Walk the walk to reduce catheter-related bloodstream infections

Using evidence-based practices, nurses can help prevent deadly infections linked to central venous catheters.

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ALTHOUGH CENTRAL VENOUS CATHETERS (CVCs) are indispensable in critical care, they're linked to serious infections that can lead to illness and death. CVC insertion disrupts skin integrity, greatly raising the patient's risk of infection by bacteria, fungi, or both. Catheter-related bloodstream infections (CR-BSIs) can result in hemodynamic changes and organ dysfunction associated with severe sepsis and death.

Almost half of intensive care unit (ICU) patients have CVCs, accounting for 15 million central catheter days annually. In the United States, CR-BSIs have a mortality of approximately 18% and are linked to a mean excess cost of $18,432 and a mean excess length of stay of 12 days.

Increasing evidence shows that specific best practices can help achieve the goal of preventing CR-BSIs. A Joint Commission national patient safety goal required hospitals to fully implement evidence-based practice guidelines to prevent CR-BSIs by January 1, 2010. This article describes evidence-based nursing practices that aid CR-BSI prevention and discusses strategies that promote the nursing practice changes needed to prevent these infections and optimize care for patients with CVCs.

Risk factors for infection

ICU patients have a greater risk of CR-BSIs because:

- their underlying illness makes them more susceptible to infection
- their treatment commonly involves invasive devices that disrupt skin integrity, antibiotics that raise the risk of bacterial resistance, and steroids that compromise the immune system
- they are likely to undergo surgery, transplantation, or dialysis or to receive chemotherapy or radiation therapy.

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LEARNING OBJECTIVES

1. Identify evidence-based nursing practices related to the prevention of catheter-related bloodstream infections.
2. Discuss strategies for implementing these practices.
3. Describe methods to enhance compliance with these practices.

Age is an important risk factor, too. Premature infants and patients older than age 65 are the most vulnerable to these infections.

Evidence-based practices to prevent CR-BSIs

Scientific evidence—particularly the results of randomized, controlled trials—provides a solid foundation to identify the nursing care activities that help prevent CR-BSIs. The evidence also helps identify practices that may add nothing and should be discontinued.

Care "bundles" are groupings of best practices that pertain to a specific disease process. The Institute for Healthcare Improvement is one source for these bundles. Implementing all practices in the bundle together results in better outcomes than using the practices individually. The evidence supporting the bundle components is adequately established to be deemed a standard of care.

One proposed central-line care bundle is based on a protocol used at Rady Children's Hospital in San Diego. Proven effective in preventing CR-BSIs, it includes the following components:

- *Hand hygiene.* For healthcare workers caring for a patient with

an intravascular line, rigorous hand hygiene is critically important to remove transient hand flora that may have been picked up from other patients or environmental surfaces.

- *Maximal barrier precautions during insertion.* During central line placement, the patient should be covered with a sterile drape from head to toe, with a small fenestration at the insertion site. The operator must wear a cap, mask, sterile gown, and sterile gloves.
- *Chlorhexidine skin antisepsis.* Evidence shows chlorhexidine is more effective than povidone-iodine or alcohol in reducing skin flora around the insertion site and has a residual effect not seen with povidone-iodine or alcohol.
- *Optimal catheter-site selection with femoral-vein avoidance in adults.* Although many intensivists and anesthesiologists prefer the internal jugular site for easier insertion, evidence suggests that lines placed using the subclavian vein have the lowest infection risk.
- *Daily review of line necessity, with prompt removal of unnecessary lines.* Every day a catheter stays in place, a risk exists that infectious organisms may gain entry through the insertion site or by line manipulation. Every day, assess patients with CVCs for necessity of the line; unnecessary lines should be removed as soon as possible.

Best nursing practices

The following nursing practices help prevent CR-BSIs.

- *All-inclusive catheter cart or kit.* Use an all-inclusive cart or kit that keeps the necessary supplies for CVC insertion together in one place.
- *Hand hygiene.* Conscientiously perform thorough hand hygiene before and after patient care.

Be sure to disinfect the catheter hub before you enter the line—every time.

- *Site care.* Besides using chlorhexidine for skin preparation before catheter insertion, use a well-adhered transparent dressing, which can stay in place for 7 days.
- *I.V. site maintenance.* Evaluate the necessity of the central line daily, and check the site for redness and drainage. Keep the dressing dry and intact at all times. Change a transparent dressing every 7 days and a gauze dressing every 48 hours unless it's compromised. If the dressing doesn't stay occlusive or becomes damp or soiled, change it as soon as possible.
- *Line access.* A recent pediatric ICU study found that a CVC in a critically ill child was accessed an average of 16 times per shift; in extreme cases, it was entered up to 80 times. Reducing the number of entries into and connections for an intravascular line decreases the infection risk. Be sure to disinfect the catheter hub before you enter the line—every time.
- *Appropriate staffing and nursing workloads.* Understaffing and increased nursing workloads can increase the CR-BSI risk.

Sterilizing needlefree catheter hubs

Centers for Disease Control and Prevention (CDC) guidelines for CR-BSI prevention don't clearly indicate which agent to use or the time frame required for disinfecting the catheter hub. The conventional practice is to disinfect a needleless I.V. catheter connector hub by swabbing it vigorously for 3 to 5 seconds with 70% alcohol. However, one study showed this doesn't reliably prevent organisms from entering the line.

To help clarify the best practice, Kaler and colleagues conducted a study at Rady Children's Hospital to determine the required duration and disinfectant to use when "scrubbing the hub." The study compared the efficacy of 70% alcohol alone to that of 3.15% chlorhexidine/70% alcohol used for 15 seconds. Investigators also sought to determine whether the design of a mechanical valve hinders its ability to be properly disinfected. A total of 300 mechanical valves of four different types were inoculated with a 105 colony-forming unit (CFU) suspension of the organisms most commonly seen in clinical practice (*Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas aeruginosa,* and *Candida albicans*). All valves were flushed with 0.5 mL saline solution; the flush was collected onto blood agar plates that were incubated for 48 hours to promote bacterial growth.

The inoculated access ports that hadn't been disinfected grew 103 organisms. No microorganisms were recovered from any port that had been disinfected for 15 seconds with alcohol alone or chlorhexidine/alcohol. Investigators concluded that scrubbing a catheter access port for 15 seconds with friction using either alcohol or chlorhexidine/alcohol was effective in sterilizing mechanical valve ports inoculated with a 105-CFU suspension of microorganisms. Results were the same whether the valve was made with positive, negative, or neutral displacement technologies.

Poor compliance with evidence-based CVC practices

Research shows poor clinician compliance with evidence-based practices that prevent catheter-related bloodstream infections (CR-BSIs). Warren and colleagues assessed adoption of 1996 guidelines for BSI prevention from the Centers for Disease Control and Prevention. An April 2002 survey of 25 intensive care units (ICUs) revealed poor compliance: Only 28% of the ICUs had a policy on using maximal sterile barrier precautions during central venous catheter (CVC) insertion, just 36% specified the subclavian vein as the preferred insertion site, and only 52% had formal training programs for CVC insertion.

A 2008 University HealthSystem Consortium benchmarking study assessed 19 academic medical centers (719 patients with 1,032 CVC insertions and 7,781 catheter days) for adherence with best practices to reduce CR-BSIs. Results showed a relatively high CR-BSI rate (7.07 per 1,000 catheter days). Compliance varied widely, and all centers performed poorly at providing evidence of adherence to best practices.

Of the documented insertion sites, the subclavian vein was used 44% of the time. The median percentage of CVC insertions performed using maximal barrier precautions was 0%; skin preparation with chlorhexidine, 2%; and daily assessment of medical necessity for the catheter, 16%. (These practices may have been used but not documented.) The highest compliance rate (98%) was for dressing inspection. Only two of the 19 facilities had a policy on best practices and only two mandated use of a CVC insertion checklist. Other investigators also have found poor compliance.

Improving compliance with evidence-based practices

Although numerous studies show that evidence-based practices help prevent CR-BSIs, these practices aren't being translated to the bedside to the extent required. (See *Poor compliance with evidence-based CVC practices*.) Human-factors research indicates that consistent compliance with guidelines may be viewed both as a systems property of ICUs and the result of individual clinicians' decisions and habits. The work system of an ICU includes not only the unit's physical layout but its culture, as beliefs and attitudes affect care providers' behavioral patterns.

To improve compliance with evidence-based practices, both facility and provider issues must be addressed, as in the three-step "dress rehearsal" approach described next. It can be used to flag both potential problems with proposed procedures and problems with procedures already in use. In this rehearsal, ICU team members mentally map and physically walk through a proposed or existing protocol to identify and mitigate concerns, such as supply availability and compatibility with existing workflow patterns.

1. **Walk the process**. Walking through a new process before implementation may reveal problems. In one facility, for instance, one of the goals of physician rounds was to evaluate the need for existing vascular lines. But clinicians on rounds couldn't readily identify which lines a patient had in place. To remedy the situation, nursing staff now detail the lines on a whiteboard that can easily be seen during rounds.
2. **Observe a clinician**. In this step, the team observes a clinician performing a new protocol in order to flag potential failure modes. For example, a clinician might note that the supplies needed to perform the central line insertion bundle are spread out over eight different places in the unit. A solution is to centralize supplies in line-insertion kits or on a cart.
3. **Learn the context**. When clinicians express opposition to policies, feedback should be solicited to help determine the root cause of the anticipated noncompliance. For example, a nurse might resist having to scrub a connector hub for more than 3 to 5 seconds. Highlighting the evidence in published literature can help the nurse understand why adhering with the prescribed duration is important. (To meet the time requirement, sing the "Happy Birthday" song twice while scrubbing.)

Resolving system issues

The facility, unit, or other system may pose barriers to compliance, such as ambiguity. One group of researchers conducted in-depth interviews and observations of 20 healthcare providers in two surgical ICUs. They found a fair amount of system ambiguity that could explain noncompliance with guidelines aimed at CR-BSI prevention. The research team identified two basic types of ambiguity.

- *Expectation ambiguity* results when clinicians aren't clear on what's expected of them. For example, when nurses in one ICU received data on the CR-BSI rate, they didn't know what to do with it. Told that infection rates were "4.6/1,000 line days," they didn't perceive this data as directly relevant to bedside practice. The solution was to report the raw number of CR-BSIs in as close to real time as possible, so infection could be discussed during rounds while the patient was still in the bed.
- *Exception ambiguity* can occur because it's not always possible to be 100% prescriptive in describing a best practice or developing a protocol. Inserting a CVC in a subclavian vein isn't possible in some patients; also, chlorhexidine is contraindicated in children younger than 2 months. Highlighting potential issues such as these on the insertion checklist can reduce excep-

tion ambiguity. If clinicians can't use a particular practice, they can document the exception.

Resolving care-provider issues: A case in point

In 1998, the CR-BSI rate in the surgical/burn/trauma ICU at Barnes-Jewish Hospital in St. Louis, Missouri was almost double the average rate documented in the National Nosocomial Infections Surveillance database. Infection control specialists determined that nurses weren't being educated on how to care for central lines or on how CR-BSIs occur. To improve their performance, a thorough education module was implemented; subsequently, the infection rate on that unit fell 66%. (See *Barnes-Jewish Hospital's education module.*)

Seeing the success of the educational intervention, physicians and nurses in the unit wanted to drive the CR-BSI rate even lower. A multidisciplinary team used the Plan-Do-Study-Act method to develop pictorials—a series of photographs showing each key step in the procedure. Laminated sets of central-line insertion pictorials were placed in resident manuals and on procedure carts. The team also mapped and photographed the process for changing a central-line dressing and created pictorials to be placed in each patient's room. Physicians and nursing staff found these reminders helpful.

"Scrub the hub" targeted education

In 2006, Missouri Baptist Medical Center saw an upward trend in its CR-BSI rate. The facility had implemented the education module described above more than a year earlier. After implementation, one ICU went 212 days without a CR-BSI; then a patient developed a CR-BSI. Close observation of nursing practice found nurses weren't scrubbing the catheter hub before injecting medications or antibiotics into the line.

To improve compliance, a highly focused intervention was implemented. Eye-catching posters reminding clinicians to "scrub the hub" were made into computer screensavers and posted throughout the hospital. A "scrub the hub" maintenance bundle was implemented, and nurses were educated on the required practices. Although some questioned the need to scrub for 30 seconds, that duration was kept in the protocol in the hope it would prompt busy ICU nurses to scrub for at least 15 seconds. (See *"Scrub the hub" maintenance bundle.*) Since implementation of the "scrub the hub" initiative, the ICU has gone more than 18 months without a CR-BSI. The initiative is now part of the ICU nurses' daily line-care routine.

Key factors for success

In the examples above, several factors helped ensure the success of the initiatives designed to prevent CR-BSIs.

- Nurses held themselves and others accountable for identifying, implementing, and ensuring compliance with evidence-based practices.
- The initiatives got 100% support from hospital administrators, physicians, and nursing staff.
- Educational efforts included mandatory education, annual educational module testing, and a requirement that all new ICU nurses complete the education module.
- Reminders included laminated pictorials placed in resident manuals and patient rooms and on procedure carts.
- Staff received feedback. For instance, they were informed of infection rates in as close to real time as possible.
- Infection prevention and control staff performed rounds and worked with nurses and physicians.
- Current and potential problems were flagged by nursing, medical, and infection prevention and control staff.

Reducing infections: Possible and imperative

Published reports and clinical experience show CR-BSIs can—and

Barnes-Jewish Hospital's education module

With the goal of decreasing primary bloodstream infections in patients with central venous catheters (CVCs), Barnes-Jewish Hospital in St. Louis, Missouri, implemented a nurses' education module on correct practices for CVC insertion and care. Components included a pretest taken by nurses before they received education, fact sheets posted and changed every week, a 10-page self-study module, and a posttest. Nurses received attention-getting buttons and other nonmonetary incentives for completing the program. Also, a lead fellow in the unit strongly supported the initiative.

Researchers conducted a pre- and postinterventional observational study to find out if the education module reduced the rate of catheter-related bloodstream infections (CR-BSIs) in a surgical intensive care unit. They found that nurses' knowledge scores increased significantly from 78.3 ± 12.9 on the pretest to 89.9 ± 8.3 on the posttest ($P < 0.001$) and that the CR-BSI rate declined by 66%. The table below compares the infection rate before the education module was implemented to the infection rate afterward ($P < 0.01$).

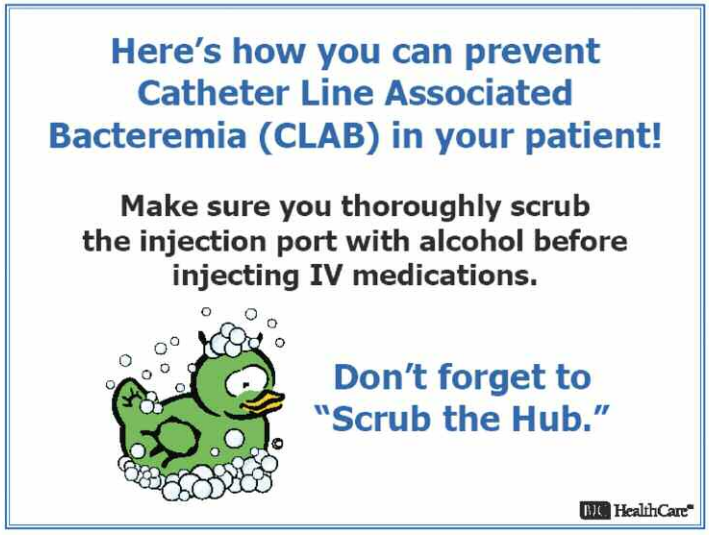
Pre-module CR-BSIs	Post-module CR-BSIs
10.8/1,000 catheter days	3.7/1,000 catheter days

An education module also was developed for physicians, which increased compliance with best practices for central-line insertion.

"Scrub the hub" maintenance bundle

Scrubbing the hub is a key component of the central-line maintenance bundle outlined below, which is based on a protocol developed by Chris Abe at Rady Children's Hospital in San Diego.

- Perform hand hygiene.
- Don clean gloves before accessing the line.
- Perform a 30-second "hub scrub" using alcohol and friction in a twisting motion on the hub, as if you're juicing an orange.
- Draw the blood, administer medications, and label them per your facility's central-line access policy.
- Discard gloves and perform hand hygiene.



should—be substantially reduced or even eliminated. Nurses can help achieve this goal by promoting a culture of zero tolerance for noncompliance with proven measures for CR-BSI prevention. Both system issues and staff behavioral patterns should be addressed through recurring education, reminders, competency assessment, use of physician and nursing champions, sharing of published data, and ongoing feedback to staff. By implementing and complying with evidence-based nursing practices, nurses can play a vital role in preventing CR-BSIs. ✯

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