eResource
an education program on infection control and patient safety

Catheter-associated bloodstream infections: *is it possible to get to zero? Implementing*

Introduction

Intravascular catheters are indispensable in contemporary medical practice. These catheters provide essential vascular access, however their use puts patients at risk for local and systemic infectious complications, including local site infection, catheter-related bloodstream infections(CABSI),septic thrombophlebitis, endocarditis, and other metastatic infections (e.g., lung abscess, brain abscess, osteomyelitis, and endophthalmitis). The incidence of CABSI varies by type of catheter, frequency of catheter manipulation, and patient-related factors such as co-morbidities and acuity of illness.

This online continuing education program will focus on prevention strategies to reduce or eliminate CABSI. Through a review of the evidence-based interventions and interviews with leading experts in the field of infection control on how successfully they have implemented prevention protocols getting to zero may be achievable.

Healthcare organizations, realizing the significant impact of catheter-associated bloodstream infections (CABSIs) on the patient and the bottom line, have undertaken measures to prevent the occurrence of such infections, particularly those that originate with central venous catheters (CVCs). To reduce CABSIs, some organizations have implemented the Institute for Healthcare Improvement's central line bundle,[1] a grouping of evidence-based recommendations that, when implemented together, have been shown to reduce infections. The components of the bundle include hand hygiene, chlorhexidine skin antisepsis, optimal site selection, use of maximal barrier precautions during catheter insertion, and prompt removal of catheters when no longer needed. Other healthcare organizations use intravenous-therapy teams, composed of specially trained nurses, to manage catheter care. These efforts have resulted in a decline in the number of catheter-associated bloodstream infections. In some cases, healthcare organizations are reporting zero CABSIs. How is it possible to achieve zero CABSIs after years of sustained CABSI rates?

The process began as the general public, regulatory agencies, and patients increasingly focused on healthcare-associated infections (HAIs). Healthcare organizations have looked within for solutions, particularly for HAIs that result in increased morbidity, mortality, and healthcare costs. Bloodstream infections are associated with significant mortality and higher costs.[2] A number of states have passed legislation requiring healthcare organizations to report CABSIs, and hospital infection rates are posted on the Web, allowing the public to make comparisons among healthcare organizations and exert pressure on them to improve. As part of the Federal Deficit Reduction Act, the Centers for Medicare & Medicaid Services (CMS) has revised the reimbursement criteria for cases of hospital-acquired infection and will no longer reimburse for certain preventable hospital-acquired complications, including CABSI. These changes impact a healthcare organization's bottom line, so is it any wonder that these organizations are striving to get to zero infections? The results are impressive, and some inspiring success stories are recounted towards the end of this document.

Accreditation Statement

This continuing nursing education activity was approved by the Vermont State Nurses' Association Inc. (VSNA) an accredited approver by the American Nurses Credentialing Center's Commission on Accreditation.

Provider approved by the California Board of Registered Nursing. Provider #1447.

Learning Outcomes

Upon completion of this program, the participant will be able to:

1. List the five (5) interventions that when implemented together can reduce catheter-related bloodstream infections (CABSI)
2. Identify the risk factors for CABSI
3. Describe the method(s) of surveillance for CABSI

Instructions

1. Read all articles.
2. To receive continuing education credits click on "Take Test" at the end of the program.
3. Follow instructions to log in.
4. Complete the post-test.
5. Complete the participant evaluation.
6. To earn 1.5 contact hours of continuing education, you must achieve a score of 70% or more. If you do not pass the test you may take it one more time.
7. Upon successful completion of the post-test your certificate will be issued immediately.
8. The fee has been waived through an educational grant from Covidien.
9. This program will expire March 31, 2011.
10. Faculty Disclosure: No conflicts were disclosed.
11. VSNA and ANCC do not endorse any commercial products.

The issues surrounding catheter-associated bloodstream infections are complex and warrant close examination.

Human and financial costs

It has been estimated that, in the United States, 80 000 CVC-associated bloodstream infections and 28 000 deaths occur annually among patients in intensive care units (ICUs). The average rate of CVC-associated bloodstream infections is 5.3 per 1000 catheter days.[3] (Table 1) The attributable cost of care for a patient with a CABSI is estimated to be between $34 508 and $56 000.[4,5] The annual cost of care for all patients with CABSIs ranges from $296 million to $2.3 billion.[6,7] It is estimated that the annual number of CABSIs in hospitals in the U.S. is 250 000, with mortality at 12%–25%.[8]

CABSIs increase the length of hospitalization and can result in sepsis, septic shock, multi-organ failure, endocarditis, thrombophlebitis, and death.[9] Other complications include local and systemic infection, lung abscess, brain abscess, osteomyelitis, and endophthalmitis.[2]

Risk factors

Patients with co-morbid medical conditions are at greater risk of acquiring a CABSI. They frequently stay in the ICU and may require total parenteral nutrition, emergent insertion of a central line, and/or prolonged hospitalization.[8] Adding to the complexity of CABSI are factors associated with the type of catheter.

The vast majority of infections and serious complications are associated with CVCs, especially those placed in patients in the ICU.[2] This occurs for several reasons: catheters are often placed in emergent situations when attention to aseptic technique is not optimal[10,11]; there is more manipulation of CVCs for infusion of blood products, drugs, and fluids and access for blood sampling; catheters remain in place for extended periods, which results in colonization of the catheter with microorganisms. Pulmonary artery catheters and peripheral arterial catheters are accessed numerous times a day for hemodynamic monitoring or to obtain laboratory specimens, thereby increasing the risk of contamination and subsequent infection.[10,11]

The organisms mostly commonly associated with CABSI are Staphylococcus aureus, coagulase-negative staphylococci, and enterococci.[2] Migration of microorganisms

The key components of the Central Line Bundle are:

1. Hand Hygiene
2. Maximal Barrier Precautions Upon Insertion
3. Chlorhexidine Skin Antisepsis
4. Optimal Catheter Site Selection, with Avoidance of the Femoral Vein for Central Venous Access in Adult Patients
5. Daily Review of Line Necessity with Prompt Removal of Unnecessary Lines (Institute for Healthcare Improvement)

Table 1

Table 1. **Pooled means and percentiles of the distribution of device-associated infection rates, by type of ICU, ICU component, January 2002 through June 2004**

Central line-associated BSI ratey Percentile								
Type of ICU	**No. of units**	**Central line-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	60	116,546	3.5	1.0	1.5	3.2	7.0	9.0
Cardiothoracic	48	182,407	2.7	0.0	0.9	1.8	2.7	4.9
Medical	94	312,478	5.0	0.5	2.4	3.9	6.4	8.8
Medical-surgical								
Major teaching	100	430,979	4.0	1.7	2.6	3.4	5.1	7.6
All others	109	486,115	3.2	0.8	1.6	3.1	4.3	6.1
Neurosurgical	30	56,645	4.6	0.0	0.9	3.1	5.8	10.6
Pediatric	54	161,314	6.6	0.9	3.0	5.2	8.1	11.2
Surgical	99	358,578	4.6	0.0	2.0	3.4	5.9	8.7
Trauma	22	70,372	7.4	1.9	3.3	5.2	8.2	11.9
Burn	14	43,002	7.0	—	—	—	—	—
Respiratory	6	12,593	4.8	—	—	—	—	—

Source: National Noscocomial Infections Surveillance (NNIS) System Report

from the skin at the catheter insertion site to the catheter tip is the most common source of bloodstream infection for peripherally inserted, short-term catheters.[2] Colonization of long-term catheters frequently occurs when the catheter hub becomes contaminated.[2,10] Less common causes of CABSI include infection at another site leading to a hematogenously seeded catheter, and, rarely, contaminated infusate.

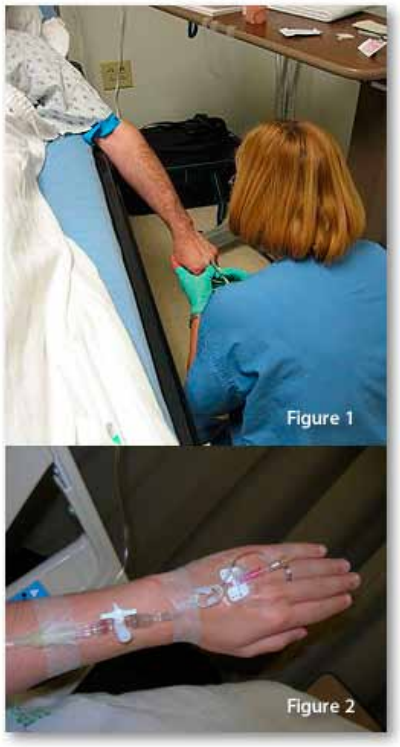
Figure 1

Figure 2

Methods of surveillance

Surveillance for CABSI in the acute-care setting includes a daily review of all positive blood cultures. A review of the medical record should be performed to determine the cause of a positive blood culture. Replacement of temporary catheters over a guidewire in the presence of a bloodstream infection is not recommended, because the source is usually colonization with skin flora from the insertion site. Short-term CVCs should be replaced if there is purulence at the insertion site, purulence being an indication of infection.[2] If infection is suspected, two sets of blood cultures should be drawn, one through the IV catheter and one percutaneously obtained via venipuncture.

Strategies to prevent infection

Several professional and government agencies have published evidenced-based guidelines for the prevention of CABSI.[2,12] The following summarizes interventions and their rationales for practices that will reduce risk of CABSI . Further description is provided of the central line bundle elements as well as additional interventions aimed at reducing microorganisms around the catheter exit site, minimizing microorganisms originating at the catheter hub, and minimizing risks related to contaminated infusate.

Catheter selection

The intravascular catheter and insertion site that carry the lowest risk of complications and are most appropriate for the type and duration of intravenous (IV) therapy should be selected. Peripheral IV catheters (Figure 1 and 2) are frequently utilized, and the incidence of bloodstream infection resulting from their use is very low when compared with infection rates for CVCs.[10] If a central line is the most appropriate choice, the subclavian site is preferred over the femoral or jugular sites as it is associated with a lower risk of infection. (Figure 3) If intravenous therapy is to exceed 6 days, it is recommended that a peripherally inserted central catheter (PICC) or a midline catheter be considered.[2] Note that a midline catheter (Figure 4) is considered a peripheral catheter and should be selected only when the intended infusion therapy is appropriate for peripheral IV administration. As a result of CMS no longer paying for vascular catheter-related infections that occur in the hospital, and the low risk of infection with peripheral IV catheters, it is likely that many clinicians are taking a closer look at the appropriateness of a peripheral IV catheter versus early placement of a CVC.


Figure 3

Catheter insertion and replacement

Healthcare professionals involved in CVC insertion and care should receive appropriate training and education, and the professional inserting the catheter should demonstrate competence.[2,12]

Because migration of microorganisms from the skin at the catheter insertion site to the catheter tip is the most common source of bloodstream infection for peripherally inserted, short-term catheters, attention to infection-prevention procedures at the time of catheter insertion is a critical step in infection prevention. Hand hygiene should be performed with an alcohol-based product or antiseptic before insertion. The use of maximal sterile barrier precautions is an important component of the central line bundle. For the professional who places the CVC (including placement via a guidewire exchange) and those assisting, this means strict adherence with hand hygiene and wearing cap, mask, sterile gown, and sterile gloves. A large sterile

The use of maximal sterile barrier precautions is an important component of the central line bundle.

drape should be placed over the patient, covering the patient from head to toe, with a small opening at the site of insertion.[2,12]

Skin disinfection is an essential step, needed to remove microorganisms residing on the patient's skin that may contaminate the catheter site. Options for CVC insertion-site disinfection include 2% chlorhexidine-based antiseptic, 70% alcohol, an iodophor, or tincture of iodine if there is a contraindication for chlorhexidine. Using 2% chlorhexidine is preferred due to its superiority in reducing CVC-related colonization and potential bloodstream infection.[13,14] The antiseptic must be allowed to dry before catheter insertion. If povidone-iodine is used, it should remain on the skin for at least 2 minutes for optimum effectiveness.

Site assessment, care, and dressings

The catheter site should be checked daily, and dressings should be changed if they become wet, loosened, or visibly dirty. Site care should be performed regularly in conjunction with dressing changes. This includes regular removal of the catheter dressing, disinfection of the skin surrounding the catheter exit site, and re-application of a sterile dressing. Aseptic technique is required when providing site care; this includes hand hygiene and use of sterile gloves and mask when dealing with central vascular access devices.[15] As with site disinfection at the time of catheter replacement, 2% chlorhexidine preparations are the preferred skin disinfectant for patients older than two months of age.[2,12] The use of topical antibiotic creams or ointments is not recommended during catheter insertion or dressing changes.

Aseptic technique is required when providing site care; this includes hand hygiene and use of sterile gloves and mask when dealing with central vascular access devices.

Maintaining a clean, dry, and occlusive dressing is important to protect the catheter insertion site and reduce the risk for infection. Either sterile gauze or a sterile transparent semi-permeable dressing may be used to cover the site. Transparent sterile dressings allow visualization of the catheter site and less manipulation, as they are changed less frequently. Gauze dressings are an appropriate choice for the patient who is experiencing site drainage, who perspires excessively, or who has a sensitivity reaction to transparent dressings. The research supporting the choice of dressing is limited, and the evidence does not support one choice over another. In a systematic review of controlled trials that compared the effects of gauze and tape versus transparent dressings, there was no evidence of difference in the incidence of infectious complications. It is important to note, however, that the studies were from small samples and there was a high level of uncertainty regarding risk for infection related to type of dressing.[16]

For short-term CVCs the dressing should be changed at least every 2 days if gauze is used and every 7 days if a transparent dressing is used.[2] The dressings on tunneled CVCs (e.g., Hickman, Broviac) should be changed no more than once per week until the site has healed.[2]

Attention to the catheter hub and needless injection caps

Colonization and CABSI may occur with longer-term catheters when the catheter hub becomes contaminated. Failure to disinfect the cap when accessing the infusion device or administration set for flushing or medication administration is recognized as a significant problem. The Institute for Safe Medication Practices (ISMP) documented[17] infection-control problems, including failure to disinfect the injection cap/valve when accessing the infusion for flushing or medication administration. The 2009 Joint Commission National Patient Safety Goals have a specific recommendation to "use a standardized protocol to disinfect catheter hubs and injection ports before accessing the ports."[18] The Infusion Nurses Society and ISMP clearly recommend that the injection or access port be aseptically cleansed with an approved antiseptic, usually 70% alcohol, prior to use. While there are no specific evidence-based guidelines documenting the optimal disinfectant or duration of cap disinfection, the "scrub the hub" mantra is frequently cited, emphasizing the importance of friction when disinfecting.

Failure to disinfect the cap when accessing the infusion device or administration set for flushing or medication administration is recognized as a significant problem.

Maintaining catheter patency

An initial saline (0.9% NaCl) flush is used to assess catheter patency and to aspirate for blood return from the catheter prior to its use. If there is no blood return, the catheter should be considered non-functioning and a determination made as to whether it should be replaced. Use of thrombolytic drugs is very effective in restoring patency, including ability to withdraw blood, and should be consistently considered in reducing the risk of catheter replacement.

Although there have been studies linking heparin to biofilm formation, heparin still remains the solution of choice to prevent clots within the catheter. There are some catheters and needleless injection connectors that require only saline for flushing. The frequency of catheter flushing is dependent on the clinical setting.[2]

Administration sets

Administration sets, including secondary sets, should be replaced at 72–96 hours. However, tubing used to administer blood, blood products, or lipid emulsions should be replaced within 24 hours of infusion. Also of note, the Infusion Nurses Society (2006) makes a separate and distinct recommendation for administration set changes to be done every 24 hours for infusions that are administered via a capped IV catheter and the IV tubing is disconnected from the patient's catheter after each infusion. When an intermittent infusion is repeatedly disconnected and reconnected for the infusion, there is much more manipulation of the tubing and at the catheter/injection cap or valve, increasing the risk for contamination and potential catheter-related bloodstream infection.

Integrity of parenteral solutions

Contaminated infusate is considered an uncommon cause of CABSI; nonetheless, parenteral solutions should always be mixed in the pharmacy, where quality control can be maintained, using aseptic technique under a laminar-flow hood. It is important that the infusion solution and container are carefully assessed prior to administration Containers that are cracked, turbid, or have particulate matter should be disposed of immediately. If sterility is compromised, the medication vials should be discarded.

It is recommended that single-dose medication vials and single-use prefilled heparin and saline flush syringes be used whenever possible, so as to prevent contamination that can occur from frequent accessing.[2] (Figure 5) Any medication left in single-dose vials should be discarded. The top of the medication vial should be cleaned with alcohol prior to access, and only a sterile device should be used to withdraw the medication.

Catheter replacement

CVCs should not be routinely replaced, but peripheral venous catheters should be replaced at least every 72–96 hours in adults to prevent phlebitis. In pediatric patients, peripheral IV catheters may remain in place until no longer required, and are removed only if a complication occurs.

Summary of infection-prevention practices

- Always use aseptic technique when inserting, exchanging, or removing any intravascular catheter. Maintain a sterile field and sterile technique throughout the procedure.
- Perform hand hygiene with an alcohol-based sanitizer or with antiseptic soap prior to catheter insertion or manipulation and after removing/changing gloves. The use of gloves does not negate performing hand hygiene.
- When inserting or exchanging an intravascular catheter, wear mask, head cover, gown, and sterile gloves. Cover the patient with a large sterile drape during the insertion procedure.
- Thoroughly prep the skin at the CVC insertion site before incision. Apply an

antiseptic containing 2%–4% chlorhexidine gluconate to the skin and allow it to dry.

- Apply either gauze or a transparent sterile dressing to the catheter site after insertion. A transparent dressing allows for easy assessment of the site and less manipulation.
- Disinfect catheter hubs, injection ports, and needleless connectors, "scrubbing" with a chlorhexidine antiseptic or 70% alcohol solution prior to accessing.
- Every day, assess the patient with an intravascular catheter to determine the continued need for the device. Remove the catheter when it is no longer medically indica

Strategies to prevent CABSI

- Use a central-line bundle kit to reduce CABSI. This approach has proven to be effective for a number of organizations. Instructions for implementing the change in your organization can be found at http://www.ihi.org/IHI/Programs/Campaign/CentralLineInfection.htm.
- Provide staff training and education on catheter insertion and site care. Standardize how staff insert and care for CVCs.
- Have staff demonstrate competency in catheter insertion and site care.
- Require staff credentialing in CVC insertion, which ensures that staff are knowledgeable about insertion techniques.
- Provide a checklist of the steps for CVC insertion and site care. This checklist will serve as a reminder to staff and ensure that no steps are missed.
- Require monitoring, measuring, and providing feedback of results to individuals involved in this aspect of patient care. This will increase the likelihood of improvement.

Special strategies have been recommended for use in populations or locations with an unacceptably high rate of CABSI that is not declining with the use of current prevention strategies:

Use antiseptic or antimicrobial-impregnated CVCs in adult patients. The risk of CABSI has been reduced with the use of some CVCs impregnated with antiseptics such as chlorhexidine-silver sulfadiazine and antimicrobials such as minocycline-rifampin.[7,19,20] Rather than for routine use as a preventive measure, these catheters are recommended for patients with poor venous access and a history of recurrent CABSI, and for patients with a high risk for severe illness if they acquire a CABSI (e.g., heart surgery patients). Such catheters are not approved for use in children.[12]

Use a chlorhexidine sponge dressing for CVCs in patients older than 2 months.[13,21] This is a small disc that is placed around the catheter at the exit site, is covered with a transparent dressing, and is changed every 7 days according to manufacturer's recommendations. Of note, there are also new chlorhexidine dressing products available such as a transparent dressing with a chlorhexidine gel built in. Chlorhexidine-impregnated dressings are effective in reducing bacterial colonization at both vascular and epidural sites and have also been identified with a trend towards reduction of catheter-related bloodstream infections.[22] However, organizations that have implemented the fundamental components of the central line bundle have been able to reduce CABSI without these specialty dressings. The dressings are currently recommended for patients with poor venous access and a history of recurrent CABSI or for those with a high risk for severity of illness if they acquire a CABSI.[12]

Success stories

The United Hospital Fund in collaboration with the Greater New York Hospital Association engaged 38 New York hospitals in a quality-improvement initiative to reduce the number of CABSIs in intensive care units in 2007. The hospitals were

able to reduce CABSIs in their ICUs by 70%. This reduction has been sustained over a two-year period.[23] A collaborative of children's hospitals was able to reduce CABSI by 43%, prevent an estimated 275 infections, save $9 million, and prevent an estimated 40 deaths by adhering to recommendations for CABSI prevention such as appropriate hand hygiene, maximal barrier precautions, use of chlorhexidine skin antiseptic, correct line placement, and daily assessment.[24] A cohort of hospitals in Michigan participated in a collaborative over 18 months to reduce CABSI that resulted in a decrease from 2.7 at baseline to 0 at 3 months post-intervention. The intervention was comprised of hand hygiene, full-barrier precautions during catheter insertion, disinfection of the catheter site with chlorhexidine, avoidance of the femoral site, and removal of unnecessary catheters. These efforts resulted in up to 66% reduction in CABSIs throughout an 18-month period.[25]

Getting to zero may be difficult, but it is achievable, as these hospitals have demonstrated. There are numerous stories of healthcare organizations that have achieved zero or significantly reduced CABSIs. By standardizing practices, following the recommended guidelines, and providing education, training, and feedback to healthcare workers involved in catheter placement and care, a zero infection rate is possible.

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CABSI Strategies: ***Interviews with the Experts— continues on next page***

Denise Murphy, RN, MPH, CIC is Vice President and Chief Safety and Quality Officer at Barnes-Jewish Hospital in St. Louis, MO.

1. Has your institution/facility identified a facility-specific "bundle"(products, protocols) to reduce the occurrence of CABSI? What are the elements of that bundle?

Yes—we use the bundle recommended by the IHI (Institute for Healthcare Improvement):

- hand hygiene
- maximal barrier precautions upon insertion
- skin antisepsis with chlorhexidine
- optimal catheter site selection, with the subclavian vein as the preferred site for non-tunneled catheters
- daily review of line necessity with prompt removal of unnecessary lines

2. How did your facility determine this bundle, and how was it implemented?

Our large academic medical center (1300 beds and 6 ICUs) had been following general IHI recommendations since 1999. We became involved in the IHI's 100,000 Lives Campaign launched in 2005 and subsequently adopted the bundle.

The process began before 2005, however. We'd been looking at the problem of CABSI since 2000, and specifically at 3 areas: education for healthcare workers, aligning our policies with those of the CDC (Centers for Disease Control and Prevention), and issues surrounding the process of placing and maintaining central lines. We knew that we'd been following recommendations but not consistently, so we had decided to audit the process of care; it was the right thing to do for our patients. We were thus well-prepared to implement the bundle.

The people responsible for overseeing implementation of the bundle were the bloodstream-infection prevention team. They targeted the ICUs first and mapped out 4 steps:

1. In each ICU, identify 1 or 2 people (e.g., physician, nurse) to champion the cause.
2. Ensure that the administration is involved also.
3. Draw up a checklist of every element in the bundle.
4. Implement the bundle and provide the checklist across all the ICUs.

It took a year before the bundle was implemented in the 6 ICUs. We are currently taking it to the rest of the patient-care units.

3. What are the elements—products and procedures—of your organization's bundle that have produced positive outcomes?

Every central-line insertion involves 5 steps:

1. decision to insert
2. preparation for insertion
3. insertion
4. care and maintenance of the line
5. discontinuation process

We want all our patients undergoing this process to have the same experience: the best experience. A static process of merely setting rules won't ensure that, so we're performing value-stream analyses to redesign the patient's experience. Apart from patients, the key stakeholders in this analytic process are the IV team, hospitalists, the anesthesia department, the Lean Six Sigma group, patient care directors, nurse and physician educators, and even a human factors engineer.

In the meantime, staff nurses who are patient-safety liaisons audit compliance with the bundle. Subsequently, every month the Manager of Infection Prevention provides members of the executive team, unit medical directors, and nursing leadership with compliance data and a list of the infections (with risk factors) that have occurred.

Any instance of CABSI is treated as a sentinel event. It elicits a rapid response, and we perform a bedside root-cause analysis. The main question is *Where did the process break down?*

When there's a problem, the front-line staff tell us what's wrong. It's evident that interruptions, noise, or crowded rooms can interfere with the process, and we currently have a human-factors engineer studying ways to improve this. We've discovered some major barriers to a good CVC outcome for patients; for example, staff don't have the materials needed. This is usually because kits are missing critical items.

The doctor is interrupted while placing a line. Now we put a big stop sign on the CVC supply cart, then park it in front of the door to the patient's room. This has cut down on interruptions.

We all know that resources are tight; nonetheless, we ensure that experienced people are involved: IV-team nurses put in PICCs (peripherally inserted central catheters), and the hospitalist procedure team puts in most CVCs. Clinicians are also asking for a better vascular-access coordinating function (similar to air traffic control).

We have a policy that CVCs are not to be used for drawing blood samples, but nurses are often pressured to be quick, and some occasionally use the CVC. This is an example of how it's often the system that's at fault, not the people working within it. When we discover a situation such as this pressure to be fast, our response is not to be punitive but to communicate and drill down instead and to look for root causes of shortcutting and ways to improve the situation.

We also realize that, in the past, nursing schools did not ensure that their students were proficient in starting peripheral IVs; as a result, nurses would ask for a central line to be placed. Our affiliated school of nursing is responding to this, providing simulations so that students, and our hospital nursing staff, get the necessary experience.

a) Can you tell us about site preparation, connectors, flushing protocols, etcetera?

The answer is pretty simple: follow the bundle. Use anything (for example, chlorhexidine) where there is good evidence. Use the right catheter and insertion procedure for the given situation. And communicate often to everyone involved with the experience, including the patient.

b) Do you feel that a renewed emphasis on staff education may be necessary to reinforce good practice for antisepsis of valves? of any other elements?

Absolutely! Education has too often been scattershot, hit-and-run. Education must be continuous. We have on-line modules that residents must study at the beginning and repeat at the start of an ICU rotation. They're also observed placing lines and are left alone only when we're satisfied that it's being done correctly. To help the process, laminated pictorials of procedures are available. Nurses are trained in every aspect of managing central lines, not just dressing changes, so they can also help provide house staff with the best hands-on training. We've also been asking patients about their experiences and, as a result, are developing brochures to explain our efforts.

c) What methods have proven most beneficial for you in improving decontamination of IV ports?

We have a vigorous "scrub the hub" campaign going on.

4. What would you consider the reasons for your success in reducing CABSI? What do you feel still needs to be done?

Until we instituted the bundle we had been having more than 300 cases of CABSI each year, but this year we've had approximately 40. The team approach has been vital to our success. We have knowledgeable, empowered management. We have commitment from our infection-control leaders, because they've been educated and understand the problem and are being given solutions. And we have front-line staffers redesigning processes because nobody knows patients like they do.

At our hospital we're still refining our approach to infection prevention, but we have real commitment from administration and staff, which is important. This is continual work that requires a long-term commitment.

5. Is there anything else on this topic that you feel should be mentioned?

I feel lucky to be in my position. It's wonderful to be an advocate for both patients and staff. As with any experience, it must be a partnership between those doing the work at the front line, those supporting and resourcing the work (leadership), and those that the work impacts (our patients). Although it has been somewhat of a rough road at times, increased pressure from external forces, such as accreditation and regulatory bodies, as well as consumer advocates has helped us in patient safety and quality roles to bump patient-care practices higher up on the priority list—for everyone.

Russell Olmsted, MPH, CIC is an epidemiologist in Infection Control Services at Saint Joseph Mercy Health System in Ann Arbor, MI.

1. Has your institution/facility identified a facility-specific "bundle"(products, protocols) to reduce the occurrence of CABSI? What are the elements of that bundle?

The Saint Joseph Mercy Health System (SJMHS) has employed a specific five-item bundle to be used within our system:

- hand antisepsis by the health professional inserting the central line prior to starting the procedure
- preparing the insertion site with chlorhexidine gluconate
- maximal sterile barrier precautions, including sterile gloves, cap, sterile gown, and sterile drape
- avoiding insertion into femoral veins, because of possible mechanical complications and increased risk for infection
- daily assessment of the continued need for the central line, with the idea that the line should be removed as soon as possible.

2. How did your facility determine this bundle, and how was it implemented?

Saint Joseph Mercy Health System, an integrated, regional healthcare provider, participated in a state-wide performance-improvement collaboration led by the Michigan Health & Hospital Association's (MHA) Keystone Center for Patient Safety & Quality. The Keystone Center coordinated implementation of the central line associated bloodstream infection (CABSI) prevention bundle across a large number of hospitals with intensive care units (ICUs) in Michigan. SJMHS enrolled its four ICUs in this Project. The elements in this bundle were based on scientific evidence.

Our system was an enthusiastic participant in the MHA Keystone Project because we were determined to reduce device-associated risks and improve our patient care performance. That enthusiasm gained us the support of hospital leadership and ICU staff, and we had valuable infrastructure and networking from the MHA and the principal investigator, Dr. Peter Pronovost, who was awarded a grant from the federal Agency for Healthcare Research & Quality (AHRQ) to study the translation of scientific evidence to direct patient care.[1] In addition, a coordinator helped each hospital's panel of subject-matter experts (SMEs) to develop site-specific programs that were then adapted for individual units, such as ICUs, within each hospital.

Implementing the bundle began in February 2004 at each hospital's pilot sites, and we were pleased to encounter deep and significant participation by direct-care personnel. The momentum of the experience in the ICUs has resulted in expansion of Keystone prevention initiatives in other areas such as surgery and medicine.

We can credit smooth implementation of the bundle to excellent teamwork, strong communication, and enhancing the culture of safety within our system. The focus is on patient safety, and everyone is involved because we have a common understanding of that goal.

3. What are the elements—products and procedures—of your organization's bundle that have produced positive outcomes?

The Saint Joseph Mercy Health System requires that a designated person—usually a nurse—be responsible solely for ensuring that all elements of the bundle are employed each time that a central line is inserted, and for monitoring for continued need thereafter. A checklist is used during the insertion to ensure that no element of the bundle is forgotten. If there is any difficulty or uncertainty at any stage, the monitor can alert the clinicians involved and rapidly consult with a physician leader on the involved unit to resolve these efficiently. I think that this process is helped by the fact that critical-care nurses have a long history as patient advocates, so this is a comfortable role for them.

a) Can you tell us about site preparation, connectors, flushing protocols, etcetera?

Site preparation is the same whenever a line is installed: follow the checklist. We've found it helpful to use prepackaged central line kits that contain many of the necessary items such as drapes, chlorhexidine gluconate, catheter, and insertion device. In our ICUs we have catheter-insertion carts with all the necessary equipment.

Different types of lines call for different connectors or flushing and care protocols, and training is provided each time a new element is introduced. Of note: the CABSI prevention bundle is focused on technique of insertion, but there is also a need to assure good practices for care and maintenance of the vascular device thereafter. We're in the process of exploring extension of the bundle elements to these aspects.

Manufacturer-prepared saline syringes are the most common method of flushing vascular access devices (VADs) at SJMHS. The sequence of steps for flushing VADs is based on the instructions for use from the manufacturer of the IV (intravenous) equipment.

There is increasing interest in maximizing use of single-dose vials following some reports of cross-transmission in ambulatory care settings. We do, as much as possible, emphasize use of single-dose vials but still have some multidose products in use. For the latter there is a comprehensive pharmacy-services policy that addresses use and dating of these medications.

b) Do you feel that a renewed emphasis on staff education may be necessary to reinforce good practice for antisepsis of valves? of any other elements?

I don't think that *renewed* emphasis applies to our situation, because the use of monitors and checklists means that we have *continual* reinforcement on good practices. We do cover this in new-staff orientation, and existing staff make sure that newcomers implement the bundle plus other aspects of VAD site care and use. Ongoing education and reinforcement are necessary, however, with VADs as there is a multitude of different valve technologies on the market. We also work closely with other departments such as anesthesia and imaging services, since they insert various central lines also.

We have transitioned from a split-septum valve to Luer-activated needleless neutral-pressure valve technology. There are other valves such as Luer-activated positive-pressure devices that are available but we've had no direct experience with these. Some have been temporally associated with increased risk of infection, but the evidence is not definitive.

c) What methods have proven most beneficial for you in improving decontamination of IV ports?

We currently advocate using isopropyl alcohol. New research[2] suggests that other methods—such as having an antimicrobial inside the valve or even incorporated into the valve—might help prevent contamination but we've not considered this further at the current time. However, it is important that providers disinfect the access point prior to each entry.

4. What would you consider the reasons for your success in reducing CABSI? What do you feel still needs to be done?

The Keystone Study says that a 66-percent reduction in incidence of CABSI is achieveable.[1] Other large performance-improvement collaboratives have reported similar results.[3] Even with implementing the bundle, the infection preventionist (IP) serves a key role of maintaining surveillance for CABSI, as it is an ongoing challenge to eliminate all of these but a goal that has become the goal. In general we've seen significant and sustained reductions; for example, one of our units has had no infections for four years. Having monitors and checklists ensures that the bundle is followed. We haven't needed to use additional measures such as antimicrobial catheters or special dressings, but we have implemented a patient-cleansing process that uses chlorhexidine as an adjunct to the bundle.

Whenever a CABSI does occur, the bundle has altered the conversation wherein there is intense scrutiny of what happened, and there is open communication with the direct-care providers to determine what, if anything, should have been done differently.

5. Many think of blood reflux as a risk factor only for occluded lines. Do you feel enough attention has been paid to blood reflux and the role it can play in CABSI?

Not entirely. Reflux can play a role in CABSI. Our checklist doesn't address this situation, and occluded lines are an area that can be a significant challenge. We do monitor VADs for patency.

Can you elaborate on the "procedural problem" aspect involved in the use of the devices? Exactly what human factors have you observed or suspect are to blame?

Human-factors engineering points to some of these issues. For example, the range of VAD valve design is extensive, and each specific valve requires slight variations in flush technique; with some, no flush is required. This complexity makes it difficult for the direct-care provider to be aware of which kinds of valves are in use and the correct methods of accessing the different types. A principle of human-factors design is to engineer products and establish environments that simplify care processes so that providers can focus on the needs of patients and not be distracted by an overly complex infusion system.

6. Is there anything else on this topic that you feel should be mentioned?

Clinicians commonly use the term *catheter-related bloodstream infection* (CABSI). However, the data that most IPs collect relate to CABSI. For inter-facility comparisons, therefore, one needs to be aware of definitions used and how rates of CABSI are being expressed. As with other fields, understanding terminology is important, especially with the growth in public reporting of healthcare-associated infection (HAI) data. Therefore I foresee only continued growth in the need for the IP to be a key member of an interdisciplinary team that is working to optimize patient safety.

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Shannon Oriola, RN, CIC, COHN is the lead in infection prevention and clinical epidemiology at Sharp Metropolitan Medical Campus in San Diego, CA.

1. Has your institution/facility identified a facility-specific "bundle"(products, protocols) to reduce the occurrence of CABSI? What are the elements of that bundle?

We are using the IHI (Institute for Healthcare Improvement) bundle. It has 5 elements:

- hand hygiene
- maximal barrier precautions upon insertion
- skin antisepsis with chlorhexidine
- optimal catheter site selection, with the subclavian vein as the preferred site for non-tunneled catheters
- daily review of line necessity with prompt removal of unnecessary lines

2. How did your facility determine this bundle, and how was it implemented?

We were part of the 100,000 Lives Campaign, which created a platform for our cause for action. Also, California state legislation required us to report process measures with regard to infection control. We were engaged in developing a process module, but it was not yet implemented throughout the facility. When we looked at elements of the IHI bundle, it was the obvious choice.

We decided to implement it first in high-volume insertion areas: operating rooms, the emergency department, and interventional radiology suites, followed by the ICUs. We instituted a task force to manage implementation, because it was important to get all of the stakeholders to buy in to the concept. We began by getting key physicians and nurse educators involved.

There was a little controversy at first—for instance, intensivists were not happy about using long drapes; we now supply 2 half-drapes instead of 1 full drape. We were also faced with the fact that the vascular access team does not work after hours. We solved that by having each unit identify key people responsible for changing central venous catheter dressings when necessary. I'm not aware of any reluctance to participate in the audit process on the part of people such as nurses and doctors. We've been able to get everyone on board with the idea.

We haven't quite finished implementing the bundle. The last element is the daily review of line necessity, something also required by the California Department of Health Services. The relevant patients' electronic medical record will prompt the nurse daily to evaluate the need for the central line. This will also make it easier to audit and document the process. We're currently using exclusion criteria. If the patient does not meet criteria for a central line, the nurse will communicate with the physician to determine if the central line is still necessary.

3. What are the elements—products and procedures—of your organization's bundle that have produced positive outcomes?

Because we're still implementing the bundle, it's hard to say for sure. One concept that our medical executive committee has embraced is that of having an observer for each procedure. In our hospital, a nurse observes the process each time a central line is inserted and can stop the procedure if the elements of the bundle are not being adhered to.

We also have infection-prevention associates (IPA) throughout the hospital. Each unit sends a nurse to meet once a month to discuss infection prevention and control issues, and the IPA is considered an infection-prevention resource on the unit. IPAs identify and report on practices that may not be in accordance with hospital policy; they also communicate unit-specific surveillance data to their peers. IPAs are also instrumental in communicating changes in policy that are related to infection prevention. Many participate in our quality improvement projects such as the ventilator-associated pneumonia (VAP) task force and central-line infection prevention efforts. We recently added other disciplines—imaging and respiratory care, for example—to our associates' program. This program has been extremely helpful in communicating information to direct healthcare providers.

a) Can you tell us about site preparation, connectors, flushing protocols, etc.?

We use a chlorhexidine gluconate and alcohol solution to prepare the site. Our clinicians have been using dressings impregnated with chlorhexidine for several years. Our IPAs audit central-line dressings to ensure that they're done appropriately. One item of note: We have not introduced silver technology into our interventions designed to reduce bloodstream infections associated with central venous catheters (CVCs).

For Luer-lock injection caps, we've gone from positive-pressure to neutral-pressure devices. These neutral-pressure devices are flushed with saline solution. We're still using positive-pressure devices in the NICU (neonatal intensive care unit), but there are issues that must be addressed separately in that environment. Making decisions for the NICU must be a separate process in itself.

There is not an abundance of literature on how long to clean the injection caps. An article on the topic[1] gives evidence for scrubbing the hub for 15 seconds with alcohol or a chlorhexidine-alcohol solution; we use that as evidence for our practice recommendation.

The Centers for Disease Control and Prevention (CDC) recommend using single-dose vials (Category II) and not using any leftover content in those vials (Category IA). We try to utilize single-dose vials when possible.

Our facility has also developed an order set for flushing central venous catheters. The correct flushing protocol is selected on the order set by the physician or vascular access nurse.

b) Do you feel that a renewed emphasis on staff education may be necessary to reinforce good practice for antisepsis of valves? of any other elements?

Yes. We provide real-time feedback to a unit where a CVC-associated bloodstream infection occurs. We also offer Web-based self-learning modules. When we were implementing the bundle, there was a mandatory one-time Web-based module that each nurse was required to take.

c) What methods have proven most beneficial for you in improving decontamination of IV ports?

We require that the port be scrubbed with an alcohol pledget for 15 seconds. It's difficult to audit decontamination of IV ports and of Luer-lock injection-cap changes. At our next IPA meeting we'll be discussing how to increase compliance with our policies. We also plan to audit decontamination of the cap during our med pass audits.

4. What would you consider the reasons for your success in reducing CABSI? What do you feel still needs to be done?

Throughout the hospital we have the vascular access team place the majority of peripherally inserted central catheters (PICCs) and do the dressing changes. In the ICU the rate of CABSI has declined over time because of multiple interventions, some specifically mandated in the bundle. Incidence has declined by over 25% throughout the facility. We know that central-line insertions taking place outside the ICU can be problematic; for example, the required equipment is not always available. That's one of our next areas of focus.

The decline in our CVC-associated bloodstream infections is occurring because administration, staff, and physicians are embracing the culture of patient safety. We have buy-in from all areas. And when there's a problem, we aren't punitive; we emphasize teaching, not blame.

5. Many think of blood reflux as a risk factor only for occluded lines. Do you feel enough attention has been paid to blood reflux and the role it can play in CABSI?

No, not enough attention has been paid to what the reasons may be for occlusion. I think that we need more research on central-line occlusion—for instance, it's difficult to determine if there is blood left in the injection cap. At this time there is only one company that manufactures a clear injection cap that can be assessed for blood left after flushing, and further research in this area is needed. But we also have to look at why a line is placed in the first instance. As our organization improves in our adherence to our process measures, we're hoping to reduce the number of central lines placed in our patients.

6. Is there anything else on this topic that you feel should be mentioned?

Of course, we advocate attention to patient safety for its own sake, but it's also wise to keep in mind that increasingly fewer payors are underwriting the costs of CABSI. If you're interested in doing more about CABSI prevention, APIC (Association for Professionals in Infection Control and Epidemiology) offers the toolkit Eliminating Catheter-related Complications; it's available from the APIC website at www.apic.org. The CDC offers helpful guidelines at http://www.cdc.gov/ncidod/dhqp/gl_intravascular.html.

Reference

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