rate of CLABSI and other infections associated with all types of vascular access devices (eg, exit-site infection, suppurative thrombophlebitis). Consider reporting CLABSI rates as SIR.

F. Process and outcome data should be linked to initial and ongoing competency assessment. Initial competency should be assessed at employment, after orientation, and with the introduction of new equipment or technology. Ongoing competency assessment is determined by process and outcome data with the facility deciding the frequency for repeated competency assessment.[43]

G. Measurement of education outcomes is needed on several levels. The learner's satisfaction with the program is assessed by completion of the evaluation form immediately following completion of the program. This form also includes the learner's self-assessment of achieving the learning objectives. The next level is measuring the change in learner's knowledge, most often accomplished by comparison of scores on written pre- and posttests. The third level is to measure the actual change in behavior in clinical practice following the completion of the program. Using only the first and second levels of measurement will not ensure that a change in clinical behavior will occur.

Numerous factors affect CLABSI surveillance, including CVC type, CLABSI definition, blood culturing practices and written policies, laboratory practices, and staff attitudes and beliefs. Standardization of these factors facilitates benchmarking within and between organizations. Additionally, variations in these determinants could impact publicly reported CLABSI rates and influence reimbursement for hospital-acquired conditions.[32,247]

H. Surveillance for CLABSI outside the ICU is becoming more prevalent, especially with increasing use of electronic methods for data collection.[253,254]

I. Feedback to all healthcare staff is critical for the success of any evaluation program. Unit-based recognition of achievement of low CLABSI rates or the length of time between CLABSI events is a useful method to encourage staff involvement. The goals for improvement should be clearly and frequently articulated. Audit compliance with completion of insertion checklists and share this data with the staff. Other forms of feedback include periodic (eg, monthly, quarterly) communication (eg, e-mail messages, written reports) of process measurement data: posters, reports, or other forms of communication with graphs showing cumulative compliance with process measures.[245,250,255,256]

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